

Research Habits of WPI Project Teams

An Interactive Qualifying Project Report
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This report represents work of WPI undergraduate students submitted to the faculty as evidence of a partial degree requirement. WPI routinely publishes these reports on its web site without editorial or peer review. For more information about the projects program at WPI, see <http://www.wpi.edu/Academics/Projects>.

Abstract

This study analyzed the research techniques and efficiency of Interactive Qualifying Project teams at WPI. The relevance and reliability of the sources found were evaluated and compared to those found by a research expert to define a measure of research efficiency. The results showed that the quality of the sources found by the students compared favorably with those found by the expert. Most project teams followed the same basic search strategy, using tools such as Summon, Google Scholar, and Google. Few teams used advanced search techniques or specialized databases and often gave up if the full text of the article was not easily available. The results of the study identified areas of focus for research training programs for the Gordon Library at WPI.

Executive Summary

The purpose of this project was to study how WPI project teams approach research focusing on how the teams use the internet to search for references. We observed 13 IQP teams (44 students total) during C term of 2012. All of the teams were currently enrolled in ID2050 (Social Science Research for the IQP) in preparation for going abroad in D term. Each team was given a research question relevant to their IQP and then asked to spend 20 minutes searching for relevant literature. An experience research librarian was given the same question and the same time. We then evaluated the sources obtained to define a measure of research efficiency for the student project team.

We developed three tools in order to standardize our observations of the students:

- Pre-Observation Questionnaire: designed to collect basic information about each student and help us choose the research question for the session;
- Research Efficiency Observation Protocol (REOP): designed to guide and standardize our observations of the session;
- Research Efficiency Source Analysis (RESA): designed to measure the quality of the sources obtained during the observation session.

The REOP was a checklist that was created to be used during observation. This checklist consisted of various databases and search techniques that observers could check off when they observed a project group. The RESA was a rubric used after the observation session to rate each source in nine categories pertaining to its relevance and reliability.

All of the tools were pilot tested on four different project teams of four students each as well as an experienced research librarian in B term 2011. We used the results from this pilot test to revise our RESA and REOP before working with the 13 project teams in C term.

With the help of the library, each of the 13 IQP teams was scheduled for a 30 minute observation session before their regular meeting with the research librarian for a research consultation. The Pre-Observation Questionnaire was given to each team before the session. At the start of the observation session, a research question was identified using information from the questionnaire and in consultation with the IQP team. In each case, the research question was relevant to the project so the students had motivation for the search we would observe.

Each group was given 20 minutes to conduct research on the internet for their topic and was asked to provide the five best sources found. During this twenty-minute session, two members of our team were present to observe and the observers used the REOP to record standard observations.

An experienced research librarian was also given 20 minutes to search for sources relevant to the team's research question. Our team then took two lists of five sources for each question and evaluated them using the nine categories in our RESA. We took the average score from each team's five sources and divided it by the average score for the research expert's sources to define a "percent efficiency" of the project team.

The efficiency of the student teams ranged from 62.3% to 114%, with 9 out of 13 in the range 75-90% efficient. The most efficient team in our test outperformed the research expert, with a final efficiency of 114%. While the student scores (on RESA) were good, it was surprising that there was little overlap (5 sources) in the sources found by the students and the librarian.

Most students used basically the same search strategy. They started with Summon and then proceeded to use Google Scholar and Google. Fewer than half of the groups used any specialized academic databases. We also noted that students often abandoned a promising source if the full text was not immediately available. Finally, we observed that few students used filtering or proper keyword search strategies. In fact, many students simply entered the exact research question given and didn't try to narrow down the results.

The observations indicated a clear need for continued research education, with emphasis on filtering techniques, finding full text, and advanced keyword searching.

The original goal was to focus on an ethnographic study of how project teams approach research. The goal shifted to an analysis of research efficiency as measured by the speed of searching and the quality of sources found. The limited time allowed may have had a significant impact on what the student were willing to try when searching. We did not obtain enough data on the pre-observation questionnaire to come to any conclusions regarding the impact of the students' background or research experience at WPI.

For future studies using our tools, we suggest that our tools are revised and that research questions specific to the participating teams project are still used. We also suggest that future studies find a way to minimize anxiety during the observation sessions.

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Introduction

The Merriam-Webster dictionary simply defines research as “a careful or diligent search.” Research is not only a tool to be used for school papers and projects; it is also used throughout our everyday lives. People are constantly researching, whether it’s to find credible information on American history or simply looking for ways to save money at the grocery store. Research is about gaining knowledge.

Over time the way research has been conducted has changed drastically. We have advanced from passing down knowledge using word of mouth, to now spreading knowledge across all corners of the globe using the internet. Research was a highly valued skill that was only allowed to be done by experts within the field. For example, great scholars such as Newton and Einstein, during 1500’s-1800’s, were some of the only men of their times with the resources available to pursue knowledge. During this period research was heavily done using books, papers and consulting the few individuals who had extended knowledge in the area. With the development of printing presses and libraries, information became easily accessible to the common man. Because of this, more and more people began to research and gain knowledge. In the present day research has moved from being solely done using physical mediums, to being focused on an electronic distribution of information. The cause of this change is undoubtedly due to the advent of the internet. The internet has enabled all type of sources, ranging from magazines, books, and scholarly articles to be accessed at the touch of a button. This has quickly become the preferred method of searching because information can be easily accessed by almost anyone. However, because more information is available for researching, it can be difficult to find relevant and reliable sources within everything that is available.

In 2011 there was an IQP project titled “Information Literacy of WPI Project Teams.” The project focused on how well students interpret data. The information literacy team found that 60% of students

scored lower than 70% on an exam that assessed information literacy. (Dao, et al. 2011) The data showed that there was a noticeable relationship between first-year students' perceived confidence and their actual performance. The students who were more confident in their research skills scored higher than students who lacked confidence in their ability. Overall the study produced useful data for Gordon Library and the team insisted that they continue to administer this first-year assessment program to better understand the information literacy skills of the incoming classes. Our project is similar to the previous project in that we are looking to aid the library staff here at WPI. However, we will be looking at project teams' abilities to find relevant, reliable information, as opposed to a student's ability to interpret sources given to them.

Problem Statement

Worcester Polytechnic Institute has a group project-oriented curriculum that often requires students to work together for seven to twenty-eight weeks. Group projects tend to be more open-ended and have a broader scope than individual research projects. Group members must do more in-depth research on a wider, varied range of topics. Not only does this affect their research methods, it affects how the group works as a whole, including the interaction between team members, problem solving, and division of labor. With groups doing so much research, efficiency is key. Using ethnographic methods, as well as some other research methods, we aim to better understand how efficiently Interactive Qualifying Project groups conduct research. This is crucial in determining how WPI librarians can adapting their research education to better suit project team needs.

The Interactive Qualifying Project (IQP) is a major aspect of WPI's curriculum. Along with the Major Qualifying Project (MQP), it is a project that students are required to complete in order to graduate. The IQP is often the first large-scale research project encountered by students; it requires students to collaborate with a team and conduct research in a way that most have yet to experience. Many students struggle due to the open-ended nature of the problem, and the lack of direction and structure of the project. The IQP is also an interdisciplinary project, taking students out of the comfort zones of their majors and requiring them to focus on real-world problems. We believe that studying IQP teams would be an effective way to observe and analyze how efficiently students are able to find the information relevant to their respective projects. Our study also incorporate a comparison of the project teams research habits with that of a research expert, a librarian with more than ten years of experience.

One of the most important aspects of any research project is being able to efficiently obtain desired information. This involves knowing what tools to use to find needed information, as well as how to work around obstacles encountered, such as dead links or obtaining the full text of an article. Efficient

research requires the team to manage their time and resources to the best of their abilities. For example, four students all researching the same topic in a group may not be as efficient as having each member focus four different, more specific topics. Studies such as The Rochester Study and the Ethnographic Research at Illinois Academic Libraries project have touched on student research habits, but there has been little research on how groups of students conduct research. Our goal was to analyze the research efficiency of project teams, as measured by the speed of searching and the quality of sources found. By using ethnographic and other research methodologies, such as individual questionnaires, a group observation, and an analysis rubric, we will gather and analyze research techniques used by groups, as well as the relevance and reliability of the sources found. Comparing these results against those of a research expert, we hope to show how efficiently the groups conduct research, as well as strengths and weaknesses of research habits exhibited by the groups. The results will allow us to make recommendations to the library, about how the librarians could help student groups become more effective and efficient researchers.

Background Research

What is Ethnography?

Ethnography is the study of human behavior and culture in everyday settings. (American Anthropological Association 2004) This is of particular interest to understanding how project teams work because it addresses the study of people in a qualitative manner. Qualitative studies are more text based, so methods such as the use surveys are not applicable for gaining data. These studies consist of a focus group, with more in-depth interviews. They are also more subjective, meaning it would describe the research habits from the point of view of the project groups themselves, not solely the conductor of the research. However, we must keep in mind that qualitative studies cannot be used for generalization of the problem. In this case, with project groups we can't apply our findings to every group as we could with a quantitative study, which is based on numbers. Instead, a qualitative study builds on itself from the data it uncovers; it will give a better understanding of how these projects groups are performing research in a natural setting, and how they react to the research process. Ethnographic studies will help us to understand the behaviors and study habits of the group as they go into more research with their projects. It will shift the results from being generalizations to more in depth and detailed, based on the methodologies these groups use to conduct their research. (Agar 1996) These types of studies include "Studying Students: The Undergraduate Research Project at the University of Rochester" and "The ERIAL Project". Ethnographic studies produce data that will help cultivate a better understanding of how students specifically operate, and allow for improvements to be made to the current system, which will help librarians' better assist students.

Ethnographic Methods

A recent trend for libraries is to employ ethnographic research methods to learn about students and researchers in order to improve library services and instruction. Ethnographic researchers use many different methods to collect information. The most common is direct, first hand observation. This is

when participants are observed while either doing every-day activities, or doing an activity instructed by the observers. This allows the observers to see the way the participants act, and to identify trends and characteristics. It also allows the observers to distinguish between what people say and what they do. Another commonly used method is interviewing. These interviews often include different forms of conversation, including small talk in order to make the interviewees more comfortable. Interviews allow researchers to gather information on the way people think and how things affect them. Questionnaires allow the observers to identify habits, beliefs and perceptions. They are also very useful when trying to measure changes in individuals or groups that are being studied. A combination of ethnographic methods can be useful in discovering underlying trends that are connected with what is being studied. (Michigan Tech n.d.)

The Rochester Study

The Rochester Study was an ethnographic study conducted at The University of Rochester in New York by a group of the university's librarians and an anthropologist. One of the goals of the study was to learn about the research habits of undergraduate students, as well as what resources they need. This information was used to help the University librarians improve the library and its resources. Many different ethnographic methods were used including interviews, observation sessions, and photo surveys. (Marshall, Burns and Briden 2007) The results of the Rochester study shed light on how students in the age of technology work on a research paper, or in some cases how they don't work. Many students were found to see nothing unusual about holding a conversation over Instant Messenger, while listening to music on iTunes and typing a report at the same time. One particular student took his multitasking so far that he was found to be playing five hands of poker simultaneously. (Foster and Gibbons 2007) From the study we gathered a lot of information on single student work, and used this to compare to group work, but beyond that much of what they found didn't directly apply to our study at WPI. However, the methods used in the Rochester study can be modified to accommodate

a larger number of students, and this is part of the reason the Rochester study has been used countless times, most specifically in “The ERIAL Project,” which is mentioned below. They employed a wide variety of ethnographic tools that have proven useful such as photo surveys or covertly watching groups by sitting nearby. Many of the methods used in the Rochester study were very helpful to us as we continued on with our project here at WPI.

Ethnographic Research in Illinois Academic Libraries (ERIAL)

Even more closely related to what we tried to accomplish here at WPI is “The ERIAL Project”. This study was conducted over two years at five different universities in Illinois. The purpose of their research was to “understand how students research, and how relationships between students, teaching faculty and librarians shape that project”. The ERIAL researchers accomplished their goals using ethnographic methodologies similar to the Rochester Study, including interviews, surveys, photo journals, and observations. This study yielded many different results. It showed librarians that there were a large number of students who were not skilled in research; they overused Google as a search tool and neglected to search for scholarly articles. Students often didn’t even realize that they were under-skilled researchers due to the fact that nobody had ever taught them efficient research techniques. ERIAL also yielded many very useful results as far as how faculty and librarians impact this research. They found that students that were friendly with one or more librarians were usually very satisfied with the help they received, and also that students that had attended instructional sessions with a librarian had noticeably better research skills than students that did not receive any sort of formal training. (Asher, Duke and Green 2010) The major problem was that most students never see librarians as people that could aid in their researchers; they tend to think of librarians as people that are just there to watch over the library and put books away. The ERIAL project provided a useful basis for the study we did this year at WPI.

Collaborative Information Seeking (CIS)

Collaborative information seeking (CIS) is defined as how multiple people work together to search for information, or simply how groups conduct research. CIS is an active process, requiring group members to be constantly searching for the information they require. It does not solely focus on searching for information, but also on gathering and sharing this information. While information seeking used to be considered an individual activity, in the modern world most situations require people to work together in teams. Often situations are complex, and may be difficult to tackle alone. Therefore groups must work through multiple meetings exploring, gathering, and evaluating their information before they can move forward. (Reddy and Spence 2011) Three widely accepted major areas in the field of collaborative information seeking have emerged recently: control, awareness and communication. Control focuses on the structure or team dynamic of a group. Aspects such as the roles people take and the rules set by the groups are important to any group's functioning. If members don't take, or agree upon, roles and rules then the group will not be effective. Awareness deals with the understanding of what other members are doing, and how it affects what the person does. This touches upon the member's awareness of their workspace, and also the group's awareness of what they have achieved and what they still need to achieve. This awareness has a major impact on how groups progress and assign tasks to members. The final area, communication, may be the easiest to comprehend, however it may also be the most important. How the group communicates, whether it be assigning tasks, discussing research, or deciding on a direction for their assignment, is something that can make or break a team. Also, the way in which the team communicates is important. While some teams may favor a more laid back form and others may favor a more strict style, if all members are not on the same page, it will negatively affect the group as a whole. (Hartzum 2008) This field of research not only focuses on studying methods and motivations of people working collaboratively, but also on building systems for supporting this type of research. At this point, however, email is still the most used system because of

the lack of specialized tools explicitly for collaborative information seeking. And though a few CIS-supported systems have emerged, unfortunately they are underwhelmed and underused. Librarians at WPI are interested in CIS and tools that can help project teams be more effective and efficient, so we were able to utilize CIS theory when developing our observation protocol.

Efficiency in Research

There is a battle between speed and quality of information found when it comes to efficiency in research. The time it takes to find relevant information on a topic is key for keeping the project on track, however the quality and relevance of the information found is of great importance. It can take longer to find sources of good quality to use, however it provides a greater pool of knowledge that can be used within the project. Hence, a balance is needed between the speed and quality of research so that research is efficient and helps with the project's progression. Tools that are useful for efficient research are numerous, including the WPI databases used by IQP project teams. These databases provide access to scholarly articles, as well as articles that cannot be found for free on the web. Other sources such as Wikipedia and random Google search don't always provide findings from credible sources, especially for highly specific IQP real-world project topics. In order to also be efficient in research, waste has to be limited. This means that the researcher must stay on topic, ensuring relevant databases and key phrases are used, and eliminating anything that might stray from finding the information needed. These aspects tie directly into time management. The ability to properly assign time to different parts of an active research aids in keeping it on task and keeping an overall organized atmosphere. Other sources that can be used in efficient research include books, journals and other physical mediums that have credible sources. Our research team defines research efficiency as finding reliable, relevant information in an appropriate time frame.

The Effects of the Internet on Accessing Information

Google Analysis

Google has affected millions of people in the way they access and consume information. The once quiet pastime of reading literature for pleasure, for some, has become a hobby of the past. A good book used to be the one source needed to enlighten and entertain an individual. Now other media sources such as television and the internet have taken this over by providing this information in a more efficient way.

The ease of web searches, Google in particular, makes it easy to have this entertainment and knowledge at your fingertips. When a user goes to the main Google site, the page has a clean design with few options to click on, a nice big logo and the search bar underneath. This simple design is the basis of why Google is thriving. People don't want to be confused when searching for anything; the direct method is always the best method. Other major sites such as Yahoo and MSN have redesigned their search engines based on this new standard that Google has set. When a search is being performed, usually there will be a feature turned on that tries to guess what the user is searching for and provide a list of most common searches that might apply to them. After enter is pressed, Google displays a list of the results and a short text description of what each site is about. This makes scrolling through the page easy and cuts down the time needed to find information. This has encouraged a new trend called power browsing, which is rapidly scanning links, clicking on what links seem relevant to the user and then skimming through those pages for needed information before moving on to another link. This is becoming a popular practice among all age groups, regardless of their research topics. (See 2010)

In a recent report by Peter Williams and Ian Rowland, *Information behaviour of the research of the future* found that individuals, ranging from professionals to college students stated they rarely read for pleasure and skim through most writing that was longer than four paragraphs. (Rowlands and

Williams 2007) This lost ability to concentrate on such a short piece of literature isn't caused by Google, but is definitely aided by it. We are now living in a society where everything is fast paced, from the way food is prepared to our means of transportation; it is of no surprise that reading a few paragraphs has become a tedious process. The mentality of people is shifting from knowledge gaining to specific information seeking. This could be a problem because it begs the question, what will happen to society when they become dependent on only knowing specifics? These factors all contribute to decreasing the value of physical books, because all of its information is now readily available online. Most now ignore paper resources when there are electronic resources available. Some people, however, still like the physical aspect of books because it gives them comfort to actually hold a book and turn a page. Innovation such as the e-reader is quickly addressing this issue. Physical books, however, will not become obsolete because they serve as a permanent way to store information over time.

One of the best qualities of Google, and the Internet, is how convenient it is to find information. This convenience is why we use Google and not as many print sources anymore. However, it is this convenience that is changing us. Books require concentration and focus, a "linear" type of thinking. The Internet, however, fosters a more "scattered" format, with links taking us back and forth from small tidbits of information. Google is not only changing the way we obtain information, it is literally changing the way we think. This is because the brain is considered to be a "social" organ, meaning that it is responsive to the environment. Modern neuroscience has revealed that the brain has a certain "plasticity" to it, allowing our habitual practices to actually change its neural structures. (Naughton 2010) For example, humans are born illiterate, so reading and writing requires training. The more we use these tools, the more our brains develop around them. And the same is happening with our use of the internet. Psychologist Patricia Greenfield concluded during a study that "every medium develops some cognitive skills at the expense of others" and that the subjects showed a "new weaknesses in higher-order cognitive processes". (Carr 2010) Our neural pathways are being changed by the tools we

use to find and store information, so the more we use Google, and even the internet in general, the more our brains are shaped by it. It also means that the more we use these tools, the less our brains are used to using lengthier literature sources. Even pioneering neuroscientist Michael Merzenich agrees that our brains are being “massively remodeled” by our extensive use of the internet.

Reading and writing books and essays require “big chunks” of thinking. They require long time frames analyzing and contemplating their meaning and context, because the author’s thoughts and opinions are found throughout. However, the internet is the exact opposite, only requiring the reader to apply “small chunks” of thinking. Articles are concise and link the reader to articles with others thoughts as well. There is no linear analysis of ideas, and by jumping around from article to article we replace deep analysis with quick synopses. This pace and pattern of information seeking, and how we digest ideas on the internet, is the difference. This stresses different cognitive areas in our brain, forcing them to adapt to this new style of thinking. Because of this, we’ve turned into scattered, unfocused, and undisciplined thinkers who constantly follow links from one item to the next, not worrying about where we started. We lose our patience looking through long forms of information due to the fact there is so much “unrelated” information compared to the small internet articles. If information is not immediately available and easily accessible, we don’t know any other way to find it. The web has become the world’s collective memory; why bother memorizing detailed information when we can retrieve it from Google whenever we want? Our brains can no longer forge a strong connection with the information we find, causing our thoughts to be disjointed and our memories extremely weak. This lack of depth in our thinking process makes our minds hungry for constant stimulation, constant quick tidbits of information. The combination of this mentality, and of the nearly unlimited possibilities of Google, is what drives us to be constantly jumping from article to article, and what prevents us from being able to sit down and read lengthy pieces of literature to obtain our information. (Naughton 2010)

Our brain is constantly changing and rewiring itself to adjust itself to how we use it and what we do. In the past, deep reading of long articles was common and students were taught that in order to learn material they had to analyze what they read and come up with their own understanding of the material. With the advent of the internet and the widespread availability of not only those same texts, but summaries of them and analysis of those same summaries, those deep reading skills are slowly being rewired out of existence. Students don't need to look for the deeper meaning of a novel when they can jump to Wikipedia and read in one paragraph what the author spent 200 pages subtly implying. In an article by David Derbyshire, (Derbyshire 2009) Prof. Susan Greenfield mentions that teachers have noticed student attention spans steadily declining. The internet and it's easy to access information isn't the only thing effecting how our brain works. The same article discusses how word processors have made proper spelling less relevant when it can all be fixed on the fly by the computer, and being able to read and understand a simple map is all automated by global positioning systems. In a society that puts ever growing emphasis on technology, the work we have to do ourselves is slowly being chipped away at by each new tool we're given. In the same way that the introduction of calculators shifted how students learned mathematics, the computer has already had a profound impact on how they research and read. These same issues are echoed an article by Nicole Ferraro, (Ferraro 2011) who mentions that not only do we no longer need to memorize things such as direction, but email addresses and phone numbers as well. This idea was backed up by a study at Columbia University that showed people are much more capable of remembering where information can be found rather than what the information actually was. So instead of having everyone's phone number memorized, we just know where they are saved and how to look them up.

Social Media Effects

In today's world, the technology we use to communicate has made a large impact on the manner in which we write. The simple, informal ways of communication, such as texting, instant messaging, and

email that we use every day have led to many short cuts in the English language. These short cuts originated when texting first started gaining popularity. Typing using the numerical keyboard was time consuming, so people began abbreviating their texts to save time. These abbreviations eventually found their way into instant messaging and email, and they've been around ever since. The lack of vowels such as pls (please) or nd (and), the single letters r (are) and u (you), the acronyms ttyl (talk to you later) and lol (laughing out loud), and the use of numbers such as l8r (later), have become a normal part of many people's vocabularies. (Alejandro 2011)

Social networking sites, such as Facebook, Twitter, and Tumblr, have a large impact on the way people are writing today. It is clear that these tools are leading us away from long articles and towards short, concise thoughts. The "tweet" function on Twitter has a limit of 140 characters for all posts. Because of this, Twitter users are forced to get right to the point with their thoughts. There is no such thing as a long post on Twitter, and considering that it is one of the most popular social networking sites in the world, not many people are upset about it. Facebook's status updates also have a character limit. This limit of 5000 characters, although larger than Twitter's limit, still keeps updates fairly short. Tumblr, although there is no set character limit, still tends to consist of short blog posts, using pictures and links to help get the user's point across. These limits have a large effect on reading and writing because using these websites we will never have to worry about reading more than a few paragraphs.

A perfect example of society's unwillingness to read long articles is the phrase "too long; didn't read" (which is normally shown as 'tl;dr'). "tl;dr" is widely used on forums or in comments when a person didn't bother to read the post or article because it was too long. So not only do people not want to read anything longer than a few paragraphs, but they also don't want to take the time to spell out four words. They will, however, take the time to express the fact that the article was too long, using up the time that they could have spent actually reading the article. A large factor in this laziness is the

above-mentioned “Google effect.” Because it is so easy to skim through articles and find the information we need before skipping to the next article, we do not find it necessary to read anything in its entirety; our research on IQP project teams may reveal if these groups follow the same trends and provide feedback on how to be better researchers.

The rapid spread of social media has been helpful in the spread of knowledge. By reducing the time it takes to contact people across the globe ideas can rapidly spread from one to person to millions. Features such as twitter’s “retweet” function that allows one person to repost another user’s tweets can quickly draw attention to a new idea. This same speed can be used by those conducting research, not only to spread ideas but to get information from a large group in short time. Facebook often has surveys that are underneath advertisements posted by companies. These surveys provide rapid feedback on the effectiveness of the ads that can be used by the company, but can also be used to gather other types of demographic information.

Project Teams and Research at WPI

Interactive Qualifying Project (IQP)

The Interactive Qualifying Project (IQP) is unique to WPI's curriculum. The IQP is defined as "a team-based project that examines the impact of science and technology on society". The goal of this project is for students to learn about these impacts, and how to apply them through human efforts. IQP groups consist of 3-4 students, and can be done either in one term or across three, on-campus or off-campus. This project is typically completed by students in their junior year, and is usually the first large-scale group research project encountered. WPI has put forth a general set of goals that students should achieve by completing their IQP

1. Demonstrate an understanding of the project's technical, social and humanistic context.
2. Define clear, achievable goals and objectives for the project.
3. Critically identify, utilize, and properly cite information sources, and integrate information from multiple sources to identify appropriate approaches to addressing the project goals.
4. Select and implement a sound methodology for solving an interdisciplinary problem.
5. Analyze and synthesize results from social, ethical, humanistic, technical or other perspectives, as appropriate.
6. Maintain effective working relationships within the project team and with the project advisor(s), recognizing and resolving problems that may arise.
7. Demonstrate the ability to write clearly, critically and persuasively.
8. Demonstrate strong oral communication skills, using appropriate, effective visual aids.
9. Demonstrate an awareness of the ethical dimensions of their project work.

One of these is that students should "critically identify, utilize, and properly cite information sources, and integrate information from multiple sources to identify appropriate approaches to addressing the project goals". This type of research is vital for students to develop, and will provide the project groups with the means to accurately develop methods to complete their projects. (Worcester Polytechnic Institute 2011)

We chose to evaluate the efficiency of IQP teams not only because it is usually the first large-scale group research project, as mentioned above, but also because of its open-ended nature. Because

of the lack of direction students often struggle, especially when conducting the massive amount of background research it requires. This project often provides the basis students will use when conducting research in the future, making it a crucial point in the researching career of all WPI students. The IQP environment will allow us to observe how students interact in a group setting, what search techniques the groups use, and ultimately how these affect the efficiency of their research. Librarians at WPI also spend a large percentage of their time supporting the research of IQP project teams and offer research consultations with each Global Project team. Librarians work with more than 100 project teams per year. The combination of these elements makes the IQP an ideal candidate to evaluate how efficiently groups conduct research, and will provide us with vital information that we can use to make recommendations on what aspects the library should focus on improving.

The WPI Library and Current Practices

The Gordon Library at WPI is a very popular place to research and get work done, especially for project groups. Last year an average of 12,000 people used the library every week, and tech suites were checked out almost 1000 times over the past academic year. While it seems clear that student project teams are using the library, it says nothing about the quality of their research. Of all the IQP groups last year, 87% said that research consultation with the librarians improved their ability to perform research. However, over the course of the year, only 32 general research workshops were given to 224 students. If more students were exposed to these workshops, we think that they would become much more efficient researchers.

The library currently offers a number of informational sessions and consultations that are aimed at improving the information literacy and research techniques of students, as mentioned above, more than 100 consultations with IQP groups alone. The first practice in place is the orientation sessions for new students. There are also web-based tutorials that provide students with access to learn about the many features of the library's website. The library also offers general programs that focus on research skills

such as *Cited Reference Searching*. Another useful feature of the library is that they offer one-on-one research consultations with a librarian if a student requests one. Apart from these voluntary practices, there are also some library sessions that are standard in courses and projects. For many courses that require research projects, there are course-integrated sessions with librarians. These are used to show students the research tools the library has to offer that are tailored to their specific project. Finally, the library is heavily involved with project groups. There is a mandatory session with a librarian for IQP groups taking ID2050, which helps to show the groups useful tools to conduct the background research required. Librarians are also involved in helping some MQP groups if requested by student teams or advisors. All of these practices put in place by the library help to ensure that students have a baseline competency when it comes to research skills, and they have the tools in place to build on their prior knowledge. (Library n.d.)

Creating Research Tools

Pre-Observation Survey

To gather basic demographic and other useful background information, we implemented a pre-observation questionnaire. In order to collect usable data from a questionnaire or survey, one of the most important aspects is the use of very clear and direct questions. These types of questions don't allow for any misinterpretations and are easily understood. In order to create reliable questions, there are two things that need to be addressed: the objective of the survey and the information trying to be collected. Keeping these two things in mind will make sure the questions will produce the wanted information, and they will produce it reliably and consistently. Also, keeping the questions, and survey both relatively brief, is important as this will make it easier for subjects to answer them.

There are several different types of questions that can be asked, and each type is designed to collect different types of information. Using the appropriate types of questions is extremely important in a questionnaire, as this forms the basis of how well the questionnaire will be able to gather useable information. There are four basic types of questions: open-ended, closed-ended, ranked/ordinal, and matrix rating scales. Open-ended questions allow for the subjects to answer in their own words, with no answers given to choose from. These questions work well when collecting information on feelings or opinions; however there are disadvantages as well. Because of the nature of open-ended questions, they require more time and thought from the subject. The answers are also much more difficult to analyze, as there is the potential for a wide variety of answers. Closed-ended questions are those with pre-determined answers given, such as multiple choice or simple yes or no questions. Questions in this category can be either dichotomous, in which subjects must choose one of two options, or multichotomous, in which they must choose one of multiple options, or can require the subject to choose multiple answers from the given options. Closed-ended questions are often used because they allow for quick and easy answers that can be easily analyzed. There can be possible disadvantages from

using these types of questions too, however. If all possible answers are not presented, or if the answers are not mutually exclusive, the subject will not be able to effectively choose the “best” answer for them. Ranked or ordinal questions are questions that have choices given in an order of importance or relevance. These questions are used to gather information what the subjects believe are the most and least important aspects of the question asked. Subjects are typically asked to simply rank the choices given based on their importance. Ranked or ordinal questions are only designed to gather this specific type of information, and therefore are useless when trying to collect other types. The final type of question, matrix rating, is used when assessing the frequency of a behavior or attitude. These questions use a consistent rating scale, with choices going from highest to lowest. Matrix rating scales can be one of two types, Likert or semantic differential. The most common use of a Likert scale is the standard “strongly agree” to “strongly disagree” scale, with other variants of these making up the middle portion of the scale. This allows us to see common trends of how subjects feel about certain things. The semantic differential scale uses a scale with opposite responses on the two ends, and asks the subject to mark where they fall within the range. This is slightly different than the Likert scale in that there isn’t a specific set of responses between the two extremes. Regardless of which of these two scales are chosen, the next step when using these is to decide if the scale will be balanced or unbalanced. A balanced scale has the same number of positive and negative choices, while an unbalanced scale does not. To avoid bias, it is usually best to use a balanced scale, but there are certain circumstances in which an unbalanced scale is beneficial. For example if you are trying to determine the differences between the levels of importance of the options, it wouldn’t matter the number of positive or negative choices.

From here there two major aspects when creating a questionnaire/survey: question intent, and creating “good” questions. Question intent addresses the issues of making sure subjects are able to understand, and answer the questions asked of them. There are three important factors that ensure this: using legible questions, relevant questions, and painless questions. Using legible questions allows

for subjects to read questions quickly and easily, meaning that the subjects won't jump to an answer without completely reading the question. Using relevant questions to both the subjects and the survey ensure usable data. Finally, using painless questions make sure the subjects don't spend too much time thinking about how to answer. Subjects don't want a survey to require a lot of effort, and will often resort to rushing through if the questions aren't "painless." Following these criteria allows for consistently accurate responses. The second major aspect is creating "good" questions, and avoiding creating "bad" questions. Even though there is no 100% correct way to word a question, there are still four criteria to follow when creating a question. The first of these is to be brief. The shortest way to ask a question is the best way to avoid confusion. The second is to be objective. Making sure questions stay objective ensures that questions don't become loaded, and assumptions aren't built in. These types are bias and may cater towards certain beliefs, which needs to be avoided. The next criterion is to be simple. By keeping to simple words and phrases, and avoiding double negatives, the subject can follow the question easier. This also helps to avoid double-barreled questions, in which the question is broken up into more than one part, which can be answered differently. The final criterion is to be specific. Precise questions, without ambiguous or general terms, make sure the question is fully understood, and that subjects don't become confused. (Survey Monkey 2011)

One of the most important aspects of a questionnaire/survey is the question sequence. This involves a good flow to the questionnaire/survey, and good opening questions to ease subjects in. Having simple opening questions helps boost subject's confidence, which has been shown to increase the subject's interest and participation. Having a good flow to the questionnaire/survey prevents any confusion, or stopping and going while filling it out. For example, if there are several general topics included in the questionnaire/survey, grouping all relevant questions to each together will ensure subjects stay on track, and don't lose their train of thought while filling it out as well. Finally, if there are

any possibly sensitive questions included, they should be put towards the end. This is so that subjects don't become discouraged, and not take the questionnaire/survey. (Survey Monkey 2011)

The next thing to consider is the survey layout. It is a general rule of thumb for the introduction of the questionnaire/survey to include general information about the observers, why the survey is important, as well as a confidentiality statement. The body is probably the most important part, as it contains the actual survey. This section should be appealing and not cluttered, can be read easily, and is relatively short. Finally, the end of the questionnaire/survey should include a thank you. This is extremely important as it promotes a sense of gratitude, which ensures the subjects feel like they didn't waste their time. (Survey Monkey 2011)

The final aspect of a questionnaire/survey is how it will be distributed and filled out. This can be done through either a paper copy or online via a survey website such as Survey Monkey, and there are pros and cons to using each. Online surveys are much faster, more cost efficient, and allow for quicker and easier answering for the subjects. It also allows for the subjects to feel more comfortable, because the observers are not watching them respond. However, there is the risk of technical issues, and without observers present, there can be no clarification of the questions or responses. However the pros for using an online survey outweigh the potential problems.

Rubric

In order to determine the efficiency of the project teams, we needed to design and implement the assessment protocol. We decided to use a rubric for our analysis, because of the ease and flexibility they provide, allowing us to not only assess varying criteria, but also how effectively each criteria was met. In general, a rubric is comprised of four parts: the task, dimensions, descriptions of dimensions, and scale. The task is, quite simply, is the assignment or behavior that the rubric is aimed at assessing. The dimensions are the individual skills that are being assessed. These skills are what the student groups will be expected to use when performing the task presented. Having very distinct dimensions allows for easy analysis of the individual components, and identification of individual trends among them. The description of dimensions is, as it sounds, a description of the various levels of performance possible for the dimensions, and how they will be assessed. This allows for steady, documented criteria on which to grade the various dimensions. The final aspect of a rubric is the scale. The scale assesses how well the student groups perform the task, based on the various dimensions. (University of Connecticut 2011) The scale can be as flexible as it needs to be, as it can have any number of levels of performance. However, because it is harder to distinguish between levels when there are more, generally three or four levels are used. For this reason, we chose to use a three-level scale. The other aspect of the scale is the point value of each dimension. Rubrics offer the flexibility of having a different number of points assigned to each dimension, based on what aspects are deemed the most/least important. However, in our case, we assigned each dimension the same amount of points for ease of grading. (Mueller 2011)

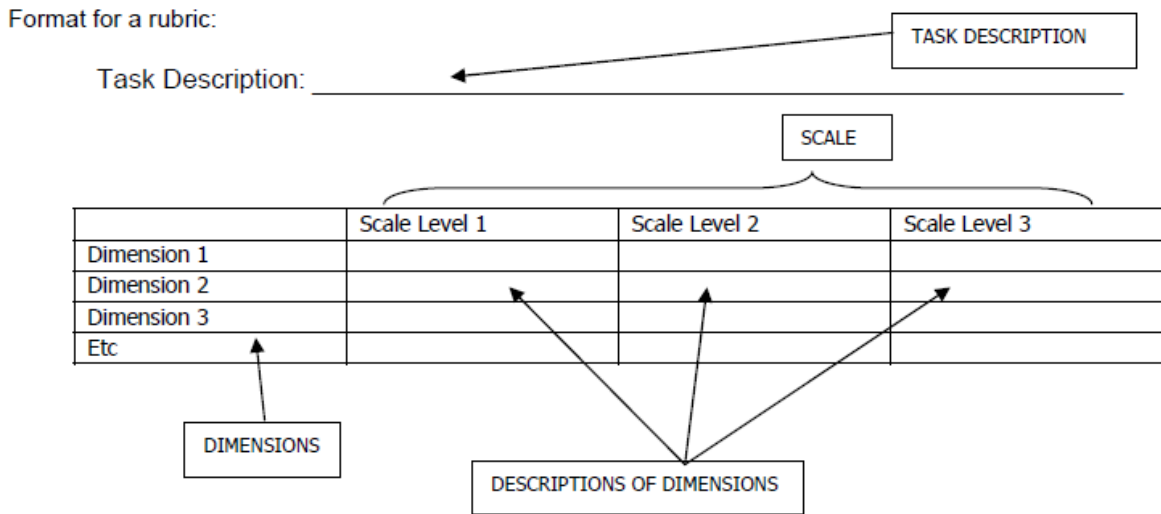


Figure 1: Format of a Rubric

When constructing a rubric, there are generally four steps. The first is known as reflecting. In this stage, what we aim to get from the rubric and what information we want to gain from students are determined. Common things addressed in this stage also include what task will be assigned, what skills the students will need to complete the given task, and what skills students need to display in order to be properly assessed. The second stage is listing. This stage is used to list particular details of the goals and expected outcomes of the rubric. Also in this stage, descriptions of the highest and lowest possible outcomes for each dimension are created, as well as what conclusions can be drawn from each of these possible outcomes. The third stage in the process is the grouping and labeling stage. This is the stage in which all the results of the first two stages are grouped together based on similarities. Once they are grouped, each group is given a name, and each of these will become the dimensions. It is very important that these dimensions are different enough to avoid any confusion. The final stage is the application stage. This is when the whole rubric comes together, and all dimensions, descriptions, and the scale are all put into the final rubric form. Abiding by these stages allows for a very thorough and comprehensive construction of the rubric, which is vital as it is the major evaluation tool we used.

Once the rubric is complete, it must be tested in order to evaluate how well it assesses the criteria we are testing for. Having peers or colleagues review it, and running through possible scenarios can offer useful insight into any limitations the rubric may have. However, pilot testing is the most effective method when evaluating any testing tool. Pilot testing involves applying your study and testing tools on groups, not to collect data on the study, but to collect data on the testing tools themselves. This allows for the use of the testing tool on actual data. From here, we can see if the score received using our rubric is indicative to the score we believe that they should have received and if not, figure out what about our testing tools needed to be changed. Pilot testing is the most useful process for evaluation because there is no substitute for actual application. (Mueller 2011)

Methodology

There are three tools developed to guide and standardize the assessment of each project team's approach to research. We will describe the tools and their purpose, the pilot test used to identify problems with the tools before the observation sessions in C 2012.

Creating Our Testing Tools

Pre-Observation Questionnaire

We developed a pre-observation questionnaire to collect basic demographic information about the participants, as well as some background information that we planned to use to gauge their level of previous research experience. For the pilot study, we specified the research question for the session. For the actual study, the pre-observation questionnaire would ask the students to specify ## research questions related to their particular project.

1. Do you agree to participate in this research study? When arrive you will be asked to review and complete a consent form. YES/NO
2. Gender: MALE/FEMALE
3. Major(s):
4. IQP Project Title:
5. Have you ever taken a Great Problems Seminar course? YES/NO
6. Has a WPI librarian ever provided a research workshop for one of your classes? YES/NO
7. Have you ever had a research consultation with a WPI librarian? YES/NO
8. Have you completed any research based projects here at WPI that have required 10 or more sources? YES/NO
9. How confident are you in your research skills? VERY CONFIDENT/CONFIDENT/SOMEWHAT CONFIDENT/NOT VERY CONFIDENT
10. List three research questions pertaining to your IQP that you look to answer in your background research:

The first questions were simple demographic topics to help ease the students into the questionnaire so they would be more comfortable. The questions consisted of gender, class year, major, and their IQP project title. From there the students were asked questions to help determine their prior research experience. Questions such as whether the student has taken a GPS course and whether they've ever met with a librarian in the past for additional research instruction were included to obtain some information on the student's prior research experience at WPI.

Research Efficiency Observation Protocol (REOP)

In order to make each observation as consistent and repeatable as possible, we developed a checklist that would be used in each observation session. This would make comparisons between observation sessions possible. The structure of the checklist was developed in collaboration with a research librarian. She described the kinds of search habits she looked for when meeting with IQP teams and we used her list to develop the pilot version of the Research Efficiency Observation Protocol (REOP). Included in the REOP were different search engines such as Summon, the specialized tool offered by the WPI library, and search techniques such as Boolean limitations (using AND, OR, NOT, etc. to limit the search results). The pilot version of our REOP is shown below.

Research Efficiency Observation Protocol

- Databases (list order)
 - Summon ____.
 - Google Scholar ____.
 - Search Engine ____.
 - Specialized (Major/Field Specific i.e. Pub Med) ____.
 - Other _____
- Filters
 - Key word
 - Published Year/Date
 - Full text
 - Author
 - Subject/Field
 - Source Title (Journal name, etc.)
 - Source type (Newspaper, journal, book, etc)
 - Peer reviewed/ scholarly
- Use references in one article to find other articles [**Author or organization**]
- Using number of citations for an article
- Full-text finder
- ILL
- Searching technique
 - All students together
 - All students separate
- Did the students skim article over for key words?
- Did the students read the abstract?
- Boolean limitations
- Did the students take notes?

Observer Notes:

Research Efficiency Source Analysis (RESA)

The next tool that was needed was a testing and grading rubric to be used when analyzing the sources collected during the duration of our study. We broke the rubric into two sections, relevance and reliability. Each section received different subsections based on what was determined to be most important when evaluating a source's relevance and reliability. We came up with 10 categories that we believed would be useful in evaluating the sources:

Research Efficiency Source Analysis

Relevance: 60 pts

- Key Concept in the title? 10 pts (0, 5, 10)
- Key Concept in the abstract? 10 pts (0, 5, 10)
- Are majority of sections about topic? 10 pts (0, 5, 10)
- Source (i.e. journal title/website publisher) looking at/tailored to the issue or topic? 10 pts (0, 5, 10)
- Key Concept in document/ (how many?) 10 pts (0, 5, 10)
- Relevance of references/key concepts in references? 10 pts (0, 5, 10)

Reliability: 40 Pts

- Are authors experts in this area? Y/N 10 pts (0, 10)
- Are references complete and written by experts in the area? 10 pts (0, 5, 10)
- Is the bias not supported by fact? Y/N 10 pts (0, 10) (N→10)
- Is the methodology sound/data used and evaluated properly? 10 pts (0, 5, 10)

Total Score:

These categories were worth ten points each. For each category, teams could earn either 0, 5, or 10 points, for a total of 100 points possible.

Pilot Testing

Once our tools for assessing efficiency (RESA and REOP) were constructed, it was necessary to begin pilot testing. It is important to note that our pilot testing was performed not to evaluate the research efficiency of students, but to test the ability of our test instruments to properly assess research efficiency. By conducting this pilot testing, we aimed to learn the strengths and weaknesses of our test instruments, as well as the best way for our group to evaluate the teams and their sources. For the REOP, we wanted to see if there was further information that we could gain through observation that was not specified in the document, and what we could add to fix it. For the RESA, we wanted to assess the individual rubric questions to see if there were any that we believed did not help us in evaluating

efficiency. We also wanted to see whether or not we believed that the overall scores were representative of the group being observed and if not, how we could make the RESA more accurate. Lastly, through the evaluation of the pilot groups' sources, we hope to gauge any differences in the evaluation techniques/ideas of our team members in order to determine the most accurate way for us to assess the sources found by the IQP teams in our final testing.

When choosing the pilot teams, the observers purposely chose groups with varying amounts of research experience. We hoped that by knowing which groups had the most experience conducting research, we would be able to tell whether or not our RESA did an appropriate job assessing research efficiency.

Administering the Pilot

Prior to any form of testing taking place on human subjects we had to receive approval from the WPI Institutional Review Board (IRB). Due to this research requiring the observation of students, an IRB form was required to be submitted. The purpose of the IRB is to create a complete consent form with all information and rights of the participant. Within the application we detailed our methodology as well as any potential risks to the participants. Even though this is a low risk procedure, the risk of participant anxiety was acknowledged on the form. We were granted approval from the IRB in about a week and were exempt from further review and supervision while conducting our testing, since we would not be retaining any personal information from our groups or releasing gained data.

We chose to present a single research question to our research expert as well as to all four of the pilot test groups. This question was "What are the major climate change issues associated with the Massachusetts coast?" Prior to the research sessions with the pilot groups, we first observed our research expert. We presented her with the research question and explained that she would have twenty minutes to come up with her best five sources, compiling references to them in a word

document so our team could get back to the articles once the observation session was completed. All of our group members were present during this session, and the first version of our REOP was used by each of the observers to mark down research techniques used, including the databases used, search filters, any linking to other articles, and use of the FullText Finder. Whenever the research expert found an article that could be useful, they made sure to read through the abstract and skim through the full article to be sure the information seemed relevant before recording the source. The research expert was comfortable searching even though we were present in the room watching, so it didn't appear as if we were adding any extra pressure or anxiety that could affect her ability to find credible sources in the given time frame. After this initial testing was completed we asked for feedback. It was suggested that we clarify that teams should search normally, as there would be no negative consequences because, even though the research expert had no trouble finding sources with our team observing, they were still very aware of our presence. In working with the project teams in the future, it was determined that we needed to make sure the teams felt comfortable participating by being friendly, open about the research study, and trying not to put pressure on the team while observing. Since we are their peers, fellow junior level students, this could be another advantage when observing project teams and making certain they were not experience anxiety.

Observing Pilot Teams

Each member of our observation team observed one team during the pilot testing. Pilot teams were given the same set of rules as our research expert, 20 minutes to compile a list of the best five sources in a way that allowed the observer to have access to the sources once the session was complete. During this observation session, the observer used the first version of the REOP to mark down the research techniques used.

Evaluating the Sources

Once all of the pilot observation sessions were completed, the observers sat down to evaluate all of the sources found. We decided to each individually analyze all of the sources found to gage differences in individual techniques. After the individual analyses were completed, the observers got together and compared the results. There were some slight differences in source scores from observer to observer, with Jerone tending to be a bit more lenient while Dave and Josh were a little bit harsher. We decided it would be better to analyze the sources as a group in the future to eliminate any fluctuations in data. The sources were re-evaluated as a team to produce the final results of our first pilot test.

Pilot Results

The grades for the pilot testing are based on first version of the RESA and are as follows. Our research expert provided us with sources that scored 55, 95, 85, 80 and 100 using the first version of the RESA, giving her an average of 83. This number was used as the efficiency reference for the other pilot groups' scores. The pilot groups' scores were divided by this expert score of 83 and then multiplied by 100, giving us our "percent efficiency". While all pilot groups, including the research expert, had both high and low scoring sources, two of the pilot groups (one and two) scored very well compared when compared to the research expert. According to our analysis these two groups were 92.7% and 100% efficient. The sources given by the other two groups (three and four) were very inconsistent, and because of this scored much lower when compared to the research expert, registering at 77.1% and 68.7% efficient, respectively. These scores went right along with what we expected, with the groups that have had a lot of prior research experience scoring close to our research expert, the group with moderate experience scoring in the middle, and the group with little to no prior experience scoring the lowest.

	Average	% Efficiency
Expert	83	---
Pilot group 2	83	100
Pilot group 1	77	92.7
Pilot group 3	64	77.1
Pilot group 4	57	68.7

Table 1: Pilot Testing Scores

While observing the pilot groups, we as observers noticed a few things that led to reassessing our RESA. First, we noticed that for this specific topic, the groups were very aware of the date the sources were published, since research on global warming is ever changing. We also noticed that although some sources were not written by “experts”, they could still be very relevant and reliable. These observations led to the creation of our final instrument.

Feedback from Pilot Groups

After the pilot observation sessions were completed, we asked the pilot groups to give us some feedback on their experience. Generally, the groups felt the test environment was adequate, and while they were aware of the observer in the room, it did not affect their ability to conduct their research. They did feel some pressure from the twenty minute time limit, but all four groups were able to produce five sources they found to be relevant to the research question.

Assessing our Research Tools

After evaluating all of the pilot team’s sources and comparing their scores to that of our research expert, it was then necessary to re-evaluate our RESA and REOP in order to see how we could improve upon them for our C-term testing. For the REOP, one thing that was noticed was that certain filtering options we hadn’t thought of were used, such as Boolean limitations, which were added to the final version of the REOP. We also decided that in order to collect better, more accurate information on how

the groups are conducting their research, a section for observer notes should be added. With the addition of this section, the observers will be able to note where students begin their research and where they go from there, as well as how the group members interact with one another. This would give us a better understanding of the chain of events that go into the IQP groups gathering of sources. The final version of our REOP is shown the next page.

Research Efficiency Observation Protocol

Project Title: _____

Observer Notes:

Databases (list order of resource used)

- Summon
- Google Scholar
- Search Engine Which one(s): _____
- Specialized (Major/Field Specific i.e. PubMed). Which one(s): _____
- Other _____

Keyword Searching and Filters within Database/Search Engine

- Keywords/phrases (jot down)

- Boolean limitations
- Published Year/Date
- Full text
- Author
- Subject/Field
- Source Title (Journal name, etc.)
- Source type (Newspaper, journal, book, etc)
- Peer reviewed/ scholarly

Observed student ... (note # of students using technique)

- using references in one article to find other articles
- using author from one article to find other articles
- using organization in one article to find other articles
- using number of citations for an article/Cited by References
- using FullText Finder to get to item
- ordering item via Interlibrary Loan
- skimming article over for keywords?
- reading article abstracts?
- Taking notes (either print or online)?
- Emailing articles/resources to self or team?
- Saving citations to RefWorks or citation builder?

Collaborative research technique:

- All students together
 - All students separate
- Notes on their collaborations: _____

There were a few changes made to the RESA:

- The scoring was changed from a 0, 5, 10 scale, to a 0, 1, 2 scale. This was simply to make our rubric easier to follow.
- The question “Is the source tailored to the issue or topic?” was removed. We decided that even though a source may not come from a journal, website, or other type of source that is specifically designed for the research question, it could still be relevant. For example, an article about climate change published in the *Wall Street Journal* could still be relevant, even though the *Wall Street Journal* is not specifically about climate change.
- The category regarding the number of key concepts in document was removed. It was decided that this category was too similar to the category “Are the majority of sections about the topic”.
- “Based on the date published, is the source relevant to the topic?” was added as a relevance category. This decision was made because for certain topics, an article that was written 20 years ago, while still a reliable source, may not be as relevant today as it was the year it was published. Simply adding “Was the source published after...” a certain date was an idea that we discussed, but we decided that question would not apply to all areas of research. For some topics, sources from 20 years ago would still be entirely relevant, whereas for certain topics (global warming for example), the relevant information is ever changing.
- “Are the authors experts in the area?” was changed to “Are the authors knowledgeable in the area?”. Just because an author isn’t considered an “expert” does not mean they do not possess quality knowledge related to the topic. For example, a writer for the *Boston Globe’s Green Blog*, while not an expert, could still provide useful information regarding climate change in New England.
- “Are references complete and written by experts in the area?” was changed to “...authorities in the area” for the same reason.
- “Is there a bias not supported by fact?” was changed to “Is the article supported by fact” because the former was worded awkwardly and we weren’t completely sure how to assess it.
- The physical format of the RESA was adjusted to look more like an official rubric. Descriptions of what gets a 0, 1, and 2 for each category were added to make it easier to maintain consistent results from source to source.
- Sections for score, source type and additional information were added.

The changes to the RESA leave it with 9 categories, each of which can receive a score of 0, 1, or 2 for a total of 18 points possible. We believed that this updated RESA would do a better job of assessing the efficiency of a source. The final version of our RESA is shown on the next page.

Library Research Habits IQP

Research Efficiency Source Analysis

Project Title: _____

Research Question: _____

Number of students: _____

Rubric used to score the sources found by the students and librarian(s).

Relevance	0	1	2
Key concept in title	There are no key concepts in the title	There are some key concepts in the title	All key concepts are in the title
Key concept in abstract/introduction	There are no key concepts in the abstract/introduction	There are some key concepts in the abstract/introduction	All key concepts are in the abstract/introduction
Are the majority of sections about the topic	There are no sections about the topic	There are some sections about the topic	All sections are about the topic
Based on the date published is the source relevant to the Topic	The source is not relevant to the topic	The source is somewhat relevant to the topic	The source is very relevant to the topic
Relevance/Key concepts in the references	None of the references are relevant and contain key concepts	Some of the references are relevant and contain key concepts	Most of the references are relevant and contain key concepts
Reliability	0	1	2
Are authors knowledgeable in this area	The author is not considered knowledgeable in this area	The author is considered somewhat knowledgeable in this area	The author is considered very knowledgeable in this area
Are references complete and written by authorities in this area	References are incomplete, and/or are not written by authorities in the area	References are somewhat complete, and/or are written by authors fairly knowledgeable in the area	References are complete, and are written by authorities in the area
Is the article supported by fact	The article is not supported by fact	The article is somewhat supported by fact	The article is mostly supported by fact
Is the methodology sound/data evaluated properly	The methodology used is not sound, and/or data is not evaluated properly	The methodology used is somewhat sound, and/or the data is not evaluated as well as it could be	The methodology is sound, and/or the data is evaluated properly

Final Source Score: _____

Source types team found (number of each):

_ Book _ News Article _ Peer Reviewed/Scholarly article _ Blog _ Website _ Other: _____

Re-evaluating Sources with Refined RESA

After applying the changes to our RESA, the observers went back and re-evaluated the sources given to them by the research experts and pilot groups. Our research expert's sources scored 18, 12, 17, 16, and 16 on our new RESA, giving them an average score of 15.8. This score will be used to compare the pilot group's scores and calculate the percent efficiency. The changes made seemed to have a significant impact on scores. While the first two groups still had significantly higher scores, Pilot group 2's score dropped from 100% efficient to 94.9% efficient. Similarly, Pilot group 4's score went from 68.7% efficient to 73.4% efficient. Because the scores became less extreme, and source scores seem more consistent in all groups, we feel that this version provides a much better representation than the first.

	Average	% Efficiency
Expert	15.8	---
Pilot group 2	15	94.9
Pilot group 1	14.4	91.1
Pilot group 3	12.2	77.2
Pilot group 4	11.6	73.4

Table 2: Re-Evaluated Pilot Testing Scores

We also looked at the pilot average score for each category. The categories are as follows

1. Key concepts in document.
2. Key concepts in abstract/introduction.
3. Are the majority of sections about topic?
4. Based on the date published, is the source still relevant?
5. Relevance/key concepts in references
6. Are the authors knowledgeable in the area?
7. Are references complete and written by authorities in the area?
8. Is the article supported by fact?
9. Is the methodology sound?/Data evaluated properly.

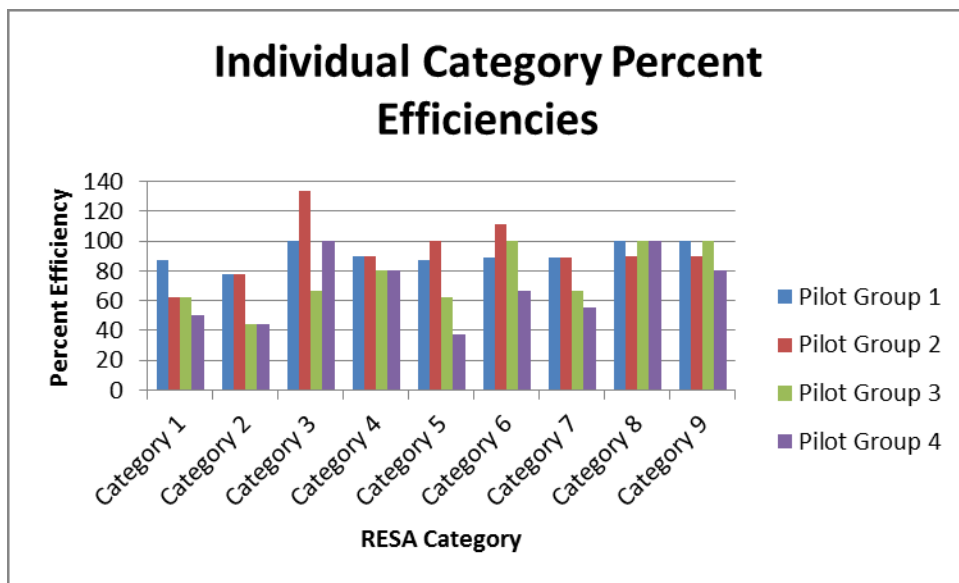


Figure 1: Pilot Testing Average Category Scores

This graphical representation helps to show the difference in scoring between the two best performing teams compared to the two worst in each category of our RESA. While it is apparent that these two teams score consistently higher, it may be worth noting that all teams scored relatively equally in Categories four, eight, and nine.

Discussion of Updated Results

We believed that this new RESA does a better job of assessing the relevance and reliability of sources. We also believe that the format of the new RESA was more professional as well as easier to read and score. Adding the description of what gets a 0, 1, and 2 for each category made it easier for the observers to accurately score sources and not fluctuate our scoring from source to source.

Research Efficiency Testing

Finding Student Teams to Participate

Our observation of students took place during the first two to three weeks of C term in January, 2012. This is the time when the most student research groups are meeting with the librarians as the global project program teams took the ID2050 course. We worked with WPI research and instruction librarians in addition to the students. Librarians already meet with groups looking to improve their research abilities at the start of their IQP. They assisted in working with the ID2050 faculty to solicit teams to participate. Our observation took place during the 30 minutes prior to the teams' research consultation with the librarian. For this project our goal was to observe approximately 10 IQP teams of 3 or 4 members each. The groups had already completed a brief online tutorial that all IQP students are required to complete that covers some basics regarding online research.

Deploying the Pre-Observation Questionnaire

Prior to their meeting the research librarian contacted the group and scheduled the meeting on our behalf, and requested they fill out the pre-interview questionnaire. Each individual student was asked to complete the pre-interview questionnaire. The purpose of the questionnaire was to obtain basic

demographic information such as gender, class year and major. In addition, students were asked about their prior research experience as well as any courses taken or instruction they've received while at WPI. All responses were kept anonymous and no identifying details were recorded. The questionnaire was hosted online. This allowed easy analysis of the responses that were used when looking at the results of our observations.

Research Topic Presented

After the student groups were selected, we created a question for the observation session to be used for that specific group. It was a general background question that was selected based on the topic of their IQP, and was hopefully beneficial to the team doing the research. This question was also given to the research expert prior to the observation session so she could conduct her timed research that was compared to the students'. The research topics addressed were as follows:

- What do patrons look for in a museum exhibit?
- What sources are available in Namibia for water treatment?
- What are some off-grid electrification success and failures in sub-Saharan Africa?
- How is recycled paper used to make insulation?
- What are some effective methods of teaching students through e-learning?
- What are some current waste-to-energy methods and their efficiencies'?
- What are some business development techniques along highways in developing countries?
- What are the policies of organizations similar to NABCOA?
- What are some other homestay programs and their problems?
- What are some effective methods of evaluating volunteer experience?
- What are the effects of air quality on health and the environment?
- What types of e-learning are most effective?
- What are some fire risks associated with hoarding?

Instructions

Once the student teams had been contacted and had filled out the pre-interview survey, they met for their research help session. When they arrived, the first part of the session was spent observing the project teams, after which the librarian continued with the rest of her session. Before starting, the

student was required to sign the IRB consent form, and if they did not wish to sign the form they would be excused from participating. After 20 minutes of searching, the students were asked to compile the five best sources that would be useful in answering the provided question. For each source found, the group was asked to provide a URL and title for any internet source. For any printed media, a title, volume and author were requested. These sources were used later by our team to analyze the quality of the source.

Group Research Observation

For the observation session two observers were always present and the majority of observation sessions took place within a computer lab where there were enough computers for each student to have their own. Students were still encouraged to bring a personal laptop if they wished to use that instead, and many did bring their own laptop. During the observation session the observers each had a copy of the REOP to fill out while the students conducted their research. The resources used by the students were recorded, along with the order in which they were utilized. Search filters such as author, date published, key words and source types, in addition to the use of Boolean limitations in the search, were also recorded on the REOP. The observers also documented the various techniques used by student groups like the full text finder, and interlibrary loan system. All this information was saved for later comparison to the results of the RESA for each group. Observers also looked for whether students filter the results such as by using different keywords, limiting the source type to books or journals, or by restricting the date published. Observers were encouraged to include any additional observations at the bottom of the form in the notes section. This included any information not already stated in the body of the REOP that the observer felt would be useful for later analysis.

Implementing the RESA

At the conclusion of the research session the students were asked to turn in a list of the top five sources found. The students were given additional time after the 20 minutes to select their five most

relevant sources amongst themselves. The selection process did not need to be completed within the research time given. If the students provided more than the five requested, only the first five sources listed were used. Once the students turned in the list they no longer needed to do anything for this study, and were allowed to continue with their research consultation, while the observers left the room. After the results of the sessions had been collected, the initial source analysis took place with the use of the RESA forms. Each individual source was rated on both its relevance to the topic question given as well as the reliability of the source. Each category on the RESA was scored as a zero, one, or two. Once the source had been evaluated, the points were totaled. This was completed for each of the group's five sources, with one RESA completed per source. The final scores of all five sources were then averaged to give a final source average for that group. In addition, each of the nine subsections of the RESA were analyzed independently in order to determine if the students had a tendency to score lower in a specific area.

Comparing Project Teams to the Research Expert

As stated previously, the research expert, a librarian with 10+ years of research experience, was given the same research question that was posed to the group prior to the meeting session, and was allowed the same time of twenty minutes to conduct research and provide five sources. The research expert's sources were analyzed in the same way as the students'. Each question researched by the research expert received its own final average score. This was recorded and compared to the students' final scores. The final research efficiency of the teams was calculated by taking their score divided by the expert's score, and multiplying the result by 100. This indicated how efficiently the project teams researched.

Results

Pre-Observation Questionnaire

Out of the 44 the students observed only 28 completed the pre-observation questionnaire that was emailed to them by the research expert. The survey results were as follows:

- 16 Male – 12 Female
- 19 Engineering Majors – 9 Non-Engineering Majors
- 7 had taken GPS courses
- 19 had had a research workshop
- 4 had had a research consultation with a librarian
- 1 Very Confident – 16 Confident – 9 Somewhat Confident – 2 Not confident
- 16 had done a research project requiring at least 10 sources in the past

The two highest scoring groups had six “*confident*” responses and one “*very confident*”. Past studies have indicated that students are very poor judges of their own skills when it comes to research, however this was not apparent in our study which is interesting (Gustavson and Nall 2011). Out of the eight students on the two highest scoring teams, only one student had a research consultation with the librarian personally, and only two had taken a GPS course. Of the seven GPS students, all of them have had a research workshop as well, while three had both a library consultation and a library workshop. All of the students in the highest scoring group have had a librarian workshop at some point in their time at WPI. The lowest scoring teams had a higher percentage of GPS students as well as more personal consultations.

Research Efficiency Observation Protocol

Project Teams

All 13 project teams we observed used Summon at some point during their session time, 12 of them used Google Scholar, and 10 used Google. Five teams used specialized search engines and five teams used alternate means of finding the links. In terms of searching, 100% of students used keywords, typically words or phrases taken directly from the question posed. Five used Boolean limitations, two

used the date of publication, four used full text, one searched by author, seven searched by subject, one searched by source title, six searched by source type, and nine searched for peer reviewed. All of students worked separately, but came together to share and compile the five sources when their time limit was reached.

Research Expert

While observing the research expert, our team found they consistently used the same search techniques to find the five sources pertaining to the specific IQP research question. They started their search with Summon, followed by Google. The research expert then utilized specialized databases such as PubMed and PyscNet, depending on the specific research question. After, they visited Google Scholar and finally some would refer to prior IQP projects, or the library catalog. The research expert used advanced techniques such as synonyms for the keywords in the questions, and made extensive use of Boolean limitations while also searching by subject/field and peer reviewed and scholarly articles. The research expert used references from one article to find others. Other techniques included using the FullText Finder to obtain full text of articles, reading the abstract and skimming over the article for keywords.

Research Efficiency Source Analysis

Project Teams

Each team sent in five sources via email. During the study fourteen groups were observed, but one of them was removed from the study. This was due to unreliable links provided by the group, making it impossible for us to score their results. In total 64 sources were analyzed and scored due to one group providing only four sources, and compared with those of the research expert. From the thirteen groups we observed, the average scores varied from 7.6 to 16, out of a possible 18. The average score was 6.5 out of 10 for relevance and 6 out of 8 for reliability, making the average overall score 12.5 out of 18. The highest scoring sections for the groups were “Is the article supported by fact?” and “Is

the methodology sound/data evaluated properly?”, both averaging 1.69 points out of 2. The lowest scoring section for the groups was “Key concepts in references”, with an average of 1 out of 2. As for the spread of group scores, one group scored in the range of 6 to 7.9, four groups scored in the range of 10 to 11.9, four groups scored in the range of 12 to 13.9, three groups scored in the range of 14 to 15.9, and one group scored in the range of 16 to 18.

Section	Average Section Score	Percent
Supported by fact	1.69	84.62
Methodology sound/evaluated properly	1.69	84.62
Relevance based on date	1.46	73.08
Authors knowledgeable	1.46	73.08
Key concepts in title	1.37	68.46
Key concepts in abstract/Intro	1.34	66.92
Majority of section about topic	1.34	66.92
References complete/ knowledgeable	1.15	57.69
Key concepts in references	1	50
Relevance	6.51	65.08
Reliability	6	75
Total	12.51	69.49

Table 3: Project Teams' Average Section Scores

There are a few things to note in this table. While the scores between sections are extremely varied, the scores for the categories “Supported by fact” and “Methodology sound/evaluated properly” are extremely high, while those for “References complete” and “Key concepts in references” are extremely low. This could be due to our tools not being able to effectively grade these aspects of the sources. Finally, the scores in the reliability section were 10% higher than those in relevance. This could be due to project teams struggling finding relevant sources, or once again due to inaccuracies in our tool.

Research Expert

The research expert's overall scores varied from 10 to 17.8 out of 18, which is understandable as the research questions were all unique. Overall, the average total score was 14.9 out of 18, or 82%. Most of the total scores were within the 16-18 point range, or 89-100%. Total score was not the only parameter we looked at. It is also valuable to know how the research expert scored in each section of our Research Efficiency Source Analysis rubric (RESA), and to also know how the research expert scored overall in the relevance and reliability subsections. The average scores per section ranged from 1.22 to 1.94 out of 2, with the two lowest scores coming in the "Key concepts in references" and "References complete" sections, with an average of 1.22 and 1.27, respectively, while the two highest scores came in the "Is the article supported by fact?" and "Is the methodology sound/data evaluated properly?" sections, with an average of 1.95 and 1.93, respectively. In the relevance subsection of the RESA, the research expert scored an average of 7.94 points out of 10, or 79.4%, while scoring an average of 6.91 points out of 8, or 86.4%, in the reliability subsection.

Section	Average Section Score	Percent
Supported by fact	1.95	97.31
Methodology sound/evaluated properly	1.93	96.54
Authors knowledgeable	1.76	88.08
Key concepts in title	1.76	87.88
Key concepts in abstract/Intro	1.71	85.38
Majority of section about topic	1.67	83.65
Relevance based on date	1.58	79.04
References complete/ knowledgeable	1.27	63.65
Key concepts in references	1.22	61.15
Relevance	7.94	79.42
Reliability	6.91	86.39
Total Score	14.9	82.78

Table 4: Research Expert's Average Section Scores

While it is not surprising that the scores in these categories are higher than those of the project teams, there are also some interesting trends to consider. Once again the scores in the categories “Supported by fact” and “Methodology sound/evaluated properly” are extremely high, while those in “References complete/knowledgeable” and “Key concepts in references” are very low. Also, our research expert scored much higher than the project teams in the reliability section of the RESA. We believe these trends point to flaws in our instrument.

Percent Efficiency

Once we had collected and scored all of the sources from both the project teams and the research expert we compared them to show the project teams’ percent efficiencies’. The percent efficiencies for both the average source scores and average section scores are shown below.

IQP Title	Groups	The Research Expert	Percent Efficiency
Australia Team #1	11.4	10	114
Namibia Team #6	16	16.6	96.39
London Team #1	13	14.6	89.04
Namibia Team #4	13.4	15.2	88.16
Namibia Team #2	10.4	11.8	88.14
Namibia Team #1	14.4	16.6	86.75
London Team #3	14.8	17.4	85.06
Namibia Team #3	15	17.8	84.27
Australia Team #2	10.2	13	78.46
London Team #2	13.4	17.5	76.57
London Team #4	12.6	16.6	75.9
Namibia Team #7	10.4	14.4	72.22
Namibia Team #5	7.6	12.2	62.3
Average of above	12.51	14.9	83.94

Table 5: Project Teams’ Average Source Percent Efficiency

Research Category	Project Teams	Research Expert	Percent Efficiency
Relevance based on date	1.46	1.58	92.46
References complete/ knowledgeable	1.15	1.27	90.63
Methodology sound/evaluated properly	1.69	1.93	87.65
Supported by fact	1.69	1.95	86.96
Authors knowledgeable	1.46	1.76	82.97
Key concepts in references	1	1.22	81.76
Majority of section about topic	1.34	1.67	80
Key concepts in abstract/Intro	1.34	1.71	78.38
Key concepts in title	1.37	1.76	77.9
Average of above	1.39	1.65	84.3

Table 6: Project Teams' Average Section Percent Efficiency

There are a few very noticeable patterns in the average source score data shown above. It is no surprise that the research expert almost always scored higher than the project teams, or that their scores were extremely high in general. However, in one instance the project team beat our research expert, which surprised us. Another surprising trend is how high the percent efficiencies of most teams were. While we were expecting in the 60-75% efficiency range for most teams, only two project teams actually fell within that expected range, with the others all scoring above. The same trends are present in the average category score data. While the research expert scored consistently higher, once again the project teams still exhibited much higher percent efficiencies than we expected. However it may be worth noting that both the project teams scored extremely lowly in the two references based categories, and extremely highly in the fact and methodologies sections. These trends were also present in the pilot groups, so we believe our instruments are the reason.

Discussion

Analyzing Results with Pre-Observation Questionnaire

Comparing the teams scores to the survey questionnaire responses show a few connections, but due to only 60% of students responding, review of the following results must take this into account. However, when looking at student confidence in their research abilities, this factor seems, in most cases, to have little effect in regard to scores. Another issue with the low response rate is that three of the four best performing teams didn't have any responses to the survey. It was decided to provide the online survey in advance to save time during the observation. However, these problems could be corrected in the future by conducting the questionnaire at the start of the meeting, which would lead to a higher response rate from students. The free online survey website used only allowed 10 questions, so also a few additional questions could be considered, but may make this part of the observation take too much time.

The four teams with a student who has participated in a research consultation with a librarian in the past scored a 16.6, 13, 10.4 and 7.6. This spread of scores shows there is little correlation between the research consultation and overall score for the group. Of the six students who have not had a research workshop, two of them were in the second highest scoring group while the two lowest scoring groups had only one student that had not taken a research workshop. Again there is no apparent link between responses and the scores the teams received. Out of the eight students on the two highest scoring teams, only one student had a research consultation with the librarian personally, and only two had taken a GPS course. All of the students in the highest scoring group have had a librarian workshop at some point in their time at WPI. The lowest scoring teams had a higher percentage of GPS students as well as more personal consultations. This suggests that GPS courses alone may only have a minimal impact on the student's research abilities; however, due to the minimal sample size of GPS students, this

aspect may warrant further studying. As a whole, the questionnaire answers had little visible bearing on any of the research scores.

Analyzing Results with Research Efficiency Observation Protocol

The REOP results showed that Summon was most often used first as a research tool by the project teams and the research expert, which shows project teams are aware of Summon, a product implemented by the WPI Library in August 2011. This was the most popular possibly because it is a reliable source provided by the university, and a gateway to many specialized databases and resources which are topic specific. This could also have been very popular due to any recent research consultations the groups may have had. Google Scholar and Google were also popular among the groups and the research expert because it provides quick access to topic specific information, which was stressed in the “Why is Google Important” section of this report. Less than half of the project teams used specialized search engines and other means of finding the sources because they were not aware of them, or was pressed by the limited time given. The teams that did use specialized databases used most commonly SciVerse, but some also used were Health and Wellness, the UK Environmental Agency, the National Fire Association, Infotrac, and Science Direct. These were very varied, but that is to be expected because of the diversity of the research topics. The common filtering done in the searches were expected, such as the limiting by peer reviewed articles and by subject. Most teams weren’t fully aware of the FullText Finder; they seemed to struggle actually finding the full text of the source. All teams, and the research expert, skimmed and read the abstract in order to decide whether the source was relevant. Other techniques such as note taking, using ILL, and saving citations in RefWorks were not observed. This could be due to the time limit, or a lack of knowledge or comfort in using these tools. There was a trend of all the students on the project teams working separately. We observed research being done on an individual basis and then students collaborated to combine the findings.

Besides noting what databases were used, we also tracked the order in which they were being used. This produced interesting results. 55% of students observed began their searches with Summon, followed by 23% beginning with Google, 18% with Google Scholar, and 4% with a prior IQP. From the students who began with Summon, 33% then went to Google, 33% to Google Scholar, 17% to a specialized database, and finally 17% remained on Summon for the duration of the study. From the students who began with Google, 60% followed up with Summon, while the remaining 40% with Google Scholar. From the students who began with Google Scholar, 25% proceeded to go to Google, 25% to Summon, and 50% remained on Google Scholar the whole time. From this data, a few key trends can be identified. The most obvious, and expected, is the fact that Summon, Google, and Google Scholar were clearly and consistently the favorite databases used, and quite often, the only databases used. However, while we thought Google would be the first resort of most students, this was in fact Summon by a surprisingly large margin over Google and Google Scholar. Another interesting trend is that no students started their search by going to a specialized database, and a limited amount even chose this as their second option. This could suggest that students don't know about specialized databases, or thought the same results would be available through Summon, Google, and Google Scholar. Regardless, this could warrant further investigation as specialized databases can be extremely useful for refined topics.

We also noticed a lot of interesting trends while observing the project teams. While in every group students searched using separate computers, we observed that students on most teams were totally silent while conducting research, and only conferred with other group members at the end of the time limit to send the sources to one person and choose their five best. This could be due to a number of things, including factors such as not knowing the other members in their group very well or, as one person told us, they could have felt uneasy talking to each other because we were observing. Looking into these two possibilities could produce a different response from groups. On the other hand, there were a few groups that were discussing the sources they found and the places they were having success

while they were researching. Some groups were even telling jokes and laughing with each other. This could possibly be explained by having friends as group members, or even just because they knew who we, the observers, were so they were more comfortable being observed.

Besides these behavioral observations, we made a number of interesting observations pertaining to search techniques. When observing how the groups used key words in their searching, there were some common trends, most of which were expected. Almost every group began their searches by typing in the question presented to them into a database, either in question form or just as a statement. The project teams had varying levels of success with this technique. This could be attributed to the questions they had, as some may have had more common themes than others. Regardless of how successful this first search was, the project teams' next attempt was to just search the few main points or topics their question was about. From here, many groups would then try searching broader key terms, or combine different key words depending on how successful their searches were. For example, if the group's question was "What are the fire risks associated with hoarding?" than after searching this question, the next step would entail searching "fire risks hoarding", and from there they might try "dangers hoarding" or "fire hoarding". Most groups would base these key words on different aspects of the question asked, while one group used topics listed in their IQP description to find keywords. Another trend we noticed was that very few groups would use Boolean limitations, such as "keyword" and "keyword" or "keyword" + "keyword". This could be because students were unaware this type of searching existed, or possibly didn't know it could provide different results than normal searching. When students encountered a source that wasn't full text, almost all would simply skip them and continue their search without attempting to access the full text using FullText Finder. This could be because students either don't know about the FullText Finder feature or, most likely, don't know how or aren't comfortable with using it. A few students would use the Ctrl+F function to search for key words in sources rather than just skimming. This allowed them to quickly find

the sections that were important to their research question. While most groups followed the common patterns outlined above, there were some unique techniques a few students used that we found interesting. One group divided their searching between members based on source types. For example one member would search only for books, while another only for journals, etc. Another group used a previous IQP project report similar to theirs, and mined through the references used. Both of these techniques were intriguing, and could warrant further investigation.

Analyzing Results with Research Efficiency Source Analysis

General Information Regarding Scoring

In all but one case the research expert had a higher average source score than the project teams, and this is undoubtedly due to years of experience, and daily research as a profession. This can also attest for the fact that not only were the scores higher, but that they were extremely high in general, with an average consistently above 14 points. The project teams' scores were very varied, with some extremely high sources and low sources, with most in the middle. This lack of consistency may be because project teams are not exposed to this open-ended problem-based research often. These same trends are apparent in the average section scores of both the research expert and project teams. Another trend that we observed was the two reference based categories scored much lower than the other categories. A possible reason behind the low scores in this category assumes that references are provided within the source. Many of the sources selected by the groups did not list any references and thus scored zero. This category may need to be reworked in the future in order to accommodate the possibility of relevant sources that don't specifically list references within the article, such as those published in scientific journals or books.

In measuring the percent efficiency of the project teams, we divided their scores by that of the research expert. This shows how close the teams came to the research expert's score. The percent efficiencies were general in the eightieth percentile, with one team actually surpassing the score of the

expert. These percent efficiencies are much higher than we expected. This could be attributed to many things, such as the efficiencies of research tools such as Summon and Google Scholar, or because the project teams had three or four members working together. For one particular team, the research expert provided useful sources for the student project; however their scope was broader than the specific research question used to score. For instance, the student team referenced a specific building code dealing with egress or evaluation procedures, whereas the librarian pointed to a broader source, the general building codes for the country. Another thing to consider would be whether or not our tools provided us with an accurate enough measurement of the sources.

In order to further test how well the RESA assessed research efficiency, the observers gave a WPI librarian three sets of sources to analyze using the RESA. The librarian was not told which of the groups of sources came from project teams and which came from the research expert. We hoped that in doing this, we would be able to see if the librarian’s results were similar to the observers’ results. There were some slight differences in scoring technique that made the efficiency scores given by the librarian differ from the scores given by the observers. This showed that our RESA could be improved upon in the future to make analyzing sources more precise.

Score Distributions

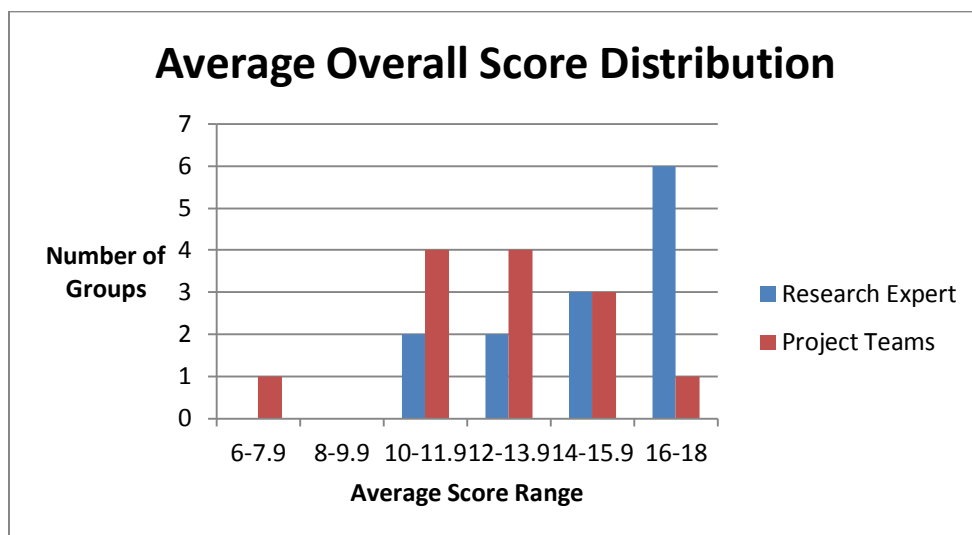


Figure 2: Average Overall Score Distribution

We decided to also look at the distribution of average source scores and average section scores.

This would allow us to see in what ranges the project teams and research expert fell in. The source score distribution is interesting because it shows the gap between the research proficiencies of the two sides.

While the research expert had 9 of 13 scores above 14 points, the project teams had 8 of 13 scores between 10 and 14.

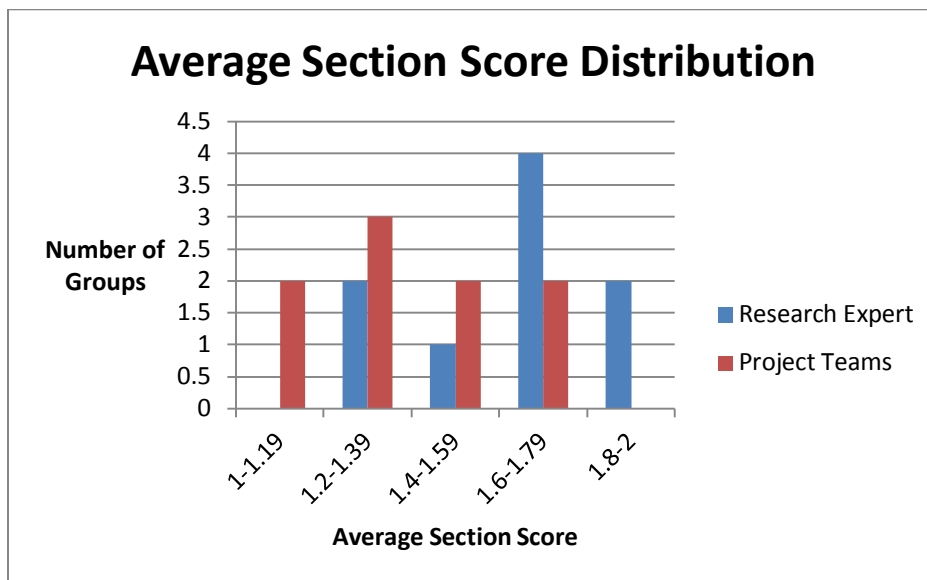


Figure 3: Average Section Score Distribution

In the section score distribution, while both sides' scores were more diverse, the research expert had 6 of 9 section scores above 1.6, compared to the 2 the project teams had. This once again points to the effectiveness of the research expert, and the lack of consistency in project teams.

Score Correlations

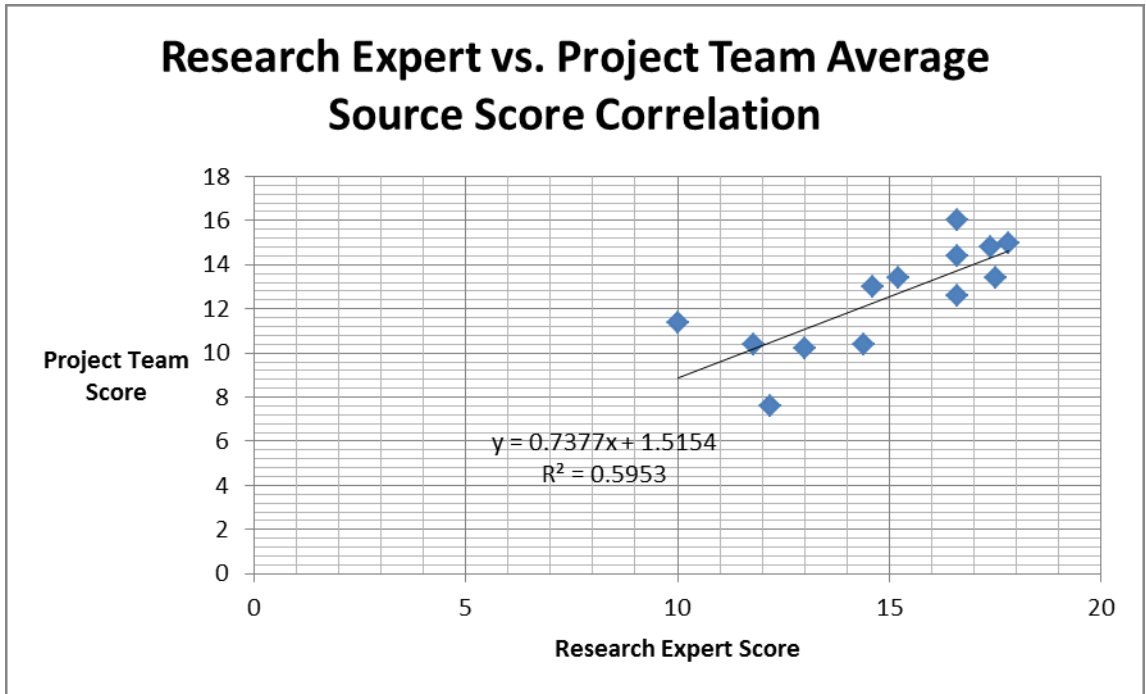


Figure 4: Average Source Score Correlation

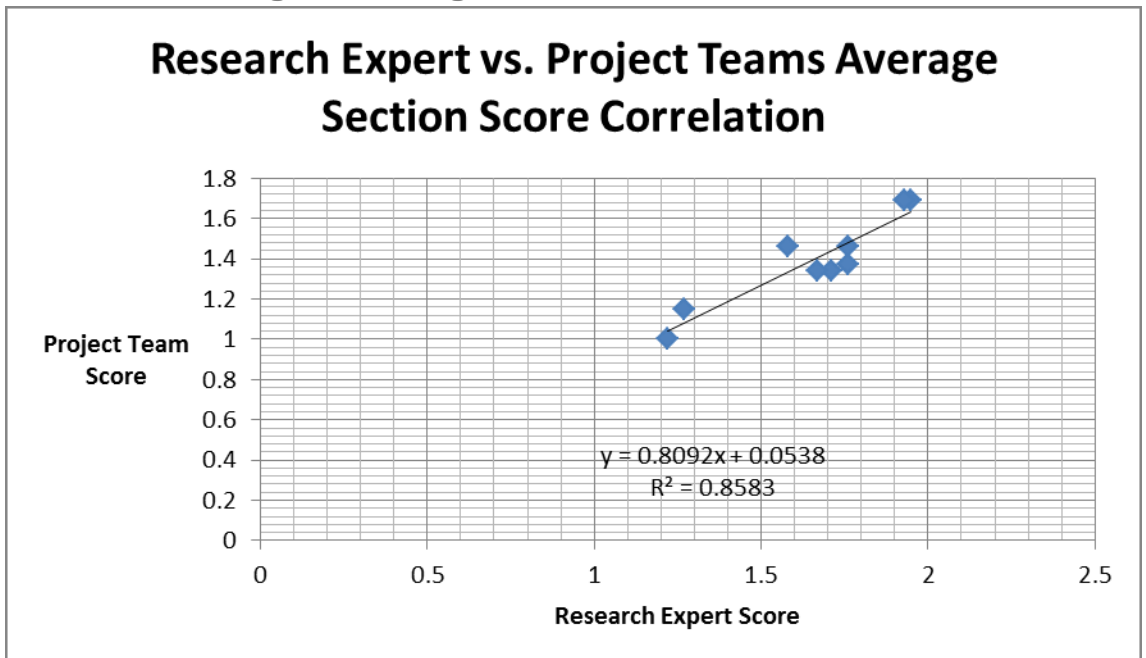


Figure 5: Average Section Score Correlation

When analyzing the relation between the research expert and project teams scores, we found some interesting patterns. First, the data lie fairly close to a line of best fit, with strong correlation and no extreme outliers. The y value is the project team score, while the x value is the research experts score. The slope of the best fit was 0.74, which means that, in general, for a one point increase for the research expert, there was an increase of 0.74 points for the project team. The same trend is present in the average section scores, with an even stronger correlation (R^2 equaling 0.86) and a best fit line slope of 0.81. This shows that, while the research expert is still better, both sides follow the same trends. This is interesting because it shows that when the research expert would score high or low, the project teams would do the same, more so in the section score than the average source score though. If there was no linear relationship between the two scores, then we could conclude that our test parameters and tools had no effect on the outcome. However, because of the linear relationship, these results point to both the research topic, and our RESA, having an effect on both sides' scores.

Source Overlap

Of the 129 sources given to the observers, 64 from project teams and 65 from the research experts, there was an overlap of only five sources, meaning that only five sources were given to us by both the project team and the research expert. One reason for the majority of sources being different between the project teams and the research expert could be that the project teams and the research expert simply have very different approaches to conducting research; differences in keywords, databases, and filters used could yield very different results. Other possible reasons could be due to how search engines such as Google provide varied results based on past searches and your location.

Research Topic

The choice of research question/topic may have had an impact on the overall scores for the project teams as well as the research expert. It was decided to use specific questions from the project teams' current work in order for the study to not only help us, but help the project teams with their

projects as well. Some questions/topics were very basic, making information easier to find while some were more specific, leading to more problems finding relevant information. Also, the librarian did not always have the background information on the overall project than the project teams did.

Recommendations

While we hope our research study provided useful information to the WPI Librarians, there are some drawbacks and other directions that could be considered in the future. One drawback to our study was the possible affect the observers being in the room had on the project teams. Being observed could have affected the way in which the teams collaborated. Another effect on collaboration may have been that the observation took place in a room with multiple computers, which could have pushed students more towards doing individual research rather than collaborative research. To minimize these factors in the future, we would suggest using video cameras in conjunction with screen capture software so observers would not need to be present during the research sessions. We would also suggest using a room similar to the WPI library tech suites, which have a single computer. This way, students would have more of an option to collaborate, or work on their own laptops.

Although we believe that our analysis tools did a good job of assessing sources and research techniques, and allowed us to compare how efficient project teams conduct research compared to a research expert, there are many things that could be improved upon in the future. The major areas that need improvement are the two sections concerning references. A large portion of the sources we evaluated using the RESA lost points in the “Relevance/Key concepts in references” and “Are references complete and written by authorities in this area” due to the sources not having references at all. The main problem with this was that a source could still be relevant and reliable without having references, such as news article. Another area for improvement of the RESA pertains to the “Is the article supported by fact?” and “Is the methodology sound/data evaluated properly?” These sections should be rethought and possibly combined into a single category since, overall, sources that received a score of 0, 1, or 2 in one category tended to receive the same score in the other. We also believe that the criteria for each category score (0, 1, and 2) could be more distinct, making it easier to determine which score each category should receive. This is mainly because for the category “Based on the date published, is the

sources relevant to the topic?" it was often difficult to discern when an article went from being "very relevant", to "somewhat relevant", to "not relevant".

Another recommendation we would make for future studies using our tools is to continue allowing the project teams to pick their research question, even though it is apparent the research question had an effect on the scores of both the project teams and the research expert. While it may be easier to compare project team's scores to a research expert's scores and other participating groups' scores, a standard question wouldn't be important to project teams and they probably wouldn't take the study seriously if they participated at all.

Deploying the pre-interview questionnaire on paper during the research session would eliminate the problem of only some of the participants filling it out, making the results more accurate and allowing for more connections between answers to the questionnaire and research efficiency to be made.

We strongly recommend the library continue with information literacy studies, though we also recommend considering observing other project group types here at WPI. Looking at the research efficiency of MQP teams would help to show where students are struggling with research even after being here at WPI for 3+ years. Also, looking at the research efficiency of first year students who have taken a GPS course versus first year students who have not taken a GPS course could potentially show whether or not GPS has an effect on student research habits.

There are also some recommendations we would like to make to the library staff here at WPI. Most importantly, we believe that the library staff should continue providing research education to the students. We personally learned a lot about research during this project that we did not know previously, thanks to the librarians. We believe that certain areas should be stressed more during research consultations with the library staff, including the use of filters in Summon, as well as using

FullText Finder and generating awareness of specialized databases. These areas improved our research skills greatly, and we believe they will do the same for others. Finally, we believe that the creation of a mandatory first year class on research skills would be beneficial to all students, since major projects such as the IQP and MQP are mandatory for graduation and require large amounts of research.

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Appendices

Appendix 1: Informed Consent Agreement Form

Informed Consent Agreement for Participation in a Research Study

Investigators: Daniel Foley, Joshua Mann, Jerone Mitchell, and David Moulton

Title of Research Study: Research Habits of WPI Project Teams

Sponsor: WPI Library

Introduction: You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study: The librarians of WPI are interested in learning about the research habits of group project teams, and more specifically IQP teams. The purpose of this study will be to observe and analyze, using ethnographic methodologies, how IQP teams conduct research.

Procedures to be followed: You will work together with your group and be given a research question(s). In a limited amount of time, specified at the start of the study, you will be asked to find as much relevant information on the topic as possible. You will be allowed to use any tools or databases you wish to accomplish this task in working with your group. During this process, investigators will be in the room observing how your group works and taking notes on your research process.

Risks to study participants: The investigators will be observing the research team, so if students are uncomfortable being watched and may experience anxiety.

Benefits to research participants and others: This study will provide useful information and insight into how IQP teams perform research, and the librarians will be given recommendations on how to improve the IQP teams' research skills.

Record keeping and confidentiality: Answers to questionnaires and the methods, findings, and interactions of the project group will be reported. No personal information regarding the identities of participants will be released. Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or its designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.

Compensation or treatment in the event of injury: You do not give up any of your legal rights by signing this statement.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact:

Daniel Foley: danfol1890@wpi.edu

Joshua Mann: joshmann@wpi.edu

Jerone Mitchell: jerone.mitchell@wpi.edu

David Moulton: djmoulton@wpi.edu

In addition you can contact:

IRB Chair: Professor Kent Rissmiller, Tel. 508-831-5019, Email: kjr@wpi.edu

University Compliance Officer: Michael J. Curley, Tel. 508-831-6919, Email: mjcurley@wpi.edu

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

Date: _____

Study Participant Signature

Study Participant Name (Please print)

Date: _____

Observer Signature

Appendix 2: Example of a filled out REOP

Q: What are effective methods
or teaching students through
e-learning

Library Research Habits IQP
Research Efficiency Observation Protocol

Project Title: Center for Teaching and Learning

Databases (list order of resource used)

- Summon
- Google Scholar 1, 6
- Search Engine Which one(s): Google 2, 5
- Specialized (Major/Field Specific i.e. PubMed). Which one(s): _____
- Other connecting-Africa.net 3
mylib.iupui.edu 7

Keyword Searching and Filters within Database/Search Engine

- Keywords/phrases (jot down)
 - teaching e-learning
 - e-learning methods
- Boolean limitations
- Published Year/Date
- Full text
- Author
- Subject/Field
- Source Title (Journal name, etc.)
- Source type (Newspaper, journal, book, etc)
- Peer reviewed/ scholarly

Observed student ... (note # of students using technique)

- using references in one article to find other articles
- using author from one article to find other articles
- using organization in one article to find other articles
- using number of citations for an article/Cited by References
- using FullText Finder to get to item
- ordering item via Interlibrary Loan
- skimming article over for keywords?
- reading article abstracts?
- Taking notes (either print or online)?
- Emailing articles/resources to self or team?
- Saving citations to RefWorks or citation builder?

Collaborative research technique:

- All students together
- All students separate

Notes on their collaborations: talking with each other about
what they are finding

Observer Notes:

- using the CTRL+F
Find for keywords
in document
- worked in silent
most of the time
- collaborating as best
5 in last few minutes

Research Habits of WPI Project Teams
Daniel Foley, Joshua Mann, Jerone Mitchell, David Moulton
1/16/2012

Appendix 3: Example of a filled out RESA

Library Research Habits IQP
 Research Efficiency Source Analysis

Project Title: Namibia Tourism Board

Research Question: What are some other homestays in Africa and their problems?

Number of students: 4

Rubric used to score the sources found by the students and librarian(s).

Relevance	0	1	2
Key concept in title	There are no key concepts in the title	There are some key concepts in the title	All key concepts are in the title
Key concept in abstract/introduction	There are no key concepts in the abstract/introduction	There are some key concepts in the abstract/introduction	All key concepts are in the abstract/introduction
Are the majority of sections about the topic	There are no sections about the topic	There are some sections about the topic	All sections are about the topic
Based on the date published is the source relevant to the Topic	The source is not relevant to the topic	The source is somewhat relevant to the topic	The source is very relevant to the topic
Relevance/Key concepts in the references	None of the references are relevant and contain key concepts	Some of the references are relevant and contain key concepts	Most of the references are relevant and contain key concepts
Reliability	0	1	2
Are authors knowledgeable in this area	The author is not considered knowledgeable in this area	The author is considered somewhat knowledgeable in this area	The author is considered very knowledgeable in this area
Are references complete and written by authorities in this area	References are incomplete, and/or are not written by authorities in the area	References are somewhat complete, and/or are written by authors fairly knowledgeable in the area	References are complete, and are written by authorities in the area
Is the article supported by fact	The article is not supported by fact	The article is somewhat supported by fact	The article is mostly supported by fact
Is the methodology sound/data evaluated properly	The methodology used is not sound, and/or data is not evaluated properly	The methodology used is somewhat sound, and/or the data is not evaluated as well as it could be	The methodology is sound, and/or the data is evaluated properly

Final Source Score: 16

Source types team found (number of each):

_ Book _ News Article _ Peer Reviewed/Scholarly article _ Blog _ Website _ Other: Journal

Appendix 4: Presentation 1 – A-term

3/12/2012

Research Habits of WPI Project Teams

Daniel Foley
Joshua Mann
Jerome Mitchell
David Moulton

Project Goal

To study the efficiency of project teams (mainly IQP teams) when conducting research in order to provide information and recommendations to the librarians on ways to assist them

Research Efficiency

- ▶ The ability to locate needed information and sources using appropriate resources within an appropriate time frame.
- ▶ Research efficiency is the concept of how productive research is conducted compared to the end results.
- ▶ Time management, division of labor, research focus, collaborative project members and a variety of relevant resources are all essential for efficient research.

Research Efficiency in Group Projects

- ▶ Division of labor– different areas for different group members
- ▶ Collaboration– talking to other group members about what you found/how it's relevant
- ▶ Time management– staying focused and on task

Why is this Important?

- ▶ IQP groups have a wide range of topics that need to be researched
- ▶ A lot of sources needed and a lot of time searching
- ▶ Being more thorough while searching will allow you to find more information
- ▶ Knowing what databases to use and what sources are relevant



Methodology

- ▶ Send out a campus-wide email recruiting project teams.
- ▶ Teams will be presented a research topic/problem and will be asked to gather information in a limited amount of time.
- ▶ During the research session, investigators will observe the groups as they work.
- ▶ A small questionnaire will be given out before this research topic to gauge students prior research experience.
- ▶ An interview with the groups will be conducted after the research session



What are we going to get from this?

- ▶ A possible connection between efficiency and prior research experience
- ▶ Which databases are preferred by students and why.
- ▶ Where students go first when starting research on a topic.
- ▶ How teams work together when searching for information.
- ▶ How successful groups are at obtaining information.
- ▶ How quickly groups find information.
- ▶ If groups give up and why. What they do to move past it.



Ethnographic Methodologies

- ▶ Ethnography - branch of anthropology that deals with the description of human interactions
- ▶ Uses qualitative not quantitative methods
- ▶ Allows us to understand behaviors and habits
- ▶ Useful when studying small groups
- ▶ Uses tools such as in-depth interviews, surveys, and observation sessions with focus groups



Case Studies

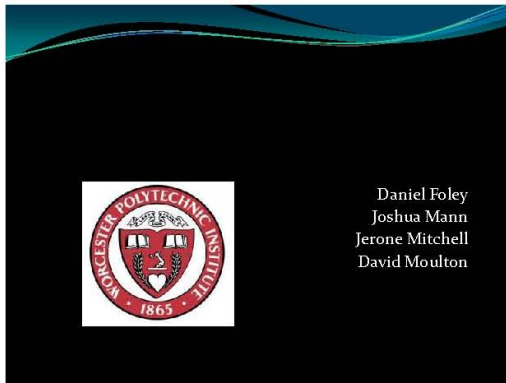
- ▶ University of Rochester Study
 - study into how students research and write a research paper at the college level
 - set out a basic set of questions for each section that would allow them to focus in on what mattered
 - narrow focus is something ethnographic studies need to ensure they don't end up vaguely answering an overly broad topic
- ▶ The ERIAL Project
 - showed students were not skilled researchers
 - overused Google and underused scholarly sources
 - students were unaware they were bad researchers because no one taught them
 - noticeably better research after instructional sessions with librarians

Is Google Making Us Stupid?

- ▶ Google emphasizes convenience by power browsing, which is skipping through relevant links and skimming specific information rather than traditional in-depth reading.
- ▶ User are becoming decoders of information rather than knowledge seekers, hence decreasing ability to interpret data and make mental connections.
- ▶ The neural circuitry of the brain is being rewired in order to adjust to this new fast pace information gathering online trend.

Appendix 5: Presentation 2 – B-term

3/12/2012



Project Goal

- To measure the efficiency of project teams (mainly IQP teams) when conducting research
- To gather information on what research techniques are used in order to identify the groups' strengths and weaknesses
- Provide recommendations to the librarians on ways to assist future project groups

Why IQP Teams?

- First large scale group research project
- IQP groups have a wide range of topics that need to be researched
- A lot of sources needed and a lot of time searching

What is Research Efficiency?

IF WE ARE GOING TO BE STUCK GOING FOR PROJECT TOGETHER WE NEED TO START BY COMING SOME RESEARCH

I GOT MY GOOD WITH ME. I'LL SEE WHAT WIKIPEDIA HAS TO SAY FOR ITSELF

WELL, MAREN SAID WE CAN'T USE WIKIPEDIA

ALEXIS! THEN I GUESS I'LL USE WIKI'S FACTS AND STUFF!

GOOD THING I HAVE IT BOOKMARKED!

© 2010 Sam McKean Under the hood.com

What is Research Efficiency?

- Finding relevant, reliable information within an appropriate time frame



Why Efficiency?

- Quality of information
- Time spent searching
- Vital when conducting a lot of background research



Who are we studying?

- 10 IQP Teams
- In conjunction with IQP groups' meeting with the librarian



Our Plan

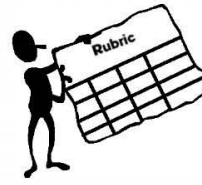
- Pre-observation questionnaire
- Research observation session
- Research Efficiency Observation Protocol (REOP)
- Research Efficiency Source Analysis (RESA)
- Same test administered to research expert

Research Efficiency Observation Protocol



www.tswtj.com

Research Efficiency Source Analysis (RESA)



edtech.kennedyschools.com

Evaluation and Analysis

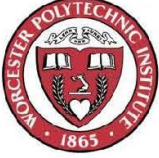
- Research Group vs. Librarian
 - $\% \text{ Efficiency} = (\text{Research Group's Score} / \text{Librarian Score}) \times 100$
- Scores compared to the librarian's
- Making connections between scores and pre-observation questions.



Appendix 6: Presentation 3 – C-term

3/12/2012

Research Efficiency of WPI Project Teams



DANIEL FOLEY
JOSHUA MANN
JERONE MITCHELL
DAVID MOULTON
FEBRUARY 28, 2012

Project Goal

- To measure the efficiency of IQP teams when conducting research
- To gather information on what research techniques are used
- Compare project team sources with that of research expert
- Provide recommendations to the librarians on ways to assist future project groups

Why IQP Teams?

- First large scale group research project
- Almost 40% of the library's course-related instruction is spent with IQP
- IQP groups have a wide range of real-world topics that need to be researched
- Convenient to meet with IQP teams vs. other types

What is Research Efficiency?



Project Timeline

- August-October 2011: Background Research
- November-December 2011: Propose, pilot, and revise methodology
- January 2011: Project team and research team observations
- February 2012: Data analysis and share findings

Team Observations



Teams We Observed (January 2012)

- Goal to observe 10 IQP teams; actually observed 13
- Worked with librarians to set up observations
- Met Global Project Center Teams going to Australia, London & Namibia
- Met for 30 minutes prior to IQP groups' research consultation with librarian

Project Team Observation

- Pre-observation questionnaire
 - Online survey
 - Gather background information
- Research environment
- Research question and instructions
 - IRB signed
 - 20 minutes

Research Efficiency Observation Protocol

- Observation checklist used to collect consistent data
- Example section of REOP

Observed student ... (note # of students using technique)

- using references in one article to find other articles__
- using author from one article to find other articles__
- using organization in one article to find other articles__
- using number of citations for an article/ Cited by References__
- using FullText Finder to get to item__

Observations of Teams

- All 13 teams used Summon, 12 used Google Scholar, 10 used Google
 - Order of databases used
- All 13 project teams observed, when no full text was found, tended to look elsewhere
- Most team members searched individually and collaborated at end to compile results
- Other searching habits

Observations of Expert

- Observed for 3 teams, then expert performed research on her own with time constraints in place
 - Search strategies were consistent
- Used “Triangulation” approach

Summon

RESULTS!

Google Scholar Specialized Databases

Research Efficiency

Determining Research Efficiency

- Research expert vs Project Team
- Research Expert: librarian with 10 years experience
- Research Efficiency Source Analysis (RESA)

○ % Efficiency = (Research Group's Score/Research Expert Score)

Research Efficiency Source Analysis (RESA)

- Both expert and project teams provided 5 sources
- “What are the fire risks associated with hoarding?”

Relevance	0	1	2
Key concepts in title	There are no key concepts in the title	There are some key concepts in the title	All key concepts are in the title
Key concepts in abstract/introduction	There are no key concepts in the abstract/introduction	There are some key concepts in the abstract/introduction	All key concepts are in the abstract/introduction
Are the majority of sections about the topic	There are no sections about the topic	There are some sections about the topic	All sections are about the topic

Analysis of Sources

- 129 sources analyzed
- Types of sources
- Source overlap
- Research Group vs. Expert

Team Comparison with Expert

Team	Group Score	Expert Score	Group Efficiency
Australia Team #1	11.4	10	114
Nanubia Team #6	15	15.6	96.39
London Team #1	13	14.6	89.04
Nanubia Team #4	13.4	15.2	88.16
Nanubia Team #2	10.4	11.8	88.14
Nanubia Team #1	14.4	16.5	86.75
London Team #3	14.8	17.4	85.06
Nanubia Team #3	15	17.8	84.27
Australia Team #2	10.2	13	78.46
London Team #2	13.4	17.5	76.37
London Team #4	12.6	16.6	75.9
Nanubia Team #7	10.4	14.4	72.22
Nanubia Team #5	7.6	12.2	62.3
Overall Average	12.31	14.9	83.94

Pre-observation Questionnaire Results

- ~65% response rate (28 students)
 - 16 Male and 12 female
 - 19 Engineering vs. 9 Non-engineering
 - 4 had research consultations in past
 - 19 had research education in past
 - 7 took Great Problems Seminar

Recommendations



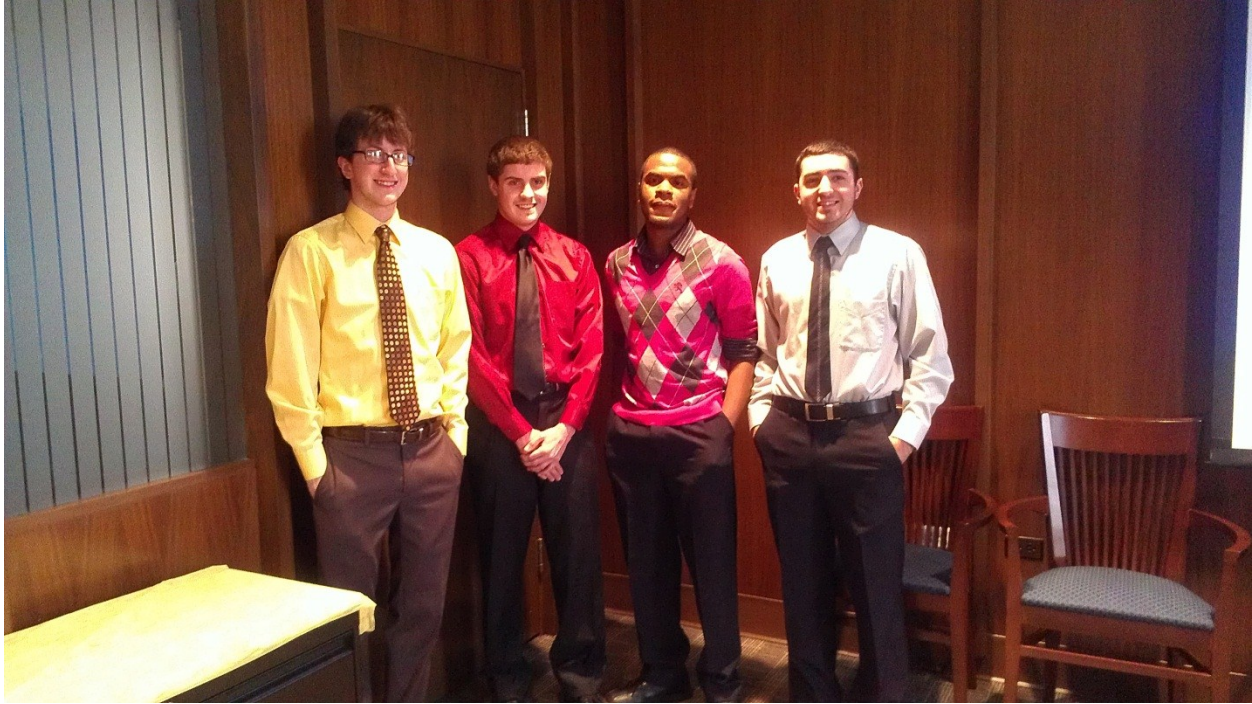
Things to Consider

- **Improving tools/protocol:**
 - Pre-Observation Questionnaire
 - Research Efficiency Source Analysis
 - Research Question
 - Research Environment

Recommendations for the Future

- **Research education programs**
 - Help students improving filtering and keyword searching
 - Awareness of specialized databases
 - Managing found information
- **Ideas for future IQP or research studies**
- **Better understanding Team Efficiency/Collaborative Information Seeking**

Appendix 7: Team Members



From left to right:

David Moulton: Biomedical Engineering

Daniel Foley: Mechanical Engineering

Jerone Mitchell: Biomedical Engineering

Joshua Mann: Biomedical Engineering