A Pilot Study of the Integration of *Students as Scholarly Researchers* Curriculum into Fall '07 3.091

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Rudolph Mitchell, Ed.D.
Associate Director for Assessment & Evaluation
Teaching and Learning Laboratory
MIT

Assessment Summary

In the Fall 2007, Professor Donald Sadoway and Ms. Angela Locknar (Materials Science and Engineering Librarian) introduced a pilot module, *Students as Scholarly Researchers Curriculum (Scholarly Researcher)*, into 3.091 that focused on three topics: the importance of scholarly research, the role of primary sources, and online search skills and library resources. Working with Teaching and Learning Laboratory staff, Professor Sadoway and Ms. Locknar decided to embark on a multi-year assessment beginning in the Fall of 2007 and identified several questions the first portion of the assessment should address:

- How much library experience did students have prior to matriculating at MIT?
- What were students' study habits regarding the Scholarly Researcher content?
- At the end of the Fall '07 semester, what value did they place on scholarly research skills?
- What impact did the Scholarly Researcher program have on them?
- How did they perceive the Scholarly Researcher experience?

A learning experience survey and pre and post library skills surveys were developed to address these questions and then administered online to 3.091 students.

Findings

High School Usage

The majority of freshmen arrive at MIT unprepared to conduct scholarly research. They seldom used their high school or public libraries, had minimal experience with online research tools, and primarily relied on Google for searches. The data highlight the need for students to gain an awareness of the importance of scholarly research skills and have the opportunity to develop them in a meaningful context.

Beliefs about Scholarly Research Skills

Students strongly support including scholarly research skills in 3.091. They believe the skills are valuable for freshmen to learn and will be relevant to their academic work at MIT.

Impact

Students reported that the *Scholarly Researcher* curriculum had an impact on their online search skills in terms of awareness, usage, and increased effectiveness. They rated highly four of six items that compose a scale that measures the curriculum's impact on online search skills. Students indicated that as a result of the scholarly research training they are more aware of the large number of resources they can access online, more likely than before to use the library's online research tools to identify relevant materials, and more able to function effectively as a researcher. Pre-post comparisons provide additional evidence of the impact of the *Scholarly Researcher* curriculum. Students reported gains at statistically significant levels in 15 of the 18 library skills.

At the end of the semester, 42% reported using research tools (online library databases) during the semester for class assignments other than 3.091. In addition, 29% indicated use of such tools to look up articles unrelated to MIT class assignments. Given that pre-survey responses suggested that many first semester freshmen possessed limited knowledge of online skills, these usage responses are encouraging: during the semester, students had begun to apply what they learned.

A contradiction in the data

In terms of beliefs, impact, instruction, and learning experience, the data vary: strong responses for beliefs and impact; mild/moderate for instruction; and flat for learning experience. Such variation poses a paradox: Given the high ratings for beliefs and impact questions, one would expect closer alignment among the four areas of data.

Implications

The results of the pilot integration of the *Students as Scholarly Researchers* curriculum into 3.091 suggest that scholarly research skills can be successfully integrated into a fast paced, content specific course if the following design steps are followed:

Seamless integration of the *Scholarly Researcher* content into the curriculum so that it does not appear as an "add on";

Emphasis on the value of scholarly research skills through commentary during lecture and by grading the *Scholarly Researcher* homework problems;

Use of multiple instructional strategies: mini lectures, video tutorials, home work problems, and model solutions.

Distribution of the *Scholarly Researcher* content throughout the curriculum.

Allocating sufficient time to scholarly research skills that would make an impact, but not an excessive amount that would interfere with the fast pace of the course.

Recommendations

Make the general themes of the *Scholarly Researcher* curriculum more explicit:

Identify several *Scholarly Researcher* principles that could be discussed or re-enforced by Professor Sadoway and the TAs during teachable moments, brief interludes that require less than five minutes and occur periodically throughout the course.

Comment on the scholarly researcher program during the first few weeks of the course: What does it mean to perform as a scholarly researcher? Why should freshmen learn about it in a chemistry class? How do you know you are performing as a scholarly researcher?

Include in the syllabus a goal or several learning outcomes related to the *Scholarly Researcher* curriculum.

Expand the *Scholarly Researcher* content to include the reasoning of a *Scholarly Researcher*. For example, Professsor Sadoway could serve as a *cognitive role model*: in class he could explain how he thinks through a literature search or how he determines the credibility of the conclusions of a journal article. Another approach would be to use a case study as a homework problem which requires critical thinking: Ask students to critique a hypothetical online search that lead a student to accept information that is not credible from a professional perspective.

Have Dr. Janet Rankin and Ms. Angela Locknar present pedagogical principles to TAs which they could use to develop teachable moments that address *Scholarly Researcher* content. Such teachable moments would require less than five minutes of recitation time and occur three times during the term. An example of a teachable moment would be TAs' explaining how they use the library's online tools to conduct a review of the literature or to search for specific information related to their research.

A Pilot Study of the Integration of Scholarly Research Content into the 3.091 Curriculum(Fall 2007)

Introduction

In the Fall 2007, Professor Donald Sadoway and Ms. Angela Locknar (Materials Science and Engineering Librarian) introduced a pilot module, *Students as Scholarly Researchers Curriculum (Scholarly Researcher),* into 3.091 that focused on three topics: the importance of scholarly research, the role of primary sources, and online search skills and library resources. Working with Teaching and Learning Laboratory staff, Professor Sadoway and Ms. Locknar decided to embark on a multi-year assessment beginning in the Fall of 2007 and identified several questions the first portion of the assessment should address:

- How much library experience did students have prior to matriculating at MIT?
- What were students' study habits regarding the Scholarly Researcher content?
- At the end of the Fall '07 semester, what value did they place on scholarly research skills?
- What impact did the Scholarly Researcher program have on them?
- How did they perceive the Scholarly Researcher experience?

This report summarizes the findings of the Fall 2007 pilot study.

Method

Subjects

Three hundred and sixty nine (369) students enrolled in the Fall '07 3.091 completed the *library skills pre survey* and four hundred and eighteen (418) students completed the *library skills post survey* and *learning experience survey*.

Innovation (treatment): description of the *Students as Scholarly Researchers* module

The module included the following components:

Lectures: Professor Sadoway periodically discussed in class aspects of scholarly research. He also demonstrated how he conducted an online search to locate a primary source.

Homework problems: During the semester, students completed three assignments that required them to perform online searches. The TAs graded these assignments and included the scores in determining the final course grade.

Video Tutorials: Students were recommended to watch five videos that were three to five minutes in length, addressed *Scholarly Researcher* topics, and demonstrated how to conduct online searches. In addition to the recommended video tutorials, a set of optional videos were suggested.

Model solutions: After completion of the *Scholarly Researcher* problems, students received model answers.

Methodology - survey descriptions

The study included three online surveys: *library skills pre survey*, *library skills post survey*, and *learning experience survey*. The *pre survey* was administered in September, 2007; the other two surveys were administered in early December.

The *library skills pre survey* explored students' high school library experiences and their confidence in library skills. For the confidence questions, students rated their confidence using a five point scale: *not confident at all* (1); *only slightly confident* (2); *somewhat confident* (3); *confident* (4), and *very confident* (5). The *library skills post* survey included the same confidence items as the *pre survey*.

The *learning experience survey* addressed study habits, scholarly research beliefs, impact, and learning experience. In contrast to the library skills pre and post surveys, the *learning experience survey* required students to use a seven point scale to indicate their level of agreement with statements that addressed beliefs, impact, and learning experience. The following phrases were used to represent seven possible levels of agreement: *strongly disagree* (1), *disagree* (2), *slightly disagree* (3), *neutra*l (4), *slightly agree* (5), *agree* (6), and *strongly disagree* (7).

Methodology - survey scale descriptions and construction

A *survey* scale consists of a set of related survey items that collectively represents a given behavior. In order to identify statistically subsets of survey items that could serve as scales, factor analysis (FA) is the preferred statistical procedure. Based on a FA of the responses to the learning experience and library skills post surveys, five survey scales were constructed. Below are brief descriptions of the scales:

a) Beliefs about scholarly research skills scale (*beliefs scale*): measures how important students view *scholarly research* skills.

b) *Impact on online search skills scale* (*impact-search skills scale*): provides a measure of the impact of the *Scholarly Researcher* program on online search skills in terms of awareness, usage, and increased effectiveness.

c) *Impact on scholarly research behavior scale* (*impact-scholarly behavior scale*): measures the influence of the *Scholarly Researcher* program on developing reasoning skills associated with conducting scholarly research.

d) *Confidence in library skills scale* (*confidence scale*): provides a measure of confidence eight library skills covered during the semester.

e) *Positive learning experience scale* (*learning experience scale*): measures how positively students found the *Scholarly Researcher* learning experience.

The coefficient alphas for the scales range between .80 and .90. A coefficient alpha is often included in a description of a scale in addition to FA data because it provides a viable, single measure of scale reliability. Its values range between "0" and "1"; a reliable scale should have a coefficient alpha value at least greater than .70, and preferably between .80 and 90. The *results section* lists the survey items and coefficient alpha for each scale. The appendix includes a description of the FA protocol along with the corresponding data.

Statistical Analysis: Descriptive statistics (means and standard deviations) were run in order to profile scales, scale items, and related scale items. Principal component analysis (PCA) was used to reduce the number of possible items to compose each scale and factor analysis was used to generate scales. See appendix for PCA and FA protocols, and FA data. Repeated measures analysis was used to examine differences among items related to primary source searches. Paired t-tests provided comparisons of students pre-post responses about their confidence concerning specific library skills.

Results and Discussion

In this section, five areas of survey responses are summarized and discussed: high school library usage, study habits related to the *Scholarly Researcher* content, beliefs about scholarly research, impact, and learning experience. The appendix includes tables for all the data.

1a. High School Usage (pre survey data)

The *library skills pre survey* asked six questions about library and online search experiences during senior year of high school. The following summarizes key responses. For complete frequencies, see appendix tables.

On average, 368 students answered the six questions. When asked the number of times they visited the high school library, 32% responded *never* or *rarely* while 39% responded *often* or *very often.* As for the public library, 54% stated they *never* or *rarely* made a visit; 22% indicated they visited it *often* or *very often*. Regarding usage of online research tools, 95% of the respondents used Google *often* or *very often*. However, their use of other online tools drops significantly: Fifty five percent indicated they *never* or *rarely* used online catalogs. Sixty percent *never* or r*arely* used article databases such as Info Track, Proquest, or Web of Science. And, 70% *never* or *rarely* used software to manage citations such as EndNote or RefWorks. The percentages of student who did use online tools other than Google at *often* or *very often* levels are small: 20% for online catalogs, 14% for article databases, and 6% for citation management software.

The responses suggest that the majority of freshmen arrive at MIT unprepared to conduct scholarly research. They seldom used their high school or public libraries, had minimal experience with online research tools, and primarily relied on Google for searches. Moreover, because of their success using Google in high school, they may naively believe their search skills are sufficient. Not knowing what they don't know about online searches may distract them from seeking to learn more sophisticated research skills. The pre survey data highlight the need for students to gain an awareness of the importance of scholarly research skills and to have the opportunity to learn them in a meaningful context, e.g., an academic subject.

1b. Study Behavior Related to Learning the *Scholarly Researcher* Content (*learning experience survey* data)

The *learning experience survey* includes ten questions that address study behavior and usage of online tools in different contexts. The following results are based on the responses of 418 students who completed the survey online at the end of the semester. As a way of obtaining a measure of how students' perceived the overall 3.091 learning environment into which the *Scholarly Researcher* content was embedded, students were asked about their lecture attendance. Twenty two percent of the respondents attended 30% or less of the lectures, while 59% attended 60% or more. Forty seven percent indicated they attended 90% or more. Such percentages suggest students were enthusiastic about the course.

Table 1 summarizes study behavior related to learning the *Scholarly Researcher* content. The appendix includes the frequencies for all ten questions.

Table 1
Study Behavior Related to Learning the *Scholarly Researcher* Content

Number of recommended tutorials watched*	**Time spent viewing video tutorials prior to completing assignment***	**Time spent on *scholarly research* problems****
Never watched: 36%	0 minutes: 21%	15 minutes: 16%
Watched a few: 32%	15 minutes: 56%	30 minutes: 34%
Watched 50% or more: 32%	30 minutes: 12%	45 minutes: 17%
	45 minutes or more: 11%	1 hr. or more: 31%

36% (150/416) reported they never watched the recommended videos, yet only 21% (88/481) reported zero minutes viewing video tutorials. The discrepancy may be due to ambiguity in the wording.

**39% reviewed solutions to the scholarly research problems

The data suggest a range of behavior. Thirty six percent indicated they did not watch the recommended tutorials while another 32% reported watching 50% or more. Students responses to time spent on the problems is bimodal: 16%, 34%, 17%, 31%. Yet, in spite of the varied behavior, that 48% spent more than forty five minutes on a given problem and 31% more than one hour, and that 39% reviewed the model solutions suggest a significant number of students approached the *Scholarly Researcher* content seriously. Moreover, responses to two other questions is most encouraging. Forty two percent reported using research tools (online library databases) during the semester for class assignments other than 3.091. In addition, 29% indicated use of such tools to look up articles unrelated to MIT class assignments. Given that pre-survey responses suggested that many first semester freshmen possessed limited knowledge

of online skills, these usage responses are encouraging: during the semester, students began to apply what they learned.

1c. Beliefs about Scholarly Research Skills (*learning experience survey* data)

The *Scholarly Researcher* curriculum emphasizes that scholarly research skills are important for freshmen to acquire, are essential for academic and professional success, and play a significant role in judging the credibility of information. Within the *learning experience survey*, one section focused on the degree to which students agree with these statements. Table 2 profiles student views in terms of a survey scale, scale items, and relevant non scale items. The *beliefs about scholarly research skills* scale (*beliefs* scale) consists of five items that collectively measure how well students' beliefs reflect the *Scholarly Researcher* themes. On average, students responded to each scale item with a 5.48 (scale range is "1" to "7" with "4" as neutral). This relatively high scale mean suggests students value scholarly research skills. Means of several scale items demonstrate how strongly they hold these views: *The scholarly research skills I learned will be useful during my undergraduate experience (5.67). I believe scholarly research skills are valuable skills for freshman to learn (5.72). Knowing how to conduct scholarly research plays an important role in one's professional life in judging the credibility of information(5.67).*

Two non scale items further illustrate students' awareness of the importance of scholarly research skills; moreover, one of the items indicates strong student support for the inclusion of scholarly research skills in 3.091. *I believe the scholarly research skills I learned will be relevant to my academic work at MIT* (5.73) and *I see the value of introducing scholarly research skills into 3.091* (5.13).

Table 2
Beliefs about Scholarly Research Skills
Profile of Scale, Scale Items and Relevant Non Scale Items

Scale and Scale items	N	Mean (SD)
beliefs about scholarly research skills scale (coefficient alpha = .87)	415	5.48 (1.08)
15d I believe the scholarly research skills I learned will be useful during my undergraduate experience.	417	5.67 (1.31)
15e I believe knowing scholarly research skills will be of value beyond my academic work.	418	5.46 (1.33)
15f I believe scholarly research skills are valuable skills for freshmen to learn.	418	5.72 (1.26)
15g Knowing how to conduct scholarly research plays an important role in one's ability to think critically as a student.	417	4.88 (1.52)
15h Knowing how to conduct scholarly research plays an important role in one's professional life in judging the credibility of information.	417	5.67 (1.26)
Relevant Non Scale Items		
15a I see the value of introducing scholarly research skills into 3.091.	418	5.13 (1.59)
15b As a result of the scholarly training, I gained an appreciation for primary sources.	418	4.60 (1.70)
15c I believe the scholarly research skills I learned will be relevant to my academic work at MIT	418	5.73 (1.30)

1d. Impact of the Curriculum (learning behavior survey and pre-post library skills surveys)

This section consists of two subsections that provide summaries and discussions of the impact data. The subsection titled, *impact (learning behavior survey),* includes data about two impact scales, their items, and relevant non scale items from the *learning experience survey*. The other subsection, *impact* (*library skills pre and post surveys)*, reports on the library skills impact data in three parts: *pre survey* profile, *post survey* profile, and pre-post comparisons.

Impact (Learning Behavior Survey): The *impact on online search skills (impact-online skills) scale* provides a measure of the impact of the *Scholarly Researcher* program on online search skills in terms of awareness, usage, and increased effectiveness. The scale's mean of 5.13 suggests that respondents view the program as having a significant impact. They responded positively to all six scale items; for four of the items, the means were greater than 5.00 which is a clear indicator of the program's impact. Their responses indicate that as a result of the scholarly research training they are more aware of the large number of resources they can access online (5.51), more likely than before to use the library's online research tools to identify relevant materials (5.29), and more able to function effectively as a researcher (5.14).

The *impact on scholarly research behavior* (*impact-scholarly behavior*) *scale* measures the *Scholarly Researcher* influence on developing reasoning skills and attitudes associated with conducting scholarly research. The scale profiles scholarly research behavior as thinking critically, having one's facts straight, examining carefully sources of information, and taking responsibility for one's learning. The means for the scale's six items range between 4.04 and 4.50 which suggest at best minimal impact. These items represent content that was barely covered, if at all. They were included in the survey because they could serve as base line data if the *Scholarly Researcher* curriculum were to expand to include scholarly reasoning behavior.

It is interesting to note that the one area where one would assume the *Scholarly Researcher* content would have an impact it did not. Students mildly disagreed (3.72) with the statement that as a result of the scholarly research training they were less likely to use Google or Wikipedia as the primary online search tool to search for substantive information. A possible explanation for

the lack of impact may be found in responses to three non scale items which focused on primary sources.

> *As a result of the scholarly research training, I know how to search for primary sources.*
>
> *As a result of the scholarly research training, I appreciate the importance of primary sources.*
>
> *As a result of the scholarly research training, I am more motivated to search for primary sources.*

The three statements represent a continuum from *knowing* to *doing*: knowing how to search for primary sources, appreciating their importance, and motivated to search for them. The three means are respectively 5.13, 4.74, and 4.58; thus, as the behavior shifts from *knowing* to *doing*, the means decrease. A repeated measures procedure was performed on responses to the three items. Results indicate that the three means are statistically different from one another which suggest that more than chance accounts for the differences.

Several causes may account for the differences. Given their academic workload and pace, students may be reluctant to devote time to searching for primary sources, a process which they may view as too time consuming. Another possible cause for the inaction may relate to cognitive behavior. If equal focus were given in 3.091 to the three areas of primary sources (knowing, awareness, and doing), one could argue that a greater instructional effort is necessary to change behavior, such as over reliance on Google or a reluctance to search for primary sources, than to teach specific online skills. However, the three areas may not have received equal focus. It is difficult to quantify the relative focus the *Scholarly Researcher* curriculum gave to the different areas of the primary source behavior because different types of instruction were used, each of which often addressed simultaneously more than one aspect of primary sources and to varying degrees. Further study is necessary to explore the relative effort required to make an impact on online search skills and scholarly behavior.

However, if it were the case that to have an impact on scholarly research behavior requires greater instructional effort than to have a comparable impact on online research skills, which is a

reasonable assumption to make, one should not necessarily conclude that the reasoning skills of a scholarly researcher are beyond the scope of the *Scholarly Researcher* curriculum. Rather, one should draw the opposite conclusion: If learning scholarly research reasoning requires additional instructional effort, then it is of value to provide the necessary instruction in as many ways and contexts as possible. The impact data from *the learning experience survey* suggest that the *Scholarly Researcher* curriculum is effective in teaching online research skills. This evidence lends itself to the hypothesis that the design and conceptual framework of the Scholarly Researcher program has the potential to support also a seamless integration of the scholarly reasoning behavior into 3.091. Such an integration could serve as model for other academic subjects about how they could seamlessly integrate scholarly research behavior into their curricula without interrupting effective instruction of the domain specific content. See recommendations for further discussion.

Table 3
Impact of *Scholar Researcher* on Online Skills and Scholarly Research Behavior
Profile of Scales, Scale Items, and Relevant Non Scale Items

Scales and Scale Items	**N**	**Mean (SD)**
Impact on online search strategies Scale (coefficient alpha = .92)	412	5.13 (1.22)
16a As a result of the scholarly research training, I am more likely to use the library's online tools to search for articles of interest.	417	4.96 (1.55)
16c In the future, when I am assigned a research paper in a class, I am more likely than before to use the library's online research tools to identify relevant material.	416	5.29 (1.44)
16d As a result of the scholarly research training, I can function more effectively as a researcher.	417	5.14 (1.42)
16n As a result of the scholarly research training, I am more likely to go to the library's home page.	416	4.73 (1.52)
16o As a result of the scholarly research training, I am more likely to use the library's electronic databases.	418	5.14 (1.42)
16p As a result of the scholarly research training, I am more aware of the large number of library resources I can access online.	416	5.51 (1.341)
Impact on scholarly research behavior scale (coefficient alpha = .94)	409	4.27 (1.30)
16f As a result of the scholarly research training, I examine more carefully sources of information.	415	4.50 (1.41)
16g Because of the scholarly research training, I am more aware of the importance of thinking critically about information.	416	4.33 (1.46)
16h As a result of the scholarly research program, my view of what makes findings/information credible has changed.	416	4.20 (1.48)
16r The scholarly research training has encouraged me to take more responsibility for my learning.	417	4.19 (1.48)
16s The scholarly research training has encouraged me to think more critically.	417	4.04 (1.49)
16t As a result of the scholarly research training, I am more motivated to have my facts straight.	416	4.30 ()1.55
Relevant Non Scale Items*		
16i As a result of the scholarly research training, I know how to search for primary sources.	416	5.13 (1.44)
16j As a result of the scholarly research training, I appreciate the importance of primary sources.	413	4.74 (1.53)
16k As a result of the scholarly research training, I am more motivated to search for primary sources.	417	4.58 (1.53)
16l As a result of the scholarly research training, I am less likely to use Google or Wikipedia as the primary online search tool to search for substantive information.	417	3.72 (1.80)
16m As a result of the scholarly research training, I am more willing to consult with a librarian.	418	3.87 (1.47)
16q As a result of the scholarly research training, I am more aware of the importance of determining the credibility (trustworthiness) of information.	416	4.61 (1.45)

***See appendix for additional relevant non scale items.**

Impact (library skills pre and post surveys): Both the pre and post surveys include 18 items that address confidence in library skills covered in the *Scholarly Researcher* curriculum. Students rated their confidence using a five point scale: *not confident at all* (1); *only slightly confident* (2); *somewhat confident* (3); *confident* (4), and *very confident* (5). The *confidence scale* provides a measure of student level of confidence in eight of the library skills.

On the pre-survey, students were most confident using Google, understanding the meaning of plagiarism, and understanding the difference between primary and secondary sources. They were least confident about using Endnote/RefWorks, MIT's library web page, article databases and print/online library resources. They also reported little confidence in understanding the scientific publication cycle or knowing which MIT library to use in order to research a specific topic. On the post survey, students expressed confidence in the use of citations, call numbers, and publications such as handbooks, encyclopedias, and journals as well as confidence in the three areas they indicated on the pre survey. They showed the least confidence in the use of EndNote/RefWorks, understanding the scientific publication cycle, or knowing which MIT library to use. These areas of least confidence were not covered in primary *Scholarly Researcher* content, i.e., recommended videos and homework problems, but were included in the optional videos.

In terms of pre-post comparisons, the results are very positive. The mean of the confidence scale increased from 3.18 to 3.72, a statistically significant difference. For 15 of the 18 library skills, students reported gains at statistically significant levels. These results added to the evidence of the impact data from the *learning experience survey* present a strong case for the effectiveness of the *Scholarly Researcher* program. Basically, the data from the *library skills pre-post surveys* and the *learning experience survey* indicate the following: If the *Scholarly Researcher* program addressed a given skill, students learned it.

The largest pre-post increases relate to using citations, MIT's library web page, article databases, and, print and online library resources such as journals and full text articles. The three skills in which students reported no gains relate to the meaning of plagiarism, use of Google, and knowing how to contact library staff for assistance. In each case, the lack of gain can be

explained. Since students reported a high level of confidence about their understanding of plagiarism on the pre survey, a ceiling effect precluded the likelihood of their making additional gains. As for Google, it was not the aim of the curriculum to increase students use of Google, but to introduce them to other search engines. That students made no gain in learning how to contact library staff for assistance may relate simply to the curriculum not discussing the roles of librarians, how they may serve as resources, or the context in which freshman may want to seek support from the library staff. Thus, they did not perceive a need to learn how to contact a librarian.

Table 4

Pre-Post Comparisons of Confidence in Library Skills

Descriptive Statistics and *P*-Values for Paired Sample T-Tests

	Pre Survey	Post Survey		
Scale and Scale Items (5-point rating scales)[1]	**Mean (SD)**	**Mean (SD)**	**N[2]**	***P*[3,4]**
Confidence in Library Skills Scale (coefficient alpha = .87)	3.18 (0.74)	3.72 (0.69)	285	**
Use online library catalogs to find materials quickly and efficiently	3.39 (1.11)	3.60 (0.94)	290	*
Use article databases such as InfoTrac, ProQuest, or Web of Science to find materials quickly and efficiently	2.60 (1.16)	3.55 (0.95)	293	**
Use MIT's library web page to access the materials you need	2.48 (1.12)	3.60 (0.94)	293	**
Recognize the parts of a citation	3.29 (1.07)	3.94 (0.92)	293	**
Understand the different types of information that can be found in encyclopedias, handbooks, journals, books, or other types of materials	3.54 (0.92)	3.90 (0.88)	292	**
Understand the difference between primary and secondary sources	3.90 (1.02)	4.06 (0.89)	292	*
Know how to contact library staff for assistance	3.41 (1.15)	3.53 (1.09)	293	
Know how to access both print and online library resources (e.g., books, journals, and full text articles and databases)	2.81 (1.08)	3.63 (0.96)	290	**
Relevant Non Scale Items				
Use Google or another search engine to find materials quickly and efficiently	4.45 (0.74)	4.41 (0.76)	292	
Use call numbers to find books (and other materials) on library shelves	3.58 (1.22)	3.88 (1.13)	291	**
Understand when to cite others' contributions to your research	3.48 (1.05)	3.82 (0.99)	291	**
Understand how to cite others' contributions to your research	3.28 (1.05)	3.81 (1.00)	291	**
Know the difference between the major Boolean operators (And, Or, Not) and how to use them correctly	3.25 (1.52)	3.55 (1.36)	291	**
Use EndNote, RefWorks (or some other software) for managing references and citations	1.97 (1.17)	2.47 (1.34)	288	**
Understand the scientific publication cycle	2.36 (1.12)	2.88 (1.13)	292	**
Understand the meaning of plagiarism	4.24 (0.77)	4.26 (0.77)	291	
Critically evaluate information that you find, regardless of the source (print, electronic, video, etc.)	3.46 (0.93)	3.65 (0.88)	289	*
Know which MIT Library to use to do research on a particular topic	2.12 (1.14)	2.96 (1.11)	292	**

[1]For the confidence questions, students rated their confidence using a five point scale: *not confident at all* (1); *only slightly confident* (2); *somewhat confident* (3); *confident* (4), and *very confident* (5).

[2]N indicates the number of pre-post pairs of means used in the paired t-test comparisons.

[3]Statistical significance at $p < .01$ indicated by a single asterisk (*). Statistical significance at $p < .001$ indicated by a two asterisks(**). A blank space indicates statistical significance was not achieved.

[4]Providing statistical significance for specific surveys is for heuristic purposes only. Given that multiple t-tests inflate the overall type 1 error rate, one should be cautious in interpreting significant levels for individual items.

1e. Learning Experience (*Learning Experience Survey*)

In order to profile how students found the *Scholarly Researcher* learning experience, the *learning experience survey* included two sets of questions that probed student perception from two different perspectives. For the first set, students used a seven point scale to indicate their level of agreement with six statements about specific aspects of the *Scholarly Researcher* instruction. In contrast to the strong positive data related to beliefs and impact data, the instruction responses fall mostly in mildly to moderately positive range. Students clearly indicated that by working through the scholarly research problems, they saw the value of using the library's online tools (4.84). However, they were only mildly positive when asked if they learned a lot by working through the problems (4.31), found the tutorials effective (4.34) or were motivated to do well on the problems (4.23). In general, a discrepancy appears between the impact (online search skills and library skills) and instruction responses. While the impact data are very positive, the instruction data are mild or moderate. One would expect a closer alignment given the levels of impact reported.

The discrepancy between impact and learning experience data becomes more problematic when one examines the other set of learning experience items. Using a seven-point scale, students rated 13 descriptors (see Table 6) according to how well each represented the *Scholarly Researcher* learning experience. Six of the items compose *the positive learning experience scale*. The scale mean is relatively neutral (3.86). Students gave positive ratings only to *meaningful* and *interesting*. They indicated they did not find the curriculum *stimulating*, *exciting*, or *motivating*. Their responses to the non scale items tell a similar story: they found the experience effective but not dynamic.

In terms of beliefs, impact, instruction, and learning experience, the data vary: strong responses for beliefs and impact; mild/moderate for instruction; and flat for learning experience. Such variation poses a paradox: Students indicate that the curriculum made an impact, they are clearly aware of the importance of understanding scholarly research, and they support including *Scholarly Researcher* curriculum in 3.091. Yet, they give only mild or moderate praise for aspects of the instruction and are neutral about the overall learning experience. Without additional data, it is difficult to make a strong case for any possible hypothesis about the

contradiction. The following explanations serve only as stating points for further discussion and possibly direction for future study:

a. The paradox is illusory. It is possible for a curriculum to make an impact and achieve it with instruction that students view only mildly positive and respond to less than enthusiastically.

b. Students may simply not find library research skills exciting content to learn which would dampen their view of the *Scholarly Researcher* experience.

c. The contradiction in the data may be caused in part by students not remembering or being aware of all the experiences that compose the *Scholarly Researcher* curriculum, e.g., Professor Sadoway's demonstration on how to search for primary sources.

Table 5
Learning Experience Profile
Ratings of How Well Descriptors Represented the Learning Experience

Scales and Scale Items*	N	Mean (SD)
Positive Learning Experience Scale (coefficient alpha = .90)	413	3.86 (1.21)
17a Meaningful	418	4.62 (1.60)
17c Enjoyable	418	3.54 (1.46)
17e Stimulating	415	3.90 (1.50)
17h Interesting	417	4.26 (1.47)
17j Exciting	418	3.31 (1.45)
17l Motivating	417	3.61 (1.35)
Relevant Non Scale Items		
17b Uneventful	417	4.73 (1.47)
17d Stressful	417	3.64 (1.57)
17f Tedious	415	4.94 (1.40)
17g Effective	418	4.76 (1.40)
17i Discouraging	418	3.16 (1.43)
17k Frustrating	417	3.88 (1.56)
17m Challenging	417	3.83 (1.59)

*Seven point scales with "1" the lowest value, "4" as neutral, "7" as the highest value.

Table 6
View of Specific Aspects of The Scholarly Research Module

	N	Mean (Std Dev)
18a I found the video tutorials effective.	417	4.34 (1.57)
18b I was motivated to do well on the scholarly research problems.	417	4.23 (1.69)
18c I learned a lot by working through the scholarly research problems.	417	4.31 (1.60)
18d Professor Sadoway's comments in lecture about primary sources and doing scholarly research was motivating.	416	4.72 (1.58)
18e I found looking at the solutions to the scholarly research problems helpful.	417	3.97 (1.44)
18f As I worked through the scholarly research problems, I saw the value of using the library's online tools to search for information.	417	4.84 (1.52)

Findings and Recommendations

Findings

High School Usage

The majority of freshmen arrive at MIT unprepared to conduct scholarly research. They seldom used their high school or public libraries, had minimal experience with online research tools, and primarily relied on Google for searches. The data highlight the need for students to gain an awareness of the importance of scholarly research skills and have the opportunity to develop them in a meaningful context.

Beliefs about Scholarly Research Skills

Students strongly support including scholarly research skills in 3.091. They believe the skills are valuable for freshmen to learn and will be relevant to their academic work at MIT.

Impact

Students reported that the *Scholarly Researcher* curriculum had an impact on their online search skills in terms of awareness, usage, and increased effectiveness. They rated highly five of six items that compose a scale that measures the curriculum's impact on online search skills. Students indicated that as a result of the scholarly research training they are more aware of the large number of resources they can access online, more likely than before to use the library's online research tools to identify relevant materials, and more able to function effectively as a researcher. Pre-post comparisons provide additional evidence of the impact of the *Scholarly Researcher* curriculum. Students reported gains at statistically significant levels in 15 of the 18 library skills.

At the end of the semester, 42% reported using research tools (online library databases) during the semester for class assignments other than 3.091. In addition, 29% indicated use of such tools to look up articles unrelated to MIT class assignments. Given that pre-survey responses suggested that many first semester freshmen possessed limited knowledge of online skills, these usage responses are encouraging: during the semester, students had begun to apply what they learned.

A contradiction in the data

In terms of beliefs, impact, instruction, and learning experience, the data vary: strong responses for beliefs and impact; mild/moderate for instruction; and flat for learning experience. Such variation poses a paradox: Given the high ratings for beliefs and impact questions, one would expect closer alignment among the four areas of data.

Implications

The results of the pilot integration of the *Students as Scholarly Researchers* curriculum into 3.091 suggest that scholarly research skills can be successfully integrated into a fast paced, content specific course if the following design steps are followed:

Seamless integration of the *Scholarly Researcher* content into the curriculum so that it does not appear as an "add on";

Emphasis on the value of scholarly research skills through commentary during lecture and by grading the *Scholarly Researcher* homework problems;

Use of multiple instructional strategies: mini lectures, video tutorials, home work problems, and model solutions.

Distribution of the *Scholarly Researcher* content throughout the curriculum.

Allocating sufficient time to scholarly research skills that would make an impact, but not an excessive amount that would interfere with the fast pace of the course.

Recommendations

Make the general themes of the *Scholarly Researcher* curriculum more explicit:

> Identify several *Scholarly Researcher* principles that could be discussed or re-enforced by Professor Sadoway and the TAs during teachable moments, brief interludes that require less than five minutes, and occur periodically throughout the course.
>
> Comment on the scholarly researcher program during the first few weeks of the course: What does it mean to perform as a scholarly researcher? Why should freshmen learn about it in a chemistry class? How do you know you are performing as a scholarly researcher?
>
> Include in the syllabus a goal or several learning outcomes related to the *Scholarly Researcher* curriculum.

Expand the *Scholarly Researcher* content to include the reasoning of a *Scholarly Researcher*. For example, Professsor Sadoway could serve as a *cognitive role model*: in class he could explain how he thinks through a literature search or how he determines the credibility of the conclusions of a journal article. Another approach would be to use a case study as a homework problem which requires critical thinking: Ask students to critique a hypothetical online search that lead a student to accept information that is not credible from a professional perspective.

Have Dr. Janet Rankin and Ms. Angela Locknar present pedagogical principles to TAs which they could use to develop teachable moments that address *Scholarly Researcher* content. Such teachable moments would require less than five minutes of recitation time and occur three times during the term. An example of a teachable moment would be TAs' explaining how they use the library's online tools to conduct a review of the literature or to search for specific information related to their research.

Appendix

Pre Survey: High School Behavior
Frequencies

During your senior year in high school, how often did you use:

Table A
Usage: Google or another search engine

	Frequency	Percent	Cumulative Percent
Never	1	.3	.3
Rarely	2	.5	.8
Sometimes	14	3.8	4.6
Often	76	20.6	25.2
Very Often	276	74.8	100.0
Total	369	100.0	

Table B
Online catalogs in high school or public library

	Frequency	Percent	Cumulative Percent
Never	38	10.3	10.3
Rarely	125	33.9	44.2
Sometimes	133	36.0	80.2
Often	53	14.4	94.6
Very Often	20	5.4	100.0
Total	369	100.0	

Table C
Usage: Artitcle databases such as Info Track, Proquest, or Web of Science to find articles on a topic

	Frequency	Percent	Cumulative Percent
Never	125	33.9	33.9
Rarely	101	27.4	61.2
Sometimes	93	25.2	86.4
Often	38	10.3	96.7
Very Often	12	3.3	100.0
Total	369	100.0	

Pre Survey: High School Behavior (con't)
Frequencies

During your senior year in high school, how often did you use:

Table D
Usage: EndNote, RefWorks, or other software to manage your citations

	Frequency	Percent	Cumulative Percent
Never	264	71.9	71.9
Rarely	48	13.1	85.0
Sometimes	33	9.0	94.0
Often	14	3.8	97.8
Very Often	8	2.2	100.0
Total	367	100.0	

Table E
Visit: Your high school library

	Frequency	Percent	Cumulative Percent
Never	26	7.0	7.0
Rarely	91	24.7	31.7
Sometimes	111	30.1	61.8
Often	81	22.0	83.7
Very Often	60	16.3	100.0
Total	369	100.0	

Table F
Visit: Your public library

	Frequency	Percent	Cumulative Percent
Never	78	21.3	21.3
Rarely	119	32.5	53.8
Sometimes	89	24.3	78.1
Often	50	13.7	91.8
Very Often	30	8.2	100.0
Total	366	100.0	

Learning Experience Survey: Study Habits
Frequencies

Table G
What percentage of the lectures did you attend?

	Frequency	Percent	Cumulative Percent
0*	4	1.0	1.0
10	43	10.3	11.2
20	25	6.0	17.2
30	19	4.5	21.8
40	14	3.3	25.1
50	25	6.0	31.1
60	19	4.5	35.6
70	36	8.6	44.3
80	37	8.9	53.1
90	119	28.5	81.6
100	77	18.4	100.0
Total	418	100.0	

*No responses were replaced with zeroes because zero was not included as an option and almost all respondents who left items 5, 6, 9, or 10 blank answered all other items which suggests their no response represents zero.

Table H
What percentage of the lectures did you view online?

	Frequency	Percent	Cumulative Percent
0*	67	16.0	16.0
10	176	42.1	58.1
20	38	9.1	67.2
30	31	7.4	74.6
40	17	4.1	78.7
50	21	5.0	83.7
60	8	1.9	85.6
70	15	3.6	89.2
80	14	3.3	92.6
90	17	4.1	96.7
100	14	3.3	100.0
Total	418	100.0	

*No responses were replaced with zeroes because zero was not included as an option and almost all respondents who left items 5, 6, 9, or 10 blank answered all other items which suggests their no response represents zero.

Table I
Number of recommended tutorials watched?

	Frequency	Percent	Cumulative Percent
None	150	36.1	36.1
Few	134	32.2	68.3
Half	48	11.5	79.8
Most	58	13.9	93.8
All	26	6.2	100.0
Total	**416**	**100.0**	

Table J
Number of optional tutorials watched?

	Frequency	Percent	Cumulative Percent
None	273	65.6	65.6
Few	92	22.1	87.7
Half	27	6.5	94.2
Most	15	3.6	97.8
All	9	2.2	100.0
Total	**416**	**100.0**	

Table K
On average, how many hours did you spend on each assigned scholarly research problem?

	Frequency	Percent	Cumulative Percent
a. zero*	8	1.9	1.9
b. 15 mins	66	15.8	17.7
c. 30 mins	140	33.5	51.2
d. 45 mins	72	17.2	68.4
e. 1 hr	90	21.5	90.0
f. 1 hr 15 mins	9	2.2	92.1
g. 1 hr 30 mins	19	4.5	96.7
h. 1 hr 45 mins	3	.7	97.4
i. 2 hrs	8	1.9	99.3
j. > 2 hrs	3	.7	100.0
Total	**418**	**100.0**	

*No responses were replaced with zeroes because zero was not included as an option and almost all respondents who left items 5, 6, 9, or 10 blank answered all other items which suggests their no response represents zero.

Table L
On average, how many hours did you spend viewing the video tutorials prior to completing each assigned scholarly research problem?

	Frequency	Percent	Cumulative Percent
a. zero*	88	21.1	21.1
b. 15 mins	234	56.0	77.0
c. 30 mins	51	12.2	89.2
d. 45 mins	26	6.2	95.5
e. 1 hr	15	3.6	99.0
f. 1 hr 15 mins	3	.7	99.8
g. 1 hr 30 mins	1	.2	100.0
Total	**418**	**100.0**	

*No responses were replaced with zeroes because zero was not included as an option and almost all respondents who left items 5, 6, 9, or 10 blank answered all other items which suggests their no response represents zero.

Table M
Took notes while reviewing the video tutorials?

	Frequency	Percent	Cumulative Percent
Yes	46	11.2	11.2
No	366	88.8	100.0
Total	**412**	**100.0**	

Table N
Reviewed the solutions to the scholarly research problems?

	Frequency	Percent	Cumulative Percent
Yes	161	38.5	38.5
No	257	61.5	100.0
Total	**418**	**100.0**	

Table O
Used the research tools (online library databases) this semester for any class assignments other than 3.091?

	Frequency	Percent	Cumulative Percent
Yes	174	41.8	41.8
No	242	58.2	100.0
Total	**416**	**100.0**	

Table P
Used the research tools this semester to look up articles unrelated to MIT class assignments?

	Frequency	Percent	Cumulative Percent
Yes	121	28.9	28.9
No	297	71.1	100.0
Total	**418**	**100.0**	

Learning Experience Survey (beliefs)

Table Q
Beliefs about Scholarly Research Skills
Profile of Scale, Scale Items and Relevant Non Scale Items

Scale and Scale items	N	Mean (SD)
beliefs about scholarly research skills scale (coefficient alpha = .87)	415	5.48 (1.08)
15d I believe the scholarly research skills I learned will be useful during my undergraduate experience.	417	5.67 (1.31)
15e I believe knowing scholarly research skills will be of value beyond my academic work.	418	5.46 (1.33)
15f I believe scholarly research skills are valuable skills for freshmen to learn.	418	5.72 (1.26)
15g Knowing how to conduct scholarly research plays an important role in one's ability to think critically as a student.	417	4.88 (1.52)
15h Knowing how to conduct scholarly research plays an important role in one's professional life in judging the credibility of information.	417	5.67 (1.26)
Relevant Non Scale Items		
15a I see the value of introducing scholarly research skills into 3.091.	418	5.13 (1.59)
15b As a result of the scholarly training, I gained an appreciation for primary sources.	418	4.60 (1.70)
15c I believe the scholarly research skills I learned will be relevant to my academic work at MIT.	418	5.73 (1.30)

Table R
Profile of Impact Scales, Scale Items, and Relevant Non Scale Items

Scales and Scale Items	**N**	**Mean (SD)**
Impact on Online Search Strategies Scale (coefficient alpha = .92)	412	5.13 (1.22)
16a As a result of the scholarly research training, I am more likely to use the library's online tools to search for articles of interest.	417	4.96 (1.55)
16c In the future, when I am assigned a research paper in a class, I am more likely than before to use the library's online research tools to identify relevant material.	416	5.29 (1.44)
16d As a result of the scholarly research training, I can function more effectively as a researcher.	417	5.14 (1.42)
16n As a result of the scholarly research training, I am more likely to go to the library's home page.	416	4.73 (1.52)
16o As a result of the scholarly research training, I am more likely to use the library's electronic databases.	418	5.14 (1.42)
16p As a result of the scholarly research training, I am more aware of the large number of library resources I can access online.	416	5.51 (1.341)
Impact on Scholarly Behavior Scale (coefficient alpha = .94)	409	4.27 (1.30)
16f As a result of the scholarly research training, I examine more carefully sources of information.	415	4.50 (1.41)
16g Because of the scholarly research training, I am more aware of the importance of thinking critically about information.	416	4.33 (1.46)
16h As a result of the scholarly research program, my view of what makes findings/information credible has changed.	416	4.20 (1.48)
16r The scholarly research training has encouraged me to take more responsibility for my learning.	417	4.19 (1.48)
16s The scholarly research training has encouraged me to think more critically.	417	4.04 (1.49)
16t As a result of the scholarly research training, I am more motivated to have my facts straight.	416	4.30 ()1.55
Relevant Non Scale Items		
16b As a result of the scholarly research training, I am more likely to use the library's databases to search for information of interest.	416	4.83 (1.50)
16e As a result of the scholarly research training, I am more aware of the sources of information.	417	5.28 (1.38)
16i As a result of the scholarly research training, I know how to search for primary sources.	416	5.13 (1.44)

16j As a result of the scholarly research training, I appreciate the importance of primary sources.	413	4.74 (1.53)
16k As a result of the scholarly research training, I am more motivated to search for primary sources.	417	4.58 (1.53)
16l As a result of the scholarly research training, I am less likely to use Google or Wikipedia as the primary online search tool to search for substantive information.	417	3.72 (1.80)
16m As a result of the scholarly research training, I am more willing to consult with a librarian.	418	3.87 (1.47)
16q As a result of the scholarly research training, I am more aware of the importance of determining the credibility (trustworthiness) of information.	416	4.61 (1.45)
16u As a result of the scholarly research training, I am more aware that the library is more than simply a building, that it is a virtual world of information.	418	4.73 (1.59)
16v The scholarly training has made me more aware of the role that intellectual honesty plays in scholarly research.	417	4.53 (1.56)

Library Skills Post Survey (confidence in library skills)

Table S
Scales, Scale Items, and Non Scales items
Pre-Post Responses
Descriptive statistics and p-values for paired sample t-tests

	Pre Survey	Post Survey		
Scale and Scale Items (5-point rating scales)[1]	**Mean (SD)**	**Mean (SD)**	**N[2]**	***P*[3]**
Confidence in Library Skills Scale	3.18 (0.74)	3.72 (0.69)	285	**
7b19b Use online library catalogs to find materials quickly and efficiently	3.39 (1.11)	3.60 (0.94)	290	*
7c19c Use article databases such as InfoTrac, ProQuest, or Web of Science to find materials quickly and efficiently	2.60 (1.16)	3.55 (0.95)	293	**
7d19d Use MIT's library web page to access the materials you need	2.48 (1.12)	3.60 (0.94)	293	**
7h19h Recognize the parts of a citation	3.29 (1.07)	3.94 (0.92)	293	**
7i19i Understand the different types of information that can be found in encyclopedias, handbooks, journals, books, or other types of materials	3.54 (0.92)	3.90 (0.88)	292	**
8a20a Understand the difference between primary and secondary sources	3.90 (1.02)	4.06 (0.89)	292	*
8d20d Know how to contact library staff for assistance	3.41 (1.15)	3.53 (1.09)	293	
8g20g Know how to access both print and online library resources (e.g., books, journals, and full text articles and databases)	2.81 (1.08)	3.63 (0.96)	290	**
Relevant Non Scale Items				
7a19a Use Google or another search engine to find materials quickly and efficiently	4.45 (0.74)	4.41 (0.76)	292	
7e19e Use call numbers to find books (and other materials) on library shelves	3.58 (1.22)	3.88 (1.13)	291	**
7f19f Understand when to cite others' contributions to your research	3.48 (1.05)	3.82 (0.99)	291	**
7g19g Understand how to cite others' contributions to your research	3.28 (1.05)	3.81 (1.00)	291	**
7j19j Know the difference between the major Boolean operators (And, Or, Not) and how to use them correctly	3.25 (1.52)	3.55 (1.36)	291	**
7k19k Use EndNote, RefWorks (or some other software) for managing references and citations	1.97 (1.17)	2.47 (1.34)	288	**
8b20b Understand the scientific publication cycle	2.36 (1.12)	2.88 (1.13)	292	**
8c20c Understand the meaning of plagiarism	4.24 (0.77)	4.26 (0.77)	291	

8e20e Critically evaluate information that you find, regardless of the source (print, electronic, video, etc.)	3.46 (0.93)	3.65 (0.88)	289	*
8f20f Know which MIT Library to use to do research on a particular topic	2.12 (1.14)	2.96 (1.11)	292	**

[1]For the confidence questions, students rated their confidence using a five point scale: *not confident at all* (1); *only slightly confident* (2); *somewhat confident* (3); *confident* (4), and *very confident* (5).
[2]N indicates the number of pre-post pairs of means used in the paired t-test comparisons.
[3]Statistical significance at $p < .01$ indicated by a single asterisk (*). Statistical significance at $p < .001$ indicated by a two asterisks(**). A blank space indicates that statistical significance was not achieved.

Table T
View of Specific Aspects of The Scholarly Research Module

	N	Mean (Std Dev)
18a I found the video tutorials effective.	417	4.34 (1.57)
18b I was motivated to do well on the scholarly research problems.	417	4.23 (1.69)
18c I learned a lot by working through the scholarly research problems.	417	4.31 (1.60)
18d Professor Sadoway's comments in lecture about primary sources and doing scholarly research was motivating.	416	4.72 (1.58)
18e I found looking at the solutions to the scholarly research problems helpful.	417	3.97 (1.44)
18f As I worked through the scholarly research problems, I saw the value of using the library's online tools to search for information.	417	4.84 (1.52)

Table U
Learning Experience
Profile of Impact Scales, Scale Items, and Relevant Non Scale Items

Scales and Scale Items	**N**	**Mean (SD)**
Positive Learning Experience Scale (coefficient alpha = .90)	413	3.86 (1.21)
17a Meaningful	418	4.62 (1.60)
17c Enjoyable	418	3.54 (1.46)
17e Stimulating	415	3.90 (1.50)
17h Interesting	417	4.26 (1.47)
17j Exciting	418	3.31 (1.45)
17l Motivating	417	3.61 (1.35)
Relevant Non Scale Items		
17b Uneventful	417	4.73 (1.47)
17d Stressful	417	3.64 (1.57)
17f Tedious	415	4.94 (1.40)
17g Effective	418	4.76 (1.40)
17i Discouraging	418	3.16 (1.43)
17k Frustrating	417	3.88 (1.56)
17m Challenging	417	3.83 (1.59)

Factor Analysis

Description of protocols used to construct survey scales

Scale development occurred in two phases. In phase 1, based on models of the behaviors that the survey items were hypothesized to represent, the items were categorized a priori into groups that possibly could serve as scales of these behaviors. Principal component analysis was applied initially to each group to reduce the number of items. In the case of the *impact* items, a slightly different approach was used to identify potential scale items because well defined hypothesized models did not exist. Factor analysis (varimax rotation) was applied to all the *impac*t items which lead to the formulation of two groups of items that possibly could serve as measures of the impact on online search skills and scholarly research behavior. The phase 1 analysis generated five groups of items: four groups consisted of items from the *learning experience survey* which used seven-point ratings scales, and one group consisted of items from the *library skills post survey* which consisted of five point rating scales. The four *learning experience survey* groups represented beliefs about scholarly research skills, impact on online search skills, impact on scholarly research, and positive learning experience. The group items from *library skills post survey* addressed confidence in library skills.

In phase 2, in order to determine the final scale membership for each of the four *learning experience survey* scales, a cross-validation design was followed to ensure scale reliability. This required the following sequence of procedures: Randomly divide the post-survey sample of 417 respondents in half, Sample A and Sample B. Using Sample A data, apply factor analysis (varimax rotation) to the set of variables included in the four phase 1 groups. Once the final composition of the scales has been identified with Sample A data, replicate results by applying the factor analysis with varimax rotation to Sample B. If factor analysis with sample B data leads to same results as occurred with sample A data, a claim of scale reliability becomes tenable.

In phase 2, the final version of the *confidence in library skills* scale was constructed separately. The rationale was this scale consisted of items from the *library skills* survey which used five-point rating scales in contrast to the seven-point rating scales used in the *learning experience* survey. Applying factor analysis to items consisting of different rating scales requires the use of correlation matrices, a frequently used approach in social science, but which is less desirable from a mathematical perspective than the use of covariance matrices. An additional reason for analyzing the *library skills* scale separately was that the scale was intended to measure specific topics covered in the *Scholarly Researcher* content, consequently it included several items similar to those identified a priori for the learning experience survey scale items. Such redundancy would complicate a factor analysis items that included items from the library skills and learning experience survey scales. See Table V below for factor analysis loadings.

The following protocol guided the final formulation of the *confidence* scale: Run principal component analysis on Sample A to verify appropriateness of items identified a priori to compose the scale. Validate results by applying same procedure to Sample B.
For sample a, all items loaded greater than .50. N = 217. The coefficient alpha was .82. For Sample b, all items loaded greater than .50. N = 197. The coefficient alpha is .88. The coefficient alpha for all post survey responses (N = 414) is .87.

Table V

Formulation of the Four Learning Experience Survey Scales

Factor Analysis with Varimax Rotation

Rotated Component Matrix[a]

	Scales			
	Impact: scholarly behavior	Impact: online skills	Positive Learning Experience	Beliefs
15d I believe the scholarly research skills I learned will be useful during my undergraduate experience.	**.204**	**.559**	**.204**	**.593**
15e I believe knowing scholarly research skills will be of value beyond my academic work.	**.211**	**.289**	**.144**	**.745**
15f I believe scholarly research skills are valuable skills for freshmen to learn.	**.056**	**.300**	**.154**	**.782**
15g Knowing how to conduct scholarly research plays an important role in one's ability to think critically as a student.	**.403**	**.014**	**.263**	**.688**
15h Knowing how to conduct scholarly research plays an important role in one's professional life in judging the credibility of information.	**.223**	**.112**	**.163**	**.772**
16a As a result of the scholarly research training, I am more likely to use the library's online tools to search for articles of interest.	**.226**	**.733**	**.175**	**.330**
16c In the future, when I am assigned a research paper in a class, I am more likely than before to use the library's online research tools to identify relevant material.	**.254**	**.765**	**.184**	**.293**
16d As a result of the scholarly research training, I can function more effectively as a researcher.	**.356**	**.692**	**.153**	**.325**
16n As a result of the scholarly research training, I am more likely to go to the library's home page.	**.267**	**.695**	**.270**	**.072**
16o As a result of the scholarly research training, I am more likely to use the library's electronic databases.	**.220**	**.795**	**.284**	**.174**
16p As a result of the scholarly research training, I am more aware of the large number of library resources I can access online.	**.270**	**.749**	**.258**	**.037**
16f As a result of the scholarly research training, I examine more carefully sources of information.	**.745**	**.356**	**.125**	**.222**

16g Because of the scholarly research training, I am more aware of the importance of thinking critically about information.	**.806**	**.235**	**.199**	**.242**
16h As a result of the scholarly research program, my view of what makes findings/information credible has changed.	**.780**	**.203**	**.160**	**.203**
16r The scholarly research training has encouraged me to take more responsibility for my learning.	**.765**	**.290**	**.285**	**.142**
16s The scholarly research training has encouraged me to think more critically.	**.813**	**.193**	**.306**	**.197**
16t As a result of the scholarly research training, I am more motivated to have my facts straight.	**.815**	**.315**	**.225**	**.134**
17a Meaningful	**.318**	**.348**	**.516**	**.357**
17c Enjoyable	**.170**	**.171**	**.797**	**.172**
17e Stimulating	**.223**	**.311**	**.745**	**.206**
17h Interesting	**.121**	**.331**	**.722**	**.258**
17j Exciting	**.193**	**.121**	**.855**	**.094**
17l Motivating	**.324**	**.202**	**.774**	**.105**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.