Computational Thinking Instruction in Library and Information Science Education Programs

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Chapter 1: Introduction

Statement of the Problem

Computational thinking has several different perspectives of what it is and what should be, but all definitions of computational thinking involve problem-solving skills. Computational thinking has many interdisciplinary applications across all grade levels, from K12 to postsecondary education, and lifelong learning (National Research Council, 2011). This qualitative study will add to the relatively new research area of computational thinking and will aid in defining and understanding the application of computational thinking in the context of library and information science education (LIS). Computational thinking skills are transferrable as the skills to promote problem-solving skills and decision making. Though there are many types of "thinking" theories such as design thinking, systems thinking that computational thinking may seem like just another theory but its importance in today's technology-fueled world requires appropriate applications and training for educators. The literature and studies are recent, but computational thinking can trace its roots back to artificial intelligence, human-computer interaction, and user experience (Holt, 2005). The problem is LIS education programs are not preparing librarians to teach computational thinking skills. Are librarians being prepared to use and teach computational thinking skills? How will LIS graduates prepare to use these skills as it applies to human-computer interaction working with their students and how are they teaching these skills to students?

Presenting the various computational thinking definitions is significant in understanding its importance in LIS education. Dwarkanathan's (2017) whitepaper "Jumping onto the AI wagon" presents a core question about how one reacts in new environments and presents three common situations: a child in a playpen, the first day of work for new employees, and a person

at a new bank kiosk. Using examples of new environments, the author states all three scenarios are examples of how cognitive thinking helps us with ideas and navigating new environments. The examples are relevant to the study of artificial intelligence and its applications to guide users in new environments. The 2016 International Society for Technology in Education (ISTE) Standards for Students defines the goal for computational thinkers as "students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions." (ISTE, para 6). As referenced in Taylor, Moore, Visser, and Drouillard (2018) ,Braun and Visser (2017) include how computational thinking is transferable to other applications and to ask and answer complex and abstract problems. ISTE identifies the five core skills for computational thinking as decomposing, generalizing, algorithmic thinking, evaluation and abstraction (ISTE, 2017).

Need and Value

This study will explore the need for incorporating computational thinking courses to LIS education based on librarian feedback and suggestions. Library science education programs lack the focus and rigor of 21st-century skills necessary to teach library science students. LIS students and professionals need to understand the concepts of computational thinking while also being prepared to use the principles to prepare instructional material and lesson plans to support computational thinking. The recent 2018 study by Taylor, Moore, Visser, and Drouillard provides recommendations about integrating computational thinking into LIS courses. Interviewing early career librarians who have graduated with a library science degree would best determine how librarians feel about their knowledge of computational thinking. The research is significant to add to the literature and to aid in supporting information on the changes that LIS education must consider to better prepare librarians on the application of computational thinking.

Research Questions

The purpose of this phenomenological, qualitative study is to explore the educational and professional experiences of early career academic librarians to learn if their education is a solid preparation for computational thinking methods and applications. The following questions will guide this exploratory, qualitative study:

- How are librarians teaching computational skills to their undergraduate students?
- How well prepared are librarians in the application of teaching and learning computational thinking skills?
- What further education as it pertains to computational skills if any, would librarians suggest incorporating in the LIS curriculum?
- What is the state of computational thinking in LIS education?
- What are the obstacles librarians face in creating and applying computational thinking skills?

Chapter 2: Literature Review

Theoretical Framework

Several theoretical frameworks could apply to the interdisciplinary nature of LIS education and the complexity of computational thinking. Goal-driven learning theory is a broad approach combining cognitive science, education, and artificial intelligence (Ram & Leake, 1995). Goal-driven learning theory also involves the learner's goals, and in this case, the learners are the professional academic librarians. The constructivist worldview applies to frame this study to gain a rich insight into the participant's experiences (Creswell, 2018).

Librarians of the future need to be technically savvy but must also educate others on the use of various technologies. There is an opportunity for more literature and studies in the area of

LIS education as it pertains to computational thinking. This literature review is twofold as it will present research about computational thinking theories and applications in addition to the current state of LIS education programs. One definition of computational thinking incorporates the ability to program a computer to think, as referenced in Nims, Storm, and Stevens (2014), Tyckoson states until an information system is genuinely intuitive that a person can use without any human intervention, that users will still need librarians for assistance given the users are working in the context of the library. Librarians need the ability to use computational thinking ability as well as to be able to teach others.

Computational Thinking

There is plenty of literature about librarians and critical thinking in the context as leading students to sources but also teaching the students critical thinking when using resources. There is not much in the literature to make the connection between librarians and computational thinking. Nims, Storm, and Stevens (2014) provide many examples of the integration of teaching critical thinking skills along with technology and how librarians provide instruction to develop student critical thinking skills. Library education and general undergraduate education will prepare librarians to integrate critical thinking in instruction lessons, but it is now time to concentrate efforts on computational thinking. The history and significance of computational thinking are necessary to understand its importance in LIS education.

Barr and Stephenson (2011) state the computer science field are multi-faceted combining programming, databases, artificial intelligence, databases and even information retrieval to name a few. When the world chess champion, Garry Kasparov, lost to the IBM “Deep Blue” computer in 1997 brings to light the concept of “Human Machine Decision Making.” There is no relation to chess and intelligence as there is no clear research as to what separates bad chess players from

the good (Kaparov, 2018). Some of the artificial intelligence literature references chess. Marsland and Schaeffer's 1990 book focuses on the programming and the computational thinking that is behind many of the popular chess computer programs. Carr's (2010) premise in his book the *Shallows* focuses on how the Internet has changed the way we think—not better or higher IQ but process information different (p147-148). During infancy, children learn the skills to solve puzzles and categorize items. The use of the computer and internet strengthens these early learning skills (Carr, 2010).

LIS Education

The recent 2018 study by Taylor, Moore, Visser and Drouillard had participants meet both in person and online to develop or redesign LIS graduate courses to incorporate computational thinking. The researchers also used artifacts in the form of syllabi to review six LIS courses taught from April to December of 2017. Though the sample was small analyzing only six courses, the courses illustrate the expanse of the LIS courses and the importance of computational thinking as it applies to 21st Century skills. The researchers worked with the deans to integrate computational thinking in the six courses ensuring the courses would still meet accreditation and course requirements by adding learning objectives such as "demonstrate basic concepts of coding and computational thinking" while changing one objective from "create pathfinders, web quests and other materials to facilitate access and promote learning" to "create programming plans and other materials to promote learning." (Taylor et al., 2018, p.12).

"Libraries Ready to Code" is an initiative by the American Library Association (ALA, 2017). Libraries Ready to Code is a timely initiative to understand to understand computational thinking as it relates to coding and other areas The ALA site defines computational thinking (CT) "as the thought processes used to formulate problems and their solutions (Wing, 2006).

These include breaking down problems into smaller parts, looking for patterns, identifying principles that generate these patterns, and developing instructions that computers — machines and people — can understand. It is an approach to critical thinking that can be used to solve problems across all disciplines (ALA, Google's Exploring Computational Thinking, 2017).” ALA is only focusing on how computational thinking works with children and K-12, not in a higher education setting.

It may be helpful to learn how teacher education programs integrate computational thinking to understand applications in library education programs. Yadav’s (2017) aim is to correct any misconceptions that computational thinking refers to computer science programs or skills but rather analytical thinking with multi-disciplinary applications to support problem-solving skills by breaking down problems into smaller parts (Yadav, 2011). Though the article discusses k-12, the section about teacher education is the need to train teachers how to integrate or embed computational thinking in their courses. The author states how the teacher will need to understand how computational thinking works in the context of their subject area, this, of course, will not pertain to librarians as they provide instruction to many different courses, and subjects. Yadav recommends transforming teacher education to include The Technological Pedagogical Content Knowledge (TPACK) framework. Yadav’s recommendation would also apply to LIS education. Yadav (2011) provides recommendations on how to implement computational thinking in teacher preparation courses such as the significance of computer science educators collaborating with teaching educations to develop a curriculum which focuses on higher order thinking skills.

Research in the area illustrates a promising future of computational thinking is integrating into teacher education**.** Lye and Koh’s (2014) empirical study of 27 interventions introducing

computational thinking studies prove its importance in teaching and learning. The Lye and Koh article list the 27 studies (Table 3 p.55-56) with a mix of experimental studies, case studies and action research to understand computational thinking concepts, practices, and perspectives in K12 and higher education settings**.** Lye and Koh recommend more intervention studies to learn how instructional interventions can develop the computational thinking skills of students. The interventions included game strategy creation, programming using Scratch and logo programming languages. Altanis, Retalis, and Petropoulou (2018) present the results of their study in two junior high schools in Athens, Greece. Throughout nine weeks (March–April 2017), the students had to design a game, and at the end of the nine weeks, the students strengthened their computational skills during this intervention or exercise. The Swedish government is now requiring digital competence with programming skills for K-9. The implementation should start by fall 2018. The teachers need the training to learn programming and digital competence (Heintz & Mannila, 2018). Yasar (2018) relates computational thinking to the skills of abstraction decomposition and modeling and simulation (M&S).

Bertot, Sarin, Jaeger (2015) delve into the abilities and skills future LIS professionals need and how the needs into LIS curriculum. Bertot et al. research show the current MLS curriculum does not provide what employers are looking for, with only “an obscure, muddled graduate education” and there is a disconnect between librarian and future employer expectations.

Chapter 3: Methodology

One goal of qualitative research is to connect ideas to human experiences (Huff, 2009). This study will uncover the educational and professional experiences of early career librarians to learn if their LIS education prepares them in the teaching and learning activities of

computational thinking methods and applications. The goal is to have unstructured and semi-structured interviews using open-ended questions (Huff, 2009) with early career librarians to learn about their perception and belief in their understanding of computational thinking and if the library science education program indeed enhances or prepares them to teach or guide students with their applications of computational thinking. Another option to research would involve a qualitative artifact analysis to review the curriculum of LIS programs. Though the artifact analysis may be more efficient, it may also be more subjective and would not provide recording the personal experiences of academic librarians in practice.

Population and Sample

The study will use a purposeful sample to target professional academic librarians at postsecondary institutions. The librarians will be contacted via professional library association email listserv. The goal is to recruit participants meeting the following criteria (1) Graduate of an LIS program in the last three years. (2) Practicing academic librarian for at least six months and be willing to sit for a 60-minute interview. The academic institution is not relevant to the recruitment of subjects as the subject of the research is the librarian's education not the place of work. Data will be collected via 60-minute semi-structured interviews following a brief demographic survey. Saturation will determine the sample size; the expectation is to conduct from three to ten interviews or perhaps until some common themes emerge (Creswell & Creswell, 2018).

Procedures

Table 1 lists the timeline and procedures for the year-long study. The study will start by researching LIS programs and to contact the ALA to obtain a list of schools offering the library science master's degree in addition to a literature search of all resources in a variety of formats

from streaming media to articles and books**.** The following steps are to complete and submit the IRB application. Following IRB approval, recruiting participants is the next phase of the process. Librarian professional associations will also be contacted. The goal is to recruit participants. Once the subjects agree to the interview, the IRB will be contacted to verify the recommendation to qualify the participants. Although the academic institution is not relevant to the recruitment of subjects as the subject of the research is the librarian's education not the place of work. Librarians who meet the criteria will be asked if they are attending the annual national ALA conference. If so, there is an option for the 60-minute interview to take place during the June conference at the conference location or meeting room. Librarians not attending the conference will still have the opportunity to sit for an interview either via Skype or in-person. The participants will be ensured anonymity. Transcription/Initial coding of interview data. Determine the need for more information from participants or the possibility of recruiting new subjects. The interview coding of data will require the use of qualitative research software such as Qualtrics. There is a need to recruit at least one student researcher to assist and record the interviews then transcribe the data.

Interview Questions

1. What is your current position?
2. Please describe the library instruction program at your school?
3. What subjects do you teach?
4. What is your definition of computational thinking?
5. Do you provide instruction involving computational thinking?
6. How would you describe your LIS education?
7. Did you have any courses covering computational thinking during your LIS program?

8. Do you remember your classes? Which course prepared you for your role now?
9. What surprised you about being a librarian? For example, things you wish you had known in library school.
10. How would you rate your LIS education?
11. If you could change anything about your education to better prepare you for example in applying computational thinking, what would you recommend adding to LIS education?
12. Where do you find inspiration?
13. How do you think you could apply computational thinking principles to your library instruction?
14. Any advice for potential librarians looking for LIS programs?

Limitations

The study has limitations and potential risks for failure that are common with the qualitative research design. Using the narrative style and open-ended style of asking interview questions is time-consuming. Gathering and coding the data is also a challenge. The logistics for coordinating the interviews may require schedule rescheduling. There may also be a need to collect more data; the data may not answer the research questions. Also, the IRB may make recommendations to change the research design. The conclusions could be subjective, and the data is only as good as the recorder and the researcher (Huff, 2009). Limitations to qualitative interviews include the number of subjects willing to participate. The participants may hold back or may not be truthful or forthcoming in their responses. A quantitative or action research design may be more suitable to the topic of the functionality of computational thinking (Lye & Koh, 2014). The researcher's role or reflexivity as a practicing librarian may influence the study.

Table 1

Timeline for study start date, completion, and reporting

January - February	Research is existing Library Science Education programs, review course offerings offer, and descriptions online. An extensive search of American Library Association (ALA) website to obtain a list of schools offering the library science master's degree. A literature search of all resources in a variety of formats from streaming media to articles and books.
March	Submit IRB application.
April	Secure approval of IRB.
May	Recruit participants: Send the initial round of emails via professional academic library listservs to recruit participants to interview. The professional associations will also be contacted. The goal is to recruit participants who meet the following criteria: • A graduate of an LIS program in the last three years • Practicing academic librarian for at least six months. • Be willing to sit for a 60-minute interview The academic institution is not relevant to the recruitment of subjects as the subject of the research is the librarian's education not the place of work.
June	Librarians who meet the criteria will be asked if they are attending the annual national ALA conference. If so, there is an option for the 60-minute interview to take place during the June conference. Librarians not attending the conference will still have the opportunity to sit for an interview. Ensure
June	Contact respondents, ensure anonymity and arrange to conduct the interviews at the conference location or meeting room. Request appropriate permissions from librarians' employers. Coordinate with student researcher, test recording software and microphone and proceed to interview participants at scheduled times. Re
July	Coordinate with remaining subjects on an agreeable interview meeting time Travel to subject location. Request appropriate permissions from librarians' employers
August - September	Transcription/Initial coding of interview data. Determine the need for more information from participants or the possibility of recruiting new subjects.
October - December	Final coding and analysis. Report results to IRB and other parties in preparation to publish. Thank participants and share results.

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