The Processes of Maker Learning and Information Behavior In a Technology-Rich High School Class (Pre-publication Copy)

Koh, K.; Snead, J.T.; & Lu, K. (In Press). The processes of maker learning and information behavior in a technology-rich high school class. *Journal of the Association for Information Science and Technology.*

Abstract

This mixed-method study investigated the processes of making and information behavior as integrated in self-directed learning in a high school maker class. Twenty students engaged in making projects of their choice with low- and high-technologies for fifteen weeks. Data collection included visual process mapping activities, surveys, and Dervin's Sense-Making Methodology-informed interviews. Findings included inspirations, actions, emotions, challenges, helps, and learning that occurred during the making processes. Information played an integral role as students engaged in creative production and learning. Students identified information as helps, challenges, how they learn, and learning outcomes. The study proposes a new, evolving process model of making that illustrates production-centered information behavior and learning. The model's spiral form emphasizes the non-linear and cyclical nature of the making process. Squiggly lines represent how the making process is gap-filled and uncertain. The study contributes to the scholarly and professional fields of information science, library and information studies, maker, and STEAM (Science, Technology, Engineering, Art, and Math) learning.

Introduction

Information behavior (IB)—a person's cognitive, physical, and affective engagement in information—is an integral part of our lives. The scholarly field of IB investigates how people interact with information and informs the development and provision of relevant information systems, services, and environments (Case & Given, 2016; Fisher, Erdelez, & McKechnie, 2005; Savolainen, 2008). IB research produces people-centered and process-oriented knowledge on how people recognize information needs and seek, use, share, and create information in different contexts. IB research on contemporary youth (ages 0-18 years), who are born into this technology-rich society, is particularly significant because their IB reflects the changes in the

contemporary information environment most explicitly. Youth preferences and approaches to information are shaping the future of the information world.

IB is seamlessly embedded in different aspects of youth lives, including learning (Beheshti & Large, 2013). Despite the growing interest in the intersection between information and learning, few studies explain the role of information in technology-rich, student-centered learning, such as maker learning. Maker learning, also called maker-centered learning (Clapp, Ross, Ryan, & Tishman, 2017) or learning by/through making (Willett, 2017), is a type of learner-centered, hands-on learning that stems from the pedagogical traditions of constructivism (Piaget, 1972 & Vygotsky, 1978), constructionism (Papert, 1993), experiential learning (Kolb, 2015), and community of practice (Lave & Wenger, 1991; Wenger, 1998). Maker learning refers to learning as a process, creating artifacts that are personally meaningful and contribute to a community.

Maker learning has become prevalent with a growth of the maker movement—a community of people who engage in creating, designing, tinkering, and sharing projects with low- and high-fabrication technologies (Maker Ed, 2018). The maker movement is increasingly widespread in libraries, museums, schools, and other organizations across the world, offering a dedicated space for creation called makerspaces, or maker programs that promote production-centered experiences. Besides access to tools and technologies, makerspaces provide a diversity of learning opportunities, from structured workshops to informal mentoring to drop-in or mobile tinkering activities to intrapersonal or collaborative projects (Bowler & Champagne, 2016; Moorefield-Lang, 2015; Sheridan et al., 2014). Yet, little research illuminates the processes of making and IB embedded over the course of maker learning.

This article presents the results of a mixed-methods study in a high school maker class. The goal is (1) to investigate the processes of maker learning and IB and (2) to propose a model of making processes that deepens the knowledge on production-centered IB, integrated with maker learning. The research questions include:

1. What are the processes and patterns of maker learning by high school students?
2. What challenges do students face?
3. What facilitates students' maker learning?
4. What are the roles information plays in maker learning?

Existing Models and Theories

This section presents a brief review of selected models and theories relevant to the processes of information behavior [IB], production-centered learning, and making.

Information Behavior Models

Information process models that are particularly relevant to youth and learning include Information Search Process (ISP), BIG 6, and iLearn. Kuhlthau's (2004) ISP (Figure 1) explains people's thoughts, actions, and feelings while they conduct research projects. ISP suggests people progress through seven sequential but iterative stages, including Initiation, Selection, Exploration, Formulation, Collection, Presentation, and Assessment. Based on the ISP model, Kuhlthau, Maniotes, and Caspari (2012) developed the Guided Inquiry Design (GID) (Figure 2), a framework for designing inquiry instructions for school curriculums. The GID process includes eight phases—Open, Immerse, Explore, Identify, Gather, Create, Share, and Evaluate. The Big 6 model (Lowe & Eisenberg, 2005), on the other hand, is a six-stage model that guides students' problem solving and inquiry processes (Figures 3). The stages include: Task Definition, Information Seeking Strategies, Location and Access, Use of Information, Synthesis, and Evaluation. Additionally, the iLearn model (Neuman, 2011) directly focuses on learning with information and includes six stages: Identify, Locate, Evaluate, Apply, Reflect, and Know (Figure 4). These models present identifiable stages for information seeking and inquiry.

Figure 1: Information Search Process[1]

	Initiation	Selection	Exploration	Formulation	Collection	Presentation	Assessment
Feelings (Affective)	Uncertainty	Optimism	Confusion Frustration Doubt	Clarity	Sense of direction / Confidence	Satisfaction or Disappointment	Sense of accomplish-ment
Thoughts (Cognitive)	Vague →			Focused →		Increased interest	Increased self-awareness
Actions (Physical)	Seeking	Relevant Exploring	Information →	Seeking	Pertinent Documenting	Information	

Figure 1: ISP (Kuhlthau, 2012).

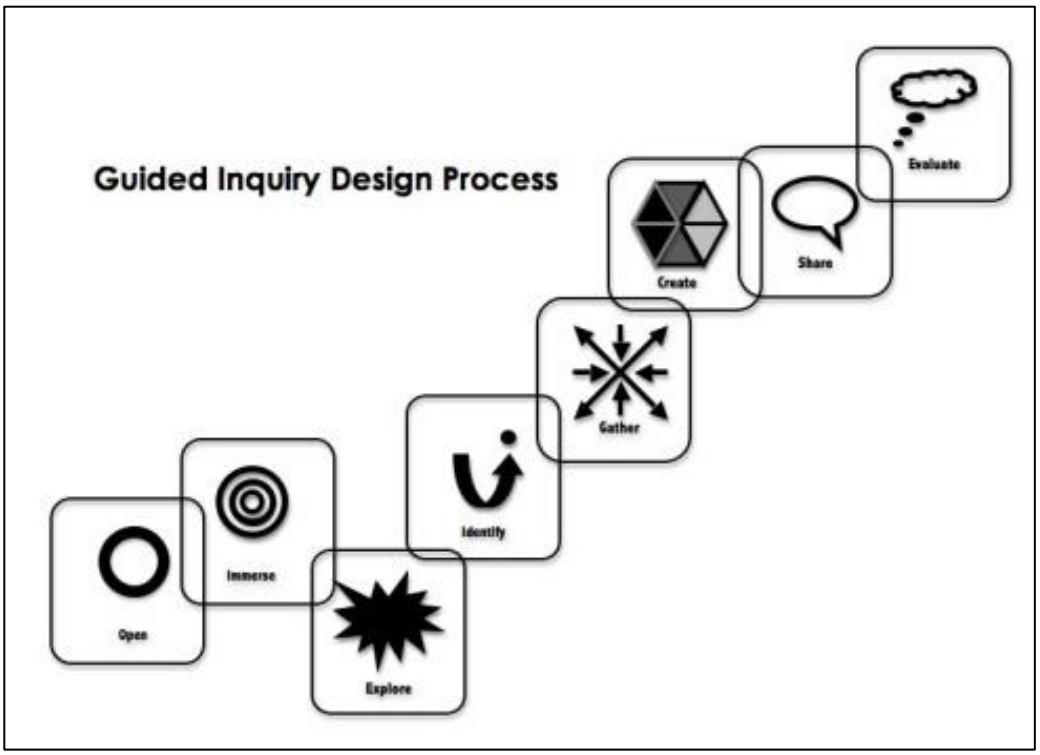
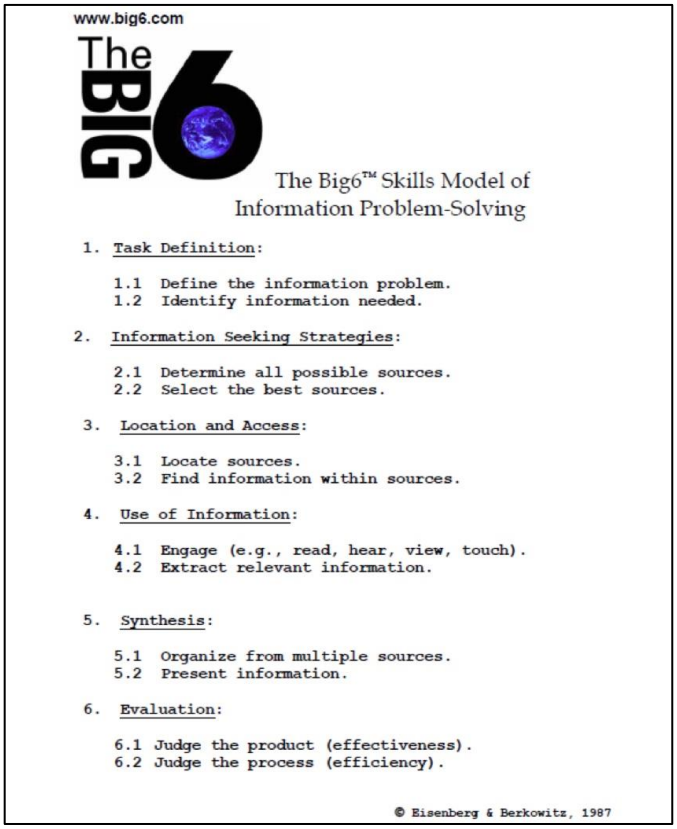


Figure 2: GID (Kuhlthau, Maniotes, and Caspari, 2012, pp. 2).


www.big6.com

The BIG 6

The Big6™ Skills Model of Information Problem-Solving

1. Task Definition:
   - 1.1 Define the information problem.
   - 1.2 Identify information needed.
2. Information Seeking Strategies:
   - 2.1 Determine all possible sources.
   - 2.2 Select the best sources.
3. Location and Access:
   - 3.1 Locate sources.
   - 3.2 Find information within sources.
4. Use of Information:
   - 4.1 Engage (e.g., read, hear, view, touch).
   - 4.2 Extract relevant information.
5. Synthesis:
   - 5.1 Organize from multiple sources.
   - 5.2 Present information.
6. Evaluation:
   - 6.1 Judge the product (effectiveness).
   - 6.2 Judge the process (efficiency).

© Eisenberg & Berkowitz, 1987

Figure 3: BIG6 (Lowe & Eisenberg, 2005, p. 65).

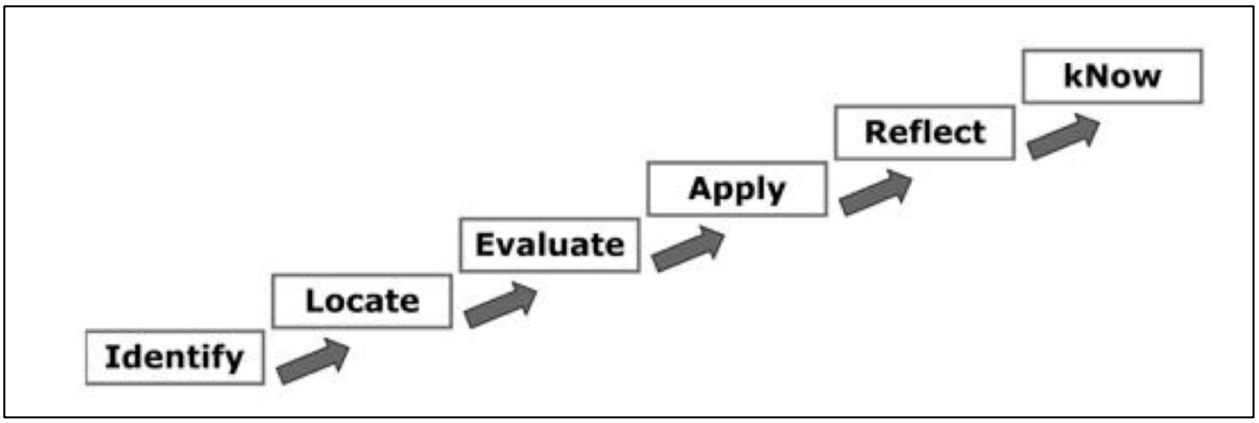


Figure 4: iLearn, (Neuman, 2011, p. 3).

Yet, Koh (2013) asserts IB models and theories must advance knowledge on how people create information further in this era of participatory culture (Jenkins, 2006) or the maker culture (Martinez & Stager, 2013), in which people are information creators beyond users and consumers. Koh proposes the concept of information-creating behavior (ICB), defined as "the way people create messages, cues, and informative content that can be used to meet the existing or potential information needs of the creator or other users" (p. 1827). Understanding ICB is significant for designing information services and systems that support people who are knowledge producers. More research is needed to explain the ways different types of IB (e.g., information seeking, using, managing, and sharing) interplay when people create information, as well as the role technology plays in information creation (Koh, Oh, Agarwal, & Belkin, 2015).

Learning with Digital Media

A cross-disciplinary body of research on digital media and learning explains how contemporary youth learn with technologies. HOMAGO, which stands for hanging out, messing around, and geeking out, describes different degrees of youth engagement in digital media (Ito et al., 2010). Hanging out describes friendship-driven practices in which teens use technologies to stay connected with friends. Messing around represents a more intense engagement with technology, such as looking around online, experimentation, and play. Geeking out refers to a serious and frequent commitment to media with a highly specialized expertise. Transitioning between hanging out, messing around, and geeking out can be either a liner or nonlinear progression. Ito et al. (2010) suggest teens "often move fluidly back and forth between these genres" (p. 254).

Connected learning is learning that occurs when youth pursue their own interests, have social support from peers and supportive adults, and link their interest to academic achievement,

career possibilities, or civic engagement (Digital Media and Learning [DML] Research Hub, 2013). Core properties of connected learning include opportunities for production, shared purposes across ages and cultural boundaries, and an openly networked environment. Connected learning is production-centered learning "that comes from actively creating, making, producing, experimenting, remixing, decoding, performing, and designing" (DML Research Hub, 2013, p. 75). Since their inception, the HOMAGO and connected learning frameworks have proven to be useful in libraries, museums, and other youth-serving organizations to engage youth in creative, social, and learning opportunities (Braun, Hartman, Hughes-Hassell, & Kumasi, 2014).

Making and Designing

The uTEC model conceptualizes learning in makerspaces in four stages: Using, Tinkering, Experimenting, and Creating (Figure 5). The model posits that individuals begin at one broad stage (using), proceed to tinkering (making changes to existing objects), then experimenting, which requires more trial and error, and finally creating, such as inventing a novel product.

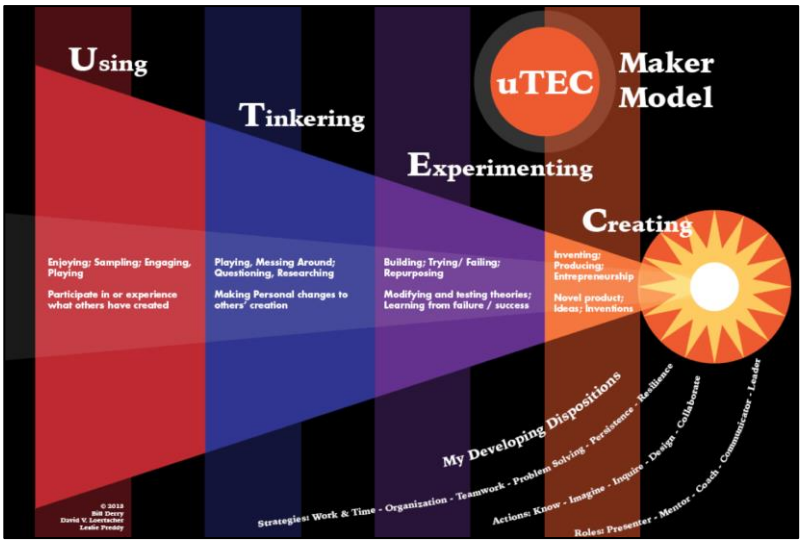


Figure 5: uTec (Loertscher, Preddy, & Derry, 2013).

Museums have developed maker learning models. Learning Practices of Making, developed at the Children's Museum of Pittsburg's MAKESHOP, serves as observable behaviors of learners. The learning practices include: inquire, tinker, seek & share resources, hack & repurpose, express intention, develop fluency, and simplify to complexity (Wardrip, Brahms, Reich, & Carrigan, 2017). Dimensions of Learning and Facilitate Moves is a framework developed at the Exploratorium Tinkering Studio to explain learning-through-tinkering (Gutwill,

Hido, & Sindorf, 2015). The four dimensions of learning include: engagement, initiative and intentionality, social scaffolding, and development of understanding. Professionals can promote these learning dimensions through three facilitators: sparking interest, sustaining participation, and deepening understanding.

Finally, Design Thinking is an approach to and/or process of problem solving through empathizing with others, generating ideas, rapid prototyping, testing, and iterating. Design Thinking processes are, in practice, cyclical, ambiguous, and complex (Tran, 2017). Design Thinking was originally developed in the design field, and it has spread to different areas, including education and librarianship (IDEO, 2013, 2014).

The presented study aims to extend the current knowledge across the disciplines. The study intends to fill the gap in the existing information behavior models and theories and further explain information-creating behavior, beyond information seeking and use. The study also attempts to contribute to the cross-disciplinary field of digital media, learning, making, and design by explicating the role of information in self-directed and production-centered learning.