The UW Senior Research Study 2009

OEA Report 10-01

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OFFICE OF EDUCATIONAL ASSESSMENT
Improving Learning Through Assessment

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EXECUTIVE SUMMARY

The University of Washington's Senior Research Study (UW SRS) was designed to help us understand and assess the research that UW undergraduates are typically required to do as a normal part of their progress through their UW experience. The study was exploratory rather than hypothesis-driven, aimed at allowing us to cast a wide net into students' research experience to see what we would find.

Research is an important skill to assess, because conducting research teaches students that discovery is often built on or against old knowledge and that the community of scholars in a given field determines the ways knowledge is created. Research, in fact, brings them into that community of scholars as participants. In addition, research requires students to use critical thinking, writing, quantitative reasoning, planning and other skills to bear in service of a single project. Finally, being able to conduct research is a skill valued not only by academic communities; learning to find and use information is often cited by employers as the most important skill a college education can give its graduates and UW graduates have indicated they share that value on alumni surveys.

While being able to find and use information is considered an important skill by scholars, faculty, and students alike, it is challenging to gather information on the kinds and amount of research students do at the UW, partly because what it means to do research varies across the disciplines. In other words, the research processes that an art major must engage in to produce a piece of metalwork for his senior project will differ from the research methods an oceanography major must follow to complete a project for her capstone course. Knowing that the subjects, methods, purposes, and practices for research vary across the disciplines makes it necessary to examine students' research experience at the departmental level. Therefore, focus groups with seniors in specific departments seemed the ideal way to capture the research experience of undergraduate majors. Departmental focus groups would be valuable to departments as they thought about their curricula, and they would allow us to move inductively from those examples to the larger picture for the UW undergraduate experience.

Methodology

Researchers invited 23 UW departments to participate in the project. Seventeen of these 23 departments communicated that they were interested in having their majors participate, and of that group, we were able to gather information for 15. We were unable to recruit enough student participants to volunteer for focus groups for two of the 17 majors. The study included seniors in four departments in the arts and humanities, two engineering departments, four departments in math and sciences, and five departments in the social sciences. In total we spoke with 138 students across 24 focus group sessions.

Depending upon the number of student volunteers, OEA researchers conducted either one or two focus groups with seniors in each of the 15 departments, giving them $25 UW Bookstore gift certificates for their participation. We asked for students to bring a copy of their unofficial transcripts to the focus groups because some of our questions asked them to list courses they had taken early in their time at the UW, and we also asked students to bring a copy of something they had done in their majors that had required research and that they considered challenging. In addition, as soon as students arrived at the focus group, they were given a short survey to complete, asking participants, among other things, to create lists of the courses inside and outside the major that had required them to do research.

After conducting and analyzing focus group and survey responses from senior participants in all 15 departments, OEA researchers completed individualized reports that were sent to each of the participating departments.

Findings

Major study findings included the following:

- All students conducted research while at the UW, and almost all of them conducted research both inside and outside their majors. Overall, students conducted research in an average of 13 courses at the UW, about half inside and half outside their majors.
- There was little overlap in research methods students used in high school and those they used at the UW.
- Differences in purpose and methods characterized the research students did for the various disciplines they represented. Some noteworthy differences included:
    - While often grouped together, humanities and arts research practices and purposes differed. In the arts, the purpose of research was predominately to help students create something new. Therefore, research methods in the arts could be formal, such as conducting interviews, consulting texts, and conducting experiments on materials. However, research in the arts could also be fluid, continuous, and untraceable in the piece it informed. In the humanities, the purpose of research was primarily to interpret an object or a text that someone else created. Humanities research, therefore, frequently relied on consulting texts online and in the library databases for support for interpretations and could be traced in the papers and projects it informed, often via footnotes.
    - Also while often grouped together, mathematics and science research processes differed. While both processes included trial-and-error and experimentation, pure math research was often a more internal process than research in other sciences, needing fewer physical tools and less knowledge in their use.
    - Student research in interdisciplinary science fields, such as public health, differed from research in traditional science fields, such as biology and chemistry, in that it was less focused on one's own experimental work and more on the experimental work of others, as well as using a wider array of research methods, such as interviews.
    - Research in social sciences appeared similar across majors, but each of the social science disciplines was highly specialized, favoring certain methods over others and, therefore, certain research approaches over others.
- Some similarities in purpose and methods across disciplinary areas were surprising, such as:
    - The purpose for research conducted in the arts was similar to that described for engineering. The purpose of research for both was to inform the creation of something new, whether that was a painting or a computer program. Students in both areas spoke of research being conducted all the time, so that the line between research and living was blurry.
    - The method of research conducted in mathematics was similar to that described for philosophy, in that both relied primarily on the mind of an experienced student wrestling with the internal logic of an argument or problem, rather than seeking external validation or evidence.
- With the exceptions of seniors in two of the majors, students did not feel that learning how to conduct research was intentionally structured into the curricula of their majors.

- Most students said that they had learned to do the kinds of research required by their majors by trial-and-error or from random courses inside or outside their majors. Students also received substantial help from UW librarians.

- Students evaluated how much they had learned about finding and using information at the UW as a grade of about "B" (3.0 out of 4.0), and they evaluated their confidence at being able to find and use information in the future as slightly higher—a B+ (3.3).

- Regardless of disciplinary context, students' comments about what the most important things were for conducting research successfully in their majors were similar. Students from a number of fields recommended that others:

    - Use all resources available
    - Take time at the beginning of a project to make sure you understand the assignment and clarify, if necessary
    - Seek help from faculty
    - Learn to read and use journal articles in the field
    - Start early
    - Learn to use the library
    - Write well

- Similarly, regardless of disciplinary context, students' suggestions for improving the undergraduate research experience in their majors were similar, as follows:

    - Provide more instruction in how to conduct research
    - Give students more information about departmental resources and research opportunities
    - Require more research (earlier in the program)
    - Focus on writing by providing students with help in writing in the major or by requiring more writing
    - Connect students in the major to the world of work related to the major

- How we define research determines what we capture when studying information literacy. In the UW SRS, students' comments about what research meant to them raised questions about what institutions count as research. For example:

    - Art and creative writing majors spoke of gathering images constantly, creating a pool they might draw on later, as well as gathering images that were related to specific projects they were working on. Engineering majors spoke of a similar kind of activity.
    - English, Spanish, and philosophy majors spoke of the careful re-reading of a single text to gather information for papers they were writing.
    - Mathematics majors spoke of sorting through what they had in their own heads in order to solve problems, and some of them spoke of a trial-and-error/testing-and-evaluating approach to solutions that seemed similar to science majors' descriptions of conducting experiments.
    - Nearly all students had topics, ideas, and interests that they were researching on their own online, some of which related to their courses and majors and some of which was motivated by their independent interests.
    - Spanish majors spoke of study abroad as research in their majors, because their primary purpose for study abroad was to improve language skill and experience a Spanish-speaking culture.

    These examples suggest that if we are educating students to conduct research in their majors, we need to define research in such a way that includes them. We need to know how well we are teaching students to look, to listen, to test new information against knowledge they already have, as well as to find, evaluate, and use information.

UW Senior Research Study

"…all scholars work from the grounding provided by predecessors." – The Boyer Commission, 1998

"If you're looking at someone's argument, you need to think about building on it, and that will take the argument to a different realm." – UW Senior, 2008

INTRODUCTION

The University of Washington's Senior Research Study (UW SRS) was designed to help us understand and assess the research that UW undergraduates are typically required to do as a normal part of their progress through their UW experience. The study was exploratory rather than hypothesis-driven, aimed at allowing us to cast a wide net into students' research experience to see what we would find.

Like faculty at other large, public research institutions, faculty at the University of Washington are frequently criticized for their focus on research; often the public appears to see research in conflict with a focus on effective teaching. However, much of the teaching we do at the UW involves helping students learn to conduct research themselves, including helping them learn to formulate questions that matter to various publics, design effective ways to answer those questions, conduct the research needed to provide those answers, and either report results to audiences who care about those findings or incorporate results into designs and creative works.

Research teaches students that discovery is often built on or against old knowledge and that the community of scholars in a given field determines the ways knowledge is created. Research, in fact, brings them into that community of scholars as participants. In addition, research requires students to use critical thinking, writing, quantitative reasoning, planning and other skills to bear in service of a single project. Perhaps for these reasons, the Boyer Commission's (1998) first recommendation for improving undergraduate education was to "make research-based learning the standard" (p.15). Boyer argued:

> *In a setting in which inquiry is prized, every course in an undergraduate curriculum should provide an opportunity for a student to succeed through discovery-based methods. The basic idea of learning as inquiry is the same as the idea of research; even though advanced research occurs at advanced levels, undergraduates beginning in the freshman year can learn through research*. (p.15)

Being able to conduct research is a skill valued not only by academic communities; learning to find and use information is often cited by employers as the most important skill a college education can give its graduates. UW graduates appear to share that value. Rating the importance of 17 skill areas to their current primary activity, graduates from the UW who responded to a 2007 alumni survey, one year after they had graduated, rated the ability to "locate information needed to make decisions or solve problems" as the skill most important to their primary activity. These graduates considered finding information to be more important to their current activities than skill in writing, speaking, critical analysis, technology, or leadership (McGhee and Kourenina, 2009). Similarly, UW students surveyed in 2008 who had graduated five and 10 years earlier rated their ability to locate information second only to "defining and solving problems" in terms of its importance to their current primary activity (McGhee, 2009).

While being able to find and use information is considered an important skill by scholars, faculty, and students alike, it is challenging to gather information on the kinds and amount of research students do at the UW, partly because what it means to do research varies across the disciplines. The research that undergraduates do is informed by their classes, by the paths the disciplines of their majors use to create knowledge, and by the interests of faculty in students' majors (Beyer, et al., 2007). In addition, research is often equally informed by students' own ideas and questions, with faculty playing the role of mentor or guide as students move through the process.

Furthermore, the research processes students use vary substantially, depending upon the disciplines in which students are operating. In other words, the research processes that an art major must engage in to produce a piece of metalwork for his senior project will differ from the research methods an oceanography major must follow to complete a project for her capstone course. Knowing that the subjects, methods, purposes, and practices for research vary across the disciplines makes it necessary to examine students' research experience at the departmental level.

Therefore, focus groups with seniors in specific departments seemed the ideal way to capture the research experience of undergraduate majors. Departmental focus groups would be valuable to departments as they thought about their curricula, and they would allow us to move inductively from those examples to the larger picture for the UW undergraduate experience.

This report summarizes information gathered from focus groups of students from 15 departments that participated in the UW Senior Research Study. The report integrates pre-focus group survey results with focus group results, as appropriate, and we have used student quotations when possible to illustrate findings. The report is divided into the following sections:

- Definition of research
- UW SRS methodology
- Study findings
  - Research experience prior to attending the UW
  - Comparison of research experience inside and outside the major
  - Research experience inside the major
- Conclusions

DEFINITION OF RESEARCH

Any definition of research that we presented to students needed to be broad enough so that the departments engaged in the study would recognize the definition as inclusive of what they do. Therefore, in consultation with the 15 departments participating in the UW SRS, we arrived at the following definition of research after several iterations:

> *"Research" occurs in the regular course of students' undergraduate academic experience and involves using sources outside oneself and beyond materials provided in class in order to:*
>
> - *generate or explore ideas*
> - *gather information*
> - *support arguments*
> - *formulate or analyze new problems or methods*
> - *solve problems*
> - *investigate unsolved problems*
> - *create new knowledge or objects*
>
> *Common research methods include both collecting and analyzing information in one or more of the following ways:*
>
> 1. *Direct observation/participation (both formal, as in ethnography or fieldwork, and informal)*
> 2. *Observing performances, videos, slides, or other media*
> 3. *Studying visual images, structures, word and image relationships, or image/symbol making to inform one's own or others' work*
> 4. *Consulting experts and/or texts; collecting literature (in person, online, in the library)*
> 5. *Creating/identifying/studying case studies*

6. *Designing and/or conducting experiments or tests*
7. *Gathering digital data from computers and networks*
8. *Observing computer program execution and its effect on computers and networks*
9. *Creating/testing models and/or simulations*
10. *Creating/conducting surveys or use of other statistical methods*
11. *Conducting interviews*
12. *Taking measurements*

This definition of research was included on the pre-focus group survey that we asked students to complete before we began the focus group, and students could refer to the definition throughout the focus group.

METHODOLOGY

Researchers contacted 23 department chairs, provided them with copies of the project proposal, and asked if they were interested in having their students participate in the UW SRS. The 23 departments were selected primarily because they had a large number of seniors in their majors. Of the 23 departments invited, 17 chairs said that they were interested in having their majors participate, and of that group, we were able to gather information for 15, listed in Table 1. We were unable to get enough student participants to volunteer for focus groups for two of the 17 majors.

Table 1. Majors represented in the UW SRS

Major	# Winter 2008 Seniors*	# Students participating N=138	Disciplinary Area
Biology	591	16	Science
Biochemistry and Chemistry	450	11	Science
Political Science	397	16	Social Science
Economics	394	10	Social Science
Communication	381	9	Social Science
English	334	12	Arts & Humanities
International Studies	320	13	Social Science
Art and Art History	291	10	Arts & Humanities
Electrical Engineering	268	5	Engineering
Sociology	265	5	Social Science
Computer Engineering & Computer Science	251	5	Engineering
Mathematics	187	6	Science
General Studies ~ Public Health	109	8	Science
Philosophy	106	5	Arts & Humanities
Spanish	89	7	Arts & Humanities

**Note: Students with majors across multiple SRS-participating departments were randomly assigned to one SRS department.*

As Table 1 demonstrates, the study included seniors in four departments in the arts and humanities, two engineering departments, four departments in math and sciences, and five departments in the social sciences. In total we spoke with 138 students across 24 focus group sessions.

Focus Groups

Depending upon the number of student volunteers, OEA researchers conducted either one or two focus groups with seniors in each of the 15 departments. Seniors were invited to participate and the groups were formed by OEA staff; departments did not know which of their majors participated. Participants were given $25 UW Bookstore gift certificates for their participation, and the focus groups lasted approximately 90 minutes, with one researcher facilitating the conversation and the other taking notes, nearly verbatim. We asked for students to bring a copy of their unofficial transcripts, to help participants

remember the courses they had taken as they moved through their undergraduate years. When students forgot their transcripts, we were able to give them access to them from a computer and printer in the focus group room. The protocol for the focus groups is attached as Appendix A.

We decided to use focus groups as our primary means of gathering information on undergraduate research for a number of reasons. Since we were specifically interested in documenting the particulars of students' experiences and the meanings they themselves attached to these experiences, we selected a qualitative method of research. Focus groups presented an ideal and cost-effective means of gathering such information.

However, focus groups also have other strengths that made them a useful method for the UW SRS. First, while focus groups can be used as an exploratory, initial step in a multi-method assessment process, they can also provide valid information as a stand-alone method, even though they typically include small samples of students. As Stewart et al. (2006) point out:

> *…focus groups alone may be sufficient basis for decision-making….One example of such a case in an applied research setting would be the identification of a flaw in a program…Another would be a situation in which there is reason to believe that the group of people or population of interest is relatively homogeneous, at least with respect to the issue at hand. In such cases, a small number of respondents is all that is needed to generalize to the larger population. (p.44)*

Therefore, results from departmental focus groups might be useful to departments both as they design additional assessment steps for learning in the major and as stand-alone studies whose results can inform curricular change.

Second, the interactive aspect of focus groups made them a good method for the UW SRS. Focus group research uses group interaction to produce information and shed light on insights that would be less comprehensible without the interplay of respondents. By directly moderating these interactions, we were able to encourage students to reveal aspects of their experiences and perspectives that are difficult to access with quantitative research methods. In addition, the focus group approach gave students time and guidance in thinking about research activities they performed as a normal part of their coursework and how these activities were contextualized by the academic practices of their majors, rather than conducted as generic or formalized activities. Within each focus group we could observe this making of meaning, both through students' discussion and their revisions of responses to the short surveys we handed out before the groups began.

A third strength of focus groups is that by allowing students to respond to one another, to voice agreement and disagreement, and even ask questions of one another, this method allowed participants to play a central role in defining the similarities and differences of their experiences. Focus groups, thus, allow students to share and compare their rich stories with each other, while also allowing researchers to attend to such analytical focuses as consensus and diversity.

Focus group responses were analyzed using a constant comparison method, an inductive process that allows categories of responses to be generated from students' answers rather than from pre-determined ideas about what those answers might be. Whenever possible, we identified student quotations that illustrated recurring themes in students' responses.

A Sample Piece of Work

We asked participants to bring or email us a copy of something they had done in their majors that had required research and that they considered challenging. One of the focus group questions asked about challenging research, and we felt that referring to an authentic piece of work might yield more concrete responses to that question. In addition, we were able to provide some aggregate information about the work that students brought in our reports to departments.

Surveys

As soon as students arrived at the focus group, they were given a short survey to complete. That survey is included as Appendix B. The survey asked participants to use their transcripts to create lists of the courses inside and outside the major that had required them to do research, information on the level of challenge of research they had done, information on the types of research methods they had used in the major, information about high school research, and some very general demographic questions. Students kept the surveys until the end of the focus groups, so that they could refer to and alter their course lists as needed during the focus group discussion.

Academic and Demographic Summaries

OEA summarized academic and demographic variables (such as UW GPA and ethnicity) for participants from each major and compared them the same variables for all seniors in the study, including a summary of that comparison and its implications in departmental results.

Reports

After conducting and analyzing focus group and survey responses from senior participants in 15 departments, OEA researchers completed individualized reports that were sent to each of the 15 participating departments.

STUDY FINDINGS

Results include information about students' research experience before they entered the UW, a comparison of their research experience inside and outside the major, and information about students' research experience inside their majors.

Students' Research Experience Prior to UW

The survey that students filled out as they waited to begin the focus group conversation included the UW SRS definition of research reproduced earlier in this document. The survey asked students about the amount of research they had conducted prior to enrolling at the UW, giving them the following four options:

- *Extensive. I used many of the research methods listed on page 1 and produced more than five researched papers or presentations.*
- *Average. I used mostly method(s) #_____(please indicate the number from the list of methods in definition on page 1) on the UW SRS definition of research and produced 3 to 5 researched papers or presentations.*
- *Limited. I used mostly method (s) #_____(please indicate the number from the list of methods in definition on page 1) and produced 1 or 2 researched papers or presentations.*
- *None. I did not do any research before I came to the UW.*

As Table 2 shows, about 13% of the students reported having done extensive research prior to entering the UW—using several research methods to produce five or more researched papers or presentations.

Many students (41.6%) reported having done an "average" amount of research prior to entering the UW; they used a limited number of research methods to produce between three and five papers or presentations. Close to a third (32.1%) of the students said that they had "limited" research experience prior to entering the UW; in other words, they produced only one or two researched papers or presentations. Only 18 (13.1%) students in the 15 departments had done no research prior to entering the UW.

Table 2. Amount of research done before entering UW (n=137*)

Disciplinary Area	Extensive	Average	Limited	None
Arts/Humanities (n=33)	8 (24.2%)	13 (39.4%)	9 (27.3%)	3 (9.1%)
Engineering (n=10)	1 (10.0%)	3 (30.0%)	5 (50.0%)	1 (10.0%)
Math/Science (n=41)	6 (14.6%)	14 (34.1%)	13 (31.7%)	8 (19.5%)
Social Science (n=53)	3 (5.7%)	27 (50.9%)	17 (32.1%)	6 (11.3%)
ALL (n=137)	18 (13.1%)	57 (41.6%)	44 (32.1%)	18 (13.1%)

**Note: One participant did not complete a pre-focus group survey.*

As Figure 1 indicates, few students in any disciplinary area had extensive research experience prior to entering the UW. A greater proportion of arts and humanities majors (24.2%) reported having done "extensive" research prior to entering the UW than did students in the other disciplinary areas. Additionally, math/science majors were the most likely (19.5%) to report having done no research prior to entering the UW than students in other areas.

When students reported "average" or "limited" research experience before coming to the UW, they were asked to list the methods they had used prior to entering UW. As Table 2 indicates, 18 (13.1%) of the 137 participants who completed the pre-focus group survey said that they had extensive research experience in high school, and another 18 (13.1%) said that they had no research experience in high school. Therefore, 101 (73.7%) students identified the methods of research they had used while doing "average" or "limited" research before entering the UW.

Table 3 shows the research methods that those 101 students listed, compared with the methods that all students reported using in their academic majors. The table shows big differences between the kinds of research students did as high school students and the kinds they did as college majors, as well as differences between disciplinary areas in the majors. However, because students reporting that they had done extensive high school research did not list pre-UW research methods, these differences are rough comparisons at best.

As Table 3 shows, students used more research methods as majors than they used in high school, no matter what the method. Some of these differences in methods used are striking. For example:

- About 16% created, identified, or studied cases in high school, but nearly half (49%) of college majors researched case studies
- Only 14% designed and conducted experiments in high school, compared with 43% of college majors

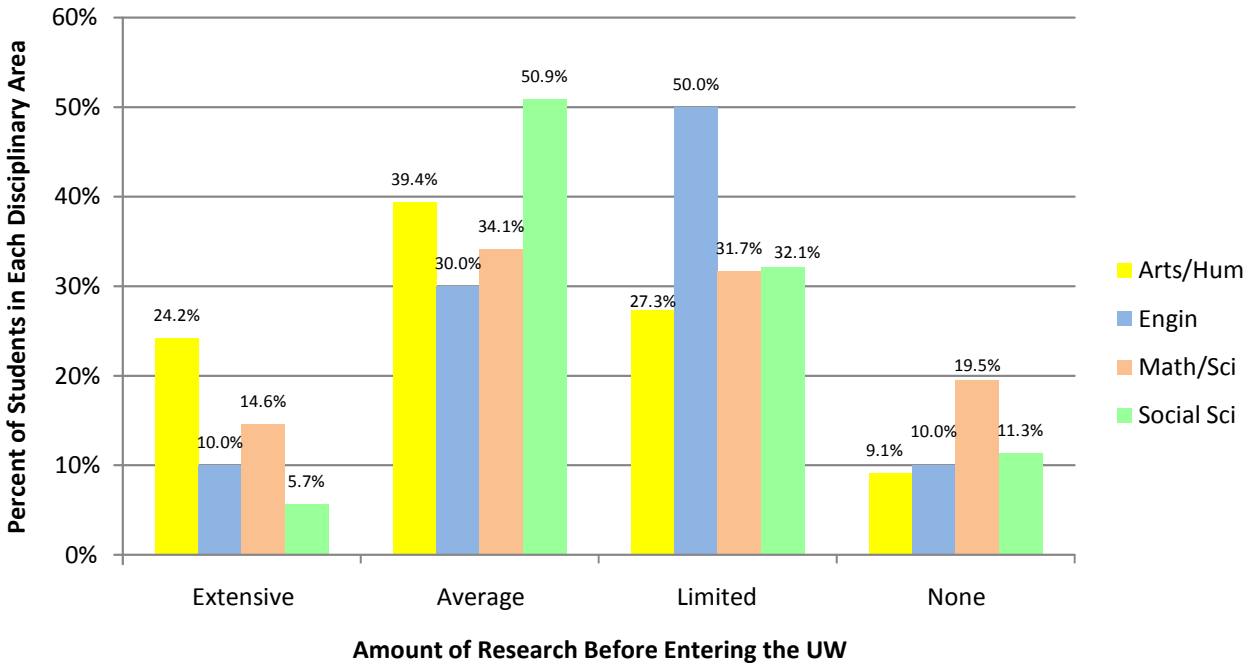

Figure 1. Disciplinary area and amount of research conducted prior to UW

- Close to 7% of the students created or tested models and simulations in high school, but about a third (33%) of college majors reported doing so

Only one research method was used by nearly all students, both when they are in high school and when they are in college—"consulting experts and/or texts"; about three quarters of SRS students reported using this method in high school and a little more than 91% reported using it in college. This commonality is also illustrated in Figure 2. Consulting experts and/or texts is indeed the research method that many people envision when the term "research" is brought up—finding written information from library and online sources that pertains to the subject the student is investigating for a paper or presentation.

However, it is important to note that the apparent similarity between the research methods students reported using before the UW and as majors—consulting experts and texts, online, in person, or in the library—is misleading in some ways. Students often reported using basic library and online search strategies in high school, as Table 3 and Figure 2 indicate, but library and online search skills in college differed dramatically from those used in high school. Indeed, they differed even from one discipline to another in college, depending upon students' majors. Once at the UW library website, students in one of our departmental groups may have had to locate and use a specific library database, such as PubMed or Sociological Abstracts, which students in another department may never use. Some students spent hours in the slide library; others did not know there was a slide library on campus. Some students in our focus groups spoke of the wonders of Summit—a resource that allows UW students to access sources all over the country; others used only one specialized library, such as the Math Library, and never entered the other campus libraries on foot or from their keyboards. The narrower the student's research topic, the more challenging and specific the library searches.

The same was true for online research. Students in some majors used Google or Wikipedia to lead them to books and articles. Others used specialized forums and discussion boards, where they could access the latest information on technological change. Often students in these majors got to know the names of individuals posting on the boards who were more reliable sources than others and followed their posts the way a history scholar might track a fellow scholar through a citation index. Some students were searching online for pieces of software code; others were looking for images of water.

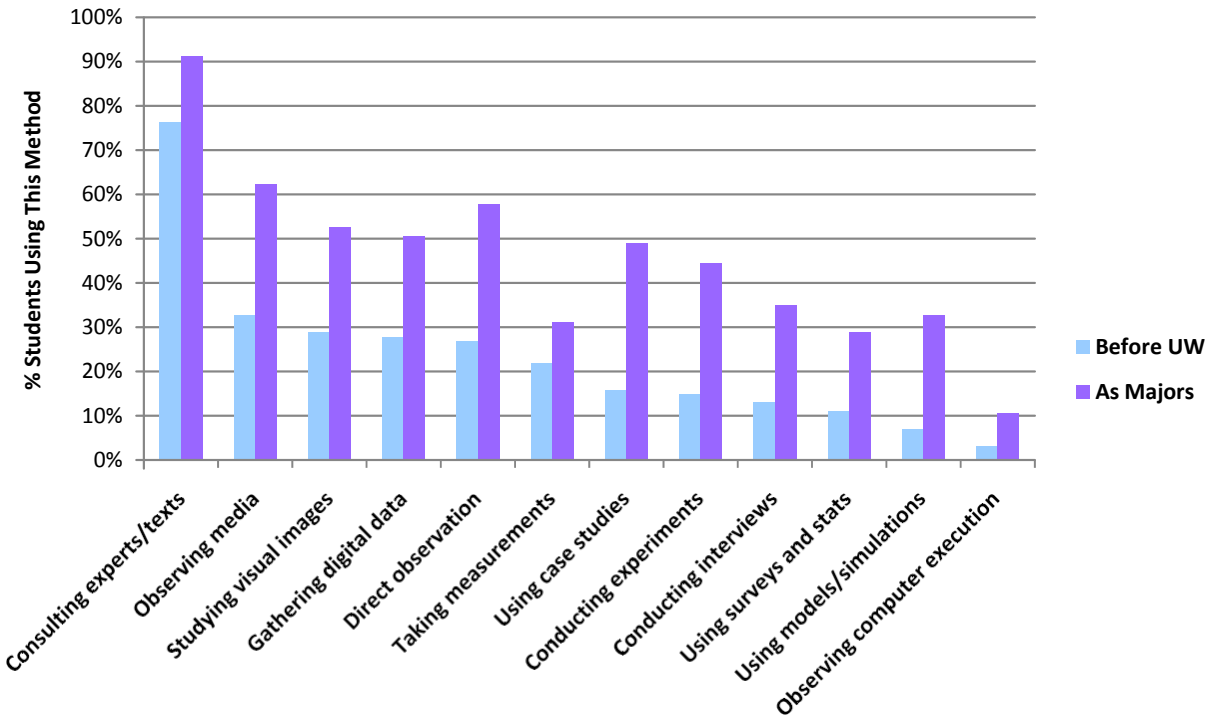

Figure 2. Research methods students used before entering UW and as UW majors

Furthermore, once students in college located an article, there was no guarantee that they could understand it. As one of our science students said, *"I had to wiki the first word in the first scientific article I read!"* Students in some disciplines described having to find sources that could help them understand the sources they had found, while students in others did not have this challenge. The use of one source to find others, however, was fairly common across the departmental focus groups.

In addition to showing the research method used most often by high school and UW students, Table 3 and Figure 2 also show that the research method least frequently used both by students prior to coming to the UW and in their academic majors was observing computer program execution and its effects—a method half the engineering majors reported using. Table 3 also makes clear the disciplinary nature of research; particularly among UW majors. For example:

- 82% of students in the arts and humanities reported having observed performances, videos, slides, or other media to gather information, but less than half (46%) of all math/science and engineering majors combined use that method. Additionally, 76% of the arts and humanities majors studied "visual images, structures, word and image relationships, or image/symbol making," while almost no engineers reported having done so.
- In contrast, while nine of the ten engineering majors took measurements for the purpose of research, fewer than 10% of both the arts and humanities and social science majors did.
- While three quarters of the math/science majors used direct observation or participation as a research method, approximately half of the rest of the SRS population reported having done so. Similarly, while only 23% of the social science majors designed or conducted experiments, another three quarters of math/science majors reported having used this research method in their major.
- Finally, whereas 69% of social science majors reported having used case studies for research in their major, this was only the case for just over a third (36%) of the rest of the SRS population.

Table 3. Research methods used before entering UW and in the major

Methods	Art/Hum		Engin		Math/Sci		Soc Sci		Total	
	Pre-UW % (n=22)	In UW Major % (n=33)	Pre-UW % (n=8)	In UW Major % (n=10)	Pre-UW % (n=27)	In UW Major % (n=40)	Pre-UW % (n=44)	In UW Major % (n=52)	Pre-UW % (n=101)	In UW Major % (n=135)
Consulting experts and/or texts; collecting literature (in person, online, in the library)	**72.7**	**97.0**	**62.5**	**60.0**	**74.1**	**87.5**	**81.8**	**96.2**	**76.2**	**91.1**
Observing performances, videos, slides, or other media	**50.0**	**81.8**	**12.5**	**30.0**	**33.3**	**50.0**	**27.3**	**65.4**	**32.7**	**62.2**
Direct observation/participation (both formal, as in ethnography or fieldwork, and informal)	**36.4**	**57.6**	**0.0**	**40.0**	**29.6**	**75.0**	**25.0**	**48.1**	**26.7**	**57.8**
Studying visual images, structures, word and image relationships, or image/symbol making to inform one's own or others' work	**36.4**	**75.8**	**12.5**	**10.0**	**37.0**	**50.0**	**22.7**	**48.1**	**28.7**	**52.6**
Gathering digital data from computers and networks*	**22.7**	**27.3**	**50.0**	**80.0**	**37.0**	**65.0**	**20.5**	**48.1**	**27.7**	**50.4**
Creating/identifying/studying case studies	**18.2**	**27.3**	**12.5**	**20.0**	**18.5**	**47.5**	**13.6**	**69.2**	**15.8**	**48.9**
Designing and/or conducting experiments or tests	**9.1**	**27.3**	**12.5**	**90.0**	**22.2**	**75.0**	**13.6**	**23.1**	**14.9**	**44.4**
Conducting interviews	**13.6**	**45.5**	**0.0**	**10.0**	**18.5**	**22.5**	**11.4**	**42.3**	**12.9**	**34.8**
Creating/testing models and/or simulations	**9.1**	**18.2**	**12.5**	**90.0**	**11.1**	**42.5**	**2.3**	**23.1**	**6.9**	**32.6**
Taking measurements	**9.1**	**9.1**	**37.5**	**90.0**	**44.4**	**65.0**	**11.4**	**7.7**	**21.8**	**32.6**
Creating/conducting surveys or use of other statistical methods	**9.1**	**9.1**	**12.5**	**20.0**	**11.1**	**32.5**	**11.4**	**40.4**	**10.9**	**28.9**
Observing computer program execution and its effect on computers and networks	**0.0**	**0.0**	**12.5**	**50.0**	**7.4**	**17.5**	**0.0**	**3.8**	**3.0**	**10.4**

Note: Numbers exceed 100% because students often selected more than one method.
**While originally intended to describe analysis of network and computer activity to identify viruses and other intrusions or problems, students may have mistaken this method to mean conducting online searches using web browsers, such as Google, a method of research we included in "collecting literature and texts." We were unable to determine how pervasive this misunderstanding was.*

Table 3 and Figure 2 make it clear that research at the UW is quite different from research students practice in high school. Furthermore, Table 4 shows that the research methods students must use vary across disciplinary areas, likely following the practice and approaches of scholars in those fields.

Research Conducted at the UW

The survey asked students to use the transcripts they had brought to help them list courses both inside and outside their majors that required research. The complete lists of specific courses that students provided were included in departmental reports, so that departments could see where their students were learning about research and completing research projects.

Table 4 summarizes the lists that students completed to determine how much research students conducted at the UW. As the table shows, on average students did research for papers, presentations, and other work in just over 13 courses, 6.4 courses inside their majors and 6.8 courses outside them. As the table also shows, the total number of courses requiring research varied from close to 15 for students in the arts/humanities to about 11 for students in engineering

Table 4. Number of courses inside and outside the major in which students conducted research

Disciplinary Area	Average # Courses Requiring Research in Major	Average # Courses Requiring Research outside Major	Total # Courses Requiring Research
Arts/Humanities (n=33)	6.7	8.2	14.9
Engineering (n=10)	5.0	5.9	10.9
Math/Sciences (n=40)	7.7	5.8	13.4
Social Sciences (n=53)	5.6	7.0	12.5
ALL (n=136)	6.4	6.8	13.3

We can roughly estimate what this level of research means for undergraduates at the UW. If we assume that students took three courses each quarter for 13 quarters (four years plus an additional quarter), they would have done research in about a third of those classes. However, this calculation is somewhat misleading, because students in all 15 departments reported doing most of the research that was required primarily in the 200, 300, and 400 levels (85.8%), with most of the research required in their majors at the 300- and 400-levels (68.7%). Therefore, a better estimate might be that close to half of the courses students took after their freshman year required them to do research, with much of that concentrated in upper-level courses.

Everyone Does Research at the UW

All study participants reported that they had conducted research in their undergraduate programs while at the UW. Three (2.2%) students among the focus group participants said that they had not done research in their majors, but all three reported having done research outside the major.

Level of Challenge

The survey also asked students to compare the level of challenge in the research required inside their majors with that required by courses outside their majors. As Table 5 shows, students' responses to this question varied by disciplinary area. One thing that should be noted at the forefront of this summary, however, is that the presence of double majors in this study complicated analysis. For students who double-majored, research *outside* the major could included research they had conducted for a major that was not the central focus of the focus group in which they participated.

On average, nearly half of all students in the arts and humanities felt that the research they had done in their majors was *less* challenging than research conducted in courses outside their majors. However, nearly a third (30.3%) of the arts and humanities population indicated the opposite, noting that research in the major was *more* challenging.

Among social science students, responses to this question varied greatly; almost as many students in this group found research in their majors to be less (30.2%) or equally (28.3%) challenging as research outside their majors than those who found research in their majors more challenging (39.6%). This wide distribution is primarily caused by two social sciences departments standing out from the other three. In

Table 5: Comparison of challenge level of research inside and research outside the major

Responses	Arts/ Humanities (n=33)	Engineering (n=10)	Math/ Sciences (n=41)	Social Sciences (n=53)	Total (n=137)
More challenging than research I did outside my major	10 (30.3%)	7 (70.0%)	26 (63.4%)	21 (39.6%)	64 (46.7%)
Less challenging than the research I did outside my major	16 (48.5%)	1 (10.0%)	8 (19.5%)	16 (30.2%)	41 (29.9%)
Equally challenging as the research I did outside my major	6 (18.2%)	2 (20.0%)	4 (9.8%)	15 (28.3%)	27 (19.7%)
I have not done research at the UW	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
I did not do research at the UW in courses outside my major	0 (0.0%)	0 (0.0%)	1 (2.4%)	1 (1.9%)	2 (1.5%)
I have not done research in my major	1 (3.0%)	0 (0.0%)	2 (4.9%)	0 (0.0%)	3 (2.2%)

one of those departments, more than two-thirds of the students found research in the major to be *more* challenging than research conducted outside the major, whereas in the other department two-thirds of students found research conducted in the major to be *less* challenging. In contrast, around two-thirds of both engineering (70.0%) and math/science (63.4%) majors felt that research conducted in courses in their majors was *more* challenging than research conducted in courses outside their majors.

As Table 5 shows, in general, most of the students participating in the focus groups (46.7%) found research in their majors to be *more* challenging than research conducted for classes outside their majors. Close to 30% found research conducted for their majors *less* challenging than research conducted for other classes, and about 20% found research inside and outside the major to be *equally* challenging.

Other Differences between Research Conducted Inside and Outside the Major

In addition to level of challenge, we wanted to know if there were other differences that students experienced in conducting research inside and outside the major, so we asked focus group participants the following:

Thinking about the two lists you made on your surveys about the research you've done in your major and the research you've done in courses outside your major, has the research you've done in courses in your major differed in any way from the research that was required in classes outside your major? If so, how? Was research in your major done primarily alone or with others?

The responses of students in most of the disciplinary areas we studied fell into two major categories: differences in purpose and method. We used students' responses to extrapolate a summary of the purposes and methods of research in the disciplinary areas of their majors, which is shown in Table 6. As the table shows, one research method is included in the research required in all four disciplinary areas: consulting experts and/or texts; collecting literature (in person, online, in the library). Students pointed to this method as a similarity between the research they conducted for their majors and for courses outside their majors, and those responses are consistent with those given for earlier questions about research conducted prior to entering the UW and as majors (Table 3).

Students in most of the disciplinary areas noted that the research methods they used in their disciplines sometimes overlapped with those used in other disciplines, but they also pointed out unique differences. Furthermore, there were sometimes differences in the academic practices of departments sharing the

same disciplinary areas, as Table 7 also shows and as the following summaries of the disciplinary areas discuss.

Arts and Humanities Summary

Students in the arts and humanities felt that the purpose for research in their majors differed from that of other majors, as did some of their methods they used and the amount of research they were asked to do in their majors. Furthermore, as Table 6 suggests, variations in the majors inside this disciplinary area were often greater than the similarities across them.

Purpose. As Table 6 shows, for many students, the purpose of the research they conducted was to help them analyze and interpret a text or an object as a way of demonstrating understanding. Often students in these majors spoke of writing arguments about others' arguments about texts or objects, and their research was devoted to finding those arguments, as well as locating commentary on them.

While the purpose of research for many students in the arts and humanities was to interpret, what was being interpreted varied between the four majors within that disciplinary area. Art history majors interpreted objects and images; English and Spanish majors primarily interpreted literary works; and philosophy majors interpreted philosophical arguments. Interpreting art pieces, literature, and philosophy required the use of theories, concepts, and practices unique to each major in the arts and humanities group. For example, English majors spoke of the need to incorporate theory into their work and philosophy majors spoke of observing disciplinary practices when they wrote their philosophy papers, as one student said:

> *"I had an ethics teacher do that—'These are the principles we want you to use to create your arguments.'"*

In contrast to the interpretive purpose of their research, arts and humanities majors pointed to other courses they had taken where the purpose of research was often to apply a set of ideas to historical events or real-world situations. One student described research outside the major as "more tangible":

> *"So it involves analyzing arguments and ideas, whereas history classes require you to take an idea and apply it, maybe to a social movement—taking the idea and doing something with it rather than just understanding the idea. A history class or communication class may involve looking at a text but also something that's not textual—like an event in history that may be described in a text, but it was something that actually happened, something tangible."*

Methods. Art majors (particularly those majoring in art history), English majors, philosophy majors, and Spanish majors noted that their primary method of research was locating books, images, or articles in the library or online in order to write papers. As one student described:

> *"Course reading gives you a sense of the general position you want to take, and you basically then go look via the electronic journals for more information that relates to that particular issue. You know the claim you want to make, and you read the articles that will give you ammunition to make that claim or to reject the one you don't want to support."*

While this method—collecting texts and images from the library and online—is used by all disciplines, for many students in the arts and humanities it is the *only* research method they use in their majors. Arts and humanities students contrasted this approach with what they considered to be more varied methods used in other disciplines, including interviews, experiments, gathering and using empirical data, and other hands-on types of experience.

Table 6: Research characteristics across disciplinary areas

Disciplinary Area	Purpose of Research	Methods	Other	Alone or Collaboratively
Arts and Humanities ***Art and Art History*** ***English*** ***Philosophy*** ***Spanish***	To help students analyze and interpret texts and/or images as a way of demonstrating understanding	o Consulting experts and/or texts; collecting literature (in person, online, in the library) o Reading and re-reading	Amount of research: many courses in the major did not require research beyond re-reading the texts assigned in class	Alone
∗ Visual design, fine arts, creative writing	To help students create something new	o Interview or consult with others o Experiment, trial-and-error	Research is ongoing and often unassigned	Alone, except for critique and consultation
∗ Philosophy		Taking a contemplative step: requires nothing physical outside the philosophical argument		Alone
∗ Spanish		Study abroad as a way to research language use and grammar		Alone
Engineering ***Computer Science and Engineering*** ***Electrical Engineering***	o To help students build or create something new o To find the "correct" or best answers to problems	o Consulting experts and/or texts; collecting literature (in person, online, in the library) o Locating, evaluating, participating in and using online forums, tutorials, user studies, online manuals, individuals known to have expertise in certain areas, and other individuals o Conducting experiments, trial-and-error o Use of quantitative methods	Research is ongoing and often unassigned	Collaboratively
Math/Sciences ***Biology*** ***Chemistry/Biochemistry*** ***Math*** ***Public Health***	To conduct experiments; to test hypotheses	o Consulting experts and/or texts; collecting literature (in person, online, in the library) o Conducting experiments, trial-and-error o Use of quantitative methods	Research skills build over time	Both collaboratively and alone
∗ Mathematics	o To understand and develop new concepts in mathematics o To understand various phenomena in nature, engineering, and science, using the tool of mathematics	Generating own data; requires nothing physical outside the problem		Alone
∗ Public Health		Use of case studies		
Social Sciences ***Communication*** ***Economics*** ***Jackson School of International Studies*** ***Political Science*** ***Sociology***	o To understand others' ideas and the causes and effects of past events o To arrive at conclusions about theories or cases by comparing them	o Consulting experts and/or texts; collecting literature (in person, online, in the library). o Conducting interviews o Using cases o Some use of quantitative data o Analysis of visual images and speech	Amount of research: many courses in the major did not require research beyond re-reading the texts assigned in class.	Alone
∗ International Studies			Research questions are highly specified and narrow making library and internet searches very challenging	

∗=*Variations*

Amount of Research. Most of the arts and humanities students noted that many of the courses in the major did not require research beyond re-reading the texts assigned in class. As students in English and Spanish put it:

> *"The classes within my major were very much text-oriented. I often found the only text I used were the source texts, and the classes outside my major required me to look for more outside opinions and things."*

> *"A lot of the courses are literature based and the literature is provided to you as texts for the course. Any analysis and work you do is based on the texts for the course, and you don't go outside that, whereas in international studies, even if you have those texts, there are research papers that require you to go outside and do research beyond that. There have been a few courses in Spanish where I had to do that but it is mostly not the case."*

Variations: Visual Design, Fine Arts, and Creative Writing. Students in three subfields within two of the departments, art and English, spoke of research experiences that were similar to each other's but were unlike those of most of the students with whom we spoke in the arts and humanities. The three subfields were visual design and fine arts in the art major and the creative writing track in the English major.

Students in those three tracks spoke of a research purpose that differed from interpretation. Students in all three tracks said that the primary purpose of research for them was to help them create something new.

In addition, students in the three tracks in art and English described differences between their methods of research and those of other majors in arts and humanities. Visual design and fine arts majors spoke of the need to interview others or consult with them. For the visual design majors, this need was sometimes rooted in the fact that they were often working with clients. For the fine arts majors, consulting with others was often linked to understanding the properties of materials they were using in their work, as these two comments indicate:

> *"CMA is the ceramics and metals arts program. I did welding and stuff like that there, and I collaborated with the technicians when I was working on that."*

> *"I talk to people a lot too. Like one of my projects—I was doing a project with chocolate, and I went to the chocolate factory to see how chocolate works, how it looks, how to use it."*

Fine arts and creative writing majors also spoke of the blurred line between what one might consider research and what one might consider "normal life." They noted that they were researching all the time, looking for ideas and images, as well as for background and cultural information. These searches were sometimes directly related to a piece they were working on and sometimes not. They described research in their creative practice as ongoing and continuous, often as part of the generative creative process.

In addition, students in fine arts and visual design noted that being willing to let the creative process define the art that they produced was central to the creative/research process. As one student said:

> "*You start off with the original idea but it keeps transforming. It rarely looks like what you planned. If you did some research, I think it's there in a holistic way. It's part of the thought process, but you can't always find it in what you've done."*

And another agreed:

> *"My final research project is never what I thought it would be, even if I planned it out. Somewhere along the line, my ideas change, my inspiration changed, the process changed. You can't really put a structure to that; it is just learning and moving along."*

Finally, students in fine arts also compared some of the research they did with scientific experimentation, noting that creating an art piece involves "trial and error." As one student put it:

> *"For me, because I'm a painting major, the type of research that I have to engage in is on an image basis. I'm working on a canvas and creating an image that is perceptively correct—meaning that it is aesthetically correct and visually correct, and if not, I'm going back in and reworking the image."*

Variations: Philosophy. In addition, students in philosophy mentioned a "research method" that seemed unique to the arts and humanities group. As well as finding and using texts in their research, philosophy majors mentioned a contemplative step as part of the normal research process in philosophy where you "just think." In two students' words:

> *"You can't do the research until you go into the cave."*

> *"A lot of the time you just think about the subject, just sit in a dark hole thinking. You don't go out—you just think."*

Engineering Summary

Engineering majors responses to the questions of how research inside the major differed from that conducted for courses outside were consistent across the two engineering majors with whom we conducted focus groups. They noted three aspects of research in engineering that differed from research elsewhere: purpose, methods, and whether research was required.

Purpose. Engineering majors said that, unlike the purpose of research outside the major, the purpose of research in engineering was aimed at helping students build or create something new. As two students in different engineering majors said:

> "*So the difference between CSE research and what I've done in other classes is that in other classes it's been writing papers where you try to support some idea or argument. You go look up some scholarly articles from others for support. In CS it's been more experimentation, creating your own model and getting results from that, especially in my senior project. Trying to come up with new ways to solve problems."*

> *"The key difference is that in double-E we are actually doing design. We actually use this research to design something and test it—to come up with something ourselves. Our purpose is to come up with ideas for how to solve the problems, but then we have to build those solutions. That's the difference. I use Google and the internet to figure out what people have done and to get example code, if you're programming something. I've never had to design something outside EE classes."*

This purpose—conducting textual research in order to inform the creation of something else—was very similar to the visual design, fine arts, and creative writing majors' descriptions of the purpose of their research. Also, these steps—library/online research and making something—are not discrete. Often they are going on simultaneously for both engineers and artists.

Methods. Students noted that on the surface, some of the research methods used for their engineering majors appeared to be similar to research conducted for courses in other fields. They pointed to the use of online resources, of Google as a search engine, and of the UW library databases as similarities between research in their disciplines and in research outside it.

However, students noted that because the purpose of research in engineering is to build something, the research in the major was more "experimental" in nature than research for courses outside the major. In addition, engineering students mentioned that research for projects had to be very current to be useful. Several students talked about the pace of change in the discipline and the relative uselessness of

textbooks as sources of information because of this fast-paced change. The pace of change in engineering fields meant that the use of online sources of information was essential to success. Students spoke of the need to find and use information from online forums, tutorials, user studies, online manuals, individuals known to have expertise in certain areas, and other individuals in order to get the most current information. The following interchange illustrates this point:

> ***Student A:*** *"In terms of the types of resources, in higher level EE courses, everything is really specialized. Everything you are going to find from a design perspective is going to be technical articles or unpublished work. If you're doing research for lower level [courses], you might get the exact same thing across schools. But at the higher level, you're using research papers. If you are doing something like VLSI [very large scale integration], you're doing the speed of your project, the power consumption—and you're trying to optimize those things. And that kind of thing isn't normally discussed in textbooks."*
> ***Student B:*** *"It's pretty important—Student A's point about everything being new. Change is really quick, so we can't really rely on past data. So when you're researching, you have to understand the perspectives of what was created. For VLSI, things change every 18 months. You can't use data from 1996, for instance. You might find two papers that are close but when they were done is important. The speed aspect of how fast things come out is important. Textbooks are published more slowly than research papers come out, so we use research papers."*

In addition, students said that the use of technological skills, statistics, and hands-on experience were also important methods of research in their fields.

The experimental nature of the methods used to design and build something new in engineering was also mentioned by the visual design, fine arts, and creative writing majors as part of their work. This was particularly true for fine arts majors, who were often "testing" materials—such as cement or metals—to see how they could alter, extend, or use them in their creative work.

Research Conducted but Not Required. As Table 6 indicates, students noted that research inside the major was often not required; they did the research because they needed to learn how to do something before they could complete an assignment, for example. Students talked about the necessity of teaching themselves to use or build software to solve problems or to do extra reading in their courses to understand systems they were asked to use.

This aspect of research in engineering was also like that described in the arts and creative writing, where students spoke of the line between research and "not-research" as being blurred and the search for images and ideas as a normal part of their every day experiences.

Math/Science Summary

Math/sciences majors noted differences between the purposes and methods of research in their majors and research outside them; however, as Table 6 shows, the comments of students majoring in mathematics and public health suggested that research for these majors differed in some ways from research in the other science courses we included in the UW SRS.

Purposes. Like the engineering majors, students in math and sciences noted that a similarity shared by courses inside and outside the major was the use of library databases and internet sources to gather textual research. However, biology and chemistry/biochemistry majors also said that even when they were doing library and internet searches, such research was often done in service of an experiment the student was working on. Therefore, the purpose of some aspects of the research in the sciences was to allow other aspects of the research to go forward, rather than to provide information useful for its own sake, as this student's comment illustrates:

> *"Research in my major is bench work and stuff, which also requires me to go through the literature and stuff, but it is more like you are doing the research in the literature so that you can do the bench work, whereas research outside my major was more for its own self and not so you can do an experiment."*

Students in public health and math did not note this point.

A second purpose noted by math/science majors as different from research conducted elsewhere was that research in math/sciences was conducted in order to find the correct or best solutions to problems.

Methods. Students noted that the databases they used and the sources they accessed in those library databases, which included complex articles from scientific journals and epidemiological studies, differed quite a bit from those used in fields outside their majors. In addition, biology and chemistry/biochemistry majors described their research as primarily experimental, hands-on work, while research methods outside the major were primarily focused on gathering texts from library databases. As one student said:

> *"The biggest difference is that I haven't done any experimentation outside chemistry. All my other research has involved observing—watching a play or maybe reading something."*

In addition, students in all math/sciences departments with whom we worked characterized research methods in math and science as more quantitative—requiring understanding and use of statistics—than research in courses outside the major. As one student said:

> *"For example, I took some music classes, and it was more like researching a musician or a style of music. There wasn't anything statistical—no surveys or anything where you'd be collecting data and recording it. It was more listening to different pieces or watching performances and reporting based on that. In my major, it was more creating your own evaluations, tests, or surveys, gathering that information, and then using statistics to do the analysis. That's the major difference I see between the two."*

Some students also said that another difference between research inside and outside the major was that research skills in math and science built over time, while research outside the major seemed to assume that students could understand how to do research by doing it once, as this interchange illustrates:

> ***Student A**: "I think in my classes, we've spent a lot of time gaining skills, slowly developing skills, connecting experience, doing research. But most of my general education classes have assumed that you can research papers easily in a short period of time."*
> ***Student B**: "Except for art classes—where you have to build up skills and do research before you begin drawing, I'd agree with Student A. Many classes assume you can do all the research in that one class."*

Variations: Mathematics. Mathematics majors' responses differed from those of the science majors. They noted that there were differences in the purposes and methods required by pure math research and those required by applied math research. In pure mathematics, students said that the purpose was to discover something about mathematics; in applied mathematics, the purpose was to use mathematics to understand something else—nature, engineering, or other real-world phenomena.

Mathematics majors also said that research in mathematics required nothing physical beyond the problem. As one student put it:

> *"It's looking at problems that haven't been solved and sometimes creating new problems. That's a very different kind of research. When I'm doing math research, there's a big difference between math and everything else. I don't need anything physical. I generate*

my own data. I very rarely have too little information. The hard thing is figuring out the pattern."

In this way, research in mathematics sounded similar to research in philosophy.

Variations: Public Health. In contrast to students in both mathematics and other science majors, several students in public health mentioned the importance of case studies as a research method.

Social Sciences Summary

Social sciences majors participating in the UW SRS agreed that the purposes and methods most frequently used in research in their fields differed from research in courses outside their fields. They also felt that the amount of research differed. However, the comments of students majoring in international studies varied somewhat from those of students in the other social sciences majors participating in the study.

Purposes. Research in the social sciences was said to be conducted for primarily for analytical purposes—understanding others' ideas and the causes and effects of past events. As one student described:

For economics…it's a more a long term thing—you have to wait for things to actually happen before you can analyze it. [For example], in one 400-level class I took, it was more looking at a crisis that happened and analyzing what was going on, what were the mistakes, what would have changed if you hadn't had them."

Students also noted that the purpose of research was sometimes to understand differences— for example, using evidence to weigh one theory against others or noting differences in two regions' approaches to ending civil war.

Methods. Most of the social sciences majors felt that the primary research methods they used were similar to methods used in courses outside the major—looking up texts in the library databases, in particular. However, they noted that often these databases, like those in other disciplinary areas, were highly specialized, with economics majors using the NASDAQ trading room in Ballmer, the Wharton database, U.S. census data, and Yahoo Financial, for example, while students in sociology might be using Sociological Abstracts, crime data gathered by local and federal agencies, and demographical information.

In addition to using textual sources, social sciences majors reported using other methods, as follows:

- Interviews
- Analysis of visual images
- Cases
- Light use of quantitative data

Amount of Research. Students in two of the majors in the social sciences felt that they did not do as much research as did students in other majors, and students in some of the majors felt that the research they had been asked to do had not been demanding.

Variation: International Studies. As Table 6 shows, international studies majors in the UW's Henry M. Jackson School of International Studies agreed that research inside the international studies (IS) major was more complex, rigorous, and extensive than research they conducted in courses outside the major, noting specifically that the level of thinking and the amount of research required were greater inside the major than outside. As one student said:

> *"I feel like the research required in International Studies is more extensive than in my other classes, and, also I've been asked to explore the underpinnings of things and theories in the Jackson School and haven't had to do that elsewhere."*

The international studies majors also mentioned differences between the kinds of topics assigned in IS and those in courses outside the major, noting that the IS research topics were more specified and narrow than in courses outside the major, which made library and internet searching more challenging than it was for other majors. Also, students noted that often they were able to pursue topics and regions they were interested in and even to track those topics or regions across courses in the IS major.

All Areas: Was Research Conducted Collaboratively or Alone?

As Table 6 shows, students in the arts and humanities and in the social sciences said that research in their majors was conducted primarily alone.

Students in the sciences (but not in mathematics) said that frequently research was conducted collaboratively, but it was often conducted alone, as well. One student described the differences as depending upon how far one had advanced in the major, saying:

> *"The chemistry courses in the beginning, you work with a partner. Research in the upper level classes was always independent, and research outside my classes was also independent."*

Another science major pointed out that even if students did not write something collaboratively, "*it's more free-form groups…you end up helping each other."*

Although mathematics majors said that research in math was conducted primarily alone, one student noted that the model of the lone researcher in mathematics might be changing, pointing out that "*about 10% of math papers used to be co-authored and now it's 50%."*

Only students in engineering majors said that the research they conducted was done mostly in collaboration with others. Engineers spoke of a process where they worked alone during the building stage of a project but came together at the beginning and ending stages, which they called "problem identification and evaluation," to confer with their peers. As one student noted:

> *"A lot about computer science is breaking down a problem into the smallest piece, so you talk to your partners about that. Then you go off on your own and do research on your own piece that you then bring back to your partners."*

For the most part, engineering majors stressed the value of collaboration and the important role it played in their understanding of research done inside the major. The mixture of independent work and peer support seemed valuable. As one student said:

> *"The best research I've done is in groups where we've put together something big, something that I couldn't put together by myself."*

Questions Raised

Our conversations with students, particularly those with students in the arts and humanities and those majoring in mathematics, raised some questions about research as follows:

- Are creative processes and research processes two different activities in the creative arts or are they the same process?
- If we cannot track the research in the work that it produces—in other words, if we cannot see the "footnotes" and the researcher cannot say for sure where such "footnotes" might be placed—in a painting or a poem, for example—does that process count as research?

- Is the careful, analytical re-reading of texts—called "close reading" in English departments—described by philosophy, English, and Spanish majors considered research?
- What if a student is sitting and thinking about an argument, comparing it to others she has read and testing it against theories she has learned—the philosophy major going into the cave or the mathematics major needing nothing physical beyond the problem? Does that count as research?
- Is study abroad research for a language major? Is it research for any major who studies abroad?

Research in the Major

Students in all focus groups were asked a variety of questions about the research in their majors.

Tools and Skills Necessary

We asked students in the focus groups:

What tools and skills are necessary for you to do research effectively in your major? Where/how did you learn these tools and skills?

Table 7 provides the focus group responses to this question for each disciplinary area and department.

Tools

As the table shows, there was wide agreement across the disciplines about tools necessary for successful research in the majors.

The UW Library System. As Table 7 shows, students from every disciplinary area and every department mentioned the UW library system and its databases as tools necessary for effective research in their fields. The words of three students from three different majors illustrate the importance of the UW libraries in students' research work:

> *"When I get a project, I use the internet, Google, LexisNexis, ProQuest, Wikipedia. The online databases of the library materials are really valuable."*
>
> *"I think that what has been most helpful for me is the use of the library. I don't find the internet to be highly successful, so I mostly look in the books—interviews with the artists or things like that and critical and aesthetic studies of the artist or of our genre. I mostly do that at the art library, but I have used the Summit checkout thing that's available through the UW library. Also, what's really important for my major is having the ability to have access to the slide library."*
>
> *"It was a librarian who actually told me, 'This is what you do. This is what an online journal is.' I knew how to do the search, but I didn't know the difference between journals and magazines. At home, I was paying for newspaper subscription, and she told me, 'Oh no, we have all of that here and you can access it for free.'"*

As noted earlier, it is important to remember, however, that although the library, its databases, and its helpful staff were important resources for students, the databases, the journals and other publications, and other media resources that students were accessing via the UW library system differed. For example, art majors used the slide library, and math majors used the math library. In addition, the narrowness of the topics being researched in part determined the difficulty of the library research students conducted. For example, a paper arguing why Margaret Thatcher failed to fulfill one of her campaign promises might require a different level of research than one on the effects of the 1974 oil crisis on Japan.

Internet Research. As the lists in Table 7 suggest, students in every disciplinary area also made use of online information. As was true with library research, beyond use of Google as a search tool and

Table 7. Tools and skills necessary to do research by disciplinary area and department

Department	Tools	Skills	How Learned
		Arts and Humanities	
Art/Art History	• UW Library, especially the slide library • Google • Google Images • People with knowledge about materials or art	• Search the internet and the library effectively • Let the creative process direct the outcome • Remain open and observant • Develop some kind of note-taking practice • Ask for information from others/networking skills	• Instruction provided by specific classes • Trial and error • One-on-one with faculty • Help from librarians • Having an observing and curious temperament • Other students • The FIG seminar • High school experiences
English	• OED • Project Muse • JSTOR • Lion (Literature Online) • Summit	• Use the tools, primarily online library databases, effectively • Write an effective argument	
Philosophy	• The UW libraries • JSTOR • Endnotes • RefWorks • Google Scholar • LexisNexis	• Knowing how to navigate the UW library system • Logic • Curiosity • Patience and liking to read	
Spanish	• UW library databases • The Spanish Dictionary online • Thesauruses • Wordreference.com	• Spanish language skills • Use of library databases • Use of other online resources • Knowing MLA style	
		Engineering	
Computer Science and Engineering	• UW Library databases • Association for Computing Machinery Portal • IEEE exporter • Google • Wikipedia • Other internet sources • Google Tech Talk videos • J-grasp • Java-Swing tutorials • Application Programming Interfaces	• Everything learned in CSE 142/3 • Determination • The ability to understand source code • Ability to adapt to new situations and apply course examples to later work • Problem-solving skills ~ sometimes teaching oneself to use new computer programs in order to solve the problems • Creativity	• Trial and error • Instruction provided by specific classes • Other students and people with knowledge (sometimes met electronically) • Jobs and internships • Having a problem-solving temperament
Electrical Engineering	• Newsgroups • Forums • Electronic bulletin boards • Library databases • MatLab • Physical lab equipment (unspecified) • User manuals	• Being able to use online search skills to locate the most current information • Knowing specifically what to look for • Knowing where to look, such as where to locate reliable code or information about MatLab • Using human resources, including peers, faculty, and people they have met online whose reputations they trust to solve problems • Evaluating sources; researching the information one has found	

Table 7 (continued).

Department	Tools	Skills	How Learned?
		Math/Sciences	
Biology	• UW Library databases, specifically PubMed • Google Scholar • SPSS • R • JNB	• Searching library databases effectively • Writing scientific papers • Having strong interpersonal/team skills • Understanding a range of computer programs • Observing and record-keeping • Knowing and being able to use laboratory techniques • Thinking critically and troubleshooting problems • Reading skill: being able to read a scientific paper	• Trial and error • Instruction provided by specific classes • Having a temperament of curiosity and self-motivation • Hands-on work in the lab, including observing others and being observed oneself • Reading scientific articles • One-on-one from faculty or grad students • Help from librarians
Chemistry/ Biochemistry	• UW library website • Web of Science computer databases • SciFinder Scholar • Physical equipment useful to one's subfield	• Necessary skills vary from one chem./biochem subfield to another • Accessing and understanding scientific articles • Writing scientific papers • Precision and accuracy in the lab • Using a lab notebook	
General Studies/ Public Health	• PubMed • Medline • JSTOR	• Skill at using the databases to locate relevant articles • Reading articles critically • Data analysis • Understanding of different research methodologies	
Math	• The math library • The internet, particularly the aspect of it where one source leads you to others • Mathematica • Sage • Computer algebra systems • Knowing how to code	• Knowing how to use the tools	

Table 7 (continued).

Department	Tools	Skills	How Learned?
		Social Sciences	
Communication	• Google • Wikipedia • JSTOR • LexisNexis • ProQuest	• Clarity about research goals • Using one source to find others • Learning to be a good media and communication critic • Knowing how to skim (the value of control F)	• Instruction provided by specific classes • Trial and error • Help from librarians • Courses outside the major • One-on-one help from faculty and TAs • Peers • Articles assigned as course readings • High school experiences
Economics	• Library databases • Online sites, such as NASDAQ trading room, the Wharton database, US census data, and Yahoo Financial • Computer programs and languages, including R, S+, Excel, and Java	• Being able to read and understand journal articles in the field • Competence in math and statistics • Graphical analysis • Knowing how to use the library • Computer skills	
Jackson School of International Studies	• Google • Google Book • Google Scholar • LexisNexis • JSTOR • ProQuest • Expanded Academic Index • Summit • Special collections • Librarians • Bibliographical management software, such as Endnote, RefWorks, KnightSight	• Everything learned in SIS 200/01 (for international studies majors) • Using the library, particularly how to find academic articles in the databases • Finding articles from other articles • Thinking critically/evaluating sources • Reading/skimming articles	
Political Science	• Google • Wikipedia • LexisNexis • JSTOR • ProQuest • Expanded Academic Index • Librarians	• Searching internet and library database resources effectively • Reading skill: noticing when writers/researchers were repeatedly linked with certain ideas; noticing writers' perspectives; being familiar with the discipline's language • Writing skill • Basic quantitative skills	
Sociology	• ProQuest • JSTOR	• Effective writing skills • Critical analysis • Understanding of theory	

Wikipedia to supply both an overview of a topic and one or two bibliographical references, the online sources students used differed from one major to the next. Philosophy majors may have used Google Scholar to find commentary on Kant and computer science engineering majors may have accessed a stranger's source code online.

Other Tools. With the exception of students majoring in art, students in the arts and humanities did not mention tools that were necessary for research in their majors beyond UW library and online resources. Similarly, students majoring in public health in math/science and students majoring in communication in the social sciences noted only UW library and general online resources (e.g., Google, Wikipedia) as necessary tools for research in their majors.

In contrast, most students in engineering, math/sciences, and social sciences noted other tools that they felt were necessary to successful research in their fields. Those tools varied, however, from one disciplinary field to another. For engineering majors, online forums, bulletin boards, manuals, sources of code, and other resources were important tools for research. For math/science majors, statistical software and other computer programs were important, as well as physical equipment used for experiments. For the social science majors, tools included statistical software, specialized online sources, bibliographical management software, librarians, and resources that support narrowly focused topics, such as the UW's special collections.

Skills

In terms of skills necessary for successful research, facility in library and internet searching was the most frequently mentioned skill essential to research in the major. Students in 11 of the 15 majors in the UW SRS noted the importance of this skill, as Table 7 shows. As one student said:

> *"Knowing which databases to use, and getting familiar with that. I've seen people waste massive amounts of time because they don't know where to look."*

However, students were quick to point out that finding information was only the first step. In the words of one student:

> "…*accessing is easy, but analyzing is something you grow with.*"

Beyond being able to find materials in the UW libraries or online, the skills that students mentioned as important to research in their majors were mostly uniquely related to those majors, as Table 7 shows. From "letting the creative process dictate the outcome" for art majors to "understanding differing research methodologies" for public health majors, the skills students found important for research reflected the disciplinary practice of their academic majors. In some disciplinary areas— particularly math/sciences— we could identify skills that crossed the majors in that area. In other disciplinary areas, such as arts and humanities, it was nearly impossible to find much common ground in the skills required of majors in the disciplinary area.

Interestingly, some skills crossed disciplinary areas. For example, students in fine arts and visual design in the arts and humanities disciplinary area noted that developing the practice of keeping an observational journal was important to research in their majors. In the sciences, biology and chemistry/biochemistry majors also noted the importance of keeping a laboratory or observation notebook. Creativity was a "skill" mentioned as important by both art and engineering majors. The importance of two key courses that provided the foundation for subsequent research was noted by international studies majors in the Jackson School and students in computer science engineering.

Skills that were shared inside the four disciplinary areas were as follows:

- Arts and Humanities
  - Conduct successful library and internet searches

- Engineering
  - Conduct successful library and internet searches
  - Know where to locate and understand source code
  - Solve problems (teaching oneself a new computer program or finding an expert online, for example)

- Math/Sciences
  - Conduct successful library and internet searches
  - Read and understand scientific articles
  - Write a good scientific paper
  - Keep an accurate record of lab work (a lab notebook)
  - Know about laboratory techniques and use them with precision

- Social Sciences
  - Conduct successful library and internet searches
  - Read and understand journal articles in the field
  - Use one source to find others
  - Understand and use basic statistics/quantitative methods
  - Think critically

Learning to Do the Kinds of Research Required by the Major

We asked students in the focus groups how they had learned to use the tools and develop the skills necessary for successful research in their majors. In addition, we asked students questions about learning to use the libraries on the survey form.

Focus Group Responses

A summary of students' focus group responses is also included in Table 7. As the summary shows, students across disciplinary area and majors learned to use the tools and skills necessary for research in two dominant ways: in specific courses where such tools and skills were intentionally taught or by trial and error.

With regard to instruction in specific courses, students in a few majors, such as international studies, said that learning about research was intentionally scaffolded into the curricula of their majors over time, so that learning about research at one level informed learning and practice at the next. However, in most of the majors, instruction in courses depended upon the goals of individual faculty members for their courses. For example, students might learn something about research skills in a 400-level course that they felt would have been useful to have learned at the 200-level.

The relative randomness of courses providing instruction in how to conduct research in the majors explains to some extent the pervasiveness of "trial and error" as the way students learned to conduct research in the disciplines. The next subsections detail students' experience in each of the four disciplinary areas, and as this part of the report shows, students in all majors spoke of having to teach themselves library, laboratory, observation, interview, programming, and other skills in order to complete the research that was required in their courses.

As Table 7 shows, in addition to instruction in specific courses and trial and error, students also frequently mentioned help provided by UW librarians and in one-on-one conversations with faculty as where they learned to conduct research in the disciplines of their majors.
Some interesting responses cross the disciplinary areas. Students in both math/sciences and the social sciences, for example, noted the importance of journal articles as ways they learned to conduct research in their fields. However, for science majors, such articles are important because they can serve as models. For example:

"I would say that a lot of the information comes from the studies themselves, that intro paragraph where they break down the method, and some of the studies are better written then others, so you can learn from them how people do things. I learned a lot from reading a ton, even studies I don't have to read."

For the social scientists articles assigned in class are important because they lead to other articles:

"You had to understand what you were searching for and how that connected to other things. You had to be able to locate things that could be remotely connected to what you were looking for. In my global communication class, we were covering Cambodia and different media outlets. You might find an article about TV and there would be a little piece about the internet, so you would have to use that and see where it led—let it lead you to other documents. You had to use each document like a stepping stone for what you were trying to find."

Another interesting idea that crossed the disciplinary areas is the idea that temperament can help students learn how to use the tools and develop the skills necessary to conducting research in their fields. Art majors, for example, often described themselves as observant by nature, which helped them in their research. Engineering majors described themselves as problem-solving by nature, which helped them teach themselves the skills they needed to conduct research in certain areas. Science majors said that they were innately curious and self-motivated, which allowed them to go the extra mile on the research projects they were involved in. Students spoke of most of these qualities as coming into play when they were asked to teach themselves how to do research that was assigned.

Details about how students learned the research tools and skills for each of the four disciplinary areas follow.

Arts and Humanities. When asked where they had learned the tools and skills necessary to conduct research successfully for their majors, students in the arts and humanities identified a variety of sources for their learning, as follows:

- *Instruction provided by specific classes.* Students in all four of the arts and humanities group (Art, English, Philosophy, and Spanish) said that one or more of their courses had provided specific instruction in the tools and skills necessary for successful research in their majors—specifically how to conduct library and/or online searches. They also noted that when other courses required research, repetition helped ease and improve their research approaches. As two students in this group said:

  "One of the best classes ever for doing research was Art History 389—she had us go and find all these random sites on the UW's library website, and that's how we found out about JSTOR and other sites online. That's a skill I consider very valuable. That class was the first time I was taught to use UW resources. I took that class when I was a sophomore."

  "I feel like I was kind of lucky because in my second quarter at UW, I was assigned to do research in online journals in English 200, and because it was a bunch of non-majors [in the class], the instructor explained the library website to all of us. That was an overview I got in my second quarter at UW, but it wasn't until my senior seminar that the professor offered to go through different journals with us. She didn't do it in class, but she made an offer to us to come to her office hours and she'd take us through the process. I think she didn't want to waste class time because she thought it would be wasting the time of some students."

- *Trial and error.* Students in three of the four majors in the arts and humanities groups said that they learned the tools and skills necessary for research in their majors through trial and error. Two students' comments illustrate this response:

  "We're just kind of thrown out there and told, 'Go learn.' It's not really learned, but experiencing—trial and error."

"When a professor tells you to do that, you think you probably should have already figured it out, so you don't want to ask in class. Like they say, 'Go look in online journals,' and you [don't] say, 'Online journals? What's that?'"

- *One-on-one with faculty members.* Students in three of the four arts and humanities majors also spoke of working one-on-one with a faculty member to learn how to use research tools and skills in their majors. For example:

  "For art history 471, a lot of the things we were researching were very specific, and we submitted the draft to the professor. She'd read and suggest some articles or books or something. One of those she suggested for me was an article in a book, but the only copy of that book was in Rome. I thought I wouldn't be able to use it, but then I remembered that you can request a part of a book and they'll scan it and send it to you. So I requested a pdf of the pages I wanted, and they sent it to me in a week. That chapter was the most useful thing in the paper. Just trying to know what is possible is important."

  "I guess when I started at the UW, it didn't occur to me that professors would really help in the sense of pointing you in the direction you need to go to get your information. I had this idea that they give you the assignment and part of the learning experience was that you figured out how to get what you needed. So I never looked to them for direction. But I found out in one of my last quarters that they are really willing to help if you tell them you aren't sure what direction you need to go."

- *Help from librarians.* Students in three groups also pointed to help they had received from librarians, usually in the library. One student advised:

  "Consult a librarian one-on-one as soon as possible, even if a librarian speaks to a whole class."

- *Temperament.* Students in two of the groups noted that often the skills most useful to research in their majors was not learned but was part of the temperament they brought to the UW. In the words of two students:

  "I think generally artists are observers. It's in their nature to notice things, to be inspired by things."

  "Having curiosity, having a special interest in that topic or being confused by something or interested in something and genuinely wanting to pursue it further—just having the drive to keep doing that. With the resources they have here, you can go for as long as you want basically."

In addition, students in two of the four arts and humanities groups said that they had learned research tools and skills from the following:

- Other students, both in the major and friends. *"We all start taking classes together and tell each other."*
- The Freshman Interest Group Seminar
- High school experience

Engineering. Students in the two focus engineering groups mentioned the following when asked where they had learned the tools and skills necessary to conduct research successfully for their majors:

- *Trial and error.* When asked where they had learned the tools and skills necessary for successful research in their engineering majors, both engineering groups said that they were largely self-taught. In one student's words:

"A lot of what we do is trial and error, so you need a lot of creativity to use these things you find on the web and apply them to what you're doing. So you need to be able to think of new creative ways to apply things to your problems. I think that's cultivated here in all the projects that you do – you get better at guessing what options might work. You develop these approaches. Creativity is both adapting something to a new use and also making something new."

- *Instruction provided by specific classes.* Students in one of the two groups also noted that they had learned tools and skills necessary for research in their majors from courses in the major. In one of the engineering departments, students spoke of learning the basics for research in the two introductory courses to the major and building on that over time. As one student said:

  "I've gotten much better at doing these kinds of things from internships and CSE classes. It just builds over time."

- *Other students and people with knowledge.* Students in one of the two groups also noted that they had learned a great deal about the tools and skills necessary to do research from "human resources"—peers, graduate students, and people they had met online whose reputations they trusted, as this interchange illustrates:

  Student A: *"When it comes to designing and building, you need actual physical components—real live stuff. You need all this information that they don't teach you about—the limitations, the specifications. That's when you have to talk to people, who will tell you that you need to think about how much power it needs or what happens to this source when you add this source. And they guide you to reading other things."*
  Student B: *"I agree. I think it is underappreciated how much information is passed from person to person."*

- *Jobs and internships.* Individuals in one of the groups also said that they learned how to conduct research through work they had done as employees and as interns.

- *Temperament.* Students in both engineering majors did not find having to teach themselves to use the tools and skills necessary for successful research, because they said that figuring it out on their own was consistent with both the field of engineering and their temperaments, as this interchange suggests:

  Student A: *"Engineering is about solving problems."*
  Student B: *"It all comes natural to us. If we didn't do that we wouldn't be engineers."*
  Student C: *"That's where critical thinking comes in."*

Math/Science. When asked where they had learned the tools and skills necessary to conduct research successfully for their majors, students in math and science majors identified a variety of sources for their learning. Although students in the majors in this disciplinary area did not describe curricula that deliberately scaffolded teaching about research methods, they did describe their learning as building over time. In one student's words:

"I equate it to learning a language. You don't really remember how you learned it. You don't remember how you learned to eat soup or use utensils, but eventually you get that dexterity and you are able to eat the soup."

- *Trial and error.* Students in all four groups in this disciplinary area said that they had learned the tools and skills necessary for successful research in their fields primarily by figuring them out on their own and through repeated, self-initiated practice. Students described teaching themselves lab procedures, computer programming, library search strategies, how to write scientific papers, and a number of other skills and tools. The following quotations illustrate this response:

"For me it was a lot of trial-and-error, figuring it out on my own, clicking on random items that I thought would help me, clicking in a box, but also just walking up to a librarian and getting instruction or direction from them."

"Usually the way I learn a new skill is to just sit down and start poking at it. I learned Mathematica as a skill by sitting down and poking around and figuring out things. Same thing with a problem. Sit down and just start applying different theorems to it and see what you come up with. Eventually you'll see that something is working."

- *Instruction provided by specific classes.* Students in three of the four majors in the math/science area noted that they learned to use the tools and skills necessary to successful research from specific courses. Three examples:

  "It's important to be able to read scientific papers well. I think we did that in a class—they assigned us a paper and told us we had to find three papers on our own related to that paper. It was mostly teaching by assignment. You go get the papers and try to figure it out. There's help, though, if you need it."

  "Chemistry 317 helps. There's a course with a long revision process. One of the meaner TAs will take a red pen to your lab report and you have to try again."

  "I took Epidemiology 420—a branch of the school of public health—and they taught us a bunch of different methods of being able to compute certain statistics, like mortality rates, incidence, prevalence, age-adjusted mortality rates, and that's where I learned the whole idea that you can make a statistic mean anything, depending on how you turn it."

- *Temperament. Students* in two of the four groups identified innate curiosity and self-motivation as traits shared by many in math and science and said they were important to learning to do research in their disciplines. As one student put it.

  "All you basically need is a curious mind and a willingness to make yourself think in new ways. You also may need the general experience and tricks that you pick up in your classes. But that's secondary."

In addition, students in two of the four math/sciences groups said that they had learned research tools and skills from the following sources:

- Hands-on work in a lab, including observing others doing lab work*. "I would always ask them to show me how to do it the next time they used that procedure. Watching how it's done and having someone watch you do it is really important for accuracy. It's really critical to have that feedback."*
- Reading scientific articles.
- One-on-one with professors or graduate students*. "But mostly I've learned it through 399 or 499. That's where a grad student stands over your shoulder and says, 'Don't press that button!'"*
- Help from librarians*.*

Social Sciences. When asked where they had learned the tools and skills necessary to conduct research successfully for their majors, students in the social sciences identified several sources for their learning.

- *Instruction provided by specific classes.* Students in all the social sciences major with whom we spoke said that they learned the tools and skills necessary for research from courses in their majors. Three responses along these lines were:

  "I think that in most of my classes, we were presented with disparate readings, so it was easy to see the differences. But in one or two classes, the professor led group discussion,

and we came to the conclusions about what was a good article. We voiced our opinions and that helped us get an idea of what the other guys thought was a good argument."

"The theory class was incredibly crucial in analyzing theories or perspectives—just analyzing period. Writing a paper in that class was the hardest paper I've ever done. It was about why—not 'Here's a cat. What does the cat do?' but 'Why does it happen? What are the things that create these moves?' I learned how my perspective influences what I'm searching, how my views affect how the data comes out, and if I'm working in a group, their perspectives will come out in that data too."

"The 200-level classes prepare you to make the analyses you do later. Those classes give you the tools. It's more like what are the consequences of shifts and change. It's more theory. In the 400-level it's more things that have happened."

Students in one of the social sciences majors—international studies in the Jackson School—spoke of learning to use the basic tools and skills necessary for subsequent research in the major from the two required gateway courses in the major, SIS 200 and 201. In their words:

"I felt that learned to use the library and JSTOR through the 200 series of International Studies (SIS). They did a library presentation and our TAs would help us with tools in the library. But that was necessary to turn out the final paper for those international studies 200, 201, and 202 classes, so you learned it."

"I feel like in the introductory SIS 200 series, they really drilled us on how to approach a research question. The 'why question' was repeated dozens and dozens of times. How to build one, and what the implications that has for your research are. They may not have given you specific databases to go to but teaching you to formulate that specific research question gave you a real conceptual framework for how to approach research

- *Trial and error.* Students in all five social science majors said that they learned some of the tools and skills necessary for research in their majors through trial and error, as the following responses indicate.

  "Coming in here as a transfer student, a junior, I didn't have any class from the library. I learned about the library by just roaming the library by myself."

  "I learned [to use the UW library databases] by banging my head against the library website over and over again and then by trial and error."

- *Help from librarians.* Students in four of the five social science groups said that UW librarians had helped them learn the tools and skills necessary for research in their majors. They noted that librarians came to their classes and provided instruction in how to access materials from the library. One student said that even if students forget what the librarians tell them in those classes:

  "Knowing they are nice is important to early students."

  Other students spoke of help they received by asking librarians to assist them in the library. In the words of one student:

  "I think I learned to search when I took Communication 304, and we had to do our own research paper or outside project. And it was a librarian who actually told me, 'This is what you do. This is what an online journal is.' I knew how to do the search, but I didn't know the difference between journals and magazines. It was just a librarian who helped me. I was stressing out and needed some help, and that's why I asked the librarian."

- *Courses outside the major.* Courses outside the major were important in helping students in three of the five social sciences majors with whom we spoke. As one student noted:

  "I think other courses helped me [learn] how to write a paper and how to form arguments, how to read an argument and critique that. I think that's what helped in economics. In economics, I think I learned how to read the numbers and understand them, but I learned about how to critique arguments in other courses."

In addition, students in two of the five social sciences majors noted the following as helpful in learning the tools and skills necessary for research in their majors:

- One-on-one help from faculty and teaching assistants. *"TAs are good about being very specific about what the professors are looking for. I think it's been so long since professors didn't know how to do research that they no longer understand what you have to know to do that."*
- Peers. "*My thesis seminar has been really influential in how I do research, because we exchange rough drafts and talk about what we're doing.*
- Articles assigned as course readings. "*I've taken papers and I've looked at them and the way they've structured their research and I've mimicked them."*
- High school experiences.

Survey Questions on Library Use

When asked how they had learned to use the tools and skills necessary for research in their disciplines, students often mentioned help from librarians, and the UW SRS pre-focus group survey asked students about library use. Table 8 shows students' responses to this question by academic department.

As the table shows, about 59% of the focus group participants reported consulting with a UW librarian in some way about a research project they were working on. Of those who consulted with a UW librarian, just over half spoke with a librarian at Suzzallo/Allen (30% of all SRS students, including those who reported never having consulted a librarian for a research project) and almost half spoke with a librarian at Odegaard (27% of all students). In addition, 23% of all SRS students reported having interacted with librarians through courses they were taking, where faculty had invited librarians to come and talk with students about research. About 17% of all SRS students also reported having used a campus library other than Suzzallo/Allen or Odegaard. In terms of disciplinary differences, students in the social sciences were more likely than the rest of the SRS population to have consulted with a librarian at least once for a research project (77% versus 46%). Additionally, nearly a third (31%) of all students had interacted with librarians in more than one setting.

We also asked students to note what they had learned in their consultations with UW librarians. Most students said that they had learned how to find articles and books in the library databases. Some students spoke of learning to find specific sources, such as articles in the newspaper archives, a U.S. Supreme Court case, resources in the UW's special collections, a book or article from a different school, and topics specifically covered in a course. As one student said:

> *"They were able to direct me to new online sources and suggest articles and books I hadn't considered. The librarian in special collections also taught me how to use the card catalogue which was (surprisingly!) useful."*

Table 8. Consulting with a librarian about a research project in the major (n=134*)

Department N=135	Yes Online, such as email or live chat	Yes I went to a class at a UW library	Yes Suzzallo & Allen	Yes Another campus library	Yes Odegaard	Yes A librarian came to a class I was taking	No
Art (n=10)	0	0	1	3	5	2	5
Biology (n=16)	1	2	3	6	4	2	8
Chemistry/Biochem (n=11)	0	0	0	4	1	0	7
Communication (n=9)	2	2	2	0	5	6	1
CS Engineering (n=5)	1	0	1	0	0	0	4
Economics (n=10)	1	1	3	1	1	1	5
Elec Engineering (n=5)	1	0	0	1	0	1	3
English (n=12)	0	0	4	1	3	1	6
GenSt/Public Health (n=8)	0	0	4	0	3	3	1
International Studies (n=13)	4	1	9	4	5	6	1
Mathematics (n=4)	0	0	0	1	0	0	3
Philosophy (n=5)	0	0	0	1	0	0	4
Political Science (n=16)	3	2	7	1	6	4	5
Sociology (n=5)	0	1	3	0	0	2	0
Spanish (n=6)	0	1	3	0	3	3	2
All Departments	13 (9.6%)	10 (7.4%)	40 (29.6%)	23 (17.0%)	36 (26.7%)	31 (23.0%)	55 (40.7%)

Note: Totals add to more than 100% because many students interacted with librarians in more than one setting.
**Some students did not respond to this survey question.*

Several students also mentioned that they had learned the physical location of books and articles for their majors in the library. In addition, individual students mentioned that they had learned the following:

- Techniques for finding the right resources
- The difference between peer-reviewed journals and other sources
- Ideas about sources that student had not considered: "*They were able to direct me to new online sources and suggest articles and books I hadn't considered."*

Students were very positive about the contributions UW librarians made to their research. As one student advised:

> *"Consult a librarian one-on-one as soon as possible, even if a librarian speaks to a whole class."*

Challenging Projects

We asked students to bring or email us a project that had required research for a class in the major, and during the focus group, students were asked:

Can you tell us briefly about the project you brought with you? Why did you choose this project to bring with you today and why was it challenging for you?

Students brought a wide range of projects, from photographs of pieces of art they had created to scientific papers. Projects represented a variety of research methods, and the challenges that students described in completing the projects ranged from the level of research required to the difficulties in writing a scientific paper. Students' reasons for bringing projects also varied, from a sense of pride in the project to the project being the only one they could find that matched our criteria.

Table 9. Challenges in the projects students brought

Disciplinary Area	Challenges
Arts & Humanities	• Being unfamiliar with the topic/subject of the assignment being researched • Finding enough information • Formulating one's own argument/coming up with one's own idea • Separating out what was important from a large body of information
Engineering	• The large, complex scope of the problems under study • Learning new programs, concepts, or processes on one's own and at the same time you are using them • Having little familiarity with the subject of the application or the thing you are building
Math/Sciences	• Having to write a scientific paper • Coming up with an original idea/question • Analyzing and interpreting data • Gathering information
Social Sciences	• Using/understanding statistics and quantitative reasoning • Using theory; relating research to theory • Evaluating the data used in other sources • Coming up with one's own idea/figuring out a position • Finding the right information or enough information, especially for narrow topics • Using the research to make a cohesive argument

As had students' projects and their reasons for bringing them, the challenges that students said they had experienced in completing the projects varied quite a bit from one major to another, even within disciplinary areas. Table 9 shows a summary of the challenges frequently identified by students in majors in each of those disciplinary areas. As the table shows, students in arts and humanities, math/science, and social sciences found coming up with an original argument or idea challenging. In addition, students in arts and humanities and the social sciences said that finding the right information or gathering enough information was a challenging aspect of the projects they brought to the focus group sessions. However, beyond those similarities, challenges identified by students in each area differed from those mentioned in the other areas.

In addition to asking students to speak about the challenges presented by the research example they brought to the focus group, we asked them in the survey preceding the focus group whether they could have produced that piece of work as entering freshmen. Table 10 shows students' responses to that question by disciplinary area and major; the table includes a relevant comment by a student in each major.

Table 10. Could you have produced the piece of work you brought as an entering freshman?

Department	Yes	No	Why	Quotation
			Arts and Humanities	
Arts (n=10)	1	9	• Lacked the knowledge and understanding gained by courses in the major • Lacked the necessary research skills • Lacked skill in observation • Lacked ability to understand art	"*A lot of what I have to offer to my work now involves life experience and knowledge from art history and learning how to observe work and thinking about concept and material I had to acquire through classes*."
English (n=12)	0	12	• Lacked the necessary research skills • Lacked the writing skills, including ability to organize, to identify a good argument, and to sustain an argument in a lengthy paper. • Lacked critical thinking skills.	*"I don't think I had the sophistication of thought as a freshman to allow me to think as critically as I can now; the piece I brought in yokes disparate ideas and mediums through one fairly well articulated idea."*
Philosophy (n=5)	0	5	• Lacked the necessary research skills • Lacked the critical thinking skills • Lacked the writing skills • Lacked the ability to read such dense texts • Lacked knowledge of the topic	*"It was the type of paper that took highly organized and critical thinking and preparing that I found very challenging—even now."*
Spanish (n=6)	1	5	• Lacked the necessary research skills • Lacked adequate Spanish language skills • Lacked the writing skills	*"My skills at finding credible information at the library (JSTOR, MLA Database etc.) have grown a lot since freshman year. Also, my knowledge of the Spanish language has also become much more proficient."*
Total A/H	***2***	***31***	***93.9% reported that they could not have produced the research paper/project as freshmen.***	
			Engineering	
Computer Science (n=5)	0	5	• Lacked necessary programming knowledge • Lacked knowledge of calculus and statistics • Lacked the ability to work on a team • Lacked time management skills	*"I barely knew how to program as a freshman and didn't know the statistical methods and calculus needed either."*
Electrical (n=5)	0	5	• Lacked the knowledge and understanding gained by courses in the major • Lack of understanding of the proper equipment and tools • Lack of critical thinking skills • Not having a network of engineers and others to serve as resources	*"It required knowledge from the courses previous to it in order to complete the project, and research was performed mostly using a computer with internet access, but required new tools."*
Total Engin	***0***	***10***	***100% reported that they could not have produced the research paper/project as freshmen.***	
			Math/Sciences	
Biology (n=16)	1	15	• Lacked the knowledge and understanding gained by courses in the major • Lacked understanding of experimental design and scientific method • Lacked sufficient laboratory skills • Lacked the ability to read and understand scientific papers	*"Looking at a graph for the first time with the notations on it, I said, 'What the heck is that?'"*
Chemistry/ Biochemistry (n=11)	3	8	• Lacked the knowledge and understanding gained by courses in the major and in other life sciences • Lacked sufficient laboratory skills • Lacked the ability to find good sources • Lacked the necessary reading and writing skills	*"[As a freshman, I lacked] the knowledge and lab skills required. I stretched my abilities after taking general and organic chemistry. Before taking those courses, I wouldn't have been able to perform what was required."*

Table 10 (continued).

Department	Yes	No	Why	Quotation
General Studies/ Public Health (n=8)	0	8	• Lacked the necessary reading and writing skills • Lacked the knowledge and understanding gained by courses in the major • Lacked knowledge of available resources • Lacked critical thinking skills	*"At the time I entered as a freshman, I did not have the knowledge about half of the resources available to me. My writing skills were not very developed, I hadn't taken any statistics classes and did not have much research experience."*
Mathematics (n=5; one student said she did not do research)	1	4	• Lacked sufficient mathematics skills and knowledge • Lacked statistical knowledge • Lacked knowledge of how to use MATLAB	*You have people [in the Math Department like Student A in this focus group] who have taken graduate courses, but for most people, you are only just beginning to do that kind of thinking. Undergraduate research is hard because I'm not sure you are even well-equipped to do it as an undergrad."*
Total M/Sci	***5***	***35***	***87.5% reported that they could not have produced the research paper/project as freshmen.***	
			Social Sciences	
Communi-cation (n=9)	1	8	• Lacked the knowledge and understanding gained by courses in the major, including knowledge of communication theory • Lacked experience in writing and thinking • Lacked critical thinking skills • Lacked the necessary research skills • Lacked ability to complete a complex assignment	*"It took a developed form of critical thinking in order to think through the problem and come up with a solution."*
Economics (n=10)	3	7	• Lacked the necessary research skills—knowing what resources were available • Lacked the knowledge and understanding gained by courses in the major, including knowledge of calculus and economic theory • Lacked the analytical/critical thinking skills necessary • Was not diligent enough earlier	*"Although I had some of the technical knowledge, I didn't have the theoretical knowledge or the diligence as an entering freshman."*
International Studies (n=13)	2	11	• Lacked the necessary research skills • Lacked the ability to read effectively • Lacked the ability to analyze and evaluate sources and information • Lacked adequate writing skills • Lacked knowledge of theoretical perspectives • Lacked knowledge of how to conduct interviews • Lacked understanding of the topics	*"My knowledge of how to find appropriate sources, how to use the library system and how to evaluate sources and information would not have been adequate."*
Political Science (n=16)	4	12	• Lacked the necessary research skills—knowing what was available and how to access • Lacked knowledge about the topics • Lacked the ability to read and analyze texts • Lacked knowledge about research methods, including case study and statistical methods • Lacked ability to conduct research in order to write analytical papers	*"As an incoming freshman, I had no tools (theoretical) or basic political knowledge to either know how to question or not take for granted all the fundamental discourse and underlying assumptions held to be true by the Political Science Department."*
Sociology (n=5)	1	4	• Lacked knowledge of how to conduct interviews • Lacked the necessary research skills • Lacked statistical knowledge • Lacked computer skills • Lacked familiarity with "the sociological perspective" • Lacked sufficient communication skills to report findings	*"There is a level of both research and comfort with sociological discussion that I would have been unable to match then."*
Total SSci	***11***	***42***	***79.2% reported that they could not have produced the research paper/project as freshmen.***	
TOTAL ALL	***18***	***118***	***86.8% of all participants reported that they could not have produced research paper/project as freshmen.***	

As Table 10 shows, about 94% of the arts and humanities majors, 100% of the engineering majors, 88% of the math/sciences majors, and 79% of the social sciences majors reported that they would not have been able to produce the project they brought as freshmen.

Students in each group listed a variety of reasons for being unable to produce their projects, including not having the following skills and knowledge:

- The knowledge and understanding about the field gained by courses in the major (noted in nine of the 15 majors)
- Sufficient research skills (noted in nine of the 15 majors)
- The necessary critical thinking/analytical skills (noted in seven of the 15 majors)
- The ability to read articles in the field (noted in four of the 15 majors)
- Lacked writing skills (noted in three of the 15 majors—all in the arts and humanities)
- Lacked understanding of statistics/quantitative reasoning skills (noted in two of the 15 majors)

The Most Important Thing to Know to do Well on Research in the Major

We asked students in all focus groups to respond to the following question:

What would you say is the most important thing for a student in your major to know about doing well on research projects in your field?

Table 11 shows students' responses to this question by department and grouped by disciplinary area. The table also includes a quotation that serves as an example of students' responses in the disciplinary area.

The most frequently mentioned lessons that students in the 15 focus groups noted and the departments in which the students who mentioned them were majors included:

- Use all resources available ~ English, Philosophy, Electrical Engineering, Biology, Chemistry/Biology, Math, and Communication
- Take time at the beginning of a project to make sure you understand the assignment and clarify, if necessary ~ Electrical Engineering, Biology, Communication, Economics, and Political Science
- Seek help from faculty ~ English, Spanish, Math, Economics, and Sociology
- Learn to read and use journal articles in the field ~ Biology, Chemistry/Biology, GS/Public Health, and Sociology
- Start early ~ Philosophy, Chemistry/Biochemistry, Communication, and International Studies
- Learn to use the library ~ Art, Communication, International Studies, and Political Science
- Write well ~ English, International Studies, Political Science, and Sociology

As Table 11 also shows, students in several groups also mentioned personal qualities that they felt were valuable for those conducting research in their disciplines, including:

- Be open and willing to change (Art)
- Be self-motivated and/or proactive (Communication, Economics, Political Science)
- Be tenacious (International Studies)

Table 11. Most important things for majors to know to be successful at research

Disciplinary Area & Department	Most Important Thing for a Major to Know about Doing Well on Research
Art and Humanities	
Art (n=10) *"You kind of have to be like the clay—pliable, open, willing to change, teachable."*	• Learn how to use the library • Know what you want to communicate • Be open and willing to change
English (n=12) *"[Using what you have already learned is] research you've already done. Working with that kind of material shows you are connecting ideas while asking for minimal work on your part."*	• Write about what you are interested in • Use what you have already learned • Talk to faculty • Write well • Take English 202/197 early
Philosophy (n=5) *"Read, reread, and reread."*	• Start early • Research all sides of the argument • Use all resources
Spanish (n=7) *"If you have any anxiety about it, do the office hours more than once."*	• Research in the major is not taxing • If you need help, go see your faculty member during office hours
Engineering	
Computer Science Engineering (n=5) *"A lot of what we do is trial and error, so you need a lot of creativity to use these things you find on the web and apply them to what you're doing. I think that's cultivated here in all the projects that you do."*	• Learn and understand programming languages • Be able to adapt to new situations; apply coursework to later examples, • Use creativity in problem-solving
Electrical Engineering (n=5) *"Don't stick to one thing. You never know where the answer to the question you are asking may come from."*	• Be open to all sources of information • Use human resources, particularly other students • Spend more time at the beginning than you may think is necessary
Math/Sciences	
Biology (n=16) *"Looking on commercial sites like Amgen's and others—they have protocols for what they sell. I use a fluorescent microscope and the company website gives you direct information about that."*	• Use all resources available • Learn to find and analyze scientific papers • Clarify everything before beginning the research • Take detailed lab notes
Chemistry/Biochemistry (n=11) *"I'd say that most important is to be able to let yourself ask others questions. If you don't know, you need to ask other people who know. For example, even in organic chemistry, you mix the chemicals together—does this color appear?—ask the TAs—is this this or is it this? They have experience in that sort of thing."*	• Get started early • Be motivated enough to fully understand the purpose of the research before starting • Use all resources available • Use the scientific literature to support your own research and show you how to set up experiments, how to write according to scientific standards, and how to gauge the originality of the work.
GS/Public Health (n=8) *"In [one of my classes], we read through research papers together and discussed what things meant—how this part of the paper was used to set up this other part of the paper. It can be difficult to get information out of research papers if you haven't been shown how to use them."*	• Know what resources are available early in the program • Seek to understand cultures different from one's own • Get comfortable with reading and interpreting scholarly work from academic journals • Be thorough

Table 11 (continued).

Disciplinary Area & Department	Most Important Thing for a Major to Know about Doing Well on Research
Math (n=6) *"Very little worth knowing comes easily. Research takes a lot of work, a lot of time. If you had 30 hours a day, it's not enough."*	• Recognize that research takes time • Scale down your expectations for yourself in order to do the math you need to do • Work on the biggest problems • Know a professor to whom you can turn for help
Social Sciences	
Communication (n=9) *"…sometimes there is a lot of gray area, and when you turn it in and present it, they may say, 'No this really wasn't what I was looking for.'"*	• Get started early • Have a clear sense of what the professor wants in the assignment before beginning • Be self-motivated; take initiative • Know the library; talk to a librarian • Be aware of all the resources available to you
Economics (n=10) *"You take a big thing—like you want to see if communist countries are poorer than capitalist countries—but then you have to keep defining what specifically you mean—what time period, what countries."*	• Be proactive. • Have the courage to approach the faculty with questions. • Be specific about what you are trying to do in your project before you begin it. • Use the tools and the language given to you in your classes
International Studies (n=13) *"I think the most important thing is starting earlier than you would start for something in any other major."*	• Start early. • Begin with a "why" question • Have a clear thesis • Pay attention to the flow of the argument • Back up the argument with good quality research • Work with topics that are interesting enough to sustain over the time • Think critically • Consult a librarian as soon as possible, even if a librarian speaks to a whole class • Limit the amount of time you spend on your research • Be tenacious
Political Science (n=16) *"In my freshman year in some of my courses when I was writing my papers I was limited by wanting to use big collegiate words. I couldn't understand why I couldn't break a 3.7, so I talked to the TA, and she said, 'You just need to be explicit. You need to answer the question and answer it simply.' I saw this phrase once that an essay doesn't have any extra words, just as a drawing has no extra lines and a machine has no extra parts. And that's stuck with me."*	• Know how to use the library system/resources and talk with librarians • Be proactive about talking to professors and TAs ahead of time to clarify their expectations for assignments • Seek help with writing • Understand that in being asked to do research, students are being asked to build on others' arguments • Understand quantitative methods
Sociology (n=5) *"I also think getting involved is an important part of research. Sometimes you don't know what you want to do; you've just got this burning inside you to do something, and to me research is just letting out that burn. Learning what people are doing in your department, tagging along on their research, going to lectures. I've never been more amazed than I am by the amount of opportunity available here."*	• Know how to write • Read a lot of journal articles • Check in with the TA or professor about the project; see if they will read a draft • Get involved in your project and in the research going on in the department • Be familiar with electronic databases

How Much Majors Learned about Finding and Using Information

In the surveys that students completed before the focus group conversations, students were asked to rate how much they had learned about finding and using information, as well as to assess their levels of confidence in this area. Students were presented with a four-point rating scale ("none," "some," "quite a bit," and "a great deal"). Table12 shows participants' responses to these three questions, grouped by disciplinary area.

As the table shows, on average, students' confidence level in every disciplinary area exceeded how much they felt they had learned about finding and using information while at the UW. In addition, students' average ratings for how much they had learned about finding and how much they had learned about using information were very close, around a "B" grade, with students rating their confidence about finding and using information in the future at about a B+.

Table 12. How much majors learned and how much confidence they have in their ability

Disciplinary Area	N	How much learned at the UW about finding information? (Mean)	How much learned at the UW about using information? (Mean)	How much confidence do you have in your ability to find and use information in the future? (Mean)
Arts and Humanities	33	3.0	3.2	3.4
Engineering	10	2.6	2.7	3.1
Math/Science	39	3.0	3.1	3.3
Social Sciences	52	3.0	3.0	3.4
ALL	134*	3.0	3.0	3.3

**Some students did not answer all survey questions.*

Students in engineering rated their abilities to find and use information and their level of confidence for future research a bit lower than did students in the other disciplinary areas. However, two aspects of this group of students set it apart from the others. First, the sample size for engineering is much smaller than that for the other three disciplinary areas; therefore, it is difficult to generalize from the group of participants. Second, students in both engineering majors included in the UW SRS spoke of the need for gathering only the most current information in order to conduct research and the rapid changes in information in their fields.

These aspects of their fields meant that most of their research was done online, and students noted that it was difficult to "teach" them how to find and use these sources. In addition, seniors in engineering are aware that these sources and how we access them are likely to change many times over as they move through their careers; therefore, one's confidence in how well he or she may be able to access information and conduct research in the future may be time-stamped.

Improving the Undergraduate Research Experience

Students were asked in the focus groups:

What, if anything, could the UW or your department have done to make your research experience in your major better?

As Table 13 shows, in responding to this question, students often identified improvements to the major, rather than only addressing how their research experience could be improved, sometimes noting a relationship between the two. Five themes in students' responses crossed departments and disciplinary areas. Those themes and the majors of the students identifying them were:

- Provide more instruction in how to conduct research
    - Art
    - Biology
    - Computer Science Engineering
    - English
    - International Studies
    - Philosophy
    - Political Science
    - Public Health

- Give students more information about departmental resources and research opportunities
    - Chemistry/Biochemistry
    - Communication,
    - Computer Science Engineering
    - Economics
    - Electrical Engineering
    - Public Health
    - Sociology
    - Spanish

- Require more research (earlier in the program)
    - Chemistry/Biochemistry
    - Communication
    - Economics
    - English
    - Math
    - Political Science
    - Sociology

- Focus on writing by providing students with help in writing in the major or by requiring more writing
    - Chemistry/Biochemistry
    - International Studies
    - Math
    - Philosophy
    - Political Science

- Connect students in the major to the world of work related to the major
    - Art
    - Communication

Table 13. What could the department or UW do to improve your research experience?

Department	Disciplinary Area and Response
Arts and Humanities	
Art	• Connect students to the art world and the business of that world • Offer better information on contemporary and/or less well-known artists in art history • Offer students instruction in library use early • Understand the role of research in the creative process —both formal research that is driven by an idea a student already has and less formal research processes that may find their way into students' creative work
English	• Teach majors to do library research in English 202/197 • Teach students how to bring things together into a paper • Require more research and guide students in the process
Philosophy	• Provide instruction in research and writing in the discipline early • Provide more instruction to graduate students teaching courses • Keep Suzzallo open longer
Spanish	• Include a focus beyond literature • Require research that is more challenging • Acquire more library resources and make them easier to access • Provide more information to students about departmental resources
Engineering	
CSE	• Provide formal training on where to find information (including C++) • Provide a list of available research opportunities to majors
EE	• Provide an online resource that gathers into one place the datasheets for all the parts that the EE Store sells, the relevant user manuals, a page of "useful commands," and "the few simple tricks we commonly use" • Encourage students to do internships • Host an EE forum
Math/Sciences	
Biology	• Make laboratory training and experience available to students earlier • Encourage freshmen interested in biology to speak with departmental advisors before entering the major • Require a statistics class and/or a bioinformatics class; do not require physics • Provide more small upper-level classes for majors
Chemistry/ biochemistry	• Provide instruction in scientific writing • Incorporate research earlier • Require more writing in general chemistry • Help students find research opportunities • Provide support for *both* pre-professional and other biochemistry majors
GS/Public Health	• Require actual public health research • Make public health a real undergraduate major • Offer a class in research methods • Advertise the help available at Odegaard and Suzzallo libraries
Math	• Require more research earlier in the program • Provide instruction in writing in the discipline • Require courses in programming • Create a faculty-to-undergraduate mentoring system
Social Sciences	
Communication	• Require more research • Limit redundancy in the theory, passages, videos, and other materials used in classes • Provide students with information on research projects taking on undergraduate researchers • Connect experience in the major to careers after the major
Economics	• Require more research • Require a capstone experience • Give students information on opportunities in the major • Ask for more collaborative work
International Studies	• Provide instruction in advanced research strategies and methods • Emphasize peer review • Clarify qualifying paper requirements
Political Science	• Require more research • Create a curriculum that allows students to build skills • Require more writing • Require a course in research methods, particularly quantitative methods, for undergraduates
Sociology	• Give undergraduates more information about available research opportunities • Give undergraduates more information about resources, such as the sociology writing center • Provide funding for students assisting with research • Require more research projects that take students through the steps of the process

Research Outside the Classroom

We included a question in the focus groups on research students did independently, because previous research on the undergraduate experience (Beyer et al., 2007) has shown that nearly all UW undergraduates regularly add to their knowledge by looking up additional information and material, mostly online and mostly related to their courses.

This question, however, focused on the research students did for their own knowledge acquisition and growth, rather than on independent research they had conducted in relation to coursework. All students reported doing research—mostly online—about topics they were interested in. Some of the more interesting responses and the major of the student respondent were as follows:

- How to make a book (Art)
- How to use compost worms in one's apartment (Biology)
- Anime (Chemistry/Biochemistry)
- Best teaching methods for literacy work (Communication)
- Visiting different online streaming music libraries to learn about different composers (Computer Science Engineering)
- Iceland (Economics)
- Learning to sew and sewing machines to buy (Electrical Engineering)
- The recipe for a dish the student had in Germany[+] (English)
- How to conduct an interview (Public Health)
- The veracity of assertions made by people on talk radio shows (International Studies)
- Comparisons of differing translations of Greek myths (Math)
- Pedagogy and learning styles[++] (Philosophy)
- Dance – approaches and performances (Political Science)
- Legal requirements for protesting the Church of Scientology (Sociology)
- The role of art in social change (Spanish)

+ "I give total props to the library staff. When I was in Germany, I had a German dish, and I did not know how to make it. I went to the librarian and asked that question. They looked for it, but they couldn't find it, so they got a bunch of other librarians to look for it. They found something similar in a Hungarian cookbook they had. And it was the recipe! I had a lot of respect for the staff after that."
++ "Reading about different learning styles is important to me. I've seen this attitude a lot—if a student can't learn that's a problem with the student not the teaching. I think sometimes that's because the teacher has a very narrow way of teaching. I've looked up inductive vs. deductive teaching. Tutoring got me to do that. Research on different learning styles helps me be more sensitive to that."

CONCLUSIONS

We can draw the following conclusions from the UW SRS:

- All students conduct research while at the UW, and almost all of them conduct research inside and outside their majors.
- The research students did in high school is not likely to help them with the research required in college. Even the one method that 76% of the participants reported having done in high school—consulting texts that are found in the library or online—requires different knowledge at the UW than it did when students found and used texts in high school. At the UW students use specialized databases and journals to locate information for specific academic disciplines, which was not true of high school research. Beyond consulting texts, entering students have had very little experience with the kinds of research methods they are required to use in their majors.
- Differences in purpose and methods characterized research in the disciplines. Some of the noteworthy differences included:
    - Research in the humanities differed from research in the arts, and differences were rooted in the purposes of research for both. In the arts, the purpose of research was to help students create something new. Therefore, research methods in the arts could be formal, such as conducting interviews, consulting texts, and conducting experiments on materials. However, research in the arts could also be fluid, continuous, and untraceable in the piece it informs. In the humanities, the purpose of research was primarily to interpret an object or a text that someone else created. Humanities research frequently relied on consulting texts online and in the library databases for support for interpretations and could be traced in the papers and projects it informed via footnotes.
    - Research in mathematics was somewhat different from research in the sciences. While both processes may include trial-and-error and experimentation, pure math research was often a more internal process than research in other sciences, needing fewer physical tools and less knowledge in their use.
    - Research in interdisciplinary science fields, such as public health, differed from research in traditional science fields, such as biology and chemistry, in that it was less focused on one's own experimental work and more on the experimental work of others, as well as a wider array of research methods, such as interviews.
    - Research in social sciences appeared similar across majors, but each of the social science disciplines was highly specialized, favoring certain methods over others and therefore, certain research approaches over others.
- Some similarities in purpose and methods across disciplinary areas were surprising, such as:
    - The purpose for research conducted in the arts was similar to that described for engineering. The purpose of research for both was to inform the creation of something new, whether that was a painting or a computer program.
    - The method of research conducted in mathematics was similar to that described for philosophy, in that both relied primarily on the mind of an experienced student wrestling with the internal logic of an argument or problem, rather than seeking external validation or evidence.
- With the exceptions of seniors in international studies and computer science engineering, students did not feel that the curricula of their majors were intentionally structured to teach them how to conduct research. Most students said that they had learned to do the kinds of research required by

their majors by trial-and-error or from random courses inside or outside their majors. Students also received help from UW librarians, and most of them had learned about conducting research projects from one-on-one consultations with librarians or because librarians had been invited by faculty to come to their classes and speak to students about research.

- Students evaluated how much they had learned about finding and using information at the UW as a grade of about "B" (3.0 out of 4.0), and they evaluated their confidence at being able to find and use information in the future as slightly higher—a B+ (3.3).

- Regardless of disciplinary context, students' comments about what the most important things were for conducting research successfully in their majors were similar. Students from a number of fields recommended that others:

  - Use all resources available
  - Take time at the beginning of a project to make sure you understand the assignment and clarify, if necessary
  - Seek help from faculty
  - Learn to read and use journal articles in the field
  - Start early
  - Learn to use the library
  - Write well

- Similarly, regardless of disciplinary context, students' suggestions for improving the undergraduate research experience in their majors were similar, as follows:

  - Provide more instruction in how to conduct research
  - Give students more information about departmental resources and research opportunities
  - Require more research (earlier in the program)
  - Focus on writing by providing students with help in writing in the major or by requiring more writing
  - Connect students in the major to the world of work related to the major

- How we define research determines what we capture when studying information literacy. In the UW SRS, students' comments about what research meant to them raised questions about what institutions count as research. For example:

  - Art and creative writing majors spoke of gathering images constantly, creating a pool they might draw on later, as well as gathering images that were related to specific projects they were working on. Engineering majors spoke of a similar kind of activity.
  - English, Spanish, and philosophy majors spoke of the careful re-reading of a single text to gather information for papers they were writing.
  - Mathematics majors spoke of sorting through what they had in their own heads in order to solve problems, and some of them spoke of a trial-and-error/testing-and-evaluating approach to solutions that seemed similar to science majors' descriptions of conducting experiments.
  - Nearly all students had topics, ideas, and interests that they were researching on their own online, some of which related to their courses and majors and some of which was motivated by their independent interests.
  - Spanish majors spoke of study abroad as research in their majors, because their primary purpose for study abroad was to improve language skill and experience a Spanish-speaking culture.

  These examples suggest that if we are educating students to conduct research in their majors, we need to define research in such a way that includes them. We need to know how well we are teaching students to look, to listen, to test new information against knowledge they already have, as well as to find, evaluate, and use information.

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APPENDIX A: FOCUS GROUP PROTOCOL

UW Senior Research Study
Focus Group Questions on Research (90 minutes)

Note: Explain that we are speaking of research that is required by courses, not of research they do for courses but which is not required, until the last question.

1. Thinking about the **two lists you made on your surveys** about the research you've done in your major and the research you've done in courses outside your major, has the research you've done in courses in your major differed in any way from the research that was required in classes outside your major? If so, how?
   Prompt: Research in your major done primarily **alone or with others?**

2. What **tools and skills** are necessary for you to do research effectively in your major?
   Prompts: **Tools?** (examples: software, electronic database, petri dishes and beakers, camera)
   Skills? (examples: statistics, programming/coding, writing, interviewing)
   Examples? Courses?

3. How did you **learn to do** the kinds of research required by your major?
   Prompts: Did you receive any **instruction** in how to do that research in any of your classes?
   Did you receive **help from peers**?
   Did you receive **assistance in the library**—a class or a one-on-one consultation?

4. Can you tell us briefly about the **project** you brought with you? Why did you choose this project to bring with you today and why was it challenging for you?
   Prompts: *Keep it short!*

5. What would you say is **the most important thing** for a student in your major to know about doing well on research projects in your field?
   Prompts: **In addition to simply getting started early**?

6. What, if anything, **could the UW or your department have done** to make your research experience in your major better?

7. What about research **you've done on your own**? Have you gathered extra information on something when you weren't required to do so?
   Prompts: Why did you do that? Are these mostly class-related or other?
   When did you start doing that?
   How did you learn to do that?

8. Do you think you're a better researcher now than you were a year or so ago? If so, what have you learned that has made you better at research now than you were then and how did you learn it? If not, why not?
   ASK IF TIME PERMITS

ADD after #8 for appropriate department

Communication: The Communication department has discussed creativity as an important learning goal for its majors. What would you say creativity means in the major? Do you feel that you've been taught to think creatively in the major?

Sociology: Do you see any connections between the methods sociologists use to collect information and how that information is analyzed? If so, what are those connections?

APPENDIX B: UNIVERSITY OF WASHINGTON SENIOR RESEARCH STUDY (UW SRS), PRE-FOCUS GROUP SURVEY

Definition of research ~ please read: "Research" occurs in the regular course of students' undergraduate academic experience and involves using sources outside oneself and beyond materials provided in class in order to:

- generate or explore ideas
- formulate or analyze new problems or methods
- create new knowledge or objects
- gather information
- solve problems
- support arguments
- investigate unsolved problems

Common research methods include both collecting and analyzing information in one or more the following ways:

1. Direct observation/participation (both formal, as in ethnography or fieldwork, and informal)
2. Observing performances, videos, slides, or other media
3. Studying visual images, structures, word and image relationships, or image/symbol making to inform one's own or others' work
4. Consulting experts and/or texts; collecting literature (in person, online, in the library)
5. Creating/identifying/studying case studies
6. Designing and/or conducting experiments or tests
7. Gathering digital data from computers and networks
8. Observing computer program execution and its effect on computers and networks
9. Creating/testing models and/or simulations
10. Creating/conducting surveys or use of other statistical methods
11. Conducting interviews
12. Taking measurements

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1. Please circle or underline the kinds of research you've done in your major from the list above.

2. What, if any, kinds of research did you do in your major that are <u>not</u> covered in the above definition?

3. Thinking about the challenging research project you brought with you today and about others like it in your major, could you have produced that piece of work as an entering freshman?

o Yes o No

Please explain briefly why or why not.

4. Please look over your transcript, then list the courses that required you to do research as follows below. Providing the course number (ex. STAT 311) will suffice.

Courses that were NOT in my major but required research	*Courses In my major that required research*

5. My research experience before I came to the UW was:

o **Extensive.** I used many of the research methods listed on page 1 and produced more than five researched papers or presentations.
o **Average.** I used mostly method(s) #_____(please indicate the number from the list of methods in definition on page 1) on the UW SRS definition of research and produced 3 to 5 researched papers or presentations.
o **Limited.** I used mostly method (s) #_____(please indicate the number from the list of methods in definition on page 1) and produced 1 or 2 researched papers or presentations.
o **None.** I did not do any research before I came to the UW.

6. Compared with the research I've done at the UW OUTSIDE my major, my research experience IN MY MAJOR is:

o More challenging than research I did outside my major
o Less challenging than research I did outside my major
o Equally challenging as the research I did outside my major
o I have not done research at the UW
o I did not do research at the UW in courses outside my major
o I have not done research in my major

7. Have you ever consulted with a librarian at the UW regarding a research project in your major? (check all that apply)

o No
o Yes – at Suzzallo & Allen Library
o Yes – a librarian came and spoke to my class
o Yes – online, such as e-mail or live chat
o Yes – at Odegaard Undergraduate Library
o Yes – at one of the other libraries on the UW campus
o Yes – I went to a class at a UW library

If you did consult with a librarian, what did you learn?

	1 None	2 Some	3 Quite a bit	4 A great deal
8. How much would you say you've learned at the UW about how to find the information you need?	o	o	o	o
9. How much would you say you've learned at the UW about using the information that you find?	o	o	o	o
10. How much confidence do you have in your ability to find and use the information you may need in the future?	o	o	o	o

DEMOGRAPHICS AND ACADEMIC BACKGROUND

11. What is your gender?

o Male
o Female
o Other:_____

12. Did you enter the UW as a….

o Freshman
o Transfer student
How many college credits (if any) did you earn before enrolling at the UW?_____

13. What is your ethnicity? (check all that apply)

o African American
o Native American
o White American
o Hispanic/Latino American
o Asian American
o Hawaiian/Pacific Islander American
o International Student
o Other:_____

14. What is your age?_____

15. What is your major? _____

16. Do you belong to the following honors programs? (check all that apply)

o university honors program
o departmental honors (please specify department)_____

17. In addition to your major, are you completing (check all that apply)

o a second major (if so, please specify)_____
o a minor (if so, please specify)_____