TITLE: Building positive learning experiences through pedagogical research guide design

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Abstract

Library research guides are traditionally designed in a pathfinder-style format by resource type. However, would a pedagogical-style guide, which moves students through the research process, better support the student learning experience? This study sought to answer the question: Which guide design best supports the student information literacy learning experience outside of a classroom setting? This article reports results of a usability study (n=22) of first-year to graduate students who interacted with either a pedagogical or pathfinder-style research guide through a simulated research assignment. Results indicate that although there is no statistically significant performance difference between guide type, students using the pedagogical guide reported a more positive experience than those using the pathfinder guide. As a result, this led them to spend more time on, interact more with, and consult more resources on the research guide. Librarians who wish to enhance the usability of research guides may get greater student engagement by designing their guides pedagogically.

Introduction

Information literacy (IL) has been recognized as an imperative in higher education (Wiebe 2016) and to society (Thompson 2003). Recent publications, such as findings from a study conducted at Stanford, indicate that students are woefully lacking in their ability to evaluate online information, and emphasize the importance of teaching IL (Wineburg et al. 2016). In 2016, the Association of College and Research Libraries (ACRL) released the *Framework for Information Literacy for Higher Education*, which situates itself as part of an educational reform movement (Association of College & Research Libraries 2016). The Framework's more complex, nuanced approach, moves information literacy away from the *Standards for Higher Education* (Association of College & Research Libraries 2000) and its quasi-checklist approach to IL competencies. Academic librarians teach IL competencies in a variety of ways: in stand-alone courses; in collaboration with faculty embedded in disciplinary courses; and online, through research guides, learning objects, and tutorials. It is in the latter context that the present study is situated.

Library research guides are ubiquitous. Excluding home-grown systems, as of April 2018, over 158,000 libraries worldwide are using Springshare's hosted research guide platform, LibGuides (Springshare). Research guides were traditionally designed to help students find library resources and therefore librarians often organize them in a pathfinder-type format by resource type (e.g., find books, find articles, or find websites) (Smith 2008; Vileno 2007). However, learners can become overwhelmed with the amount of information presented, causing cognitive overload, which can greatly diminish the guides' effectiveness (Little 2010; Paas, Renkl, and Sweller 2004). Cognitive overload, coupled with negative emotions connected to research anxiety

(Einbinder 2014; Kuhlthau 1991; Papanastasiou and Zembylas 2008; Rezaei, Zamani-Miandashti, and Shiraz 2013), may render guides less effective for students. Research guides may be more effective if they are designed to guide students through the IL research process, rather than primarily listing resources. The need to observe a clearly modeled research process is particularly an issue for distance students or those who do not attend an in-person library instruction session.

This usability study sought to answer the question: Does a pedagogical design, where the guide leads a student through the research process, aid in learning IL competencies more effectively and positively than a traditional pathfinder guide, especially if used outside of a classroom setting? This study complements a separate in-classroom study using course, rather than subject, guides, see Stone, Lowe, and Maxson 2018. Many usability studies on library research guides focus on design components such as the optimal number of tabs, boxes, or effectiveness (e.g., whether students can find resources). Few have studied students' learning experience. In the present study, the authors observed how students (n=22), ranging from first-year to graduate students, across a range of disciplines, interacted with a research guide through a simulated research assignment. After convenience sampling, students were assigned to either the pathfinder or the pedagogical guide based on a first-come, first-served basis. Participants were also asked to provide basic demographic information and complete a survey. As library research guides have the potential to function as tools to help students find library resources as well as to teach IL concepts, this study sought to determine if there was a more effective design that could improve the student learning experience.

Literature Review

The pedagogical design used in the present study draws on decades of research on how students learn and impediments to learning. Of particular relevance to the present study are cognitive load theory, how students learn new ideas, and impediments to learning, specifically research anxiety. Cognitive load is the amount of mental effort used in the working memory to learn (Sweller 1988). If too much information is presented at once, working memory is overwhelmed with information, causing cognitive overload, and therefore learning cannot happen (Sweller 1994). Additionally, students learn new ideas by referencing existing knowledge (National Research Council 2000). Sequencing content helps ensure that students have the prior knowledge to learn new ideas (TeachingWorks n.d.). Because learning happens through the lens of what is already known, and research can be an unknown to students, a major impediment to learning IL research concepts is research anxiety. First identified as "library anxiety," Mellon (1986) found students' initial response to library research was fear. This concept became better known as research anxiety through the work of Kuhlthau (1983). Central to Kuhlthau's work is the Information Search Process (ISP) and students' emotional levels during each stage of research, which begins with uncertainty and confusion and ends with relief (Kuhlthau 1991). In a two-part study, Kracker presented the ISP model to students and found that there was a significant, positive, change in anxiety levels related to the research process (Part I, 2002; Part II, 2002).

A sub-set of learning theory includes a large body of literature on online learning (for example, Bernard et al. 2004; Means et al. 2009) and tutorials or digital learning objects (Blummer and Kritskaya 2009). A meta-analysis by Means et al. (2013) found that students in online learning conditions performed modestly better than those receiving face-to-face instruction. Bowen

(2014) found no pedagogical advantage between LibGuides versus other formats (e.g., web pages) of IL tutorials. When comparing audio/video (dynamic) tutorials to text/image (static) tutorials, Turner, Fuchs, and Todman (2015) found that students learned more effectively from the static tutorials. Because research guides are not tutorials in the traditional sense, the present study leaned towards the web design, UX (user experience), and cognitive learning literature rather than recommended best practices for tutorials when developing the pedagogical guide. For example, while tutorials usually require a logical progression to learn a topic, a research guide is intended to be navigated based on the information needs of the student. Also, best practices in tutorial and digital learning object design highlight active learning and quizzes (Blummer and Kritskaya 2009), which are usually not possible with a static research guide.

The design of the guides in the present study is grounded in past research in the area of online guides, especially best practices and design, and whether or not students can find resources via guides. Through student questionnaires, Hintz et al. (2010) found that a simple and clean layout was one of the most important aspects for usability. Cognitive load is another important aspect of best practices in guide design (Little 2010; Paas, Renkl, and Sweller 2004). Little (2010) suggests breaking large topics down into smaller chunks and avoiding jargon. Multiple studies recommend designing course or assignment guides as a best practice, rather than creating more general subject guides (Bielat, Befus, and Arnold 2013; Gibbons 2003; Ladner et al. 2004; Leighton and May 2013; Mann, Arnold, and Rawson 2013; Reeb and Gibbons 2004; Somerville and Vuotto 2005; Strutin 2008). The present study was mindful of these findings, especially as we used a general subject guide and not a course-specific guide. Still, Ouellette (2011), in a small focus group study, discovered that while students do not use subject guides often, they

might if guides were customized to meet their needs. For a more extensive discussion on guides, especially best practices and design, and the use of guides in instruction see the literature review of the complementary in-classroom study (Stone, Lowe, and Maxson 2018).

Best practices in guide design, however, do not address how the content is communicated. In other words, librarians can follow best practices and still have guides designed in the traditional pathfinder-style. This makes sense as research guides were developed in the 1960s to help students find their "way" in the library and so were designed to teach students how to use the library and find resources (Hemmig 2005). They were not built around the research process (e.g., Brazzeal 2006; Pendell and Armstrong 2014). Nevertheless, there is an awareness in librarianship that perhaps the pathfinder-style is not user-friendly and may not be conducive to student learning. Sinkinson, et al. (2012) state that research guides need to fit better with the user's research process. Quintel (2016), through a student survey and usability testing, developed a set of recommendations for University of Alabama libraries, which included a pedagogical element of adding explanations and descriptions that inform students how to use the guide. Students in Baker's (2014) study gave more positive feedback to tutorial-type, rather than pathfinder-style, guides. In an A/B study, Greenwell (2016) found students using a pedagogical guide (based on the I-LEARN model) used the guide more often and reported more benefits from using it than those using the control (pathfinder) guide.

Guide design also draws on research in user experience (UX). In the UX field, user experience is considered in all aspects of the process of interacting with a product, system, or service (Norman and Nielsen; "User Experience Basics"). The UX evaluation explores not only if the product is

usable but also useful, desirable, and valuable. UX practitioners and researchers measure

experience with user's emotions, attitudes, or perceptions (Cleveland-Innes and Campbell 2012;

Conrad 2002; Smith 2017; Zembylas 2008; Zembylas, Theodorou and Pavlakis 2008). These

studies found that emotion plays an important role in the learning environment, thereby

influencing students' learning experience and achievement of learning outcomes. Emotion also

plays a vital role in cognitive and affective function in daily life (Isen 2001; Norman 2004) and

is a critical factor to measure user's loyalty (Jarvis 2014; Mombelli 2016). In order to design a

better online learning environment, studies in cognitive learning theory suggest ways to reduce

cognitive load such as use of proper cues and signals for how to process information, as well as

consistent layout for displaying text and corresponding graphics (Clark, Nguyen, and Sweller

2006; Mayer and Moreno 2003).

Methods

Guide Design

To answer the research question: Does a pedagogical design, where the guide leads a student

through the research process, aid in learning IL competencies more effectively and positively

than a traditional pathfinder guide, especially if used outside of a classroom setting, we created

two library guides. Using recommended best practices from research on student learning and

web design, the authors developed two Political Science subject research guides. Although, as

stated in the literature review, best practices advocate for course, rather than general subject,

guides, this study used a subject guide because we were focusing on learning outside of the

classroom. If a student is in a class without a course guide, a distance education class, or doing

an independent research project, they may be likely to access to a subject, rather than a course

guide. As stated previously, the present study complements an in-classroom research project that studied student learning via course-specific guides (Stone, Lowe, and Maxson 2018). The subject of Political Science was chosen for a number of reasons. First, the research design depends on the use of a subject guide, and this is the liaison area of one of the authors. Second, students are often required to take courses outside their major or discipline so the use of a guide outside their area of expertise would not be an unusual event. Third, scholarship in the discipline of Political Science, which is situated in the Social Sciences, uses language more readily understood by a lay audience, and either journal articles or books can be used as supporting evidence for a research paper (for example, Chi 2012). In contrast, research in STEM disciplines typically uses highly specialized language (Ossola 2014), and humanities disciplines often rely primarily on books as evidence (Stanford Humanities Center).

While both guides contained the same resources, one was designed in a traditional pathfinder style (organized by source type) and the other incorporated more pedagogical elements (explaining processes, defining terms, etc.). Both the pathfinder and pedagogical guides were developed with a side-menu layout based on web design recommendations (see Figure 1), and design best practices were used in each, such as a simple layout, limited library jargon, brief descriptions (e.g., database information), and smaller chunks of information either by source type or research process (Gonzalez and Westbrock 2010; Hintz et al. 2010; Mattson 2013; Pittsley and Memmott 2012; Sonsteby and DeJonghe 2013). Additionally, all resources on the guide were related to the subject (Alverson et al. 2015), so there were no general resources completely unrelated to Political Science. We deliberately used best practices for both guide types in order to

focus on students' perceptions of content and minimize the impact of how the differences in presentation might influence behavior.

(Insert Figure 1)

Unlike format-based guides, the pedagogical guide is organized around the research process and draws on the research of how students learn. The guide's homepage features a visually attractive infographic (see Figure 2, originally published in Stone, Lowe, and Maxson 2018) about the research process. In addition, sequential numbering and descriptions are available in the left side-menu navigation: 1: Your Question, 2: Background Information & Books, 3: Find Materials, 4: Evaluate, 5: Refine Topic, 6: Organize & Cite, 7: Think & Synthesize, 8: Write. The research process is modeled after Kuhlthau's Information Search Process (1991) with the intention of reducing negative emotions connected to research anxiety. The sequential numbering reduces students' uncertainty, minimizes their cognitive load (Clark, Nguyen, and Sweller 2006; Little 2010; Mayer and Moreno 2003), and encourages them to go through the entire guide. In cognitive learning theory, cues or signals to indicate how to use a product help learners minimize their cognitive load by removing extraneous information (Mayer and Moreno 2003). Moreover, in the UX field, in order to minimize user tension, progress trackers show users their progress along the way by presenting information in chunks as well as in logical and numbered steps. UX practitioners state that the visibility of status-like progress trackers increases conversion rates (the percentage of visitors to a website who complete a desired goal out of the total number of visitors) because users see a clear path to completion; thereby minimizing cognitive overload

(Babich 2016). Like the progress tracker design, sequential numbering in the pedagogical guide functions as a cue to follow the tabs in a step-by-step manner.

(Insert Figure 2)

UX Testing

The authors conducted this study between March 31 and June 21, 2016 in a designated UX lab. The study was marked exempt, or minimal risk, by the university's IRB. Before conducting the study, the authors administered two test sessions to refine the study design, material language, and logistics. Participants were recruited voluntarily via the library website, social media, a campus newsletter, and email. Participants received a $10 gift card after completing the study. A total of 70 students agreed to participate, but only 22 students kept their appointment at the UX lab. The study included n=22 students from first-year to graduate in various majors who were enrolled either in the 2016 spring or summer semesters. Literature on usability testing recommends at least n=20 in order to have statistically significant numbers (Nielsen 2012) as data gathered from 20 participants has been found to cover almost 98.4 percent of usability problems (Faulkner 2003).

A/B testing was applied to compare the two guide designs (pedagogical and pathfinder) in terms of participants' performance, experience, and interaction with the guides. After convenience sampling, participants were assigned to either the pedagogical or pathfinder guide based on a first-come, first-served basis, n=11 in each design group. The study consisted of three steps: 1) participants completed a profile (demographic) form; 2) participants engaged in usability testing with a simulated research assignment for a political science course; and, 3) participants

completed a Likert scale survey with questions about the usability of the research guide and their perceived learning experience with the guide. Sessions lasted 40 to 90 minutes. At the beginning of the study, the participants read the IRB-approved study information sheet and discussed it with the authors. Before each step, the authors reiterated the purpose of the study and that there was no right or wrong answer.

Through a profile form, participants were asked to provide basic demographic information including their school year, major, and background knowledge of the library (e.g., number of library instruction sessions attended and research papers written, as well as awareness of research guides prior to the study) (see Table 1 for a description of participant demographics). Then, both design groups were asked to do a simulated research assignment that asked them to formulate a research question from the given topic and to find three reliable, scholarly sources of which at least one had to be a scholarly article. Participants cited the sources in a separate Word document and explained why they thought the sources they found would be suitable for their research question. They were required to start from either the pedagogical or the pathfinder guide, depending on which design group they were in, to complete the simulated task. Last, the participants completed a survey, which included two, multi-part Likert scale questions about the guide's usability and their perceived learning experience using the guide (see Table 2). The usability question included statements such as: "The research guide was easy to use"; "I quickly became skillful with it"; and "The research guide was user friendly." The learning experience question included statements such as: "The research guide helped me develop my research question"; "The research guide helped me evaluate sources (decide if something was a good source to use)"; and "Overall, I am more confident about my research."

(Insert Table 1)

(Insert Table 2)

Student information literacy performance was captured via the simulated research assignment

document (see the Appendix), which sought to assess four learning outcomes based on the

Framework for Information Literacy. The four outcomes that were observed included: 1) apply

different searching language types (e.g., keywords and synonyms) (Frame: Searching is Strategic

Exploration); 2) formulate questions for research of an appropriate scope (Frame: Research as

Inquiry); 3) identify authoritative information sources (as seen in their choice of a relevant and

scholarly article) (Frame: Authority is Constructed and Contextual); and 4) evaluate the authority

of information (Frame: Authority is Constructed and Contextual). Each participant's perceived

learning experience (i.e., how they felt about how they learned) was assessed through the survey

questionnaire and by the researchers' observations of the participants' emotions articulated

during the process using a three-point scale. Participants were encouraged to think out loud to

express their thoughts and emotions in words as they worked on tasks. The interaction with the

guides was measured by the number of submenu clicks, the overall time spent for the entire

process, and the number of resources consulted. Adobe Captivate was used to record both

participants' verbal comments and their actions on the computer screen, which enabled the

authors to measure their interaction with the research guide and emotional responses to the

research process.

For data analysis purposes, the responses on the research assignment document were evaluated based on a rubric (ranging from 1-*initital* to 3-*developed*, see Table 3) and were then transferred to solely numeric values. Both authors evaluated one participant at the beginning of the study and came to an agreement on their interpretation of the rubric levels as well as the scores to norm the rubric. The Likert scale numerical data (1-*strongly disagree* to 5-*strongly agree*) from the responses to the learning experiences was analyzed. The computer screen movements captured in the video were transferred to quantitative data formats such as number of submenu clicks, time spent, and number of resources consulted from recorded sessions.

(Insert Table 3)

In addition, the authors also transcribed participants' verbal comments recorded when they were carrying out the simulated research assignment and, based on these transcripts, the emotional responses during the research process were categorized and counted. In order to analyze the verbal expressions to capture their emotion, the RSentiment package (Bose et al. 2017) in R was initially applied, but it did not work well in this research context. This is because the package recognized "I don't know…" or complicated sentences like "It's helpful and better as I didn't like …" as neutral. There were also five categories in the RSentiment package: Very negative, Negative, Neutral, Positive, and Very positive. In this research context, the students' emotional responses were not varied enough to fit into these five categories, and it was hard to distinguish between very negative and negative as well as very positive and positive. Therefore, the authors read the expressions and manually coded them in three categories, Positive, Doubtful, and Negative, and defined them as explained in Table 4.

(Insert Table 4)

After completion of the study, a Chi Square test was applied to verify whether there was an association between participants and non-controlled variables. A t-test was conducted to compare the means of the pedagogical and pathfinder groups on their performance, learning experience captured via the Likert scale, and interaction (number of submenu clicks, time spent, and number of resources consulted).

Results

Study data was analyzed in three areas. First, performance, or participants' rubric scores based on assessing IL learning outcomes on the simulated research assignment. Second, the learning experience, or participants' perceptions of the guides based on survey responses as well as their verbal comments and corresponding emotional scale rankings while navigating through the guides. Third, student interaction with the guides as measured by the screen capture tool. For example, how often they returned to the guides from library databases and how many guide tabs they clicked on.

Performance

The participants' IL abilities on the simulated research assignment were measured via a rubric (1-*initial* to 3-*developed*) in five learning outcome categories: Keywords & Synonyms, Research Question, Article (Relevance), Article (Scholarly), and Evaluation (see Table 3). In the categories Keywords & Synonyms, Article (Relevance), and Evaluation, the participants in the

pedagogical group (2.00 ± 0.77 points; 1.98 ± 0.83 points; 2.14 ± 0.63 points; n=11) on average scored higher than the ones in the pathfinder group (1.64 ± 0.50 points; 1.77 ± 0.69 points; 1.77 ± 0.66 points; n=11) (see Figure 3). Participants in both groups were equally likely to formulate a research question (2.09 ± 0.94 points; n=11 each) and find scholarly articles (Pedagogical: 2.45 ± 0.43 points vs. Pathfinder: 2.45 ± 0.37 points; n=11, see Figure 4). However, statistical tests indicated that there was no difference between these two groups in any of the five categories.

(Insert Figure 3)

(Insert Figure 4)

Learning Experience

The post-study learning experience survey revealed that the pedagogical guide design was, on average, perceived better than the pathfinder design in all aspects of usability and learning experience (Likert scale 1-*strongly disagree* to 5-*strongly agree*) (see Figure 5 and Table 2). In the one instance where the pathfinder design received a higher score (Question 16), that was because the question asked whether too many resources were listed on the guide; the average score of the pedagogical design was slightly lower than that of the pathfinder design, indicating participants in the pedagogical design group felt less overwhelmed by the number of resources than those in the pathfinder group. Furthermore, t-tests determined the following survey questions had means that were statistically different (p-value < 0.05) between the two groups, with the pedagogical guide outperforming the pathfinder guide.

- Q4: I learned to use the research guide quickly (two-sample t-test, t=2.22, 19 d.f., p=0.038)

- Q5: I easily remembered how to use the research guide (two-sample t-test, t=2.25, 19 d.f., p=0.036)

- Q6: I quickly became skillful with it (two-sample t-test, t=4.38, 19 d.f., p=0.0003)

- Q17: I would like to be able to refer to any subject research guide provided by the library for my future research projects (two-sample t-test, t=2.19, 19 d.f., p=0.041)

(Insert Figure 5)

Participants' verbal expressions were analyzed in order to see how they felt while completing the simulated research assignment. At the beginning of the study, participants in both groups indicated that, in general, they were not sure how to conduct research or how to use databases. Participants expressed statements such as "I don't know how to find articles in general" (Participant ID 1) or "I've never heard of any databases except Wikipedia" (Participant ID 13). However, throughout the simulated research assignment, the pedagogical group expressed more positive feelings than the pathfinder group regarding the research guide (Figure 6). Some comments made by the pedagogical group include:

"It is helpful to define what a scholarly article is as I didn't know what it really meant."

(Participant ID 1)

"This [research process graphic] is so cool." (Participant ID 5)

"I like the organization of the Find Materials page." (Participant ID 13)

"I was not sure if this article was peer-reviewed until I saw the evaluation section on

[this] guide." (Participant 15)

"I like the way the resources are organized." (Participant ID 19)

"I like the short descriptions and explanations about think tanks. I didn't know what it

was. In addition, I learned what peer-reviewed meant. So I guess a think tank would

be not!" (Participant ID 21)

In comparison, participants in the pathfinder group said:

"I don't know how to use databases and the research guide doesn't help me figure out."

(Participant ID 3)

"I don't know where to start." (Participant ID 4)

"I am not sure where to go to find articles and not familiar with databases listed. But I've

heard of EBSCO before." (Participant ID 12)

"I knew that this article was scholarly because I heard this journal before. But I can't find

any information on how to evaluate the article on this guide." (Participant 14)

"So confusing." "Nothing on the guide would be helpful in navigating the research

process." (Participant ID 16)

"I don't understand what I am looking for here and what to do with the guide."

(Participant ID 18)

(Insert Figure 6)

Student Interaction with the Guides

The pedagogical group's interactions with the guide were statistically significant ($p<0.05$) in

three areas. First, the pedagogical group spent more time on the guide (495 ± 312 seconds) than

the pathfinder group (141 ± 159 seconds) (two-sample t-test, t=3.35, 20 d.f., p=0.003). Second,

there was more back and forth interaction between the guide and resources in the pedagogical

guide (23 ± 13 interactions) than the pathfinder guide (12 ± 7 interactions) (two-sample t-test, t=2.61, 20 d.f., p=0.016). Third, participants in the pedagogical group consulted more resources (6 ± 3 resources) than those in the pathfinder group (3 ± 1 resources) (two-sample t-test, t=3.31, 20 d.f., p=0.003, see Figure 7).

(Insert Figure 7)

There were 9 submenus in the left column in the pedagogical guide and 10 submenus in the pathfinder guide, including the home tab (see Figure 1). The participants in the pedagogical group were also, on average, more likely to click through the submenus (5 ± 2 clicks) than the pathfinder group (3 ± 3 clicks). However, there was no statistical difference between these two groups in terms of submenus clicked (two-sample t-test, t=1.21, 20 d.f., p=0.24).

Discussion

Students using the pedagogical guide reported a more positive experience than students using the pathfinder guide. The pedagogical design outperformed the pathfinder design in all guide usability areas as well as the learning experience. This positive experience led students to spend more time on the pedagogical guide, interact more with it, and consult more resources than those in the pathfinder group. Although there is no statistically significant performance difference on the IL learning outcomes as seen in the rubric scores between the students who used pedagogical versus pathfinder-type guides, there is a pedagogical advantage to having a more usable guide as well as in reducing negative emotions related to research.

Research anxiety exists to varying degrees among students, whether they are a first-year or more experienced graduate student. At the beginning of the simulated research activity, the participants in the pedagogical and pathfinder groups were equally unsure about how to conduct research or were not familiar with the databases listed in the research guides. The key question here, however, is whether the research guide can help students cope with their research anxiety and learn IL concepts. Otherwise, they may remain confused, frustrated, and uncertain in spite of using a research guide. These affective responses result in a poor user learning experience; therefore, students are likely to leave the research guide and move to other quicker, easier options.

Pathfinder-type guides have been criticized because they do not fit with students' research process and may cause cognitive overload. A new approach to the role and purpose of research guides leads to applying tutorial-based guide designs (pedagogical), organized around research processes, assignments, or student needs, rather than format (Baker 2014; Hicks 2015). In spite of the new design approach, many studies (as described in the literature review) have focused only on resolving usability issues in the format-based (pathfinder) guide organization. The pathfinder design for the Political Science research guide still allows students to easily locate library databases such as PAIS or Academic Search Premier. Including links to these databases facilitated finding high quality, scholarly sources without providing more background information on the use of those sources (Brophy and Bawden 2005). Similarly, students can apply filters in databases for scholarly sources by checking a box without knowing what a scholarly source is. This may explain why the two groups did not differ significantly on their IL

rubric performance scores on the simulated research assignment. However, the findings of this study demonstrate that database navigability alone is not sufficient to improve students' learning experience as well as their interaction with the guide and resources linked from the guide.

The pedagogical guide design was found to help students mitigate negative emotions such as confusion or uncertainty while inducing positive feelings that encourage them to use the guide. Emotion plays a vital role in cognitive and affective function in daily life and is a critical factor to measure user's loyalty. Emotion also influences students' learning in an online environment. Students' interests, motivation, and self-efficacy are correlated with their positive emotion and experience. Therefore, many educational technologies have tried to improve not only usability but also learning capabilities in digital systems (Kim, Baylor, and Shen, 2007; Picard 2000; Shen, Wang, and Shen 2009). In the present study, the positive emotions students perceived from using the pedagogical guide led them to read explanatory text while the pathfinder group skipped this reading. In addition, although the pathfinder guide listed only 3-5 resources per page by format, the group consistently reported that they felt overwhelmed or there were too many resources. In contrast, in the pedagogical guide, approximately 20 resources were listed on the Find Materials page in chunks by resource type with explanations. However, the participants in the pedagogical group did not report feeling confused or overwhelmed; rather, they indicated the guide provided the right amount of information. Furthermore, this positive experience triggered participants in the pedagogical group to have more back-and-forth interaction between databases and the guide while the pathfinder group was less likely to come back to the guide once they linked out to the databases. As a result, the pedagogical group consulted more resources than the pathfinder group.

Limitations & Recommendations for Future Research

Even though this study was carefully prepared and heavily advertised via various mediums to recruit participants, there were limitations. Since participants were recruited based on convenience sampling, there were non-controlled variables that may affect the study's results such as school year, major, number of library instruction sessions attended, number of research papers previously completed, and the use of research guides prior to this study. Based on the profile form, the authors were able to identify that sophomore, senior, and graduate participants were evenly assigned, but 4 out of 6 first-year students were assigned to the pedagogical guide while only 1 of 4 junior students was assigned to it. In terms of participants' subject area, both groups had a diverse representation. But there was no difference between the two groups regarding the number of research papers previously written (Pearson's Chi-squared test, X-squared=2.4, 4 d.f., p=0.662), and prior use of research guides (Pearson's Chi-squared test, X-squared=1.4, 2 d.f., p=0.4966). The pedagogical group did have one more participant with prior library instruction than the pathfinder group (Pearson's Chi-squared test, X-squared=10.4, 3 d.f., p=0.015), although there was no difference regarding how participants used the guide and no one was exposed to the pedagogical guide prior to the study. Regarding school year, when attempting to determine performance differences on the simulated research assignment between graduate (n=4) and undergraduate (n=18) there was no difference in any area except article relevance (p=0.007) however, due to the small sample size, this finding could be challenged statistically. As the study focused on pedagogical versus pathfinder designs, that reduces the sample even further (pedagogical: undergraduate n=9, graduate n=2; pathfinder: undergraduate n=9, graduate n=2). Comparing undergraduate versus graduate use of the pedagogical guide, there was no

difference in guide interaction except for article relevance (p=0.04), but due to the small sample size (n<11) it is difficult to know if this finding is statistically significant. For the pathfinder guide, there was no difference between graduate and undergraduate interaction, again, though, the small sample size (n<11) makes it difficult to determine if that difference is significant or not. Finally, there was no difference between graduate and undergraduate participants in the number of library instruction sessions and number of research papers completed.

Furthermore, the goal of this study was to examine which guide design better supports student learning outside of a classroom without in-person librarian mediated help. Although the study attempted to measure learning of IL learning outcomes based on the *Framework for Information Literacy*, there was not a statistically significant performance difference in rubric scores on the simulated research assignment. A study with a larger sample size might address that issue. There are also additional questions related to guide design that should be addressed in future research. Further research could be conducted to compare two guides in a specific discipline (for example, business or engineering) with a controlled group of participants such as first-year or graduate students. While the present study used a discipline-specific subject guide, as noted in the literature review, multiple studies have found students prefer course-specific guides. Therefore, duplicating this study with course guides may be useful. There should also be more assessment of the pathfinder and pedagogical guides in a classroom setting (e.g., building on prior research by Greenwell 2016 and Stone, Lowe, and Maxson 2018) to identify which guide designs students prefer after library instruction.

Conclusion

Pathfinder-style guides have been the standard in libraries since the 1960s. However, the amount of, and access to, information has exploded since then. The exhaustive list of resources in a pathfinder guide can be overwhelming for students, thereby increasing research anxiety, which can hinder students' ability to attain a higher level of competency with complex IL concepts. Coupled with the shift to the *Framework for Information Literacy,* this recognition calls for a move for library guides to reduce lists of resources, and emphasize learning objects that guide students through their research. In the present study, students using the pedagogical-style guide outperformed those using the pathfinder-style guide in usability preferences and affective measures. They also expressed more positive emotions about the pedagogical guide and were less confused by it than those using the pathfinder-style guide. While this study did not find a statistically significant difference between their performance on an assigned task, participants using the pedagogical guide experienced a more positive learning experience in finding and evaluating sources when moving through the simulated research assignment. This positive learning experience was demonstrated by their spending more time on, interacting more with, and consulting more resources on the pedagogical research guide. If research and course guides are to be effective for students, and not just for other librarians, designing them in a more pedagogically-based style appears to be one important way to maximize their impact, especially outside of the classroom.

The authors have integrated the results of this usability study into local library research guide best practices. Because participants in the pedagogical group clicked four tabs, on average, the research process infographic was redesigned from eight steps to five (see Figure 8, originally published in Stone, Lowe, and Maxson 2018). The authors do not feel as if the research process

has been "dumbed down," but do feel students will be less intimidated by the number of steps and more likely to explore the entire process. Subject librarians have also been encouraged to follow best practices, including: numbering the left-hand navigation tabs, explaining processes, and carefully evaluating how much content is added to a guide to avoid cognitive overload. Other libraries can take similar steps to refresh their guides. It is not necessary to drastically redesign traditional pathfinder guides to get some of the benefits of a pedagogical guide. The simple steps mentioned above, numbering navigation tabs, explaining the "why," and limiting content, go a long way towards making guides more usable and less opaque for students.

(Insert Figure 8)

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Appendix: Simulated Research Assignment

Your research paper for this semester has to relate to the **role of Islam in the Middle East**. This can be in any area. For example, economic (anything to do with trade or budget); political (anything to do with forms of government, the rights of people, political relationships with other countries); cultural (anything to do with language, beliefs, practices); or geographical (anything to do with borders, resources, environment).

You must use the library research guide prepared for this assignment.

[URL for either the pedagogical or pathfinder guide]

Step 1: Define your research question.

Step 2: Find 3 reliable, scholarly sources to support your question. These can be books or articles.

- Cite your sources.

- Explain why you think the source would be suitable for your research question.

Source 1:

Citation:

Why did you choose it?

Source 2:

Citation:

Why did you choose it?

Source 3:

Citation:

Why did you choose it?

Figure 1: Organization of side menu for each subject guide (Pathfinder, left, vs. Pedagogical, right)
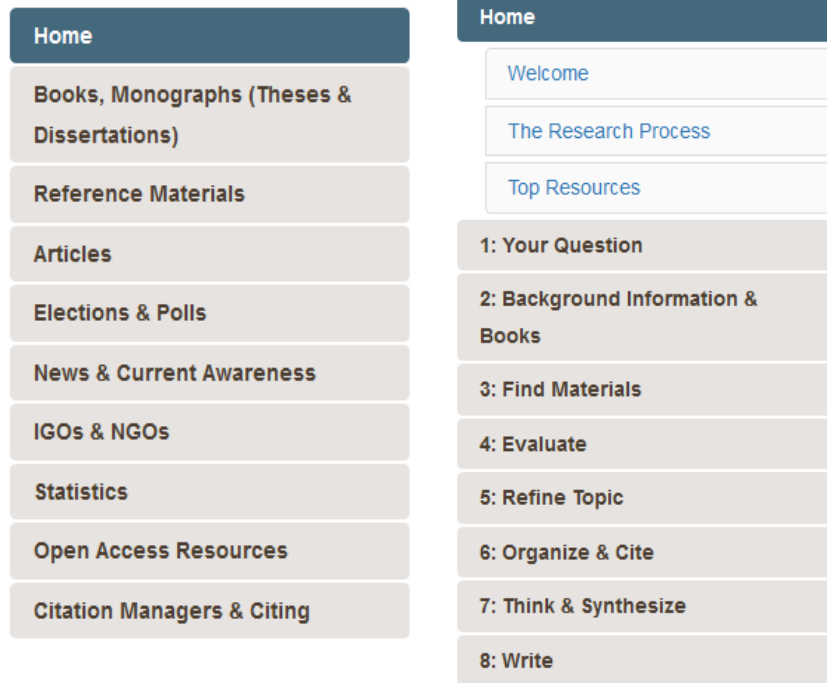

Pathfinder (left):

Home

- Books, Monographs (Theses & Dissertations)
- Reference Materials
- Articles
- Elections & Polls
- News & Current Awareness
- IGOs & NGOs
- Statistics
- Open Access Resources
- Citation Managers & Citing

Pedagogical (right):

Home

- Welcome
- The Research Process
- Top Resources
- 1: Your Question
- 2: Background Information & Books
- 3: Find Materials
- 4: Evaluate
- 5: Refine Topic
- 6: Organize & Cite
- 7: Think & Synthesize
- 8: Write

Figure 2: Infographic of the Research Process in the Pedagogical Guide (Stone, Lowe, and Maxson 2018)
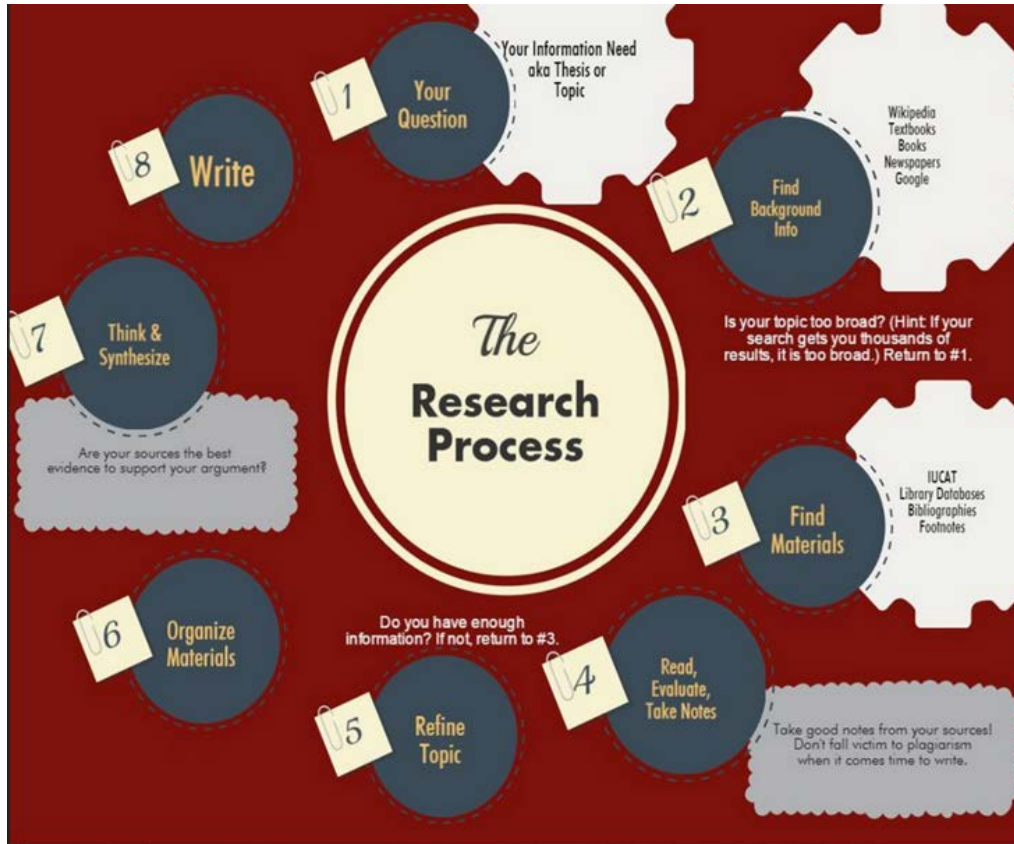
Figure 3: Boxplot of Keywords, Article (Relevance), and Evaluation Scores Between the Two Guide
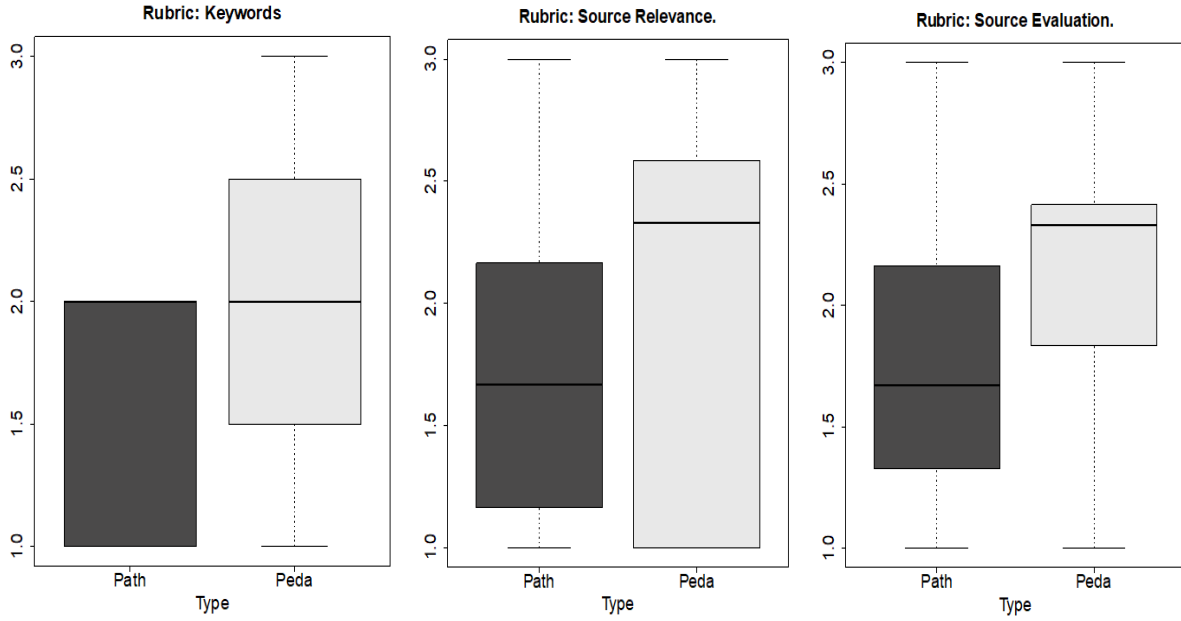
Design Groups

Figure 4: Boxplot of Research Question and Article (Scholarly) Scores Between the Two Guide Design
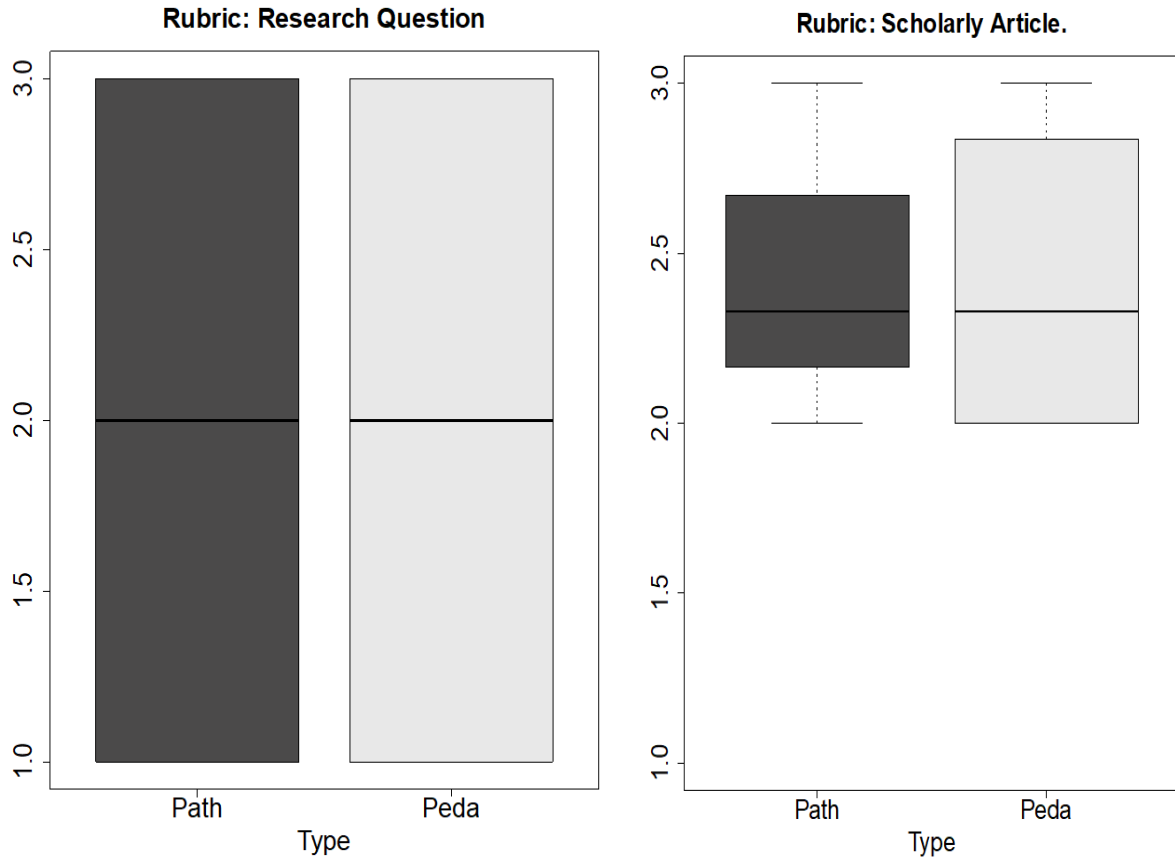
Groups

Figure 5: Average Usability and User Experience Score for the Pedagogical and Pathfinder Guides
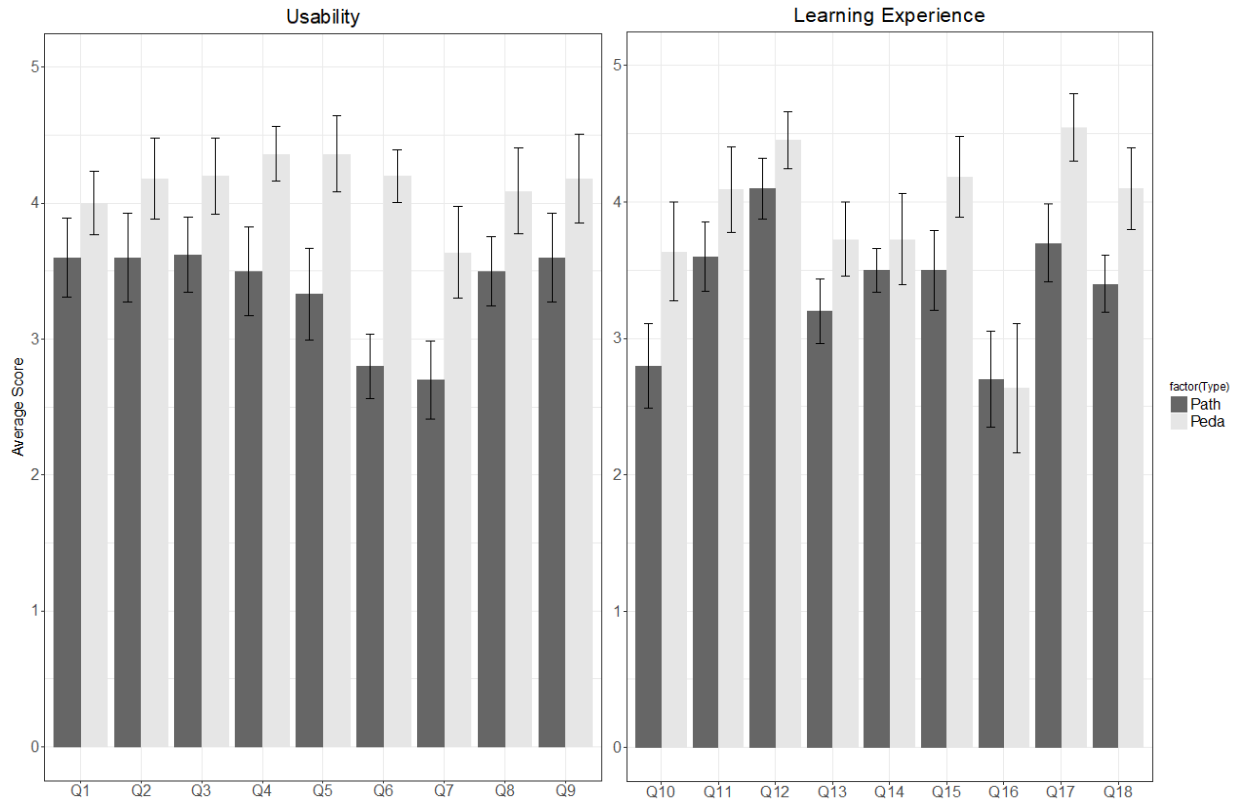
Figure 6: Emotional Response Frequency Based on Reactions to the Research Process, Using Databases, and Using the Assigned Library Guide
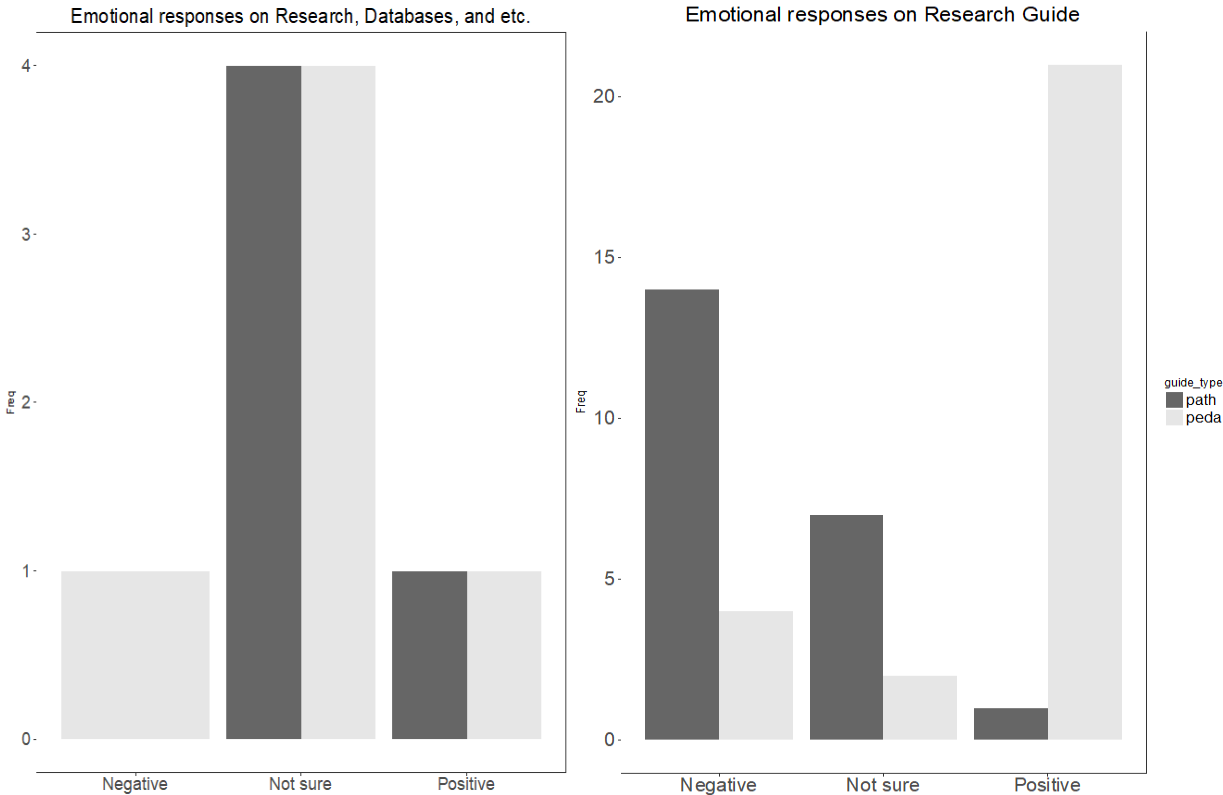
Figure 7: Boxplot of Student Interactions Including Time Spent on the Guide, Number of Interactions,
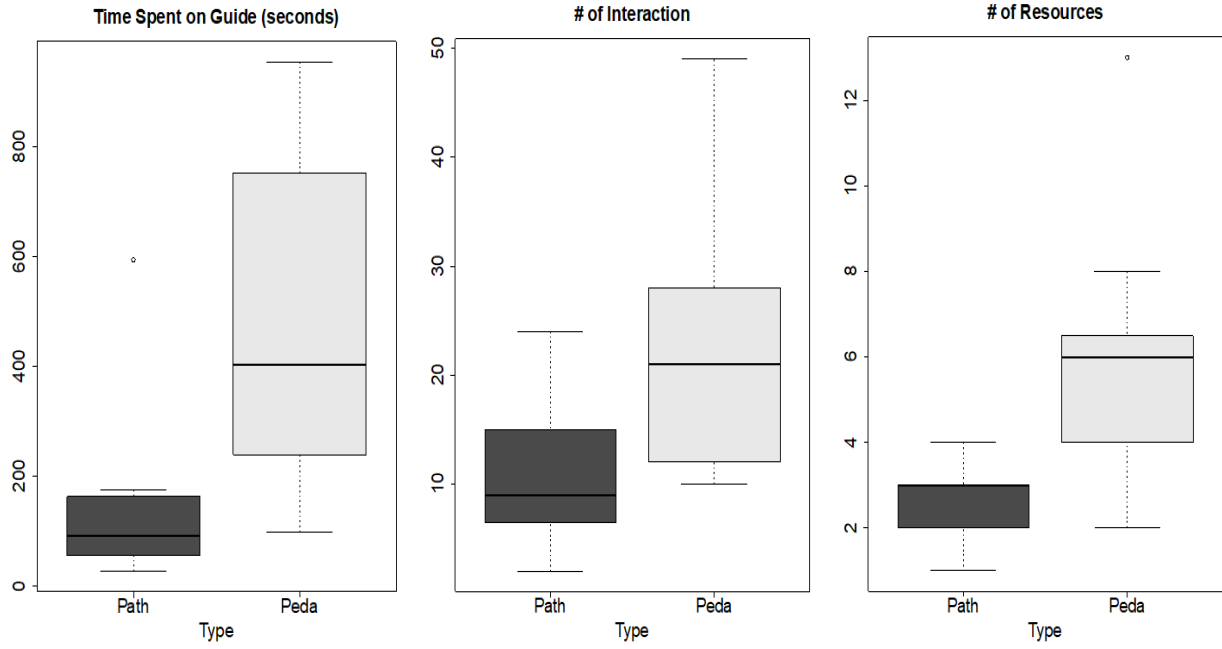
and Number of Resources Selected

Figure 8. Modified Infographic of the Research Process (Stone, Lowe, and Maxson 2018)

Table 1: Overview of Participant Demographics

ID	Year	Major	# of library instruction	# of research papers	Use of library guide	Guide Type
1	Freshman	Management/Marketing	3	2-5	Yes	Peda
2	Sophomore	Media Arts and Science	2	2-5	I don't know	Peda
3	Sophomore	Mechanical Engineering Technology	2	2-5	Yes	Path
4	Freshman	Neurobiology/Physiology	0	0	Yes	Path
5	Junior	English	2	More than 10	I don't know	Peda
6	Sophomore	Biomedical Engineering	1	6-10	Yes	Path
7	Senior	Neuroscience/Biology	3	2-5	Yes	Peda
8	Graduate	Biomedicine	0	2-5	No	Path
9	Senior	Electrical Engineering	1	6-10	No	Peda
10	Senior	Psychology	1	6-10	Yes	Path
11	Freshman	Journalism	2	2-5	Yes	Peda
12	Junior	Community Health	1	More than 10	Yes	Path
13	Graduate	English	2	More than 10	Yes	Peda
14	Graduate	Higher Education & Student Affairs	0	More than 10	No	Path
15	Graduate	Philanthropic Studies	2	6-10	Yes	Peda
16	Junior	Psychology	2	2-5	Yes	Path
17	Freshman	Finance/Spanish	2	2-5	Yes	Peda
18	Junior	Computer and Information Technology	0	2-5	I don't know	Path
19	Freshman	Mechanical Engineering	2	2-5	Yes	Peda
20	Freshman	Computer Graphics Technology	1	6-10	Yes	Path
21	Sophomore	Political Science	3	6-10	I don't know	Peda
22	Senior	Anthropology	2	NA	Yes	Path

Table 2: Post-Survey Questionnaire to Assess Participants' Impressions of the Research Guide and their

Perceived Learning Experience with the Research Guide (Likert-scale 1-s*trongly disagree* to 5-*strongly*

agree)

Please answer the following questions about the research guide you used.	
Q1	The research guide was easy to use.
Q2	The research guide was user friendly.
Q3	I was able to recover from mistakes quickly and easily.
Q4	I learned to use the research guide quickly.
Q5	I easily remembered how to use the research guide.
Q6	I quickly became skillful with it.
Q7	The research guide worked the way I want it to work.
Q8	I would recommend the research guide to a friend.
Q9	Overall, I am satisfied with the ease of using the research guide to find a scholarly source.
Please answer the following questions about your learning experience with the research guide.	
Q10	I was able to use the research guide without any additional instructions.
Q11	The research guide helped me develop my research question.
Q12	The research guide helped me find scholarly sources.
Q13	The research guide helped me evaluate sources (decide if something was a good source to use).
Q14	The research guide helped me improve my research skills.
Q15	The resources listed on the research guide were sufficient for my needs.
Q16	The resources listed on the research guide were too many for me.
Q17	I would like to be able to refer to any subject research guide provided by the library for my future research projects.
Q18	Overall, I am more confident about research.

Table 3: Rubric for Evaluating the Research Assignment Document

Learning Outcome	Level of Achievement		
	Developed **3**	**Emerging** **2**	**Initial** **1**
Keywords & Synonyms	Sufficient keywords and synonyms ● Multiple keywords identified ● Multiple, appropriate synonyms identified for each keyword	Insufficient keywords or synonyms ● Limited identification of keywords ● Few or improper synonyms	Minimal keywords and no synonyms ● No keywords beyond those used in the original question/topic ● No viable synonyms found for the keywords
Research Question	Question is relevant to the topic	Question is kind-of relevant to the topic – containing elements of the topic but not everything (e.g., Islam in America)	Question is not relevant to the topic, very vague, OR only repeats the topic in question form
Article (Relevance)	Article content seems appropriate for the proposed question/topic	Article is only tangentially related to the proposed question/topic	Article is not related to the proposed question/topic
Article (Scholarly)	Article is from an appropriate scholarly journal	Article is from an authoritative source (e.g., NY Times) but not a scholarly journal	Article is not from an authoritative source nor a scholarly journal
Evaluation	Well thought out explanation of how the article was relevant to the topic or research question	Explanation is not completely thought out or clearly copied from article abstract	No explanation or no effort to explain (e.g., it's scholarly, I found it in a database, etc.)

Table 4: Emotional Responses to the Research Process Scale

Positive	Doubtful	Negative
- Helpful - Cool - Good - I like… - Organized - I learned… - Awesome - Nice - Great	- I am not sure… - I am not certain…	- Confusing - Confused - I don't know… - It's not helpful… - I can't find… - I don't understand… - Nothing - Overwhelmed - It's not clear…