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Information use in design: what should we be teaching?

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Abstract: Librarians are regularly working to understand how students make decisions around information use to inform the development of more relevant learning activities. The more relevant the activities when students are learning any new skill, the more likely they are to understand the task and incorporate the learning into future design decisions and writing. The need to build connections and understanding is critical in adoption of information literacy. In this study, the researcher analyzed the transcript from an end of semester focus group with students in a design class about their information use during the semester project. The transcript was analyzed using deductive thematic analysis while simultaneously staying open to emergent codes.

Keywords: information user, undergraduate, focus group, information synthesis, qualitative, thematic analysis

1. Introduction

How students use information and demonstrate information literacy is a focus for academic librarians who teach. At Purdue University, information literacy is also part of the core curriculum, and as such is a competency that all graduating students are expected to achieve. Librarians are regularly working to develop and test the best ways to teach information discovery, evaluation, synthesis, and use in disciplinary contexts. To develop relevant learning activities, we need to understand how students make decisions around information use.

2. Background

Many studies that have been done of how students use information and their self-perceptions of ability, most notably the series of reports from Project Information Literacy (Head & Eisenberg, 2009), which focuses on undergraduate students in the humanities and social sciences. In addition, there have been studies that focusing on engineering students (Van Epps, 2013; Williams, Blowers, & Goldberg, 2004) and their information use as shown in final project reports. These studies show mixed abilities from the

students, and some surprising areas of student struggles. In studies where the skills tested are a near match for the information presented to the students, such as answering why citations and references are used, or identifying properly formatted citations, the students achieve well (Van Epps, 2013). Studies that look more in depth at the student process, or inquire about where they struggle (Head & Eisenberg, 2009), indicate that students are not as comfortable with information synthesis and application as basic measures of information literacy (IL) would indicate.

A number of studies have focused on engineering and technology students working on design projects and their use of information as represented in the final report (Denick, Bhatt & Layton, 2010; Wertz, et al, 2011). In these studies, the students demonstrate limited documentation of information use. In the researchers' experience, students can tell you when they need to use information, how to construction citations and reference, and why they should be included in a report, so the limited use in final reports is perplexing. It is possible the problems arise from students not knowing how to transfer the skills taught in one discipline, such as English class, to their technical coursework.

	Engineering Design Activity	Information-Seeking/Creating Activity	
Improve Design Work Processes	<i>Organize Your Team</i>	<i>Develop Knowledge Management Strategy</i> How will the team acquire and manage information?	Improve Knowledge Management Processes How do we capture and use lessons learned?
	<i>Clarify the Task</i>	<i>Establish the Project Context</i> What do the stakeholders want and what are the constraints?	
	<i>Synthesize Possibilities</i>	<i>Investigate Prior Art</i> What have others done in similar situations?	
	<i>Select Solution</i>	<i>Assess Technologies and Methods</i> How do the solutions actually work? How can components work together?	
	<i>Refine Solution</i>	<i>Integrate Technical Details</i> What detailed technical information is available?	
	<i>Communicate Effectively with all Stakeholders</i>	<i>Distill Project Knowledge</i> What is the critical information that must be passed on?	

Figure 1: Information-seeking activities corresponding to design activities. (Racdliffe, 2014, p. 48). Reproduced with permission.

One model that aims to help students make the connection of types of information use with the stages of design, and apply the skills to their technical coursework, is the Information-Rich Engineering Design (I-RED) model (Figure 1). The model shows a unified and somewhat generalized presentation of the design process that has a parallel information discovery and use activity for each design stage. This model was developed through collaboration of a librarian and engineering education faculty member, and shows one method of bringing a disciplinary focus to information literacy instruction.

The process of using information to learn, rather than just learning IL skills in a stand-alone fashion has been called informed learning (Maybee, Bruce, Lupton, & Rebmann, 2013). The process of informed learning helps students gain the information literacy skills they need, and do it through active use of the information to learn the subject matter. In some ways the I-RED model makes steps in this direction, to fully implement an informed learning approach means ensuring that the information use is taught as part of the process, rather than as parallel activities or skills. Grafstein (2002) presents a model to support a discipline-based approach to information literacy, where the librarian is responsible for the generic information literacy skills that are applicable across disciplines, such as searching, evaluating, and acknowledging sources, and the faculty member is responsible for reinforcing the IL skills that are part of the research norms embedded in the discipline being taught.

Within the engineering and technology fields, one of the primary disciplinary ways of thinking and approaching problems is through design. To best address the teaching and evaluation of information use by students in these disciplines, it is reasonable to look at a design class setting for an integrated approach to learning information literacy. This study helps address the research question of how students articulate their use of information in design work.

3. Research methodology

This study uses one piece of data that is part of a larger case study investigating student information use in a design setting. Case study as a research method is used to look at a specific situation in depth, with a goal of providing insights that can guide further investigation on a subject, or explaining a present circumstance (Yin, 2013).

The study population consists of all the students enrolled in a one-semester design class that introduced them to critical design. The class had two faculty members and eight students, and the students were all in the second semester of their second year in college. Throughout the semester the faculty members, one in computer graphics and one in libraries, used research papers to start conversations with the students and introduce them to research methods and how decisions are supported and presented in scientific literature. To further build the understanding of information use, one of the class activities asked students to identify assertions in their own writing, with a goal of helping them understand when citing information and supporting statements is required.

At the end of the semester, the librarian faculty member conducted a focus group with the students, using questions targeted on their use of information during the semester, and in the final project reports. During the focus group, the researcher repeated the activity to identify assertions to help students think concretely when responding to questions and have them articulate what they did, rather than saying what they know they should be doing. The data for this study is the transcript of the focus group conversation.

4. Data analysis

The data was analyzed using theoretical (sometimes called deductive) thematic analysis (Braun & Clarke, 2006). The theoretical framework used is the Information Rich Engineering Design (I-RED) model (Figure 1). This framework helps connect uses of information identified in the transcript with stages of design. The analysis identified additional themes, and a couple of subthemes, beyond those in the I-RED model, that are included for further discussion.

During first reading, the text was open coded at a semantic level, which uses the explicit or surface meaning of the words (Braun & Clarke, 2006). After the researcher identifying the initial codes, she reread the transcript and where possible grouped the open codes into themes that align with the stages of the I-RED model.

The codes were then checked against each theme to ensure consistency and unity within the themes identified. This process led to moving several of the codes into different categories, where the excerpt fit better, to create coherent themes. The naming of the themes was done using the labels from the information seeking stages presented in the I-RED model. Once the themes

were identified and contained a coherent set of codes, each was described based on the content.

5. Themes

The coding process identified each of the information seeking activities associated with different stages in the design process. Some of the themes contain more data and others only passing mention of related information tasks, which may be an artifact of the structure of the questions asked during the focus group. Each theme is described briefly, followed by a presentation of how the students articulated activities coded in each theme.

Develop Knowledge Management Strategy – In the I-RED model, this skill is about developing a process, in advance, for gathering and organizing the information that is part of the design process. The codes that most directly relate to this theme were the result of a direct question from the researcher about how the student organize and manage their information. Most of the codes talk about an intended process, or one that focuses on capturing information discovered that may or may not have been maintained throughout the design work. One student stated:

“I looked at 20 different sources. I just forgot to do that. I was just reading too much, [...] First few days, it was yes, we tried to do it a specific way, and then just fell off and stopped doing it.”

A subtheme (*information filtering*) was identified as it became clear that part of the information management strategy of the students is a filtering or differentiation decision that leads to a conclusion that the information doesn't need to be managed because it is “un-citeable”. A student comment made in this space of information filtering is included below.

“You wouldn't cite an instruction manual.”

Establish the Project Context – Within design, establishing the context of a project includes creating a clear description of the purpose and scope of the design need. This includes establishing the criteria for evaluating the project. Typically, from an information framework, this includes both understanding the needs and desires of the client, and understanding the culture, standards and regulations, local weather and other factors that may impose constraints on a design. Many of the codes identified throughout the transcript relate to what the students call finding background information about a location, the culture, and the people, which could influence some portion of their design

problem. While the research never asked about it specifically, the students clearly articulated a difference between background or general information, which would be retrieved from libraries resource or other credible sources, and technical information, or specific directions on how to build an object, or the technical information for an object to be used in their project, which falls into the Integrate Technical Details portion of I-RED. In discussing finding information to define the problem context, one student said:

“Because we had to delve into the whole cultural set of norms and what not. Which they did too, but we, we had to become familiar with all kinds of different culture.”

Investigate Prior Art – This information seeking stage is about discovering what products or processes already exist in the world that can influence the current project. The transcript shows that project context and prior art do not seem to be distinct categories for these students. Any of the codes initially identified as prior art fit in other themes better. The student context for prior art discovery is as part of the ‘research’ needed to prove their problem is real and make sure it hasn’t been done before.

Assess Technologies and Approaches – Within the design framework, this part of the process is about selecting between possible solution options. The transcript had very few codes associated with it during the analysis. While some of this scarcity can be explained by the questions asked, it also can be explained by this design stage encompassing the use of calculations and created information as part of design, rather than discovered information. As such it is not an activity that typically leads to citations and references, but should still be present. When students are categorizing information use, and discussing it with a librarian, the created information, such as calculations does not seem to occur to the students as being information use.

Investigate Technical Details – This portion of the framework focuses on gathering the specific technical details that are necessary to test and/or build a design, such as material strength, weight, durability, etc. In the transcript, this stage seems obvious to the students doing design and build work. They understand the need to create something, and the physical limitations of materials or processes. Interestingly, the students do not see this information, which they call technical information, as available from a library, or sources that require credibility. The primary example used for this information is

how-to guides or instructables on very specific objects, such as how to create a xylophone, or to quote one of the students:

“What is the evaporation rate of a certain body of water, with certain salinity level.”

Communicate effectively – The communication portion of the design framework is about presenting the final design back to the stakeholders and clients. The student comments around this area were not focused on writing the document and selecting what needed to be included, rather it was more about citing and referencing sources. Because of the focus from the students, a subtheme about the mechanics of information attribution, such as when to cite, is identified. The students understand the purpose for including citations and references in a final document, and bring a particularly legalistic reasoning to their description, which came through in the analysis.

“... a clear reason why anybody ever did a citation at all [...] it all comes down to legality and everything.”

The conversation about information attribution in a report revolved around avoiding a lawsuit, accusations of plagiarism, and getting a good grade. The comments from the students make it clear the process of citations and reference is externally motivated rather than coming from a place of disciplinary practice or norms.

“Where we’re at now is, we’re doing citations for a grade.”

One additional theme that arose in the analysis, which is in part an artifact of specific questions during the focus group, dealt with reasons why the students had not included citations for at least some portion of their final report. I-RED assumes the best use of information throughout the process, and is meant to provide a framework for instructors to weave information discovery and use throughout the design process in a natural way. A discussion of why the information attribution pieces are missing in a design report is therefore outside of the scope of the framework. This theme was labeled as *incomplete citations*, and the language from the students describe the reason for the gap as being unsure of the process, running out of time, or just being lazy.

“I think sometimes, when it comes down to it, we just forgot to do it.”

We're rushing.”

The second additional theme that arose is around problems the students face with *synthesis* of the information they find, and how to deal with conflicting information. This came through in conversations about information overload, both in keeping track of what they are finding, related to the information management, and in how to make sense of many pieces of information and conflicting information. The students raised this issue during conversation, rather than in response to a direct question, and it resonated with the whole group.

“I think it's more the fact that once you find the contradiction, you feel that all the work that you've done up to that point is useless.”

6. Discussion

The thematic analysis shows that many of the stages of information use in design as mapped in I-RED are included during a project, even if students are not immediately aware that this is what they are doing. The students have a general understanding of a need to learn the context of a problem, and in most cases that learning will require discovery of background information. In addition, the students recognize a need to discover existing solutions, even when such a discovery derails a project because they found someone had already pursued their solution. The other clear connection to information the students made during the discussion was in gathering specific details about how a device worked, the technical details of important pieces of a design, or how to build an artifact.

A reflection as one of the course instructors is that this group of students is very solution focused, which may be what is leading to the confusion around prior art as part of problem context. In this case, the technical details to be found are nothing more than how to do a task, how to build the thing they already know is ‘the answer’. The solution focused approach is antithetical to learning as much about the problem and scope as possible, and then seeing what else is out there that does something like the task/job you think would help with the problem. As a result, the information that needs to be communicated is also filtered through the same lens of only what is important for the solution that has been determined to be correct / best. This framing may be part of what is driving some of the early information filtering that was identified as a subtheme for knowledge management.

The lack of ability to synthesize information came through in the discussion about citations and keeping up with the information in the wide variety of sources that were found. As Lundstrom and collaborators (2015) found, students struggle with synthesis and benefit from instruction that breaks that process down into different skills. There is additional benefit if the instruction in synthesizing information is presented within the context of the primary discipline of study, where the students can begin to learn the epistemological structures for that discipline. This may mean the course instructor, and not the librarian, is the one teaching the use and application of information that is appropriate for that discipline (Grafstein, 2002). There are different opinions in the literature about how appropriate it is for the librarian to teach information synthesis, and this small study seems to show that the actual use of the information, which is integral with synthesizing multiple sources, is a big stumbling block for current undergraduate students. It is a skill that is difficult to teach and have integrated into the student mental models in a single session, which argues for disciplinary faculty teaching the skill as part of learning how the discipline researches and reports. Yet, within engineering and technology fields, is there really room for yet another piece of content embedded in the technical curriculum? That is a question to be determined in collaboration between disciplinary faculty and subject librarians.

The additional theme around the reasons for the minimal information acknowledgement in the final reports opens avenues for further research in gaining a full picture of why to cite sources, and how to synthesize divergent information and viewpoints into a coherent argument. The students in this study are including citations purely through external motivation. Understanding appropriate use of information is a challenge identified by Head and Eisenberg (2009), and continues to show up in studies like this one.

7. Conclusions

A focus group is a self-report mechanism with the bias issues inherent in such sources. Without robust design notebooks, or another way to verify the self-report, it is difficult to recreate a trail of information used during design decisions that would show when or if information discovery and use enters the discussion of solution selection, or assessing technologies and approaches.

The results show areas where librarians could shift the focus of their

instruction to assist students in using information, moving into areas beyond citation mechanics and gaining skills in synthesizing and integrating conflicting information sources.

In addition, there seems to be a need to determine how to frame student work as 'real', rather than just exercises for schoolwork, to help break the strictly external motivation for doing some tasks. Perhaps this is part of the role of completing and reporting on a project for an audience beyond just the professor(s), as is done with portfolio and design reviews in many programs. Students receiving feedback from people working in the jobs they may pursue upon graduation gives an extra weight to the feedback received and the importance of the work they are doing as students.

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