12. Fostering Information Literacy Through Autonomy and Guidance in the Inquiry and Maker Learning Environments

KYUNGWON KOH, XUN GE, KATHRYN ROOTS LEWIS, SHIRLEY SIMMONS, AND LEE NELSON

Abstract: The study investigates high school students' information practices and educators' guidance during inquiry and maker learning. Self-determination theory and imposed query offer theoretical lenses in exploring students' information practices in the learning environments that support learners' choices and interests within the standards-based curriculums. Students engaged in a variety of information behaviors, such as information seeking, use, evaluating, creating, and sharing. Information searching and credibility judgment were some of the most challenging but helpful activities for students to complete their projects. Students enjoyed production-centered activities. When given a wide range of options for information creation in the maker unit, students seemed to be both excited and overwhelmed. Educators offered different strategies to scaffold students' information practices and learning, striving to achieve a balance between providing guidance and allowing student autonomy and choice. Overall, students were appreciative and found the guidance beneficial, yet they felt some guidelines were restrictive. The study suggests educators be intentional in providing guidance that is flexible and not too restricted or controlled. The ongoing research investigates the optimal environments for learners to exercise autonomy over their information practices and learning while feeling supported and guided.

Introduction

Connected learning is learning in an age of abundant access to information and social connection, combining personal interests, supportive relationships, and real-world opportunity (Connected Learning Alliance, 2019). In this learner-centered approach, students frequently seek information in the area of their interest and construct meaning, rather than passively receiving information from teachers or textbooks. Therefore, the authors suggest, to succeed in the connected learning environment learners must be information literate—that is, be able to recognize when information is needed, and to find, evaluate, and use the needed information effectively (Association of College and Research Libraries [ACRL], 1989). Further, one of the core properties of connected learning is production-centered activities (Digital Media and Learning Research Hub, 2013); accordingly, learners—the creators of knowledge—must be able to produce information in critical, creative, effective, and ethical manners (Koh, 2013).

There is a dearth of research that investigates learners' information literacy and information practices in the context of connected learning, except for a couple of studies that explored information sharing in an online community (Martin, 2014) and information behavior in afterschool programs (Davis & Fullerton, 2016). We know little about information skills and practices that might affect students' connected learning experiences. To fill this gap, the study explored high school students' information practices in inquiry- and maker-based units. The overarching research questions are:

- What are high school students' information-related experiences during inquiry and maker learning?
- How do educators—school librarians and teachers—provide guidance to facilitate student information practices?

Ultimately, the study aims to inform educators (e.g., librarians, teachers, and administrators) how to best support student information practices and promote information literacy in the connected learning environment.

Theoretical Frameworks

Self-determination theory (SDT; Ryan & Deci, 2000) suggests the following three needs must be met in order for students to be intrinsically motivated: autonomy, competence, and relatedness. The concept of imposed query (Gross, 1995) indicates an information task in service to or on behalf of someone else, as opposed to information activities conducted voluntarily based on his/her own needs. In this study, SDT and imposed query offer theoretical lenses in exploring students' information practices in the learning environments that support learners' choices and interests, yet within the standards-based curriculums.

Review of Selected Literature: Information Literacy in Inquiry and Maker Learning

Research on information literacy in the K–12 inquiry-learning context revealed students' criteria for assessing information credibility, such as being current, topical, and easily verifiable elsewhere, as well as writing styles (Pickard, Shenton, & Johnson, 2014), reputations of the information source provider, comprehensibility, and completeness (Watson, 2014). A handful of studies focused on information literacy and information practices in the maker learning environment. Koh, Snead, and Lu (2019) found information played an integral role when high school students engaged in creative production and learning in a maker class; students identified information as help, challenge, how they learn, and learning outcomes. Meyer and Fourie (2018) studied third-year college students' information behavior and suggested information resources stimulated creativity for architecture projects. The same researchers conducted a thematic analysis of literature and suggested information behavior studies can inform the design of creative workspaces, such as makerspaces (Meyer & Fourie, 2017). Li and Todd (2016) investigated young people's information practices in a public library makerspace and found that youth sought information and help from interpersonal resources as well as through trial and error. Lofton (2017) proposed that maker programs can play a vital role in promoting student information literacy.

Research Design

The study presented in this paper is part of a three-year design-based research project that investigates inquiry and maker learning in formal school curricula (Koh et al., 2018). The study was conducted in two 10th-grade classes in Pre-AP English Language Arts II in a public high school in a suburban community in the South-Central region of the United States. In Spring 2018, each class implemented two inquiry units on social justice (Unit 1) and culture and world literature (Unit 2). The curriculum standards for the units included research skills—for example, data collection, finding credible sources, citing sources, using and synthesizing information, and constructing their own arguments. Both classes implemented two different inquiry approaches: guided inquiry design (GID) and GID integrated with maker learning (GIDM). GID is a specific type of inquiry-learning framework for pre-K–12 curricula. In GID, students select, formulate, and pursue their own inquiry questions within the subject curriculum, and educators use scaffolding strategies and tools, such as inquiry journals, logs, and one-on-one conferencing, to guide student inquiry learning (Kuhlthau, Maniotes, & Caspari, 2015). The GID framework presents eight sequential, yet flexible and iterative phases: *open, immerse, explore, identify, gather, create, share,* and *evaluate.* While all units were centered around the phases of the GID process, in the GIDM units (inquiry-based maker units) educators experimented with the integration of maker

mindsets and processes into the inquiry instructions. Two English teachers and two school librarians collaborated to implement the units. The project team members—consisting of school administrators, university researchers and their graduate assistants, and a grant manager—provided professional development on inquiry and maker learning, as well as technical, instructional, and organizational assistance.

In the social justice units, each student researched a social justice issue that he or she deeply cared about and aimed to provide possible solutions to address the problem. In the culture and world literature unit, students read a literature piece of their choice set in a different part of the world and conducted research on the culture depicted in the literature. Students constructed a research question, conducted research, and created final products. Students in the two groups (GID or GIDM) created different types of final products to address their inquiry question and demonstrate learning. GID-group students were assigned an essay and annotated bibliography, while GIDM students created a variety of projects of their choice, including 3D objects, fiction and nonfiction pieces, pictures, videos, music, and more. Each class had between 30 and 35 students. Fifteen students from Teacher A's class and 16 students from Teacher B's class agreed to participate in this study by submitting both parent consent and student assent forms.

	Teacher A	Teacher B
Unit 1: Social Justice	GIDM	GID
Unit 2: Culture & World Literature	GID	GIDM

Table 1. Units.

The data collection methods included: eight student group interviews, one group interview for two teachers, one group interview for two school librarians, participation observation and field notes, and artifact analysis of teaching materials. Qualitative analysis of data from the multiple sources was conducted (Miles & Huberman, 1994) using Dedoose, a web-based qualitative data analysis software.

Findings

Information Literacy Guidance in the Inquiry and Maker Units

Active information seeking, use, and creation occurred throughout the inquiry process in both GID and GIDM units, as students formulated an inquiry question, conducted research to answer the question, and produced a product to demonstrate their learning. The team of educators—school librarians and English teachers—provided a range of guidance, including library database instructions, one-on-one conferencing, maker technology instructions, and various classroom prompts. In the beginning of the unit, the classes met in the school library, and two high school librarians provided overviews and tutorials on information resources over multiple days. The instructions covered library materials and databases (e.g., library online catalog, reference books, encyclopedias, CQ Researcher, EBSCO, Gale, and more), along with information credibility judgment, such as the CRAP test (current, reliable, accurate, and purpose). All students had one-on-one conferencing with a teacher or a librarian at least twice during the unit, including when they formulated an inquiry question and when they collected information sources and drafted a prototype product.

The teachers used several prompts to guide students' information practices throughout the unit. The opening prompt included: "During the research process, you will construct a research question, complete academic research using reliable internet sources and academic texts, and create an annotated bibliography." Students were asked to collect a

certain number of pieces of information from credible sources and cite them correctly in order to substantiate their arguments: "For each of your 6 pieces of evidence (quote, statistic, graph, picture), you must have a parenthetical (in-text) citation." The teachers provided guidance and reminders regarding information seeking and information-credibility evaluation, such as: "Verify the source and context"; "Be aware of politically framed content"; "Make sure you address the counterargument and a solution at some point in your essay"; "Choose a source you found yesterday and check to make sure it passes the CRAP test"; "Don't get most of your news from social media websites"; "Is the source credible? Why or why not?"; and "Do you feel confident that the information you've collected will properly answer your research question? Why or why not?" One of the major assignments in all units was the inquiry log (Figure 1)—a resource students were asked to use "to keep track of your sources, compile your facts/quotes, and reflect on how you could potentially use the source."
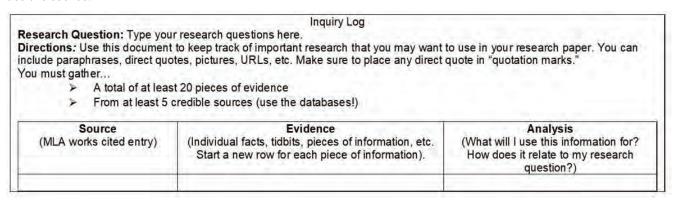
Inquiry Log		

Research Question: Type your research questions here.
 Directions: Use this document to keep track of important research that you may want to use in your research paper. You can include paraphrases, direct quotes, pictures, URLs, etc. Make sure to place any direct quote in "quotation marks."
 You must gather…
    ➢   A total of at least 20 pieces of evidence
    ➢ From at least 5 credible sources (use the databases!)		

Source (MLA works cited entry)	**Evidence** (Individual facts, tidbits, pieces of information, etc. Start a new row for each piece of information).	**Analysis** (What will I use this information for? How does it relate to my research question?)

Figure 1. Inquiry log template.

Beyond information seeking, the educators offered guidance on information organization, creation, and sharing and presenting. After students collected information sources that might potentially answer their inquiry question, the teachers encouraged students to think about "how to answer our research questions and how best to organize our ideas and evidence." Students were asked to write in their inquiry journal about: "(1) How could I share the information I have found in a more direct/concrete way? What is a product I could create that would demonstrate my knowledge this way? (2) How could I share my information in a metaphorical way? What is a product I could create that would represent what I have learned?"

Students in GID and GIDM units synthesized their research in different ways. In GID units, each student wrote a "research paper that defines the problem and poses a possible solution to address the problem," while GIDM-unit students created "a product using the Makerspace tools that illustrates the problem and poses a possible solution to address the problem." In the beginning of the GIDM unit, librarians presented the concept of making and different types of tools for maker projects in order to help students start brainstorming and determine how to present information and knowledge they obtain beyond a text-based product such as an essay. Educators provided feedback on student choice of type of maker project through one-on-one conferencing.

Imposed Information Tasks: Information Search and Credibility Judgment

The major information search task in both GID and GIDM units was finding at least 15–20 pieces of evidence (20 pieces in Unit 1: Social Justice; 15 pieces in Unit 2: Culture and World Literature) from at least five credible sources using the library databases. Students recorded information they gathered in the inquiry log. Several students in both GID and GIDM units mentioned that the inquiry logs were helpful and they would use the log again in future research projects.

Students from GID units said: "That [the inquiry log] was helpful a lot with keeping track [of] what you found so far and how it related to it"; "The inquiry log [was helpful], because I won't be really organized on my own, so it was good to have it in small steps that gradually grew to the final paper. ... I feel like it made me write better." Students from GIDM units concurred: "I realized once I went back in there [inquiry log], all the information I need for my project was already there. And all I had to do was putting it in my video and then I would be done." Some students recognized that the practice of gathering information and documenting in the inquiry log was demanding, but helpful: "It [inquiry log] was not fun to complete, but it was necessary for most projects"; "the inquiry guide [log] was really hard and it was really tedious but it was ... it kind of helped." Students also said they improved their information literacy skills over the semester: "I feel like I learned a lot during this process ... it [the research process] helped me expand the vocabulary that I was using throughout the whole process, because you couldn't just search for the same keywords in every single article. ... I feel like I am much more confident with my ability to go and find credible information that is applicable to the topics that I am researching."

Data from multiple sources—student interviews, educator interviews, and field observations, however, revealed that one of the most difficult tasks for students in the inquiry and maker processes was finding credible information relevant to their inquiry questions. Students said it was challenging to find "right information," "solid evidence," or "reliable sources on my topic." In general, two types of parameters were imposed to guide student information tasks: the number and the type of information sources to be included in their inquiry log. Students mentioned that meeting the parameter on the specific number of the required information resources (15 or 20 pieces) was somewhat daunting, although the teachers allowed a little bit of leeway. A student from the GID unit said: "Whenever I write a paper, whenever I research stuff, my issue is I don't need to find 15 different pieces from articles." A student from a GIDM unit said: "The only thing that was an issue about the project was the inquiry log; it was really large information quota to reach ... that was a little bit difficult, because ... it was forcing me out of the targeted space that I was really looking for, like the specific examples, and making me kind of get broader with the topic."

The educators encouraged students to use credible, academic sources instead of general Internet or social media sources. Librarians found it frustrating when students turned to nonlibrary resources just because looking online is less work than using academic resources: "That's really frustrating to me as a librarian, because (a) we spend a lot of money on [purchasing] resources, especially for social justice, we have so much money over the last five or six years, and (b), we spent a lot of time showing them how to use these databases and working with them." Teachers also promoted the use of academic databases during class discussions: "Why do you think academic databases (a collection of information that includes access to academic journals) tend to be more credible for research than a standard Google search?" ... "These databases contain scholarly and peer-reviewed articles written by credible authors, such as journalists, researchers, and experts in their fields."

A student from GIDM who found library databases useful recounted: "A lot of the school databases gave us a lot of opportunities just because when I was looking through... even if I only found one quote from it, it gave me a bit of a way to start to crawl off to a different subject and pick up a lot more information." A few students, however, mentioned difficulty finding information from library databases on their topics: "It was actually rather hard gathering for sure because our teacher even had us use specific sites at first and some of those sites just did not have anything at all for me. ... We were supposed to find some from like books and I just couldn't find anything because for some reason whatever I searched just nothing showed up that was like with the topic." Other students mentioned times they did not use information pieces that looked relevant to their inquiry question because of the low credibility of the sources, especially sources from social media: "It [information source for the project] was supposed to be credible. ... I did find this really great ... paragraph talking about this stuff but whenever I looked over it again, I was like, oh my gosh this is Twitter. I was like well, what you going to do ..."; "I was trying to understand emotional [aspects of abortion] ... it was kind of hard. I couldn't use these different blogs and some people went anonymously so I couldn't cite them in using them because it could be a 60-year-old man sitting at a computer [pretending to be a female who experienced abortion]"; "I found the blogs like little snippets ... but it can literally be anyone on the other side of the screen."

Some students actually used library resources to avoid information-credibility evaluation. Students mentioned in the interviews: "I feel like that [using library resources] was helpful just because sometimes I am not very good judging if it's a reliable source or not so I just chose the library sources"; "I was just with the school databases because I didn't want to branch out and find stuff that you know ... just in case it wasn't credible. I'd be paranoid with whether it was [credible] or not so I just focused on school databases." The researcher field notes captured a class conversation in which a student raised a question on why they still have to prove the credibility of sources if sources are coming from the high school library: "One of the kids asks why they need to question the credibility of sources found through the library, if the library sources have been vetted by public school employees who are technically government employees."

Information-Creating Behavior: Imposed Type (Essay) Versus Open Choice (Making)

As explained earlier, the teachers allowed students in the GIDM units to create a maker product of the student's choice, while GID students were assigned to write an essay. This production stage—called the *create* phase—was the students' favorite phase by far in both units. Students reported they felt a sense of accomplishment when they were able to take everything they had researched and put it all together in their product: "Whenever it's created it's not only are you done but you just have this piece that you made yourself and it's just really good, feels good. Especially if you know you feel confident in the materials you gather and everything matches up. I love that feeling."; "[My favorite phase was] create—just making the final argument, really. And making everything come together nicely."

During the interviews, a slightly higher number of students from the GID units reported they enjoyed the create phase than those from the GIDM units. A few students said writing is their preferred activity over making other projects. Writing an essay seemed a more familiar and well-defined task for the students, compared to a maker project that offered a range of options and might have caused anxiety and uncertainty for some students. Students who preferred the create phase in GID over GIDM said: "[Compared to GIDM] it [the GID unit] had a lot more structure and it was more straightforward, and it was in a way easier to do because you didn't have to think of a project [referring to a maker project]; you didn't have to be creative"; "I enjoy writing papers more than I like making videos [in the GIDM unit] ... it [the GID unit] was really well-defined. There was a lot less freedom to it—a lot of freedom with choosing our topics but a lot less freedom in writing. And I don't think that's a bad thing when you're restrained ... it kept us from getting off on other things."

Students who reported they enjoyed create in GIDM mentioned: "I feel like with doing this [maker] project I was more excited to come to class. You know, when we're writing an essay I'm like, 'We're just gathering information or we're doing a rough draft,' but when I was doing this project I was more excited to use my hands and be able to actually create something in class"; "[My favorite phase was] the create—the part where we actually started to put our hands on and start making something out of the information that we had"; "I looked at how to create a unique product that was outside of standard like essay style. ... Being able to create a video just allowed me to look at something and think and feel a little bit differently." Educators' feedback on the maker project was crucial to inspire students to stretch their potential. A student said: "I was pushed out of my comfort zone just a little bit by our teacher, because I was just going to do something really easy at first ... and she [the teacher] pushed me towards this software called Adobe Spark which is used for video editing, and it just really, really came to me because I got to implement music and information and I got to talk and do all of that and that was really kind of something I am comfortable with." Students appreciated teachers and librarians who encouraged them to try to create information in a new way and expand their talent.

On the other hand, teachers suggested it seemed harder for students to demonstrate their information-synthesizing skills in the making units: "It felt like there was, at least with my kiddos, less synthesizing of information with the making project because they tended to lean towards one article, one source. That is all they needed for their project, and I don't know how else I could have facilitated or changed the assignment up to what I had. I forced them to include multiple

sources." Teachers also discussed the standards and assessment issues for the GIDM units: "We spent so much time on the making unit ... in terms of critical thinking, problem solving, those skills, I think they [students] really benefit from [the maker approach]. But in terms of some of those standards [on research skills]–synthesizing information and communicating your knowledge–I didn't see that, and I don't even know how to assess for that, besides having a one-on-one conversation or making them write something, and I'm very curious how much they learned in this [maker] unit in terms of their research, versus the paper where it kinds of forced them to make maybe a bit more to research."

Discussion and Conclusion

Students exhibited a range of information behavior during inquiry and maker learning. Information searching and information-credibility judgment were the major challenges that students experienced, and were, at the same time, some of the most helpful activities for students to complete their research and making. Beyond information search and use, students further engaged in information-creating activities in different formats. Educators strived to find a fine balance between providing guidance (e.g., clear instructions, templates, and boundaries) and allowing student autonomy and choice. Students were appreciative and found the guidance helpful, though they felt some guidelines were restrictive (e.g., the parameters on the number and types of information sources). When they were given a range of options for information creation in the maker unit, students seemed to be both excited and somewhat overwhelmed and needed guidance. Students tended to be more familiar with synthesizing and producing information in a text format rather than other formats, such as audio, video, demonstration, or other artistic or technical forms. The study suggests it is important for educators in the connected learning environment to provide appropriate scaffolding and facilitation, which are different from direct instruction or giving students direct answers. To promote students' autonomous learning and information practices in schools, guidance must be flexible and not too restrictive or controlled. When a parameter is given, educators can help students see the rationales behind the boundary and allow adaptations to each individual's own learning and situation.

The study established the critical role of educators' scaffolding in guiding students' information practices in a holistic cycle–while identifying information needs, searching, using, evaluating, creating, and sharing information. Students in this study were honing their information literacy skills and greatly benefited from effective scaffolding strategies, such as detailed prompts, inquiry logs, and one-on-one conferencing. One of the most unexpected consequences when teaching students to use credible resources in this study was that some students used the library databases to avoid information-credibility judgment. Along with providing vetted resources curated by information professionals, educators must prepare students for the real-world information environment, in which students need to use critical-thinking skills to judge information encountered in their everyday lives, whether it is from blogs, social media, or other people. Findings also suggest a need for students to increase their ability to identify and create an appropriate form of information that best conveys its meaning, including nontext-based forms of information. The ongoing research investigates the optimal approaches and environments for learners to exercise autonomy over their information practices and learning while feeling supported and guided.

References

Association of College and Research Libraries (ACRL). (1989). *Presidential committee on information literacy: Final report.* Retrieved from http://www.ala.org/acrl/publications/whitepapers/presidential

Connected Learning Alliance. (2019). Connected learning. Retrieved February 26, 2019, from https://clalliance.org/about-connected-learning/

Davis, K., & Fullerton, S. (2016). Connected learning in and after school: Exploring technology's role in the learning experiences of diverse high school students. *Information Society*, 32(2), 98–116. https://doi.org/10.1080/01972243.2016.1130498

Digital Media and Learning Research Hub. (2013). *Connected learning: An agenda for research and design*. Retrieved from http://dmlhub.net/publications/connected-learning-agenda-research-and-design

Gross, M. (1995). The imposed query. RQ, 35(2), 236–243.

Koh, K. (2013). Adolescents' information-creating behavior embedded in digital media practice using Scratch. *Journal of the American Society for Information Science and Technology*, 64(9), 1826–1841. https://doi.org/10.1002/asi.22878

Koh, K., Ge, X., Lewis, K. R., Simmons, S., Nelson, L., & Doucette-Frederickson, J. (2018). When inquiry meets making: Demystifying inquiry-based making using guided inquiry design. In *Proceedings of the 2018 Connected Learning Summit* (p. 351). Retrieved from https://connectedlearningsummit.org/cls2018/proceedings/

Koh, K., Snead, J. T., & Lu, K. (2019). The processes of maker learning and information behavior in a technology-rich high school class. *The Journal of the Association for Information Science and Technology*, 70(12), 1395–1412. DOI:10.1002/asi.24197

Kuhlthau, C. C., Maniotes, L. K., & Caspari, A. K. (2015). *Guided inquiry design: Learning in the 21st century* (2nd ed.). Westport, CN: Libraries Unlimited.

Li, X., & Todd, R. J. (2016). Information practices of young people at a public library makerspace – A sense-making approach. *Proceedings of the Annual Conference of CAIS / Actes Du Congrès Annuel de l'ACSI*. Retrieved from https://journals.library.ualberta.ca/ojs.cais-acsi.ca/index.php/cais-asci/article/view/946

Lofton, J. (2017). Students are makers! Building information literacy skills through makerspace programs. *CSLA Journal*, 40(2), 18–16.

Martin, C. (2014). Information sharing, connected learning, and a professional wrestling fan community. *Proceedings of the ASIST Annual Meeting*, 51(1). https://doi.org/10.1002/meet.2014.14505101148

Meyer, A., & Fourie, I. (2017). Thematic analysis of the value of Kuhlthau's work for the investigation of information behaviour in creative workspaces in academic libraries. *Information Research*, 22(1). Retrieved from http://www.informationr.net/ir/22-1/isic/isic1626.html

Meyer, A., & Fourie, I. (2018). Information behaviour of architecture students in creative design projects. A*slib Journal of Information Management*, 70(4), 414–433. https://doi.org/10.1108/AJIM-02-2018-0030

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage.

Pickard, A. J., Shenton, A. K., & Johnson, A. (2014). Young people and the evaluation of information on the World Wide Web: Principles, practice and beliefs. *Journal of Librarianship and Information Science*, 46(1), 3–20. https://doi.org/10.1177/0961000612467813

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78.

Watson, C. (2014). An exploratory study of secondary students' judgments of the relevance and reliability of information. *Journal of the Association for Information Science & Technology*, 65(7), 1385–1408. https://doi.org/10.1002/asi.23067