information: interactions and impact

Abstract Submission Form

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Submission Details

Title of Abstract	Getting Unstuck: Information Problem Solving in High School STEM Students and Evidence of Metacognitive Knowledge	
Type of Submission (please select ONE):	Full Paper	X
	Short Paper	
	Round Table Discussion	
Themes (please select all that apply):	Information Literacies	X
	Information Behaviour	X
	Impact	X
	Information as agent of change	
	Methodological Paper	

Abstract (Please check Call for Papers for requirements):	

Aim and Introduction

This presentation reports the initial findings from an ongoing empirical study which aims to evaluate how students seek, use, and think about information when they encounter problems in the design, construction, and delivery of digital technology projects. It explores how a Science, Technology, Engineering, and Mathematics (STEM) curriculum, centred on improvisational problem solving, may have implications for student metacognitive knowledge development, and whether that development is evidenced in student information behaviour.

Context and Rationale

Greatly expanded access to information and digital technologies in formal and informal learning environments over the past twenty years has equipped students and educators with new curricular pathways focused on making, tinkering, and engineering (Gutwill *et al*. 2015; Katterfeldt *et al*. 2015; Martin 2015; Martinez, S.L. & Stager 2013). Rooted in the active pedagogy of Froebel (1887), Dewey (1944), Piaget (1950), and most recently Papert (1980), these programs infuse project-based, interest-driven learning with creative technology, asking students to use computing tools like computer-aided design (CAD) software to learn STEM subjects in a practical context (Sheridan *et al*. 2014). Iterative design methodologies prompt students to actively seek and utilise new information in open-ended problem spaces to complete projects requiring deft navigation of dense information environments in a way that has potential to develop students into critical-thinking, self-aware, independent learners (Johri & Olds 2014). More insight into the information behaviour and information literacy outcomes of these types of programs is needed to better understand how educators can optimise curricula and improve access to relevant information sources. There is also a need for more research prioritising the learning experience and information interactions involved over the technology itself, and in a classroom as well as informal settings (Papavlasopoulou *et al.* 2016).

There is potential for educators and instructors in technology-infused classrooms to benefit from this work, as a better understanding of how students interact with information, and how this process of development works in creative STEM contexts will enable them to design scaffolding and/or interventions that support interactions with information objects and improve access to relevant sources.

Methodology

This study examined students' metacognitive knowledge of how they seek and use information during problem solving in a technology-infused learning environment. It applied an interpretivist, inductive case study approach to gather qualitative data from students by observation, interview and weekly online questioning about their experience and behaviour.

The case study was conducted in a high school "Tech" classroom (students age 16-18) at the Manufacturing Technology Academy (MTA) in Traverse City, MI. The STEM-rich curriculum at the MTA centres on student-led robotics engineering projects, requiring months of research, iterative design, and complex problem solving. Fifty-three students work in teams throughout the academic year to design, construct, and compete with their robots in the spring. Online questionnaire data collection has been ongoing since January 2017, and two weeks of classroom observation and semi-structured interviews took place in March 2017. Field notes, audio recordings, and interviews were coded using NVIVO 11.

For an interpretive framework, the study applies a modified version of Kuhlthau's (1988) information search process model (ISP) that considers metacognitive information search behaviours such as those defined by Bowler (2010), i.e. balancing and scaffolding, as evidence of deep, critical thinking that enables students to become independent learners. With this framework, student approaches to information problem solving are explored when they become "stuck" designing artefacts with digital technologies such as 3D design and 3D printing. The results from Bowler demonstrate promise for this subject but her focus

was on students writing a historical research paper, a content area wholly different from STEM design and engineering.

Findings

Initial conclusions are that a number of students demonstrate many of Bowler's (2010) categories of metacognitive knowledge, including changing direction, knowing strengths and weaknesses, and understanding time and effort. Grappling with challenges in their robotics projects, these students exhibit habits and perceptions of information seeking that demonstrate metacognitive ways of thinking about their own abilities in relation to difficult tasks. Their questionnaire and interview responses evidence critical thinking about how to strategize, adapt to novel situations, perceive risk appropriately, persist through difficulty, react to failure productively, and determine efficient and appropriate methods of information seeking. Prior experience and practical ideas are highly sought after in their information searches, and while they rely on their peers and instructors for immediate help and feedback, they prioritise YouTube videos as the primary resource to teach themselves new skills or to generate ideas for their robot designs.

The open-ended nature of the robotics engineering and design problems prompts students to be creative about what information resources will move them closer to a solution. MTA students constantly weigh the value of information from 'traditional' sources, e.g. online search tools and other people, versus information that comes from first-hand sensory feedback, e.g. learning that a bigger hammer is required after failing with a smaller one. Students synthesise both types of information to solve problems. The following factors have emerged as influencing MTA student decisions to use traditional vs hands-on information seeking methods:

- Perceived availability of expertise.
- Perceived distance to the solution.
- Perceived effort level required.
- Perceived risk involved (sub-factors: physical danger, material-risk, time-risk).
- Physical vs. digital nature of the problem.
- Preference for hands-on vs non-hands on learning.
- Prior knowledge.
- Propensity to develop proficiency.

Conclusions and further work

Although educators are increasingly embracing STEM content and constructionist learning curricula, the relationship between information behaviour and effective problem solving in this type of information environment has not yet received much attention. This research addresses this gap and has identified factors influencing students' information choices. It is envisaged that further work with students at MTA and in UK-based case studies will inform the development of a model of information behaviour in a creative STEM context that will be used to develop a tool to support information decision making during the making process.

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Additional Information:	**Keywords** Computer aided design, Constructionism, Information behaviour, Maker, Metacognition, Problem solving, Robotics education, STEM, Tinkering **Presentation/paper type** Case study First author: Richter, T. Co-authors: Muir, L., Flint, T., Hall, H., Smith, C.

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