BYU McKay School
INSTRUCTIONAL PSYCHOLOGY
& TECHNOLOGY

Educational Technology

A History of Research Trends from 1970 to 2020

Abigail Boekweg, Hannah Call, Dillon Craw, Faith Jennings, Julie Irvine, & Royce Kimmons

Educational Technology | Teaching Strategies | Instructional Strategies | New Media

Our goal in this chapter is to explore the history of educational technology research by identifying research trends across the past 50 years. We surveyed 20 representative research papers from each decade ranging from 1970 to 2020. We used bibliometric data to select these representative papers and then qualitatively analyzed and manually coded them. We found that while the particular technologies investigated consistently changed, research generally progressed from addressing theoretical difficulties to determining the affordances of instructional technologies and finally to studying pedagogical strategies. We saw this trend on a macro level, occurring over 50 years. These findings imply that educational technology research (a) is iterative, beginning with the adoption of new technologies by practitioners; (b) relies on determining the effectiveness of instructional technologies; and (c) ultimately investigates teaching strategies related to technology.

Educational technology gradually changed from clay tablets to chalkboards and eventually to Chromebooks. Somewhere in that timeline, the study of educational technology became a formal field of research. Of the 13 journals used in this study, the earliest volume was published in 1953 (though for the 13 journals, the mean first publication year was 1986). This indicates that the field of educational technology research as we know it is less than a century old. Our goal in this chapter is to sketch much of the history of this field by exploring 50 years of educational technology research, from 1970 to 2020.

We have identified the prominent research themes of each decade and discussed how the field has progressed over a 50 year period. To capture a snapshot of each decade, we examined the 20 most cited articles from each ten-year period in order to discover what research made a significant impact through citation counts in each decade. The articles were sourced from 13 educational technology journals. We used bibliometrics to identify these journals and

select articles from each. After identifying the 20 articles for each decade, we manually coded and compared the articles in order to understand research trends. Once each decade was individually coded to reveal the prominent themes, all of our findings were then synthesized to show the overarching patterns and trends in educational technology research over a 50-year period.

Details about our methodology can be found in the “Methodology” chapter of this book. More information about the 13 journals we pulled articles from can be found in the appendix of this chapter.

Literature Review

Many bibliometric studies have been done in the field of educational technology. Most of these studies synthesize research over a short period of time and on a narrow subset of educational technology research. However, our study is not unique in its attempt to analyze research trends over a span of 50 years.

One paper that could be compared to ours is by Bond et al. (2019) in which they analyzed 1,777 articles published in the British Journal of Educational Technology (BJET). Bond et al. also considered 50 years of educational technology research, used a combination of computer analysis and human analysis, analyzed research trends, and organized findings by decade. The study was limited in the following three ways: (a) it considered only articles published in BJET, (b) it did not consider the impact factor of individual articles, and (c) its content analysis favored some decades (especially recent decades) more than others (see Table 1).

Table 1

Publications per Decade in BJET

Decade	Number of Publications
1970s	202
1980s	184
1990s	177
2000s	502
2010s	712

In light of these limitations, our study is needed because (a) it considers a much wider range of journals, (b) it considers only highly cited articles, and (c) it gives equal weight to each decade. Our study produces a holistic picture of how educational technology research has progressed from decade to decade.

In another study similar to ours, Chen et al. (2020) gave a bibliometric review of the topical trends of every article published in BJET during its 50 year lifetime. Our review is, coincidentally, different in ways that were recommended by Chen et al. They suggested that “further investigations may consider extending the analysis and including comparable journals such as Computers & Education in the research area" (Chen et al., 2020). We included 13 journals from the field of educational technology, including Computers & Education. Chen et al. (2020) also recommended that in order to achieve the depth possible through manual coding, future researchers should “survey representative papers, from a qualitative perspective, so as to provide more profound and fine-grained understanding of the domain of educational technology" (Chen et al., 2020, p. 707). We used bibliometrics to select the most cited articles, and then we did qualitative analyses of those articles.

Our findings corroborate many of Chen et al.’s (2020) findings. For instance, a table compiling the most common keywords in the articles Chen et al. analyzed showed a growing diversity in research vocabulary. This was noticeable in our study as well, with the later decades using new keywords and terminology related to emerging technology and

advancing theories. Another overlap is visible in the topics that became more popular over time. Blended learning, mobile learning, and game-based learning were common topics in our findings and Chen et al.'s.

These studies demonstrate the work that has been performed in educational technology research, which supports and overlaps in some instances with our current study. However, we also see gaps that were not previously addressed in these studies, such as analyzing a wide range of journals, focusing on highly cited articles, and equally examining every decade of research. It is our purpose to account for the previous limitations by presenting a broad, encompassing analysis of 50 years in research.

1970s: The Introduction of Visual Communication Media

Many of the technologies taken for granted today were in their infancy in the 1970s. During that time, researchers strove to understand the efficacy and uses of technologies like television and similar visual communication media (graphic displays, picture books, etc.). Research surrounding different instructional methods and theories also abounded as researchers sought to establish the best paradigms to use for education practitioners. The field of educational technology was young but rapidly growing.

Visual Communication Media

The majority of research throughout the 1970s sought to understand the role and appropriate uses of visual communication media in education. Researchers recognized the potential of visual communication media to supplement, support, or possibly replace written and oral presentation of information. Haring et al. (1979) examined how pictures affect childrens' comprehension of written text and found that pictures aiding written text do help with recall of main themes in the written text. Haring et al.'s findings were consistent with Levin et al.'s (1978) major literature review, which emphatically supported the general use of visual communication media to improve learning in children. However, Salomon et al.'s (1972) work was ambiguous about the potential beneficial effect of visual communication media on learning.

While most of the research of the decade supported the use of visual communication media, the need to distinguish which types of visual communication media were most effective for which purposes remained. The research of Hsia et al. (1971) was pivotal in establishing that different types of media affect learners in different ways:

The central nervous system capacity is much less than the sum of [audio] and [visual] modality capacity; therefore, its saturation can be reached by either . . . modality. The very fact that information loss . . . occurs even in an ideal communication situation can be partly explained by the disparity between the capacities of the central nervous system and multimodality (p. 65).

The essence of this comment is that not all information can be absorbed. This is due in part to humans' limited capacity to process information and, in this case, information presented through visual communication media when combined with an auditory stimulus. In a similar vein, Allen et al.'s (1975) work highlighted the reality that more cognitively capable students were able to process more information through visual communication media and suggested that the media used in education be adapted to the cognitive capacities of individual students. Holliday et al. (1976) worked on finding more practical applications for practitioners seeking to use visual communication media effectively.

Through experimenting with multiple modes of visual communication media, Holliday and his colleagues (1976) found that single flow diagrams, or diagrams characterized by their linear and relatively simple flow were more effective than textual description alone, as well as more effective than a combination of diagram and text. He also found presenting big picture information in logical chains using picture word diagrams (PWD) and block word diagrams (BWD), rather than as separate unconnected ideas without diagrams, to be most effective. Dwyer et al. supported a similar idea that "the more realistic a presentation, the more effective the transmission of the desired message" (1970, p. 1). Taken together, these findings prepared the way for future practitioners and researchers alike. Though the role and appropriate

use of visual communication media was still unfolding to researchers, the question of how to use them effectively remained for decades.

Television

Closely related to the research of visual communication was the research surrounding television. The research of the decade on this topic was frequent and intense but not entirely concordant. Television and film were widely accepted as useful tools for transferring information, but researchers were eager to know if these technologies could be used for more substantial learning. For example, Salomon et al. (1972) explored television use in learning by attempting to use filming techniques to replace or supplant more traditional forms of communicating ideas, but their results were inconclusive. Other researchers were interested in whether some of the properties of television were damaging to young children, and they were reluctant to implement it in educational settings. However, Anderson et al. (1977) claimed in their work that there was no evidence that television was harmful to the attention spans of little children. On the contrary, researchers produced evidence that television was actually more effective for instruction than pictures aiding text alone (Spangenberg, 1973) and that some television programs were even effective in teaching children general cooperation and rule following skills (Paulson, 1974). While these findings seemed promising, there was a growing number of researchers who would claim that the positive effects of television and other media forms were not inherent to the technological tools but were actually benefits of the instructional philosophies behind the technological tools which were used in delivering the instruction. This debate grew in the years that followed.

Emerging Theories and Adaptation

Not all of the research of the 1970s was focused on the emerging technologies of the time. Researchers were also spending their efforts advancing their preferred educational theories and philosophies. While some educational theories had already taken root in many institutions, there were still many challenges to these established theories by the research of the time. Merrill et al. (1975) argued that current curriculum development models, though honorable improvements from the past, were insufficient and that curriculum development needed to be more adaptable to the needs of individual learners. Merrill and his colleagues also heavily criticized Cronbach and Snow's Aptitude Treatment Interaction (ATI) method, claiming that it "stops far short of desirable and possible procedures for adapting instruction to individual differences" (p. 4). At the heart of Merrill's alternative was the freedom and ability for learners to make decisions about their own learning so that their needs would be best met. This theoretical debate was one of many at the time. Mangan et al. (1978) urged practitioners to adapt their teaching to be more culturally aware of their learners, and Ausburn et al. (1978) presented evidence of the existence of at least 11 different learning styles. They claimed that while these learning styles did not determine aptitude, the styles should point the way to personalizing and adapting instruction to the needs of specific learners.

1980s: New Technologies and Old Debates

In the 1980s, research in the largely independent fields of education, technology, and psychology began to intersect. The rising interaction between these fields brought many challenges as the paradigms, theories, and interests of the researchers were often inharmonious. However, these challenges also proved useful by bringing attention and refinement to the field of educational technology.

New Media

Many new technologies emerged in the 1980s. Several of the developments at the time were new audiovisual materials, such as television and illustrative aids, but most notable among these technologies were the Walkman, the videocassette recorder, video game consoles, and the personal computer. Each of these unique technologies had been used by the U.S. military and other government organizations for educational purposes in decades past, and with the radical general change characteristic of the 1980s, these technologies were rapidly becoming more accessible to the private and education sectors. This availability meant more developments were on the horizon for the field of

educational technology. Researchers began avidly testing the utility of these potential learning tools and sought to give guidance for how they might best be used in learning across various institutions (Gagnon, 1985; Levie, 1982).

Determining the Role of Technology in Education

Of the many emerging technologies, researchers and practitioners were particularly eager to understand the possible role of computers in providing and assisting with classroom instruction. Consequently, this led to a surge in empirical studies examining the efficacy of computer assisted instruction or CAI (also often referred to as computer based instruction or CBI; Clark, 1985). What in years previous was a congenial discourse about the role of computers in education was becoming a much more heated debate as research findings boomed in support of and against the role and efficacy of CAI. This debate was certainly strengthened in part by one major literature review, which claimed that nearly all of the CAI-related empirical studies of the past, many of which attributed student achievement to CAI, were confounded for not controlling for instructional methods (Clark, 1985). The literature review made the claim that instructional methods, not the implementation of CAI, were responsible for disparities in student achievement (Clark, 1985). Similarly, Dalton et al. (1987) found that students receiving CAI underperformed when compared to their peers who received no CAI but worked in pairs.

Despite such claims against CAI, many of the researchers of the decade produced empirical evidence showing the significant benefits of CAI. Kinzie et al. found “a strong positive effect of computers on continuing motivation” (1989 p. 12), while Tennyson et al. (1980) showed how computers can aid and empower learners in taking control of meeting their own learning needs. This was similar to Dalton et al. (1987), who claimed that computers aid instructors and practitioners in providing personalized learning experiences to students. Yet the research of the decade continued to be rife with conflicting opinions as researchers sought to understand and define the role of technology, specifically computers, in education.

Applying Technology Through Behaviorism and Cognitivism

Behaviorism was a dominant theory used in instructional design models during the 1980s. Because of this, researchers noticed some of the drawbacks of the behaviorists’ theoretical approach and called for more methodologies to be applied to instructional design, namely cognitivism (Clark 1985). Hannafin et al. (1989) were adamant about the benefits of allowing room for multiple psychological theories to guide instructional designers in meeting the needs of students and stated the following:

The differences between behavioral and cognitive strategies involve more than mere semantics. Considerable research exists suggesting qualitative and quantitative differences in learning might result from each. The issue is not which models are best, but which design decisions are most appropriate given the demands of the learning tasks (p. 98).

Studies from the decade show that researchers began designing to test the uses of cognitive theory in educational technology (Butterfield, 1989; Clark, 1985). Clark et al.’s (1985) article showed that instructional designs using a behaviorist approach were most effective in promoting short term memory of declarative or factual information as well as procedural tasks, while instruction designed using a cognitivist approach was more effective in promoting long term memory and the ability to creatively apply learned concepts in multiple new contexts. Butterfield et al. (1989) were also strong proponents of using cognitive theory to improve instructional methods and outcomes. These findings precisely supported the work and comments from Hannafin et al. and advanced the ongoing discussion about how differing psychological theories could be applied in educational technology.

Naturalism Versus Rationalism

Throughout the decade, researchers also questioned the utility of different paradigms and modes of inquiry for research in the field of education and technology. At the forefront of this debate were the naturalistic and rational modes of inquiry. Rationalistic inquiry, often referred to as rationalistic research or scientific inquiry, is a mode of inquiry that relies heavily on reason and experimentation as the path to a true understanding of the world. It also claims that all events in the world have a cause and effect or that the world is deterministic. Rationalistic inquiry is almost always carried out

with quantitative research methods, and it had been the dominant mode of scientific research for the past century and a half (Guba, 1982). In contrast, naturalistic inquiry, often referred to as naturalistic observation, is a mode of inquiry that relies primarily on observation of the natural world without any attempt to manipulate that which is being observed. Naturalistic inquiry is most often associated with qualitative methods of research.

Despite the dominance of rationalistic inquiry, researchers of the decade had little trouble finding fault with this mode of inquiry. For example, much of the criticism was reflected by Guba et al.'s (1982) statements about how "the rationalistic model is difficult to apply and results [are] used infrequently" as well as how "practitioners lack the insight and creativity to see how research results can be applied" (p. 235). These types of obstacles were particularly emphasized by proponents of naturalist inquiry who were hoping to broaden the field's tools of inquiry. Proponents of naturalistic inquiry were quick to defend the unique insights that this type of inquiry could produce, especially in light of rationalism's shortcomings, but the true challenge with accepting naturalism lay with its lack of clear, trustworthy criteria by which the findings from this mode of inquiry could be generalized to larger populations (Guba, 1981).

1990s: Technology and Theory

In the 1990s, the internet became a global, public network and grew from one site in 1991 to over three million sites in 1999. Yahoo, Amazon, and Google were founded. Web browsers, PalmPilots, and SMS text messaging were invented. Digital cameras and CDs became affordable. Notwithstanding these technological advancements, the 20 most cited articles of this decade were mainly concerned with deepening the theoretical foundations of the field rather than exploring new technology.

Of the 20 most cited articles from the 1990s, 17 were theoretical. The overrepresentation of theoretical papers in the 1990s may have been a response to the debates and conflicting findings of research from the 1980s. Some authors wrote about problems with existing theoretical frameworks and proposed new frameworks. Other authors explained and defended their theoretical bases in order to make more compelling arguments about the proper use, development, or evaluation of educational technology. The most cited article of the decade (Garrison et al., 1999) did both. Garrison et al. (1999) proposed a theoretical framework and argued that it was a proper template for evaluating the educational merits of computer conferencing.

Technology

Even though theory was making the biggest impact on the field, there were plenty of practical discussions about the use of technology in classrooms. Some of the articles indicated that not enough was being done to use and integrate technology in the classroom. For example, Ertmer (1999) stated that schools had done little to change in response to the affordability of computing power. However, other authors cautioned against over-enthusiasm for technology.

One of the major debates over technology during the 1990s occurred between Kozma and Clark. Their debate centered on the role of technology in fundamentally changing education. The debate also discussed whether changes in technology had a transformative effect on education or if changes in technology were merely improvements in efficiency. Kozma (1994) claimed there was an urgent need to understand the relationship between technology and learning to facilitate the integration of emerging technologies. He argued technology had the potential to significantly impact how students learn and construct knowledge. In contrast, Clark's (1994) response was while media is necessary to deliver instruction and can decrease the cost of doing so, media is never directly responsible for learning. He critiqued the emergence of unrestrained support for technology in the field, claiming technology does not fundamentally change learning. Clark also warned that researchers who indicate media is responsible for learning are likely misinterpreting their findings and are possibly laying a groundwork for inadvisable investments. This debate over the role of technology in education opened a discussion on technology integration that even affected other fields in education research.

Kozma and Clark's debate impacted other researchers as well. In an earlier article supporting Clark's argument, Johnstone (1991) argued that teachers' enthusiasm for new technologies for classroom demonstration (like ticker

tapes and the Wilson Cloud Chamber) were partly to blame for why science is difficult for students to learn. In support of Kozma's position, Jonassen and Rohrer-Murphy (1999) claim technology allowed us to accomplish innovations in areas like instructional design that would not have been possible without technology. This debate continued in succeeding research, it and posed questions that impacted the field of educational technology for many years.

Aside from debating the integration of technology in the classroom, researchers also discussed different types of commonly used technology. Computer technology was the most common, and video technology was the second most common. Authors would either talk about technology in broad terms ("computer technology," "media," etc.) or be very specific ("ASK Jasper," "GeometryTutor," etc.), rather than talking about established categories of technologies. Researchers in the 1990s employed a less stratified vocabulary for technology than we have today.

Discussion

Constructivism gained popularity in this decade. Prior to the 1990s, instructional systems technology (IST) scholars had been actively rejecting the behaviorist foundation of IST (Jonassen, 1991) and the field of instructional technology had become increasingly accepting of the constructivist philosophy of learning (Rieber, 1996). During the 1990s, activity theory was being used to realize constructivist practices (Jonassen & Rohrer-Murphy, 1999).

Among the articles we considered for this decade, there were 40 distinct keywords or key phrases, including "paradigm shift," "media theory," "theoretical underpinnings," "conceptual framework," and "early discussion." These key phrases point at the overrepresentation of theory in the 20 articles from the 1990s. Only three of the 20 articles in this decade were experimental (Mayer et al., 1995; Hill & Hannafin, 1997; and Byrne et al., 1999), and two of these were the least cited of the 20 (Mayer et al., 1995 and Byrne et al., 1999). Perhaps these three articles were early indicators of a shift to empirical research in the 2000s.

The 1990s were a formative time for educational technology research. Regarding the 1960s, Johnstone (1991) wrote "[they] made us stand back and ask serious questions about science, its concepts, its overarching theories and insights, its consequences, its issues and its place in education and in society in general" (p. 75). Something similar happened in the 1990s. During this time, researchers pondered the place of computer technology in education, what insights it could provide, and what theories could or should drive its development.

2000s: Students and Technology

At the beginning of the 21st century, expanding uses for technology were paralleled by a dramatic increase in access to technology. These twin advancements brought with them several research questions concerning learners of this new age—learners who had been surrounded by technology since childhood. New debates arose about this upcoming computer-literate generation (often referred to as "digital natives"), and a dialogue ensued concerning the needs of these new students, the technological advancements and proper ways to integrate unfamiliar resources in the classroom (Hew & Brush, 2006; Ertmer, 2005), and the underlying strategies to best help learners and teachers with emerging educational materials.

While the '90s gave us much research focused on the theoretical implications of educational technology, the 2000s showed a major jump to empirical studies and tests related to these questions. Several controlled experiments and randomized survey-based studies were at the forefront of the research. Of the top 20 articles analyzed for this period, 13 were empirical studies. The first seven articles of the decade—which span from 2000 to 2007—were either theoretical papers or literature reviews. The remainder of the articles—spanning only from 2008 to 2009—were all reports on empirical studies. This shows a major shift in the most common research strategies as well as a shift in which articles were most likely to be cited.

Looking at the common themes researchers of this decade focused on helped us identify the issues researchers were most concerned with and the state of technology in education during the 2000s. The most common research topic during the 2000s was "e-learning" with three articles using the term e-learning directly in the titles and five articles

listing the term as a keyword (Sun et al., 2008; Liaw, 2008; Park, 2009; Motiwalla, 2007; So & Brush, 2008). Other important topics researched in the 2000s were (a) blended learning, (b) mobile learning, gamification, and Facebook, and (c) pedagogy.

E-Learning

The first publication on e-learning we analyzed in this decade was a general analysis of e-learning participants and their course satisfaction (Sun et al., 2008). Those authors conducted an empirical study to discuss what created a satisfying e-learning environment and what influences contribute most to a learner's experience. The results of the study concluded that "learner anxiety toward technology is one of the biggest influencers in a learner's satisfaction" (2008, p. 1194).

The second article concerning e-learning similarly analyzed the overall learner satisfaction in online courses, but it also focused on the effectiveness of the course layout using the software Blackboard as an empirical case study (Liaw, 2008). In the third e-learning article, the discussion was more narrowed, focusing on the use of the Technology Acceptance Model (TAM) within an e-learning design (Park, 2009). TAM is a theoretical model used to explain user behavior in technology by analyzing the perceived usefulness and perceived ease-of-use, which are believed to directly influence how the technology will then be used.

Blended Learning

Blended learning was another repeated topic. In 2004, Garrison and Hanuka defined blended learning as "thoughtful integration of classroom face-to-face learning experiences with online learning experiences," and argued that, "blended learning is consistent with the values of traditional higher education institutions and has the proven potential to enhance both the effectiveness and efficiency of meaningful learning experiences" (Garrison & Kanuka, 2004, p. 95).

Four years later, So and Brush (2008) investigated a more focused aspect of the topic: student interactions and relationships in a blended learning environment. In their study, they analyzed empirical research supporting the claim that student perceptions of collaborative learning have statistically positive relationships with perceptions of social presence and satisfaction.

Mobile Learning, Gamification, and Facebook

Three other topics that were repeated in the early 2000s were mobile learning, educational gaming, and Facebook. Two mobile learning articles were published in 2007 and 2009, the first presenting an evaluation of mobile learning in general (Motiwalla, 2007) and the second focusing on gender and age differences in mobile learning (Wang & Wu, 2009).

Gaming in education was addressed in two articles in this decade. Kiili's (2005) article, "Digital Game-Based Learning: Towards an Experiential Gaming Model," presented the "flow" theory model (Csikszentmihalyi, 1975) and argued that game learning creates an engaging environment for students to experience flow (e.g., highly absorbed or focused interest). Papastergiou's (2009) article, "Digital Game-Based Learning in High School Computer Science Education: Impact on Educational Effectiveness and Student Motivation," also centered on the effects of gaming in education. She analyzed the comparisons of students participating in game-based curricula as opposed to those who were not and found that the students in game-based learning exceeded the performance of those in the original format.

The last of these three topics, Facebook, was discussed in two separate articles that were both published in the same journal (Learning, Media and Technology) and on the same day in 2009. Selwyn's piece, "Faceworking: Exploring Students' Education-Related Use of Facebook," analyzed the use of Facebook among university students to determine if it was an asset or hindrance in education. The other article explored the social aspect of the platform to see how university students shared informal information related to their classes in an effort to connect socially with other students (Madge et al., 2009).

Pedagogy

The remainder of the articles in this decade dealt with pedagogical-related topics broadly in connection with technology. “Toward a Design Theory of Problem Solving” (Jonassen, 2000) articulated the need for a problem-based learning design in our school systems and only briefly mentioned technological devices students may encounter. As opposed to advocating for one learning model, Merrill (2002) presented several different models and discussed the underlying principles of pedagogy design that connected and supported them all. Ertmer (2005), as mentioned earlier, was concerned with the pedagogical beliefs of teachers in relation to their classroom practices, and she presented research which suggested many teachers have learning beliefs that are not carried out in practice. Two other articles explored the principles of learning design in a digital environment and discussed ways to enhance teaching with technology (Angeli & Valanides, 2009; Wang & Hannafin, 2005). Lastly, the ‘Digital Natives’ debate was discussed by Bennett et al. (2008) and Kennedy et al. (2008) as a means of addressing the learners of this generation. Both articles questioned the reality of this “new breed” of learners and argued that while learners of the generation were exposed to technology more than previous generations, they were not automatically experts and did not have different pedagogical needs than previous generations.

Reviewing the topics holistically, we see the themes of e-learning, blended learning, gaming, mobile learning, Facebook, and pedagogy leading the research of this decade. With many of the above examples, we can also notice a trend of initial research being more broad and encompassing in its scope, and later studies on the same topic being more narrow, focusing on a targeted aspect of the subject. For instance, the first e-learning article that was analyzed provided a broad study on e-learning satisfaction, while the later articles focused on specific software or a particular aspect of e-learning interaction.

Discussion

Both of the articles discussing Facebook conducted surveys and analyzed a large collection of Facebook posts to provide data for their research (Madge et al., 2009; Selwyn, 2009), while the mobile learning articles used similar methods of data collection (Motiwalla, 2007, & Wang & Wu, 2009). Several of the e-learning, blended learning, and pedagogy with technology articles were heavily based on surveys but also included face-to-face interviews (Garrison & Kanuka, 2004; So & Brush, 2008; Merrill, 2002; Park, 2009).

Research in the 2000s focused on advances in technology such as e-learning, Facebook, blended learning, digital native, learner satisfaction, TAM, environment, and technology integration. We can see that with growing technology, the diversity of models and platforms for how technology could be used in education rapidly expanded. The research of this decade rose to meet the developing questions by addressing these new and various topics, conducting empirical studies to assess tangible implications, and presenting ideas to help educators and researchers moving forward.

2010s: Mobility, Connectivity, and Flexibility

The already brisk pace of technological advances in the 2000s accelerated during the 2010s. At the beginning of the decade, only 20% of mobile phone users were on smartphones, or phones that could access the internet, but by 2019 that percentage had grown to 70% (Kremer, 2019). People grew comfortable using their mobile phones not only for entertainment but also for shopping, banking, social networking, and education. This integration of mobile technology into everyday life had an immense impact on educational technology.

More people using smartphones meant more people were playing mobile games, and this sector of the gaming industry grew rapidly. Educators and researchers began examining how incorporating game elements (i.e., gamification) into educational situations could impact learning. Along with gamification, educators were also interested in how to harness social networking and augmented reality to bolster learning. Besides being interested in educational technology itself, researchers were also curious about the ways technology could be utilized to improve the traditional classroom experience.

Out of the 20 most cited articles from this decade, 13 were literature reviews. The other main direction of inquiry during this decade was learning how specific technologies or interventions impacted education. Besides the 13 literature reviews, the remaining seven articles analyzed for this section were empirical studies focused on the impacts of specific technology-driven educational interventions.

Mobile Devices in Learning

As mobile devices became more widely used by the general populace, research involving mobile devices grew in popularity as well. Gikas and Grant (2013) examined the perspectives of these "new, 21st century" students regarding mobile devices and social media. They collected data by conducting focus groups of university students in the attempt to answer the question, "What are students' experiences when mobile computing devices are integrated into higher education courses?" (p. 18). They found that students' mobile device use often allowed them to access course content anywhere and empowered them to "captur[e] information outside of the learning environment and mak[e] connections with the material" (p. 24). This finding that "learning happens regardless of location" is one of the main findings of Gikas and Grant's study (p. 25).

Sung et al. also examined mobile technology's impact on learning in their 2016 article. They examined 110 journal articles that addressed the use of mobile devices in teaching and learning. Of the 110 articles, about 73% examined hand-held devices while approximately 22% studied laptop usage. The most popular learning stage to study was higher education (43 studies), followed by elementary schools (38 studies; p. 258). While the portability of hand-held devices may encourage their use in nontraditional settings, the classroom setting was the most studied with half of the examined studies focusing on it.

Social Media

In 2011, Junco et al. examined the effect of Twitter on the grades and learner engagement of college students. They found that "using Twitter in educationally relevant ways had a positive effect on student engagement" and a positive effect on grades (p. 128). The following year (2012), Junco published another paper on student engagement, this one focusing on how it was impacted by Facebook. Junco's Facebook study found that time spent on Facebook or engaged in Facebook activities yielded mixed results depending on the specific variable being considered (p. 170). Other researchers were also interested in Facebook's influence. Roblyer et al. (2010) surveyed both college students and faculty to compare usage and attitudes regarding Facebook and found that faculty and students did not use Facebook much for educational purposes (p. 138).

Another article we analyzed examined how social media can empower learners to customize their Personal Learning Environments (PLEs). In their 2012 article, Dabbagh and Kitsantas described how social media had enabled learners to "create, organize, and share content" by creating their own PLEs, which allowed them to curate and share content as they saw fit (p. 4). They cautioned that not all students possess the "knowledge management and the self-regulatory skills" needed to create the PLE they desire for their learning experience and advocated "teaching students to become effective self-regulated learners" so they will have the skills needed for "creating, managing, and sustaining PLEs using a variety of social media" (p. 7).

Understanding Teacher Attitudes

With social media and technology evolving so rapidly during the 2010s, Ertmer et al. (2012) sought to analyze the beliefs and practices of teachers as they related to technology and student-centered learning. They found that "in general, teachers were able to enact technology integration practices that closely aligned with their beliefs" (p. 432), which they saw as a change from Fang's 1996 research finding that while "teachers could articulate their beliefs, practices were influenced by 'classroom realities'" (p. 432). Ertmer et al. gave some possible reasons for teachers' new ability to align their technology practices with their beliefs: (a) increased student access to computers and online learning resources (i.e., Web 2.0), (b) increased teacher understanding of the "new, 21st century student," and (c) increased changes in curricular emphases (p. 432).

Others were also interested in teachers' adoption of technology in their classrooms. In their 2019 paper, Schere et al. attempted to use the TAM to explain and model teachers' adoption of digital technology. This interest in the TAM is a continuation from scholars' interest in the 2000s. Schere et al. explain the continued interest in the TAM thusly:

The TAM has gained considerable prominence, particularly due to its transferability to various contexts and samples, its potential to explain variance in the intention to use or the use of technology, and its simplicity of specification within structural equation modeling frameworks (p. 14).

Gamification

Along with mobile learning, another aspect of online learning that students grew more familiar with during the 2010s was gamification. Educators sought to harness their students' enthusiasm and familiarity with gaming by incorporating elements such as "the use of narratives to change the context around a typical activity, the creation of social competition, and the incentivizing of behavior through badge and reward systems" (Hanus & Fox, 2015, p. 152). During the 2010s, schools began to embrace elements of gamification, but clear evidence of which gamification elements had the most beneficial impact was lacking.

The obstacles to distilling learners' experiences into empirical data are reflected by the details of Connolly et al.'s (2012) systematic literature review of empirical evidence on computer games and serious games. Connolly et al. gathered 7,392 papers using key words such as "computer game," "video game," and "games-based learning." However, after applying criteria requiring papers to include "empirical evidence relating to the impacts and outcomes of playing games" they narrowed the list to 70 papers, less than 1% of the original list (p. 666). This meant less than 1% of the papers they initially gathered met their requirement for high quality empirical evidence.

In Connolly et al.'s opinion, "The most notable point about the current review was the diversity of research on positive impacts and outcomes associated with playing" (2012, p. 672). The 2010s saw a wider acceptance from the public of using games to improve learning outcomes. While puzzles and simulations were the most common types of games used in learning, Connelly et al. sought to "develop a better understanding of the tasks, activities, skills and operations that different kinds of games can offer and examine how these might match desired learning outcomes" (p. 672). According to our research, Connolly et al.'s review was the most cited article from the 2010s, with 1,270 total citations, and has become a touchstone for gamification research.

Acknowledging the continued interest in digital games, Boyle et al. revisited the topic in 2015 and updated Connolly et al.'s systematic literature review. Three of the scholars from the original Connolly et al. paper also contributed to the Boyle et al. update. For their updated review, they coded the reviewed papers by geographical location, and the wide distribution of papers showed that research on games was being conducted worldwide: United States (53), Europe (45), Asia (26), South America (5), and Australia (5; p. 181).

In their 2015 mapping study, Dicheva et al. searched the research for papers presenting empirical studies regarding gamification as used in education. According to them, "the most used gamification design principles in educational context are visual status, social engagement, freedom of choice, freedom to fail, and rapid feedback" (p. 79). Within the papers they analyzed, the most popular game mechanisms cited were points, badges, and leaderboards (p. 80).

This emphasis on elements designed to set learners apart from one another may be one of the most common elements of gamification within education. However, according to Hanus and Fox (2015), it may cause harm to learning outcomes (p. 159). Hanus and Fox's longitudinal study of student outcomes from a gamified course compared to a traditional course found that students in the gamified course decreased in satisfaction, motivation, and empowerment relative to the non-gamified course (p. 159). They suggested that "giving rewards in the form of badges and coins, as well as encouraging competition and social comparison via a digital leaderboard, harms motivation" (p. 159). Since their studied class was an elective, they assumed that students who took the class did so because they were at least somewhat interested in the material and suggested that "when a reward system is imposed on top of a class students already find interesting, it may feel constraining and forced" (p. 159).

While Hanus and Fox attributed negative impacts on motivation to certain gamification elements when the learner was already interested in the subject, they proposed that incentives could increase intrinsic motivation for boring tasks and so they viewed gamification as "a double-edged sword" (p. 160). Gamification could possibly help motivate learners regarding tasks they viewed as boring, but it also appeared to smother existing intrinsic motivation learners had for subjects that already interested them. Domìnguez et al. (2012) designed gamified alternatives to exercises in an existing course and students had the option of doing the traditional exercises or the gamified versions. They found that some students had mixed feelings about games, citing a "dislike and uneasiness created by the leaderboard and the feeling of competition among students" (p. 390). These findings supported the existing thought that while gamification could be a benefit in the classroom, there were certain significant drawbacks to its use.

Flipped Classrooms

Access to mobile devices or computers is essential for students to participate in "flipped classrooms," a model which grew in popularity during the 2010s. With flipped classrooms, what was "previously class content (teacher led instruction)" is replaced with "what was previously homework (assigned activities to complete) now taking place within the class" (O'Flaherty & Phillips, 2015, p. 85). This method of instruction emerged in the 2010s in response to increased access to technology and understanding of its benefits.

In their systematic review of literature pertaining to flipped classrooms, Akçayır and Akçayır (2018) found that the number of articles published on the topic steadily increased from one paper in 2012 to 32 papers in 2016, reflecting increased interest in the model by scholars (p. 337). One reason for this interest that O'Flaherty and Phillips (2015) suggested was "The flipped classroom foster[ed] student ownership of learning through the completion of preparatory work and being more interactive during actual class time" (p. 85).

Besides student ownership, other benefits of flipped classrooms scholars have found include "enhanced learning motivation and students' positive attitudes" (Akçayır & Akçayır, 2018, p. 343). However, questions remained about whether these benefits were due to active learning rather than the flipped model itself. As Akçayır and Akçayır (2018) asked, "if a researcher use[d] active learning strategies in a traditional course instead of flipping the classroom, would s/he gain the same positive academic outcomes?" (p. 343). They went on to posit that "if the answer is 'yes,' then maybe there is no need to devote considerable time to designing and implementing the flipped classroom (developing video lectures, quizzes, etc.) or to subjecting students to large changes in their instructional format" (p. 341). This study called into question the need for the widespread implementation of flipped classrooms and provided suggestions for research on active learning instead.

MOOCs

The term MOOC (Massive Open Online Courses) was described as "the educational buzzword of 2012" (Liyanagunawardena et al., 2013, p. 203). MOOCs are online courses that typically offer free enrollment. Jordan (2014) reported that a survey in February 2013 suggested that the average MOOC enrollment was 33,000 students with an average of 7.5% completing the course (p. 134). In her paper, Jordan gathered enrollment numbers and completion rates as they were available from public sources online.

According to Jordan's data, total enrollment in MOOCs decreased over time from October 2011 to July 2013 (p. 145). She also found a trend that enrollment in a MOOC increased as the course length in weeks increased (p. 146). However, as course length grew, a smaller proportion of students completed the longer courses (p. 148).

Augmented and Virtual Reality

In the 2010s, advances in augmented reality (AR) and virtual reality (VR) technology led to increased research interest in how AR and VR could be used in education. Wua et al. (2013) conducted a literature review which gathered and analyzed 54 articles dealing with AR in education. They argued that "viewing AR as a concept rather than a type of technology would be more fruitful for educators, researchers, and designers" (p. 42). While viewing AR as a concept, Wua et al. explored different ways AR could be used in instruction and issues that possibly impact such usage.

In a similar fashion, Dalgarno and Lee (2010) examined the learning affordances of 3-D virtual environments (VE). They suggested that "because 3-D technologies can provide levels of visual or sensory realism and interactivity consistent with the real world, ideas learnt within a 3-D VE should be more readily recalled and applied within the corresponding real environment" (p. 21). This was supported by Merchant et al.'s (2014) finding that "the effectiveness of games was the same whether students were assessed immediately or after the passage of time," which indicated to them that "students learning in games have retention level beyond short-term learning" (p. 36).

Discussion

The 2010s brought dramatic technological changes to societies and classrooms worldwide. The terrain of educational technology was shifting rapidly and many researchers sought to understand the new realities of classrooms on the ground. Researchers also sought to find their bearings and map which specific aspects of education technology had already been studied by their colleagues by conducting literature reviews. The 20 most cited articles from this decade revealed that researchers were especially interested in how learners were impacted by mobile learning, social media, gamification, MOOCs, and augmented and virtual reality. The articles analyzed for this section were primarily concerned with the following questions: (a) "How does the integration of mobile technology into everyday life impact educational technology?", (b) "In general, how can educational technology improve learning?", and (c) "How do specific technologies impact learning?" The rise of mobile devices and wider adoption of online learning enabled teachers and learners to experience new models of learning such as flipped classrooms and to envision more flexible learning environments.

2020 and Beyond

There are intrinsic constraints with discussing a decade while it is still in its infancy. We would argue that the period of scholarly discourse in educational technology that began in 2010 ends, not on December 31, 2019, but once the ramifications of the COVID-19 pandemic of 2020 became apparent. Many of these articles were written before the pandemic reached global proportions and they explored similar themes as those articles analyzed from the 2010s: (a) the use of gamification in education (Troussas et al., 2020; Zainuddin et al., 2020), (b) the impact of the flipped classroom model on students (Turan & Akdag-Cimen, 2020; Lo & Hew, 2020; Bond, 2020), (c) the application of virtual reality in education (Radianti et al., 2020), and (d) the adoption of new learning technologies (Liu et al, 2020). However, three of the articles from 2020 focused on the pandemic and its impact on the field of educational technology.

The abrupt shift to remote learning related to the COVID-19 pandemic strained the capacities of educators, schools, students, and families worldwide. Two of the articles in this section discuss impacts of the COVID-19 virus. The article by Almaiah et al. (2020) asked how regional e-learning systems were affected by the COVID-19 pandemic and discussed the main challenges and factors that led to successful usage of those systems. The researchers' list of critical factors that need to be addressed for successful usage included the following: (a) technological factors, (b) e-learning system quality factors, (c) trust factors, (d) self-efficacy factors, and (e) cultural aspects (p. 5273). We anticipate that many other scholars will examine the impact of COVID-19 with similar papers in the months and years to come.

Rather than analyze the effects of the pandemic on specific learning environments in their editorial, Williamson et al. (2020) explored the macro view of how the pandemic will shape pedagogy going forward.

A distinctive approach to pedagogy has emerged as a global norm in the opening months of 2020. Distance education, remote teaching, and online instruction are not new approaches to pedagogy or curriculum design, but they have taken on renewed salience (p. 108).

Williamson et al. urged caution regarding the "educational platformization" and decentralization of public schooling necessitated by the pandemic (p. 108). They speculated the following:

The current state of 'pandemic pedagogy', in other words, may not be seen by some businesses as simply an emergency response to a public health and political crisis, but as a rapid prototype of education as a private service and

an opportunity to recentralize decentralized systems through platforms (p. 109).

This concern that Williamson et al. have of public education morphing into a decentralized system enabled by the use of private platforms called for critical studies of these “changes in the broader political economy of the COVID-19 pandemic, its antecedents, and long-term consequences” (p. 109).

A major concern Williamson et al. address in their editorial is the inequality among students, especially the lack of access many students had at home to distance learning (p. 110). They cautioned that such inequality could not simply be solved by giving students laptops for home use and that as the pandemic continued inequalities in society were likely to widen (p. 110). Williamson et al. urged us to “see this time as an important moment to support, regulate and design an inclusive digital future for us all, that is part of a society that is more socially just” (p. 111).

At the beginning of the 2020s, educational technology research was still concerned with understanding the effects of technology on pedagogy in both general and in specific instances. However, the dependence on distance education necessitated by the COVID-19 pandemic exposed the inequalities that existed in many educational systems and highlighted many questions about “politics, pedagogies, and practices” (Williamson et al.) that will need to be answered in the future.

Synthesis of 50 Years

In this section, we will discuss or summarize the themes common to every decade, important themes unique to particular decades, the evolution of educational technology, and the probable future trajectory of educational technology research.

Core Question

As we look back over 50 years of research and try to sketch a holistic picture of the field of educational technology, we note a few significant themes. The main theme that was common in every decade was research that questioned the effectiveness of specific educational technologies. For this reason, it seems a fair assessment to say that the core question of educational technology research is—or has been for 50 years—whether a particular educational technology is effective. While this is a simple question, educational technology research has remained dynamic and complex for over 50 years. This, of course, is due to the constant innovations in educational technology that allow that core question to be asked again and again, always of a new technology (and sometimes before anyone is fully done studying the old technology). If technology were static, then educational technology would very likely become a closed question.

Technological developments have frequently altered the relevance of research topics. In the ’70s, audiovisual aids in learning were the most technologically relevant. By the 2000s, e-learning was the most relevant discussion. During the 2010s, gamification was used in the hopes of increasing learner engagement. Increased access to tech and mobility led to experimenting with flipped classrooms, MOOCs, and how social media could be used to increase engagement. The increasingly rapid pace of technological advances has outstripped researchers’ ability to compete with the new information. As this chapter illustrates, educational technology research does not always focus on the newest available educational technology. Instead, researchers typically study new technology after it has made its way to the classroom (Kimmons et al., 2021). In the field of educational technology, the efforts of practitioners and researchers are closely intertwined, with researchers often considering which innovations practitioners are making in their classrooms as they consider which questions to study. It is a different model than, for example, the medical field, where research is carried out before adoption by practitioners. This symbiosis with practitioners creating innovations and researchers then mapping and verifying them increases the relevance of research to real life classrooms at the same time it necessitates a lag between the release of new technologies and research concerning them.

Important Trends

Continuing from the 1970s through the 1990s, theoretical analyses appeared in—and eventually even dominated—the highly cited research of each decade. However, from the 2000s onward, theory was no longer the focus of the most cited articles. Theoretical trends during the first three decades should be expected because the field was quite young in the 1970s, troubled by conflicting paradigms in the 1980s, and still grappling with those conflicts even as the internet exploded onto the scene in the 1990s. Even with the introduction of the internet, the most cited articles from the 1990s do not directly concern technology, instead focusing on conflicting theories and models.

What were these theoretical difficulties and disagreements that concerned educational technology research previous to the dawn of the internet age? In the 1970s, new technology created or exposed insufficiencies in established theories and models. In response, researchers challenged those theories and models. In the 1980s, much of the dialogue of educational technology centered on the behaviorism/cognitivism debate. In the 1990s, both Ertmer (1999) and Kozma (1994) urged faster implementation of technology while Clark (1994) and Johnstone (1991) warned against overenthusiasm for technology. Clark (1994) and Kozma (1994) also disagreed about the role of media in learning.

Based on the 20 most cited articles from the 1990s, there is no reason to believe that every practitioner and researcher in the field of educational technology achieved intellectual harmony regarding these debates. However, enough theoretical foundation had been built by 2000 that researchers could at least clearly communicate about their theoretical differences. Perhaps this explains why research began to trend away from theoretical papers. Beginning with papers published in 2000, we saw a trend of researchers asking whether practitioner beliefs are aligned with practice. For instance, Ertmer (2005) investigated whether there was a gap between teacher practice and the theoretical framework (like constructivism) that the teachers aligned themselves with. It appears that by the 2000s, the theoretical roots of the field had matured enough to accommodate new types of discussions.

Future Trajectory and Conclusions

In the 1980s, the knitting together of previously disparate fields created theoretical tension that had a major impact on the field of educational technology that lasted for at least 20 years. Perhaps this indicates that if cross-disciplinary discussions once again becomes central to educational technology research, then the theoretical foundations of the field may undergo another seismic shift. Or perhaps cross-disciplinary research would instead result in the formation of sub-fields. It may be that only a dramatic evolution of technology on par with the invention of the internet would result in a similarly dramatic evolution of the field of educational technology.

It seems that a natural course for educational technology research is for researchers to (a) solidify their theoretical base, (b) determine the affordances of a technology, and (c) investigate pedagogical strategies related to that technology. In 2020, many of the studies that used familiar technology were focused on pedagogy. However, the AR/VR research was meant to determine the affordances of AR/VR. Once it is clear what the affordances of AR/VR are, we would expect to see pedagogy-related research in this area.

We have speculated about why, starting in the 2000s, theoretical papers stopped having such an impact on the field, but we recommend a more thorough investigation of this topic. We also recommend continued bibliometric studies similar to ours that synthesize decades of educational technology research into a holistic picture of the field (perhaps from 2020 to 2070). As research continues, we anticipate further expansion in the field of educational technology.

References

1970s

Allen, W. H. (1975). Intellectual abilities and instructional media design. AV Communication Review, 139–170. https://edtechbooks.org/-qiaY

Anderson, D. R., Levin, S. R., & Lorch, E. P. (1977). The effects of TV program pacing on the behavior of preschool children. AV Communication Review, 25(2), 159–166. https://edtechbooks.org/-kqBY

Ausburn, L. J., & Ausburn, F. B. (1978). Cognitive styles: Some information and implications for instructional design. ECTJ, 26(4), 337–354. https://edtechbooks.org/-tDT

Campeau, P. L. (1974). Selective review of the results of research on the use of audiovisual media to teach adults. AV Communication Review, 22(1), 5–40. https://edtechbooks.org/-oBXY

Clark, R. E., & Snow, R. E. (1975). Alternative designs for instructional technology research. AV Communication Review, 23(4), 373–394. https://edtechbooks.org/-caZ

Costin, F. (1972). Lecturing versus other methods of teaching: A review of research. British Journal of Educational Technology, 3(1), 4–31. https://edtechbooks.org/-aRIV

Dwyer, F. M. (1970). Exploratory studies in the effectiveness of visual illustrations. AV Communication Review, 18, 235–249. https://edtechbooks.org/-piYv

Haring, M. J., & Fry, M. A. (1979). Effect of pictures on children's comprehension of written text. ECTJ, 27(3), 185–190. https://edtechbooks.org/-jQkI

Havelock, R. G. (1971). The Utilisation of educational research and development. British Journal of Educational Technology, 2(2), 84–98. https://edtechbooks.org/-BEVm

Holliday, W. G. (1976). Teaching verbal chains using flow diagrams and texts. AV Communication Review, 24(1), 63–78. https://edtechbooks.org/-nmg

Hsia, H. J. (1971). The information processing capacity of modality and channel performance. AV Communication Review, 19(1), 51–75. https://edtechbooks.org/-YGne

Katzman, N., & Nyenhuis, J. (1972). Color vs. black-and-white effects on learning, opinion, and attention. AV Communication Review, 20(1), 16–28. https://edtechbooks.org/-drPW

Levin, J. R., & Lesgold, A. M. (1978). On pictures in prose. ECTJ, 26(3), 233–243. https://edtechbooks.org/-VUB

Levin, J. R., Bender, B. G., & Lesgold, A. M. (1976). Pictures, repetition, and young children's oral prose learning. AV Communication Review, 24(4), 367–380. https://edtechbooks.org/-NLA

Macdonald-Ross, M. (1977). How numbers are shown. AV Communication Review, 25(4), 359–409. https://edtechbooks.org/-FZQE

Mangan, J. (1978). Cultural conventions of pictorial representation: Iconic literacy and education. ECTJ, 26(3), 245–267. https://edtechbooks.org/-pQLZm

Merrill, M. D. (1975). Learner control: Beyond aptitude-treatment interactions. AV Communication Review, 23(2), 217–226. https://edtechbooks.org/-PcEF

Paulson, F. L. (1974). Teaching cooperation on television. AV Communication Review, 22(3), 229–246. https://edtechbooks.org/-WiGU

Salomon, G. (1972). Can we affect cognitive skills through visual media? An hypothesis and initial findings. AV Communication Review, 20(4), 401–422. https://edtechbooks.org/-EDeL

Spangenberg, R. W. (1973). The motion variable in procedural learning. AV Communication Review, 21(4), 419–436. https://edtechbooks.org/-Mxmh

1980s

Bliss, J., & Ogborn, J. (1989). Tools for exploratory learning: A research programme. Journal of Computer Assisted Learning, 5(1), 37–50. https://edtechbooks.org/-PYZY

Butterfield, E. C., & Nelson, G. D. (1989). Theory and practice of teaching for transfer. Educational Technology Research and Development, 37(3), 5–38. https://edtechbooks.org/-MbJ

Clark, R. E. (1985). Evidence for confounding in computer-based instruction studies: Analyzing the meta-analyses. ECTJ, 33(4), 249–262. https://edtechbooks.org/-iVvz

Clark, R. E., & Voogel, A. (1985). Transfer of training principles for instructional design. ECTJ, 33(2), 113–123. https://edtechbooks.org/-ahm

Cohen, P. A., Ebeling, B. J., & Kulik, J. A. (1981). A meta-analysis of outcome studies of visual-based instruction. ECTJ, 29(1), 26–36. https://edtechbooks.org/-eRQm

Dalton, D. W., Hannafin, M. J., & Hooper, S. (1989). Effects of individual and cooperative computer-assisted instruction on student performance and attitudes. Educational Technology Research and Development, 37(2), 15–24. https://edtechbooks.org/-WBMF

Faidhi, J. A., & Robinson, S. K. (1987). An empirical approach for detecting program similarity and plagiarism within a university programming environment. Computers & Education, 11(1), 11–19. https://edtechbooks.org/-Tob

Ford, N. (1985). Learning styles and strategies of postgraduate students. British Journal of Educational Technology, 16(1), 65–77. https://edtechbooks.org/-DcFk

Friend, C. L., & Cole, C. L. (1980). Learner control in computer-based instruction: A current literature review. Educational Technology, 30(11), 47–49. https://edtechbooks.org/-UTBq

Gagnon, D. (1985). Videogames and spatial skills: An exploratory study. ECTJ, 33(4), 263–275. https://edtechbooks.org/-cxa

Guba, E. G. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. ECTJ, 29(2), 75–91. https://edtechbooks.org/-zSxv

Guba, E. G., & Lincoln, Y. S. (1982). Epistemological and methodological bases of naturalistic inquiry. ECTJ, 30(4), 233–252. https://edtechbooks.org/-rnJG

Hannafin, M. J., & Rieber, L. P. (1989). Psychological foundations of instructional design for emerging computer-based instructional technologies: Part I. Educational Technology Research and Development, 37(2), 102–114. https://edtechbooks.org/-Nmq

Harper, G., & Kember, D. (1986). Approaches to study of distance education students. British Journal of Educational Technology, 17(3), 212–222. https://edtechbooks.org/-MKVL

Heinich, R. (1984). The proper study of instructional technology. ECTJ, 32(2), 67–88. https://edtechbooks.org/-rDpQ

Jackson, A., Fletcher, B., & Messer, D. J. (1986). A survey of microcomputer use and provision in primary schools. Journal of Computer Assisted Learning, 2(1), 45–55. https://edtechbooks.org/-ZAhx

Kinzie, M. B., & Sullivan, H. J. (1989). Continuing motivation, learner control, and CAI. Educational Technology Research and Development, 37(2), 5–14. https://edtechbooks.org/-FoMK

Levie, W. H., & Lentz, R. (1982). Effects of text illustrations: A review of research. ECTJ, 30(4), 195–232. https://edtechbooks.org/-Vnw

Ross, S. M., & Morrison, G. R. (1989). In search of a happy medium in instructional technology research: Issues concerning external validity, media replications, and learner control. Educational Technology Research and Development, 37(1), 19–33. https://edtechbooks.org/-xevR

Tennyson, R. D., & Buttrey, T. (1980). Advisement and management strategies as design variables in computer-assisted instruction. ECTJ, 28(3), 169–176. https://edtechbooks.org/-uRh

1990s

Byrne, M. D., Catrambone, R., & Stasko, J. T. (1999). Evaluating animations as student aids in learning computer algorithms. Computers & Education, 33(4), 253–278. https://edtechbooks.org/-YsSi

Clark, R. E. (1994). Media will never influence learning. Educational Technology Research and Development, 42(2), 21–29. https://edtechbooks.org/-Dqov

Ertmer, P. A. (1999). Addressing first-and second-order barriers to change: Strategies for technology integration. EducatIonal Technology Research and Development, 47(4), 47–61. https://edtechbooks.org/-PIN

Garrison, D. R., Anderson, T., & Archer, W. (1999). Critical inquiry in a text-based environment: Computer conferencing in higher education. The Internet and Higher Education, 2(2–3), 87–105. https://edtechbooks.org/-prL

Hill, J. R., & Hannafin, M. J. (1997). Cognitive strategies and learning from the World Wide Web. Educational Technology Research and Development, 45(4), 37–64. https://edtechbooks.org/-JsqS

Johnstone, A. H. (1991). Why is science difficult to learn? Things are seldom what they seem. Journal of Computer Assisted Learning, 7(2), 75–83. https://edtechbooks.org/-lmKI

Jonassen, D. H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? Educational Technology Research and Development, 39(3), 5–14. https://edtechbooks.org/-yWdv

Jonassen, D. H., & Rohrer-Murphy, L. (1999). Activity theory as a framework for designing constructivist learning environments. Educational Technology Research and Development, 47(1), 61–79. https://edtechbooks.org/-Gfxm

Kozma, R. B. (1994). Will media influence learning? Reframing the debate. Educational Technology Research and Development, 42(2), 7–19. https://edtechbooks.org/-yjN

Mayer, R. E., Steinhoff, K., Bower, G., & Mars, R. (1995). A generative theory of textbook design: Using annotated illustrations to foster meaningful learning of science text. Educational Technology Research and Development, 43(1), 31–41. https://edtechbooks.org/-vsYc

Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. Educational Technology Research and Development, 44(2), 43–58. https://edtechbooks.org/-CdYM

2000s

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). Computers & Education, 52(1), 154–168. https://edtechbooks.org/-LcRL

Bennett, S., Maton, K., & Kervin, L. (2008). The ‘digital natives’ debate: A critical review of the evidence. British Journal of Educational Technology, 39(5), 775–786. https://doi.org/10.1111/j.1467-8535.2007.00793.x

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? Educational Technology Research and Development, 53(4), 25–39. https://edtechbooks.org/-nEwf

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. The Internet and Higher Education, 7(2), 95–105. https://edtechbooks.org/-unph

Hew, K. F., & Brush, T. (2007). Integrating technology into K–12 teaching and learning: Current knowledge gaps and recommendations for future research. Educational Technology Research and Development, 55(3), 223–252. http://dx.doi.org/10.1007/s11423-006-9022-5

Jonassen, D. H. (2000). Toward a design theory of problem solving. Educational Technology Research and Development, 48(4), 63–85. https://edtechbooks.org/-jRIj

Kennedy, G. E., Judd, T. S., Churchward, A., Gray, K., & Krause, K. L. (2008). First year students' experiences with technology: Are they really digital natives? Australasian Journal of Educational Technology, 24(1). https://edtechbooks.org/-qcX

Kiili, K. (2005). Digital game-based learning: Towards an experiential gaming model. The Internet and Higher Education, 8(1), 13–24. https://edtechbooks.org/-hLnU

Liaw, S. S. (2008). Investigating students' perceived satisfaction, behavioral intention, and effectiveness of e-learning: A case study of the Blackboard system. Computers & Education, 51(2), 864–873. https://edtechbooks.org/-UqqE

Madge, C., Meek, J., Wellens, J., & Hooley, T. (2009). Facebook, social integration and informal learning at university: 'It is more for socialising and talking to friends about work than for actually doing work.' Learning, Media and Technology, 34(2), 141–155. https://edtechbooks.org/-WPr

Merrill, M. D. (2002). First principles of instruction. Educational Technology Research and Development, 50(3), 43–59. https://edtechbooks.org/-jwSq

Motiwalla, L. F. (2007). Mobile learning: A framework and evaluation. Computers & Education, 49(3), 581–596. https://edtechbooks.org/-kNK

Papastergiou, M. (2009). Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. Computers & Education, 52(1), 1–12. https://edtechbooks.org/-xCi

Park, S. Y. (2009). An analysis of the technology acceptance model in understanding university students' behavioral intention to use e-learning. Journal of Educational Technology & Society, 12(3), 150–162. https://www.jstor.org/stable/jeductechsoci.12.3.150

Selwyn, N. (2009). Faceworking: Exploring students' education-related use of Facebook. Learning, Media and Technology, 34(2), 157–174. https://edtechbooks.org/-bXcH

So, H. -J., & Brush, T. A. (2008). Student perceptions of collaborative learning, social presence and satisfaction in a blended learning environment: Relationships and critical factors. Computers & Education, 51(1), 318–336. https://edtechbooks.org/-pzih

Sun, P. C., Tsai, R. J., Finger, G., Chen, Y. Y., & Yeh, D. (2008). What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. Computers & Education, 50(4), 1183–1202. https://edtechbooks.org/-zeo

Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. Educational Technology Research and Development, 53(4), 5–23. https://edtechbooks.org/-cRrs

Wang, Y. S., Wu, M. C., & Wang, H. Y. (2009). Investigating the determinants and age and gender differences in the acceptance of mobile learning. British Journal of Educational Technology, 40(1), 92–118. https://edtechbooks.org/-rnmw

2010s

Akçayır, G., & Akçayır, M. (2018). The flipped classroom: A review of its advantages and challenges. Computers & Education, 126, 334–345. https://edtechbooks.org/-IIrp

Boyle, E. A., Hainey, T., Connolly, T. M., Gray, G., Earp, J., Ott, M., Lim, T., Ninaus, M., Ribeiro, C., & Pereira, J. (2016). An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games. Computers & Education, 94, 178–192. https://edtechbooks.org/-ASH

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. Computers & Education, 59(2), 661–686. https://edtechbooks.org/-AKev

Dabbagh, N., & Kitsantas, A. (2012). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. The Internet and Higher Education, 15(1), 3–8. https://edtechbooks.org/-fMlq

Dalgarno, B., & Lee, M. J. (2010). What are the learning affordances of 3-D virtual environments? British Journal of Educational Technology, 41(1), 10–32. https://edtechbooks.org/-cUrQ

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. Journal of Educational Technology & Society, 18(3), 75–88. https://www.jstor.org/stable/jeductechsoci.18.3.75

Domínguez, A., Saenz-de-Navarrete, J., De-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J. J. (2013). Gamifying learning experiences: Practical implications and outcomes. Computers & Education, 63, 380–392. https://edtechbooks.org/-YcMJ

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. Computers & Education, 59(2), 423–435. https://edtechbooks.org/-nGZC

Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. The Internet and Higher Education, 19, 18–26. https://edtechbooks.org/-dLQi

Hanus, M. D., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. Computers & Education, 80, 152–161. https://edtechbooks.org/-qvGff

Jordan, K. (2014). Initial trends in enrolment and completion of massive open online courses. International Review of Research in Open and Distributed Learning, 15(1), 133–160. https://edtechbooks.org/-MtBr

Junco, R. (2012). The relationship between frequency of Facebook use, participation in Facebook activities, and student engagement. Computers & Education, 58(1), 162–171. https://edtechbooks.org/-SWKe

Junco, R., Heiberger, G., & Loken, E. (2011). The effect of Twitter on college student engagement and grades. Journal of Computer Assisted Learning, 27(2), 119–132. https://edtechbooks.org/-ALh

Kremer, A. (2019, December 31). The 2010s: The golden decade of the mobile internet. China Tech Blog. https://www.chinatechblog.org/blog/the-2010s-the-golden-decade-of-the-mobile-internet

Liyanagunawardena, T. R., Adams, A. A., & Williams, S. A. (2013). MOOCs: A systematic study of the published literature 2008–2012. International Review of Research in Open and Distributed Learning, 14(3), 202–227. https://edtechbooks.org/-voPR

Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K–12 and higher education: A meta-analysis. Computers & Education, 70, 29–40. https://edtechbooks.org/-LKwT

O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. The Internet and Higher Education, 25, 85–95. https://edtechbooks.org/-QhLd

Roblyer, M. D., McDaniel, M., Webb, M., Herman, J., & Witty, J. V. (2010). Findings on Facebook in higher education: A comparison of college faculty and student uses and perceptions of social networking sites. The Internet and Higher Education, 13(3), 134–140. https://edtechbooks.org/-zaZS

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. Computers & Education, 128, 13–35. https://edtechbooks.org/-BZmB

Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. Computers & Education, 94, 252–275. https://edtechbooks.org/-jkCp

Wu, H. K., Lee, S. W. Y., Chang, H. Y., & Liang, J. C. (2013). Current status, opportunities and challenges of augmented reality in education. Computers & Education, 62, 41–49. https://edtechbooks.org/-TsCY

2020s

Almaiah, M. A., Al-Khasawneh, A., & Althunibat, A. (2020). Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic. Education and Information Technologies, 25, 5261–5280. https://edtechbooks.org/-NsnS

Bond, M. (2020). Facilitating student engagement through the flipped learning approach in K–12: A systematic review. Computers & Education, 151, 103819. https://edtechbooks.org/-QfWsm

Liu, Q., Geertshuis, S., & Grainger, R. (2020). Understanding academics' adoption of learning technologies: A systematic review. Computers & Education, 151, 103857. https://edtechbooks.org/-DBa

Lo, C. K., & Hew, K. F. (2020). A comparison of flipped learning with gamification, traditional learning, and online independent study: The effects on students' mathematics achievement and cognitive engagement. Interactive Learning Environments, 28(4), 464–481. https://edtechbooks.org/-Yumk

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. Computers & Education, 147, 103778. https://edtechbooks.org/-nihN

Troussas, C., Krouska, A., & Sgouropoulou, C. (2020). Collaboration and fuzzy-modeled personalization for mobile game-based learning in higher education. Computers & Education, 144, 103698. https://edtechbooks.org/-Mvi

Turan, Z., & Akdag-Cimen, B. (2020). Flipped classroom in English language teaching: A systematic review. Computer Assisted Language Learning, 33(5-6), 590–606. https://edtechbooks.org/-YyJN

Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic politics, pedagogies and practices: Digital technologies and distance education during the coronavirus emergency. https://edtechbooks.org/-BtYR

Zainuddin, Z., Shujahat, M., Haruna, H., & Chu, S. K. W. (2020). The role of gamified e-quizzes on student learning and engagement: An interactive gamification solution for a formative assessment system. Computers & Education, 145, 103729. https://edtechbooks.org/-QDh

Synthesis

Kimmons, R., Rosenberg, J., & Allman, B. (2021). Trends in educational technology: What Facebook, Twitter, and Scopus can tell us about current research and practice. TechTrends, 65, 125–136. https://doi.org/10.1007/s11528-021-00589-6

Literature Review Articles

Bond, M., Zawacki-Richter, O., & Nichols, M. (2019). Revisiting five decades of educational technology research: A content and authorship analysis of the British Journal of Educational Technology. British Journal of Educational Technology, 50(1), 12–63. https://doi.org/10.1111/bjet.12730

Chen, X., Zou, D., & Xie, H. (2020). Fifty years of British Journal of Educational Technology: A topic modeling based bibliometric perspective. British Journal of Educational Technology, 51(3), 692–708. https://edtechbooks.org/-VEYh

Previous Citation(s)

Boekweg, A., Call, H., Craw, D., Jennings, F., Irvine, J., & Kimmons, R. (2021). Educational Technology: A History of Research Trends from 1970 to 2020. In R. Kimmons & J. Irvine (Eds.), *50 Years of Education Research Trends*. EdTech Books. https://edtechbooks.org/-iCSx

Abigail Boekweg

Brigham Young University

Abigail Boekweg is a student in the Instructional Psychology and Technology master's program at Brigham Young University.

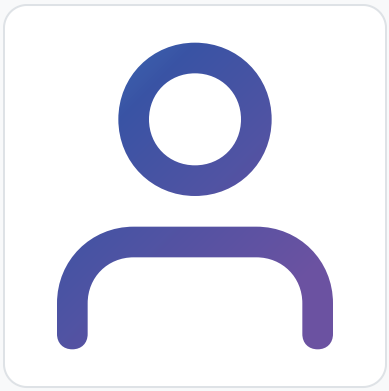
Hannah Call

Brigham Young University

Hannah Call graduated from Brigham Young University with a Bachelor's degree in Sociocultural Anthropology. She is currently a graduate student studying Instructional Psychology and Technology (IP&T) while she works as an instructional design assistant for Brigham Young University Online.

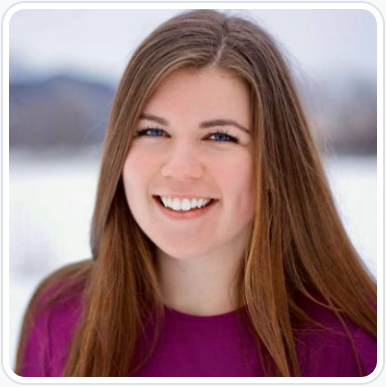
Dillon Craw

Brigham Young University



Faith Jennings

Brigham Young University



Julie Irvine

Brigham Young University

Julie is an undergraduate student at Brigham Young University. She is majoring in editing and publishing and minoring in creative writing. Julie has three years of editing experience and over five years of writing experience. She loves editing, writing, and storytelling. Julie has been an editor for EdTech Books for 1.5 years, and she has enjoyed working on open resource textbooks, writing research articles, and bringing the vision of EdTech Books to university students. If you'd like to reach out to Julie about editing or writing opportunities, she can be reached by email or through her LinkedIn profile.

Royce Kimmons

Brigham Young University

Royce Kimmons is an Associate Professor of Instructional Psychology and Technology at Brigham Young University where he studies digital participation divides specifically in the realms of social media, open education, and classroom technology use. He is also the founder of EdTechBooks.org. More information about his work may be found at http://roycekimmons.com, and you may also dialogue with him on Twitter @roycekimmons.