Access, Skill, Policy, and Motivation: A Synthesis and Research Agenda for School Librarianship and STEM Digital Learning Resources

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August 9, 2014

Abstract

Numerous policymakers have called for K-12 educators to transform science, technology, engineering, and mathematics (STEM) teaching and learning with digital resources. School librarians may be omitted from these calls, but nonetheless perform much of the implementation work. In this study, we outline the significance of pressing issues in K-12 and apply the Quadratic Usage Framework (QUF) to a qualitative synthesis of published research. Preliminary results suggest that issues relating to access, skill, policy, and motivation clearly emerge from the literature corpus and that resource curation, information seeking, educational data mining, and learning personalization provide promising areas for school librarianship research.

Keywords: K-12, science, technology, engineering, mathematics, learning resources, digital, school librarianship, educational informatics

Acknowledgement: This research was supported, in part, by NSF grants 1044315 and 1449622.

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Access, Skill, Policy, and Motivation: A Synthesis and Research Agenda for K-12 Science, Technology, Engineering, and Mathematics Digital Learning Resources

Effective learning experiences center on two variables: high quality resources and high quality pedagogy (Maull, Saldivar, & Sumner, 2011); deeply intertwined, neither alone is sufficient to improve student achievement (Morris & Hiebert, 2011). Good educational resources in K-12 education are so necessary that the ability to locate instructional information has been found to be a significant driver of teacher retention and confidence in integrating learning resources is considered a proxy measure of educator effectiveness (Arslan, 2010; Chingos & Whitehurst, 2012).

While improving teaching quality would seem to be an obvious way to improve learning quality, the role of improving access to digital instructional resources cannot be understated. The number of teachers who resist digital instructional material is dwindling (Project Tomorrow, 2010). Studies have shown that most K-12 teachers use digital media in instruction, with most teachers reporting that they daily use the Internet for digital media such as games, activities, lesson plans and simulations (PBS & Grunwald Associates, 2011). The common standards movement, e.g., the Common Core State Standards, promotes digital resource use as a way of establishing a common resource base (Chingos & Whitehurst, 2012; National Science Digital Library [NSDL], 2013)

Calling upon extensive education and information science research and policy of the preceding decade, in this paper, we provide an overview of key issues that justify more exploration of K-12 science, technology, engineering, and mathematics (STEM) digital resource use; a synthesis the current research relevant to those key issues; and conclude with directions for school librarianship research.

Research Questions

RQ1. What are the major issues surrounding digital learning resources?

RQ2. What opportunities do these issues create for school librarianship research?

Literature Foundation

Two imperatives drive this investigation.

Studying K-12 Technology-Mediated Change is Important

Sustained educational change is strongly linked to technology adoption and integration. In an analysis spanning more than a decade of technology integration studies, Hew and Brush (2007) identified barriers that include: insufficient supply and support for resources, institutional barriers (such as poor leadership and support), teacher attitudes and beliefs about technology, lack of technology knowledge and skills, and tensions between perceived outcomes and technology integration efforts. Until these barriers are understood and addressed, any technology-mediated change is unlikely to have a demonstrable effect on student learning (Boston Consulting Group, 2013).

Studying STEM Digital Learning Resources is Important

The US Department of Education is urging school administrators to focus on two main reform issues: STEM and digital textbooks. Policymakers have noted that "the world today's students will inherit will be one defined to an even greater degree by science and technology…[m]astery of mathematics, science, and technology is no longer only for future scientists and engineers; it is essential preparation for all students" (U.S. Department of Education, 2010, p. 1). Promoting district and state level adoption of collections of high quality, interactive digital multimedia STEM learning content, i.e., "digital textbooks" has been at the fore of federal STEM education initiatives (Digital Textbook Collaborative, 2012; U.S. Department of Education, 2012).

Literature Synthesis Method

We used a qualitative research synthesis method for this review because our objectives were both descriptive and critical (i.e., appraising fit between article content, research questions, and the conceptual framework), rather than meta-analytic (e.g., calculating an average effect size) (Sandelowski & Barroso, 2007). This method informed our data collection and analysis.

Data Collection

In spring 2015, we conducted an advanced boolean keyword search of OneSearch, a Florida State University Libraries' research literature search tool:

("digital resource" OR "digital learning resource*" OR "electronic resource*") AND (instruction* or education*) AND ((elementary OR secondary* OR "K-12" OR "middle school" OR "high school")) AND (science OR math* OR engineering OR technology)*

We selected OneSearch because it executes federated and faceted searches of literature contained in all FSU databases, library catalogs, and the open web. From the 2306 results, we manually selected articles based on these a priori criteria:

1. Studies with direct relevance to digital learning resources in K-12 STEM education;
2. Studies published between 2000 and 2014. The National Science Foundation's NSDL was founded in 2000 and is recognized as the major source of K-12 STEM digital learning content in the United States. The evolution of the study of STEM digital learning resources can be anchored to this point of departure (Mardis & Howe, 2010);
3. Studies conducted within the United States and abroad, but limited to those published in English and focusing on settings where English is the main medium used in the digital learning resource;
4. Studies focusing on digital learning resources at the elementary and secondary levels, i.e., K-12, formal schooling. Studies involving post-secondary, adult learners, or informal learning contexts were not included;
5. Empirical studies from different methodological traditions including: experimental and quasi-experimental studies; correlational studies; surveys; descriptive studies; interpretative, ethnographic, qualitative, or case studies; and impact studies of large-scale intervention projects; and
6. Literature reviews and conceptual pieces.

We did not specify a priori exclusion criteria in the search statement, but manually eliminated any results that did not fit the above criteria. Our final search result included 486 articles.

Data Analysis

From those 486 articles, we appraised, selected, and abstracted articles in a three step process. First, each researcher reviewed articles for fit with the conceptual framework and wrote narrative synopses. Second, the completed synopses were integrated for narrative presentation.

Third, for analysis, we applied the Quadratic Usage Framework (QUF) proposed by Mardis, Hoffman, and Marshall (2008) based on the work of Marshall (2005). First developed to articulate "digital divides," or barriers, in technology integration, this framework provides a useful grouping of issues that may pertain to digital learning resource use. The framework's four quadrants include:

Access: factors related to access to, or functionality of, the artifact itself.

Skill: competency-related factors that affect the individual's skills, education, knowledge, and experience with and about technology.

Policy: values as reflected in policy structures. Policy matters include impinging factors from the external environment encompassing historic practices, organizational settings, institutional policies, as well as cultural norms and values.

Motivation: preferences, beliefs, traditions, and trust that are linked to the individual user's motivation and choice to use technology (Mardis et al., 2008)

In all, we will synthesize 173 resources for the proposed report.

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