ASEE 2022 ANNUAL CONFERENCE
Excellence Through Diversity
MINNEAPOLIS, MINNESOTA, JUNE 26TH-29TH, 2022 ASEE
Paper ID #36692

Using a Knowledge Mapping Tool in Engineering Information Literacy Instruction: A First Experiment

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Abstract

A recent comprehensive national survey in the U.S. reveals that lack of time to prepare classes and ways to motivate students in the class have been the challenges faced by academic librarians in information literacy instruction sessions. Another similar survey conducted in Israel also echoes the issue of lack of students' engagement. There are some publications about the benefits or potentials of knowledge maps such as concept or mind maps in engineering education and academic libraries. Publications show that the maps are primarily used for online assessment, student engagement, visualization, analysis, and dissemination of information. However, there is a gap in literature that describes empirical studies of knowledge maps in engineering information literacy instruction.

The purpose of this paper is to explore the effectiveness of knowledge maps in enhancing engineering information literacy instruction. With the knowledge maps, librarians can save time in preparing the library instruction materials. The maps can be used for in-class exercises and information literacy skills assessments. Engineering students can use the knowledge maps in the class and for future reference and other learning activities such as laboratory research.

The experiment was done in an information literacy instruction session for a senior-level undergraduate course in Electrical and Computer Engineering. The instructor created a knowledge map of all the contents needed for the class and built start- and end-of-session surveys in Springshare LibWizard. At the beginning of the session, the instructor introduced the knowledge map and associated software tool to the students. The students were asked to complete the start-of-session survey and submit their knowledge maps with pre-assessment answers. Then, the instructor used the original map to present the course-related contents. After the presentation, the students used their copies of the knowledge map to do in-class exercises. At the end of the session, the instructor requested the students to review their pre-assessment answers and make changes as needed based on what they learned in class. The students submitted their edited knowledge maps along with the end-of-session surveys. Survey data were collected and analyzed with LibWizard Surveys and Reports.

The instructor created a map of all the content by copying and pasting the resource links from the subject guide or sample articles. All students had hands-on practice in class. The results show that most students felt that the knowledge map tool had helped them effectively understand the course concepts. They also indicated that the knowledge map would effectively assist their research projects. Using the knowledge map tool, the instructor could save time preparing materials for teaching and in-class exercises. Further work is needed to improve the delivery of knowledge maps.

Introduction

A 2016 national online survey of U.S. academic librarians reported a few challenges to instruction such as lack of time to prepare the library instruction sessions and lack of student engagement in class [1]. Another similar survey of information literacy instructional practices in Israeli academic libraries also echoed the same challenges [2]. This article describes an experiment carried out by an Engineering Librarian who used a knowledge mapping tool to explore its effectiveness in enhancing engineering information literacy instruction in terms of teaching preparation and in-class student engagement. The experimented class is a one-time library information literacy instruction session offered to a senior-level class of engineering students at an academic institution. The institution's library is a member of the Association of Research Library (ARL) in the United States.

Knowledge Map

Given the purpose of this experiment and the similarity of the maps, the authors use the term knowledge map or knowledge mapping as a collective name for concept maps or mind maps. A knowledge map consisting of nodes and lines representing relationships of nodes is a visual diagram organized in a spider-like or tree-like hierarchy structure. The tool used in the experiment is Freeplane (version 1.9.7) which is an open-source software. There are many features of Freeplane, but the authors will only cover features that were used or are potentially helpful for future work. For example, Freeplane allows not only text but also images, and clickable URL links to be included in the nodes. Furthermore, the relationship lines between nodes can be labeled and show flowing directions. Freeplane also allows nodes to be tagged, filtered, hidden, and protected besides having a color background and different shapes. In addition, the whole map or a branch can be exported in various formats such as Microsoft Word, Excel, Project, PDF, XML, plain text, HTML, PNG, SVG (scalable vector graphic), and Latex.

The motivation behind this experiment of using a knowledge map in a library information literacy instruction came from previous studies and publications about the benefits or potentials of using knowledge maps. Knowledge maps "are a great way to introduce an overall topic, increase student involvement, and get thoughts down quickly [3]." A knowledge map also presents a big picture of all relevant points and their relationships on one page. Specific applications of knowledge maps in university libraries may include establishing a scientific library knowledge management model, assisting users in automatically searching information resources, providing cooperative digital references consulting services, and providing personalized information recommendation services [4]. The specific idea to use the knowledge maps in the information literacy instruction was inspired by the example demonstrated in Liu's article on the potential benefits of using knowledge maps to promote library subject guides [5].

Literature Review

The literature reviewed here includes the usage or potential of knowledge maps such as concept maps or mind maps in engineering education, teaching, and academic libraries. Studies on using knowledge maps in teaching environment imply that the maps are good for visualizing the contents, helping students to get overviews and find connections between subjects and topics. Adodo [6] studied the effect of mind-mapping strategy as a self-regulated learning strategy on students' achievement in Basic Science and Technology (BST). And the findings indicate that mind-mapping "helps students to associate ideas, think creatively, and make connections that one might not otherwise make in the conventional approach [6]." Based on the study, Adodo [6] suggested that teachers should adopt mind maps as a method for teaching BST.

A study by Turns et al. [7] investigated the use of concept maps for both course-level and program-level assessment in engineering education. The findings illustrate that concept maps are flexible in supporting assessment in engineering courses and programs [7]. Turns et al. [7] concluded that knowledge maps "represent an innovative way to assess and gain insight into student learning about the relationships among concepts." Conceição et al. [8] did a literature review on empirical studies that employed concept maps in research. This study categorized the use into three approaches: the relational approach, the cluster approach, and the word frequency approach.

Two studies showed positive results that knowledge maps are helpful for online assessments to get a deeper insight into a student's knowledge structure about a specific topic [9], [10]. Ma et al. [11] conducted a quasi-experiment on in-service teachers. The experiment showed that knowledge map-based online micro-learning largely improved their learning performance and engagement and helped them form a more systematic knowledge structure. Nguyen and Chowdhury [12] used the knowledge map to create and evaluate the semantic organization of Digital Library research topics and evolution. They also argued that the knowledge map could improve the research activities of any subject areas [12].

In the library field, publications showed that the knowledge map could be used as a visualization tool for the instructional tutorial on the library research process, curriculum design, information analytics skills [13], [14], [15]. The empirical study by Dilevko and Soglasnova [16] suggested that the knowledge map is an excellent way to help doctoral students in "understanding of the themes and topics that are prominent within the interdisciplinary configuration of a given academic subfield or area." Dilevko and Soglasnova [16] also suggested that librarians could use knowledge maps to identify interdisciplinary methods for collection management.

Methods

The experiment was done in a 90-minute information literacy instruction session for an engineering course of 18 students. The course is mainly for senior undergraduate students who major in Electrical and Computer Engineering. Unlike the knowledge map mentioned in the

literature review, the knowledge map was not used to represent subject concepts, but the resources located in the related subject guides.

Being new to the engineering librarian position and inspired by Liu's article [5], the instructor started to get familiar with the available resources by creating a knowledge map of all the existing engineering library guides. Since the map takes any format, the creation process involved only copying and pasting the guides' contents. When finished, the instructor realized that by adjusting the knowledge map based on the class learning objectives, the knowledge map as a teaching material is ready without recreating presentation slides.

The knowledge map is in a tree-like structure that contains a parent node with one or many child nodes and grand-child nodes, and so forth. The design of this library course guide is one main page with many subpages matching this tree-like structure. As Figure 1 shows, the root node is "Resources Knowledge Map." It branches out to have the course section and related library guides as child nodes. For instance, academic databases like "Web of Science" are the branches of the node "Recommended Databases." The course knowledge map becomes a knowledge inventory of all relevant academic resources for the class.

The goal of this instruction session is about how to distinguish between scholarly and non-scholarly sources. Besides including the relevant resources, the instructor also added another child node named "Exercise" used for the in-class exercise. With this exercise node, the instructor did not need to take more steps and time to prepare separate exercise sheets in paper or using other means. The "Exercise" node has three child nodes which are "Source," "Scholarly Source," and "Non-Scholarly Source." The "Source" node has four child nodes of hyperlinks to the pre-selected articles to be evaluated by students. Both the "Scholarly Source" and "Non-Scholarly Source" nodes have "Primary Source" and "Secondary Source" child nodes. A page called "Knowledge Map" was added in the course library guide to introduce the basic notion of the knowledge map and the basics and tutorials of the Freeplane software along with the downloadable file of this knowledge map for the instruction session.

Figure 1: Course Knowledge Map designed through Freeplane

All library instruction sessions are suggested to have start- and end-of-session surveys created using Springshare LibWizard in the author's library. The survey links were embedded in the course library guide. Both surveys are based on the template used for the information literacy instruction classes. The survey includes some personal information and information literacy self-assessment questions. Questions related to the use of a knowledge map were added for this

session to find out its effectiveness. The start-of-session survey has a control that allows the students to upload the first modified knowledge map files with their answers. The end-of-session survey includes the same feedback and self-assessment questions as those in the start-of-session survey for comparison purposes. The end-of-session survey also has a file upload control to let students upload the updated knowledge map files.

At the beginning of the class, the students were instructed to visit the course library guide website. Then the instructor showed the "Knowledge Map" course library guide page to the students and introduced the knowledge map along with the benefits of using it. Next, students were asked to download the course knowledge map file from the "Knowledge Map" page and open it via the Freeplane software that was already installed on all students' computers in class. Finally, the students used their copies of the knowledge map to do in-class exercises of differentiating between scholarly and non-scholarly sources. Students need to review the articles given in "Source" node and then move the articles' nodes from the "Source" node to the proper nodes to show whether they think the articles are scholarly or non-scholarly and primary or secondary sources. For example, if a student thought the article was the scholarly and primary source, the student would then drag that article node from the "Source" node into the child node of the "Scholarly Source"- "Primary Source" node. Then the students filled out the start-of-session survey and uploaded the modified knowledge map files with their exercise answers.

After students finished the start-of-session survey, the instructor went back to the course knowledge map and started introducing the course contents. Since every source node is hyperlinked to the respective website, the instructor just clicked the source node to show the source websites. At the same time, the instructor asked students to follow by clicking on the links on their computers. The instructor gave an overview of all the related resources included in the library guide website via the knowledge map and demonstrated strategies for efficient database searching. For instance, when looking for a recommended academic database, the instructor asked students to locate that database source node under the "Recommended databases" node on the knowledge map and click its hyperlink to visit the database website. After covering all the class contents, the instructor asked students to revisit their knowledge maps and make necessary changes to the exercise nodes based on what they learned in class. By revisiting the exercise node, the students could easily see how they did initially. At the end, the students were asked to complete the end-of-session survey along with their revised knowledge maps.

Findings

Eighteen students filled out the start-of-session surveys. Out of eighteen students, there were fourteen seniors, two juniors, and two sophomores. Ten of the respondents (55.6%) had attended a library instruction session for this course or any other courses before. The other eight students (44.4%) did not have any library instruction sessions before this class.

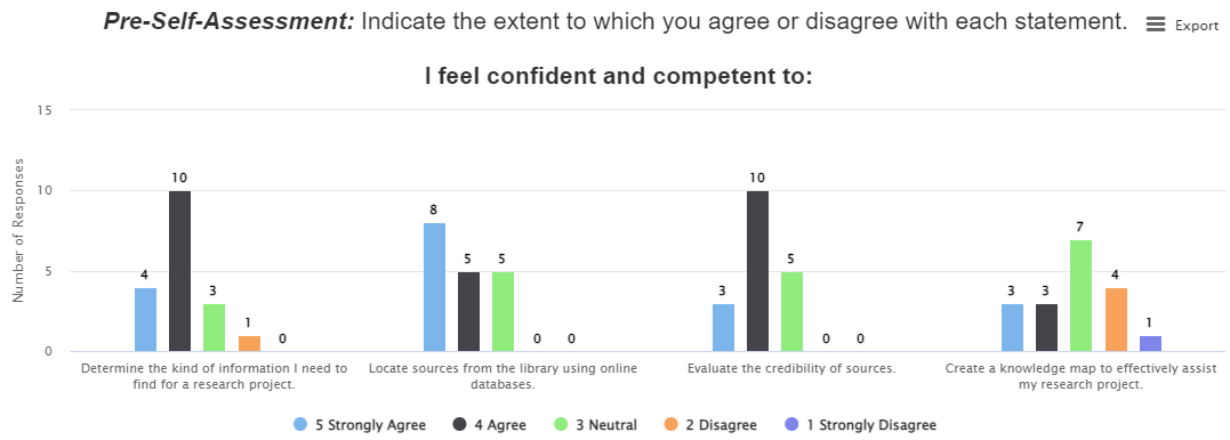

Figure 2: Column chart of the start-of-session survey pre-self-assessment result

As Figure 2 shows, fourteen students (77.8%) strongly agreed or agreed that they felt confident and competent to determine the kind of information they needed to find for a research project. Over half of the students (72.2%) strongly agreed or agreed that they felt confident and competent to locate sources from the library using online databases. And no students disagreed that they felt confident and capable of evaluating the credibility of sources. Regarding the statement "I feel confident and competent to create a knowledge map to effectively assist my research project," only six students (33.3%) selected "Strongly Agree" or "Agree." While the other students (66.7%) answered "Neutral," "Disagree," or "Strongly Disagree." This result indicates that most students were uncertain about their ability to create a knowledge map for research projects effectively.

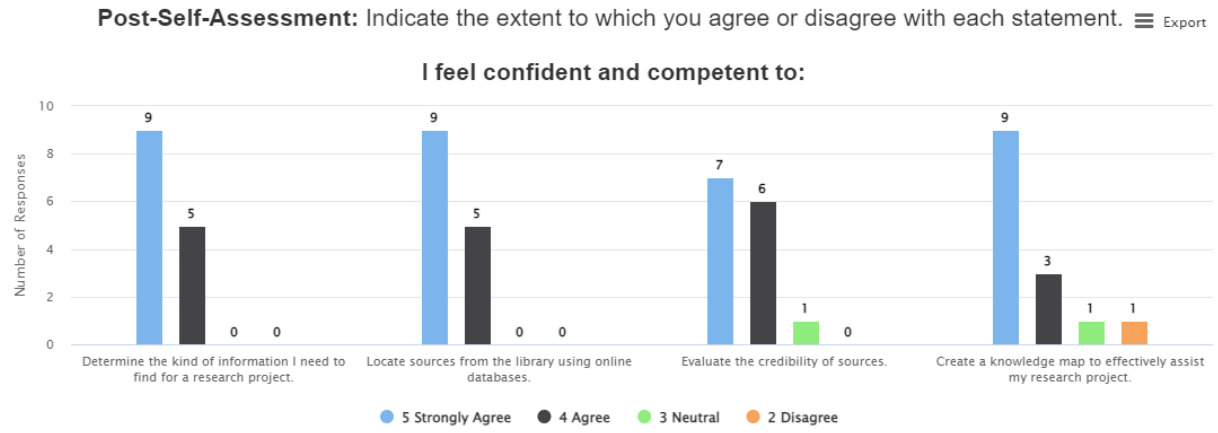

Figure 3: Column chart of the end-of-session survey post-self-assessment result

Four students left before the end of the class, so only fourteen students (77.8%) took the end-of-session surveys. Based on Figure 3, the post-self-assessment shows that all respondents (100%) agreed or strongly agreed that they felt confident and competent to determine the information they needed to find for a research project and locate sources from the library using online databases. Seven respondents (50%) strongly agreed that they felt confident and competent to evaluate the credibility of sources. And nine respondents (64.3%) strongly agreed that they felt

confident and capable of creating a knowledge map to assist their research projects effectively. Compared to the start-of-session survey results, the end-of-session survey results reveal that six more students strongly agreed that they felt confident and competent to effectively create a knowledge map to assist their research projects.

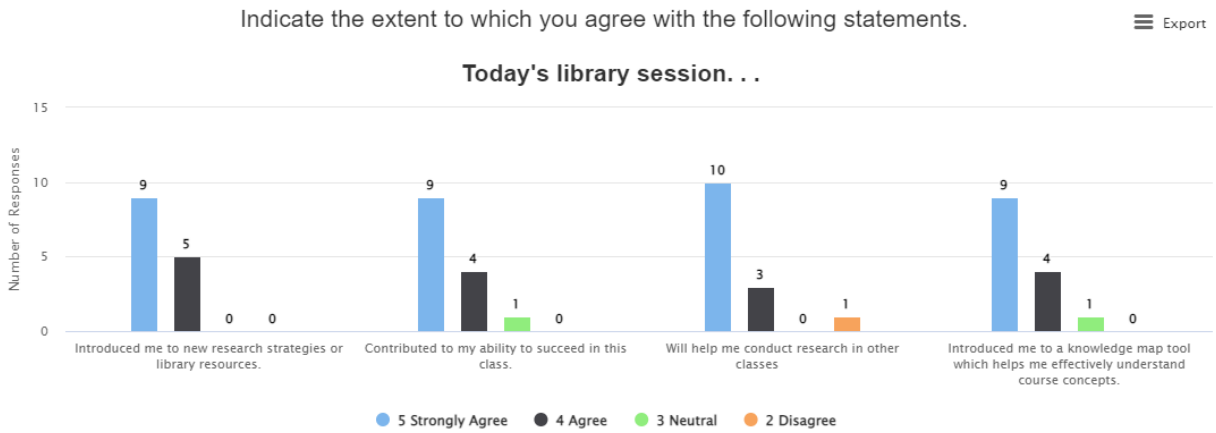

Figure 4: Column chart of the end-of-session survey reflection question result

Figure 4 shows that all respondents (100%) agreed or strongly agreed that this library instruction session introduced them to new research strategies or library resources. No students disagreed that this library instruction session contributed to their ability to succeed in this class. Ten students (71.4%) strongly agreed that the library session would help them conduct research in other courses at the university. Nine out of fourteen respondents (64.3%) strongly agreed that this library session introduced a knowledge map tool that helped them effectively understand course concepts.

Discussion

The instructor thinks using a knowledge map saves time in preparing the teaching and exercise materials. The map includes all relevant resources and their website links that match the library course guide website. Creating a knowledge map is effortless because the instructor copied and pasted the resource names and associated website links from the existing course library guide into the course knowledge map. Therefore, the instructor does not need to worry about the design and layout of slides. However, the instructor may require additional time to familiarize using a new knowledge mapping tool. Regarding the student engagement, the instructor observed that students had hands-on practice by moving around nodes. They also followed the instructor's presentation on their copies of the knowledge map by clicking the resources' links. The students could also save copies of their course knowledge maps for future research activities.

Conclusion

Applying the knowledge map in the engineering information literacy instruction class saved the librarian time and energy to prepare the lecture materials. Based on the start-of-session and end-of-session surveys, most students agreed that their information literacy skills have improved after the library instruction session. Since the “Pre-Self-Assessment” question and “Post-Self-Assessment” question use the same sets of statements, the results of these two questions can be compared to gauge students’ confidence change in information literacy skills. As Figure 2 and Figure 3 demonstrate, the number of students who strongly agree that they feel confident increases in all four statements. It means that the library instruction class did help more students improve their information literacy skills. The comparison of the responses to “Create a knowledge map to effectively assist my research project” statement indicates the number of students who strongly agree with this statement significantly increases from three responses to nine responses. This comparison indicates that this library session helped most students effectively create knowledge maps in assisting their research projects. The end-of-session survey results also revealed that the knowledge map tool helped students understand course concepts effectively.

Limitations and Further Work

The conclusion was only based on one-time experience and there were no formal treatment and control groups. Furthermore, the class surveys’ data are biased since the experiment was conducted in only one 90-minute session with a small number of students, and there were no control groups that did not use knowledge maps. Therefore, further work is needed in the following areas:

1. Given that few students had difficulties comprehending and using the knowledge maps in the class, there is still room to improve the delivery of the knowledge maps to the students such as asking students to visit the course library guide "Knowledge Map" page beforethe class to let them get familiar with the notion of knowledge maps and Freeplane.
2. In addition, other practice sessions will be added to further improve the student engagement with hands-on exercises on research activities such as brainstorming onselecting keywords for efficient search, forming research questions, or identifying research subject topics with the knowledge map.
3. Since Freeplane needs software installation and cannot be shared online, the instructor plans to find a better online knowledge mapping tool to enhance students’ group practice and collaboration.
4. Survey questions need to be more specific based on assessment needs. For example, the questions could be asking students whether the knowledge map assists them in looking for academic resources and organizing knowledge. Additional questions such as asking students whether the knowledge map increases their engagement or attention in the library instruction session should also be included in the survey.

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Appendix 1: Library Instruction Start of Session Survey

1. Student ID Number:

Response: numeric digits

2. I am a:

Response: Freshman, Sophomore, Junior, Senior, Master's Student, Doctoral Student, Other (Please Specify)

3. Have you ever been to a library instruction session for this course or any other course?

Response: Yes, No, Unsure

4. Pre-Self-Assessment: Indicate the extent to which you agree or disagree with each statement.

Response: 1 to 5 scale with 1 being "Strongly Disagree" and 5 being "Strongly Agree"

I feel confident and competent to:

- Determine the kind of information I need to find for a research project.
- Locate sources from the library using online databases.
- Evaluate the credibility of sources.
- Create a knowledge map to effectively assist my research project.

Appendix 2: Library Instruction End of Session Survey

1. I am a:

Response: Freshman, Sophomore, Junior, Senior, Master's Student, Doctoral Student, Other (Please Specify)

2. Course Subject:

Response: short text

3. Course Number:

Response: numeric digits

4. Librarian:

Response: Name of librarian who taught the library instruction session

5. Indicate the extent to which you agree with the following statements.

Response: 1 to 5 scale with 1 being “Strongly Disagree” and 5 being “Strongly Agree”

Today’s library session:

- Introduced me to new research strategies or library resources.
- Contributed to my ability to succeed in this class.
- Will help me conduct research in other classes.
- Introduced me to a knowledge map tool which helps me effectively understand course concepts.

6. What was the most confusing or unclear aspect of today’s session?

Response: short text

7. Will today’s session change the way you evaluate and/or search for sources? Please explain.

Response: short text

8. Post-Self-Assessment: Indicate the extent to which you agree or disagree with each statement.

Response: 1 to 5 scale with 1 being “Strongly Disagree” and 5 being “Strongly Agree”

I feel confident and competent to:

- Determine the kind of information I need to find for a research project.
- Locate sources from the library using online databases.
- Evaluate the credibility of sources.
- Create a knowledge map to effectively assist my research project