Educational Technology in Top-Tier Science Education Research: A Literature Review

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Abstract

Access, implementation, and teacher attitudes about technology in the classroom have increased in recent years. While numerous reports (Purcell, Heaps, Buchanan, & Friedrich, 2013; CompTIA, n.d.; Schacter, 1999) cite the impact of technology broadly, there are limited reports dedicated to exploring the impact of technology implementation in science courses. This review examines the technology tools implemented in formal and informal K-12 science settings published in top-tier science journals from 2010 to 2016. Findings include the most commonly studied technology tools in physical science, life science, and earth/space science disciplines, as well as their reported impacts on student achievement, dispositions, and student-teacher interactions. While challenges are evident, technology integration in the teaching and learning of science across disciplines has made many significant positive impacts.

- *97% of teachers reported having access to a computer in the classroom on a daily basis (2010)*
- *40% of teachers indicated they used the computers often in classroom instruction*
  - *Plan and share lessons*
  - *Interact with parents*
  - *Assign e-book readings to students*
  - *Student collaboration on assignments*
  - *Participate in online discussion boards*

Introduction

Supporters of educational technology argue that technology plays a significant role in the teaching and learning of science (NSTA, 1999). The goal of science teaching and learning is to "produce individuals capable of understanding and evaluating information that is, or purports to be, scientific in nature and of making decisions that incorporate that information appropriately, and, furthermore, to produce a sufficient number and diversity of skilled and motivated future scientists, engineers, and other science-based professionals" (Committee on Science Learning, 2007, p. 34). According to science education scholars, "the impact of digital technologies on science teacher education is more pervasive than any curricular or instructional innovation in the past" (Flick & Bell, 2000). But, just how effective is this implementation? What evidence from empirical studies document the impact of educational technology in science instruction? In particular, what can we learn about educational technology from science education literature?

The purpose of this paper is to review current literature on the implementation of educational technology in the science classroom in order to (1) identify the technologies utilized in K-12 (formal and informal) science classrooms among empirical studies published in top science education journals and to (2) describe how the aforementioned studies contribute to the field of knowledge of educational technology in science education with a particular focus on student achievement and learning of scientific concepts. Lastly, this paper addresses the implications of technology use in the classroom for urban students learning science and provides recommendations for further research.

Overview of Review Process

To select articles for this literature review, a search of the ERIC database was conducted via EBSCO Host for articles published from 2010 through the first quarter of 2016 in top tier science education journals, according to SCImago Journal Rankings. As a result, the search was narrowed to the following journals: Journal of Research in Science Teaching, Science Education, Journal of Science Teacher Education, International Journal of Science Education, Studies in Science Education, Research in Science Education, and Journal of Science Education and Technology. In an effort to identify articles related to educational technology in science education, several key terms and phrases were used ("technology uses in education", "educational technology" and "technology integration"). The original search results returned 154 articles. Of the 154 articles, an initial review of the title, abstract, and keywords of each article was performed to eliminate studies that: (1) did not explicitly focus on any level of K-12 education, (2) were not empirical studies, and (3) focused primarily on teacher professional development or pre-service teaching.

Table 1. Journal Distribution of Final Literature Review Pool .

	# of Articles
Journal of Research in Science Teaching	5
Science Education	3
Journal of Science Teacher Education	0
International Journal of Science Education	4
Studies in Science Education	0
Research in Science Education	1
Journal of Science Education and Technology	19

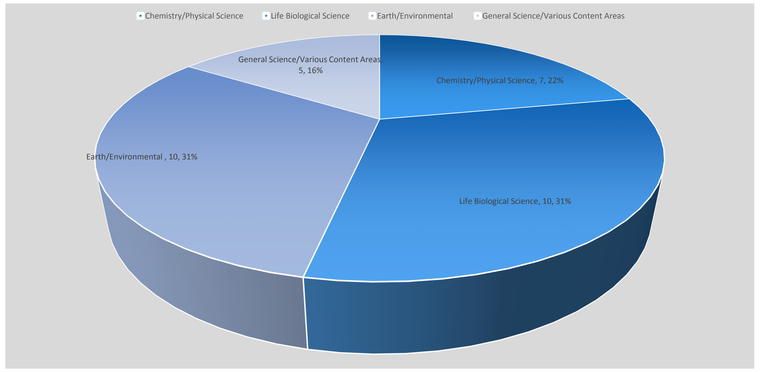

Figure 1. Representation of Science Content Area

Findings

- Technology tools researched are unique to the disciplines.
  - Life Science Technology: Online Discussion Boards, Games, Simulations, Remote scanning microscopy
  - Earth Space Science Technology: GIT Tools, Video Cases, VoiceThread®, Online Research
  - Physical Science Technology, Probeware, Simulations
- Students have benefited from the experience (achievement, attitudes, interests, perceptions).
- Teachers could use technology to save time for class discussions of data, leading to deeper learning.
- Implementation of technology does not lead to deeper learning.
- Technology integration in science may be difficult to implement with less experienced teachers and students.
- Teachers should expect "growing" pains with new tools.
- Students do not always have positive dispositions. Students have cited feelings of frustration, distraction, and confusion when it comes to using technology tools
- While most studies included detailed methodologies of the studies conducted, only some studies described the demographics of their participant pool.

Conclusions

- The representation of literature is found to be consistent with teacher use, at this point in time.
- While the research reviewed in this paper mirrors the frequency of practice, there were a number of top-tier journals with little to no representation.
- In the studies reviewed, technology integration has positively affected student behaviors, including perceptions about science, motivation, and engagement across several studies. However, the results were not as positive when considering student achievement, especially student achievement of low-achieving students (Chao et al., 2016; Kluge, 2014; Williams et al., 2012).
- Technology alone is insufficient to make positive change without effective pedagogical implementation. Students require proper instruction and pedagogical approach beyond the tool to engage in deeper learning. This approach has been longed argued by TPACK theorists (Koehler & Mishra, 2009) and has implications for future practice, including the need to professionally develop teachers to use technology in the most effective implementation.

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