Citation Indexing and Threshold Concepts: An Essential Ah-ha in Student Learning

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Understanding information organization is a key component to navigating digital library environments as an information professional. While traditionally thought of within the areas of assessment and evaluation, citation indexing is another form of organization and navigation, and learning about it can transform one's knowledge of the information environment. In this article, McLaughlin and Tucker argue that an understanding of citation indexing should be emphasized to all library and information science (LIS) students as a way to further develop search expertise, and to enhance reference services and digital information literacy in any information setting. Situating this learning experience within the theory of threshold concepts, they provide evidence from student discussions of the transformative nature of a practical and conceptual understanding of citation indexing.

Keywords: Citation indexing, LIS education, online searching, search education, threshold concepts

The pursuit of a degree in information science lends itself to a certain amount of practical and personal discovery. From theoretical and methodological nuances in how the discipline is studied, to the details associated with working in libraries and other settings, there is much to be learned about the creation, management, dissemination, and use of information. Graduate students come to our profession from a number of disciplinary and personal backgrounds and, as they share experiences with each other (and faculty) in the classroom, these perspectives have the power to shape our views about new and existing models for working with information. At times, they clash with or push the boundaries of established practices; at other times, they reinforce assumptions surrounding core principles in our field. New perspectives related to established topics in the curriculum can help bring about transformative learning for students as well as educators. Based on our experiences in an advanced search class, we believe such experiences are possible when learning about citation indexing, and we argue for the importance of this topic for all LIS students.

Learning about citation indexing leads students into a holistic understanding of the information environment. They leap from "ho-hum" appreciation of the references at the end of an article—an interesting but hardly profound peek into previous literature—into understanding the article's [relative] future in the research universe and some measure of its impact. The article now has a story to tell; the student senses new territory with a new language and is beginning to understand it. When students fully grasp the implications and applications of citation indexing, they experience their very own, and very profound, "ah-ha" moment. They are at an intersection of practical and conceptual understanding that information professionals need for expertise in navigating information environments. The experience also opens up the

possibility of joining a community of researchers and content creators, one of the ultimate stages in identity shift when developing expertise in any domain (Tucker, 2016).

Threshold Learning Experiences about Searching—"Organic" and "Almost magical"

Learning core concepts necessary for the deeper understanding that LIS professionals need to have can lead students to have threshold learning experiences, the ah-ha moments that prompted us to write this article. "Threshold concepts" (Meyer & Land, 2003) have been the focus of LIS research into search expertise (Tucker et al., 2014) and information literacy (Townsend et al., 2016), gaining substantial attention recently when the Association of College and Research Libraries (ACRL) adopted the Framework for Information Literacy for Higher Education based on six threshold concepts (Association of College and Research Libraries, 2016).

A threshold concept has five main characteristics: it must be transformative, causing a shift in perception and identity; troublesome, being initially counterintuitive or uncomfortable; irreversible, unlikely to be forgotten or unlearned; integrative, involving the accommodation of new knowledge and connectedness; and it may be bounded, indicating limits of conceptual areas or a discipline itself (Meyer & Land, 2003). In recent years additional characteristics have been added, including discursive changes, reconstitutive features, and more profound identity changes in relation to the new knowledge.

Tucker developed a search expertise model based on a study of highly experienced professional searchers and MLIS students who exhibited expert-like search behaviors in advanced search courses. At the center of the model are four threshold concepts: Information environment, a holistic understanding of the information environment; Information structures, deep understanding of content and metadata structures; Information vocabularies, fluency in search activities such as controlled vocabulary, natural language, proximity operators, and truncation; and Concept fusion, the integration of the other three threshold concepts and further defined by the ability to vision (anticipate next moves) and dance (being light on one's "search feet"), and by profound ontological shift.

In the study, participants gave citation indexing as a notable example of understanding both of the threshold concepts of information environment (specifically, content creator practices) and information structures (citations creating connective structures). It was also used for the profound identity shift occurring with concept fusion. Interestingly, threshold concepts not only represent learning portals for a discipline or subject area but also a barrier to those unable to grasp them. Because threshold concepts call for new ways of seeing which may require shedding old habits or misconceptions, these barriers are often internal. One student described the experience as helping her recognize the "internal barriers we set in our path [to new knowledge]."

Student Voices: First Experiences with Citation Searching

In LIS curriculum, citation indexing can be taught as a model of information organization, as a platform for search and discovery, or within the context of research assessment or bibliometric analysis. To get a rough measure of its potential extent, we conducted an environmental scan of the 300-plus required courses listed in the ALISE Library and Information Science Education Statistical Report 2017 (Table III-41). Of the 60 programs reporting specific required courses, almost all (51) have at least one Master's program that requires a course on organization of information, or information sources/structure and access/retrieval. However, very few (three to five

since 2015) require courses specifically on the practice of digital search and retrieval, though most do offer electives on this topic (either in a general approach, or related to a specific database). A deeper dive into program websites to examine course syllabi (if available) would be needed to check for specific mention of citation indexing and the context in which it is discussed. However, these required courses provide opportunities to introduce citation indexing to students as an important content structure within the information environment.

To show why we believe citation indexing should be mandatory learning for all LIS students, we will let students speak of their experiences for themselves. We highlight student discussion posts that reveal learning experiences ("ah-ha!" moments) relating specifically to citation indexing and how they fit within a broader understanding of information organization, structures, and environment—threshold concepts in moving toward search expertise.

In Tucker's advanced search class at San José State University, citation indexing is the primary focus of a set of modules dealing with information organization and specialized indexing. The course uses several commercial search systems, including the Web of Science™ (WoS) databases, both for lessons in ways to locate relevant publications for a literature review and to demonstrate the connections among authors, institutions, and research topics. Strengths of WoS include its analytics and data visualization features. Students generate citation maps that can be manipulated and customized to focus on prolific and influential authors and on regional publishing patterns. Students also compare WoS to Google Scholar to understand differences in search capabilities and citation counts resulting from the sources being searched and indexing practices. With the combination of WoS advanced features and the newly framed, but still familiar, Google Scholar results, the "ah-ha" moments start coming fast and fiercely.

In analyzing the student discussion posts, we found an overarching theme of discovery and greater understanding of citation indexing, and three subthemes: (1) Applying the new knowledge to one's own information needs; (2) Applying the new knowledge to helping others; and, (3) Engaging further with core principles and tactics, and responding to new knowledge.

1. Applying the new knowledge to one's own information needs.

I was anxious to try out the citation indexing tactics on my research for my term paper. When I started my literature review, I came across some of the same authors and same articles many times. Now I know to try plugging in these references.

I used to shy away from citation indexes because I did not understand just how integral they can be to the research process. I was used to looking at the article's reference list, but never would have thought to look forward in time to see what sources could have cited the initial article. I have a new and different approach to retrieve relevant results.

2. Applying the new knowledge to helping others.

Never before had I made the connection between doing citation research and helping library patrons. But now it seems like such an obvious connection. How else to help when the initial resources found on a topic might be scarce?

For one of the assignments, I created a citation map based on a journal article published by a friend and it was really exciting to see his influence from just one article.

3. Engaging further with core principles and tactics, and responding to the new knowledge.

We need to be willing to try combinations of sources, from citation indexes to people, and then adapt to the structures and vo-

cabularies of each. We have to be efficient, too, and learn what expert searchers would do with a combination of experience, a balance of confidence and skepticism, and devising and knowing when to change strategies. There's also knowing when the search is complete.

In the beginning I found the concept of citation index searching to be very confusing. I understood about using an article's bibliography, but didn't understand about searching forward in time and this was a real "ah-ha" moment.

Learning this drove me to the realization that the best searchers are cognizant of multiple search approaches and also when to apply them, based on the inquiry to be done.

Conclusion—"Mind. Officially. Blown."

The samples above illustrate the comments from a majority of students and reflect concept fusion in practice: an evolution of transformative learning around information environments, information structures, and information vocabularies. We also see evidence of threshold concepts as barriers to learning that can eventually be worked through when new skills or ideas are applied to real-world information needs. An understanding of citation indexing should be emphasized to all LIS students as a form of information management and as a way to enhance reference services and web-based information literacy in any library or information setting.

As one student reflected on his first close encounter with citation indexing:

I'd used Google Scholar for my first research paper in graduate school and thought I was doing so well. Then I had my first formal encounter with citation indexing in this class and learned about the forward and backward research process and being able to visualize second genera-

tion research impacts. Mind. officially. blown.

We suggest that anyone who has taught a class on citation indexing, attended a product training, or otherwise engaged with learners, can attest to "before" and "after" impressions like those in the comments above. Maybe you've seen a lightbulb or two go off, in a student's discussion post or reflective essay. In fact, as we conclude, we reflect on our own experiences and the "before" and "after" perspectives that led us to collaborate and bring the importance of these ah-ha moments into focus.

McLaughlin has worked for publishers and library-related vendors for nearly 15 years in advocacy of technology platforms and content. As he engaged with academic libraries around the world, he developed a keen sense of how research impact data was used for assessment and evaluation purposes. While completing an MLIS at San José State University in 2016, Jeremy had his own profound transformative learning experience while taking the advanced search class taught by Tucker. Though citation indexing was not new to him, moving through this module of the class along with other students and seeing their excitement at something he had taken for granted, was a moment of personal discovery. Examining the topic in a new way and putting these experiences within the context of threshold concepts helped him re-conceptualize citation indexing as a form of information organization and its potential importance not only to academia and to researchers but also to students and new librarians.

Like McLaughlin, Tucker's background includes years of experience working for a database vendor, both as a product architect and client training manager, prior to becoming faculty at the San José State School of Information. She started out as an academic librarian and has worked in physics, music, and law libraries. Her research into threshold concepts for search expertise led to redesigning the advanced

course such that it directly supported threshold learning experiences, and this approach to course design is taking shape in other classes she teaches, such as information architecture.

It is important to remember the value of "ah-ha" moments for instructors and professionals, too. Transformative learning is part of the lifelong professional and personal discovery that energizes how we approach instructional and research topics as scholars and practitioners. Our own ah-ha moments should never be taken for granted, as even the most seasoned among us can--and should--have their minds officially blown every so often.

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