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ARTICLE

Educational Technology Research Patterns in the Realm of the Digital Knowledge Age

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Educational technology (EdTech) is a dynamic, evolving field and as such, in identifying and mapping research patterns in this field, a systematic approach is required. Starting from when the World Wide Web became publicly available, this study conducts a systematic review of educational technology research patterns. The review showed that after 1993, there was a sudden increase in the number of educational technology publications, and that in terms of subject areas, social sciences dominate the field, which suggests that there is a need for more interdisciplinary research. Regarding the geographical distribution of the research, the review found that most of the contributions come from the same developed countries. The following themes from over the course of almost three decades were identified: 1993–1999 *multimedia learning and instructional design*; 2000–2004 *convergence of educational technology, distance education and online learning environments, and educational technology integration in traditional learning settings*; 2005–2009 *revising curriculum for educational technology, educational technology in higher education and distance education, and the bottleneck of the significant differences in educational technology research*; 2010–2014 *online learning and higher education, integration of ICT and full potential of educational technology*; and 2015–2019 *data-driven, smart educational technology, big data, and learning analytics*. While critical views are increasing, this study also observed that some discourse, such as arguments that EdTech will change education and replace teachers, are constantly articulated throughout the literature.

Keywords: educational technology; EdTech; digital knowledge age; the evolution of EdTech; research patterns

Introduction

Relating to Dewey (1916), whose ideas are originally inspired from Plato's notions on knowledge and skills of artists and craftsmen, Oliver (2013) and Jin (2011) highlight the social and material aspects of technology. Expanding these views, Friesen (2009) characterizes hard technologies with material or technical aspects, while Oliver (2013) characterizes interpretation or meaning with soft technologies. Based on the above thoughts, it can be argued that educational technology can be classified under two broad categories: soft technologies (programs, design principles, approaches, conceptual frameworks, theories, etc.) and hard technologies (pen, paper, printing machines, computers etc.). Arguably, one of the first soft educational technologies would be the invention of language and alphabets, while in the case of the hard educational technologies, it would be pen and paper. Every invention, whether primitive or modern, triggers some degree of socio-economic change, and some of the educational technologies, such as language, alphabet, pen, paper, the printing machine, in fact, stand as milestones in the history of educational technology. It is, however, digital wired technologies (e.g., radio, television, telephone, etc.) that have aroused much attention and stand as a hallmark of the last century. While these developments were exciting, it is more recent technologies, like computers, the internet, and the World Wide Web (WWW) that have changed the very way we see, interpret, and perceive education. The twenty-first century is regarded as the digital knowledge age and has witnessed the invention of innovative technologies that had once been only a dream and beyond our imagination.

In many cases, the technologies that have been created tend to be first adored but then feared. At a time of such critical discussions and diverse thoughts about the role of technology, it is believed that exploring educational technology research patterns could help provide insight into better understanding the role of technology, taking a critical position towards it, developing strategies and making decisions. In the light of these thoughts, the main purpose of this study is to identify educational research technology research patterns in the realm of the digital knowledge age.

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Related Literature

The definition of educational technology has evolved drastically (Richey, Silber, & Ely 2008) in line with transformations in socio-economic structures (Aesaert, Vanderlinde, Tondeur, & van Braak 2013; Guo, Zhang, & Guo 2016; Kara Aydemir, & Can 2019). Without clear boundaries, "each building on the previous one" (Winn 2002, p. 332), different evolutionary stages of educational technology have been identified: (I) the age of instructional design: a focus on content; (II) the age of message design: a focus on format; (III) the age of simulation: a focus on interaction; and finally the *new age* of research in educational technology: a focus on learning environments (Winn 2002). Likewise, earlier research identified three major research domains within the field of educational technology, namely (I) technology integration, (II) acceptance/attitude of emerging technologies; and (III) learning environments (Hsu, Hung, & Ching 2013). It has been further argued that technology can be regarded as a tutor, a teaching aid and a learning tool (Ross & Lowther 2009; Ross, Morrison, & Lowther 2010).

The complex and interdependent nature of education and educational technology (Weller 2018) requires revisiting scholarly discourses, and in addition to conceptual contributions (Elly 1992; Spector 2013; Ringstaff & Kelly 2002; Weller 2018), there have been many attempts to understand the research that has been conducted in educational technology. For instance, Chen, Yu, Cheng and Hao (2019) conducted a bibliometric analysis of *Computers and Education Journal* and reported that interactive learning environments, teaching/learning strategies and pedagogical issues were the most frequently studied research themes. They also pointed out that student centered research topics increased sharply from the second decade of the 2000s. In a follow up study, Chen, Zou, Cheng and Xie (2020) performed a bibliometric analysis and reported that game-based learning, technology acceptance model, assessment, virtual reality and language learning were trending hot topics. They further noted that collaborative learning, e-learning and policy, experiments and methodologies, and social networks and communities were trending research themes. Chen, Zou and Xie (2020) performed a bibliometric analysis of *The British Journal of Educational Technology* (BJET) and found communication technology, learning process, learning outcome, learning environment, learning experience and educational technology among the most studied research themes. They further noted that learning environments and learning processes were the major concern in articles published in BJET. Their analysis also revealed that topics such as blended learning, collaborative learning, online social communities, socialized e-learning, mobile assisted language learning and game-based learning have an increasing trend while problem-based learning, online professional training and teacher education have a decreasing trend in overall publications in BJET. Bodily, Leary and West (2019), from 2007 to 2017, analyzed research and trends in 65 journals. Their keyword analysis revealed the pattern over time. Chronically, the use of keywords indicated the following topics: "WebCT (2007), hypermedia (2008), digital natives and community (2010), blog (2011), blog and social learning (2012), digital literacy, online discussion, and wikis (2013), MOOCs and social network analysis (2014), and MOOCs, gamification, flipped classroom, and open education in (2015 and 2016)" (p. 72). In the same study, trends with longitudinal characteristics were as follows: "2007–2008 had many papers on social types of research and learning, 2009 emphasized K12 research, 2010–2012 had more community-based research, and 2013–2016 focused on mass distribution of education through MOOCs, wikis, blogs, etc." (p. 72). Zawacki-Richter and Latchem (2018) from 1976 to 2016, examined *Computers and Education Journal* through a systematic review approach and identified the following research themes over 40 years: "the advancement and growth of computer-based instruction (1976–1986); stand-alone multimedia learning (1987–1996); networked computers as tools for collaborative learning (1997–2006); and online learning in a digital age (2007–2016)" (p. 136). With a similar analytic approach, Bond, Zawacki-Richter and Nichols (2019), from 1970 to 2018, analyzed articles published in BJET. Their study identified the following research themes: "multimedia learning and the Open University (1970–79); the transition from AV to the design of computer-based learning (1980–89); the evolution of distance education and the rise of interactive learning (1990–99); the implementation and design of online collaborative learning and ICT in schools (2000–09); and learning analytics and mobile collaborative learning (2010–18)."

In addition to the above publications, some other studies examined EdTech in a broad sense (Baydas et al. 2015; Bodily et al. 2019; Caffarella 1999; Dick & Dick 1989; Hew, Kale, & Kim 2007; Hranstinski & Keller 2007; Klein 1997; Hsu et al. 2012; Masood 2004; Latchem 2006; Natividad, Spector, & Evangelopoulos 2018; Hsu et al. 2013; Reeves & Oh 2017; Ross et al. 2010). Common points can be seen in earlier research. Educational technology research dates back to the early 20th century (Cuban 1986; Elly 1992; Ringstaff & Kelly 2002; Spencer 1999), with some of the same debates being still very much alive (Mishra, Koehler, & Kereluik 2009). For instance, just like today, there were concerns about the role of the educator and the fear educators had of being replaced by educational technology (Elly 1992; Spencer 1999) and questions about how people learn with educational technology (Hranstinski & Keller 2007); and the effectiveness of educational technology (Delgado et al. 2015; Morrison et al. 2010; Spencer 1999). Moreover, there was an extensive focus on media and delivery methods (Clark 1983; Kozma 1991), from which the influence and dominance of the positivist paradigm emerged (Kara Aydemir, & Can 2019; Hew et al. 2007; Hranstinski & Keller 2007; Reeves & Oh 2017), replacing and neglecting critical theoretical perspectives (Reeves & Oh 2017) and more importantly, the human learners. Besides, while it is argued that "there has been a shift from often unquestioning advocacy of particular technologies to a more critical, theoretical understanding" (Weller 2020), others have argued that computer-based and online technologies and their integration into education created great enthusiasm, that the theoretical underpinning of educational technology was largely ignored (Albirini 2007; Alper & Gulbahar 2009;

Issroff & Scanlon 2002; Oliver 2013). De Castell, Bryson and Jenson (2002) further note that: "It could be argued at this point that we lack an educational theory of technology (which is not the same thing as a theory of educational technology, of which we have of course a number). The difference between these is that whereas theories of educational technology take for granted, whether as good or as harmful, the integration of education and technology; an educational theory of technology, by contrast, would investigate technology from the standpoint of educational values and purposes, and with reference to what can be discerned from a study of 'educational technology' as a socially-situated artifact (para. 17)"

This scenario can be summarized metaphorically as "The song remains the same, but the tempo keeps changing" (Mishra et al. 2009). Some have claimed that, in the field of educational technology, the "community is very bad at learning the lessons of history. One view of the future is that we shall repeat the mistakes we have made in the past. History will repeat itself with new technologies. Even worse than an inability to learn the lessons is the fact that we often do not even know the lessons. We have a strong tendency to ignore everything that has gone before in our excitement to get on with what we have now" (Rushby 2013, p. 54).

Online technologies, the internet, the web and computers have penetrated every layer of our lives, to such an extent that the internet and the web can be seen as a global brain with distributed cognition across networks. In fact, these technologies are the catalyst of the digital knowledge age. According to Winn (2002), the impact of [online] technology is greater than ever and therefore, as reported by Alper and Gulbahar (2009) and Masood, (2004), the research in this area has evolved enormously. In fact, "With the explosive growth of computers in academia in the later half of last century and for individual use in the early eighties, and emergence of the Internet in mainstream education in the nineties, educational technology has become somewhat synonymous to computer-based learning and online education" (Kinshuk et al. 2013: 3).

Purpose of the Research

According to Webster and Watson (2002), "an effective review creates a firm foundation for advancing knowledge. It facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed" (p. xiii). Similarly, Weller (2020) argues that EdTech has a shared history and we need to "learn from and remember its history" (p. 189). Sharing the same thoughts, the main purpose of this research is to explore and examine educational research patterns in the digital knowledge age by conducting a systematic review study. In this regard, the research intends to seek answers to the following research questions. What are the educational research patterns;

- in time trend, subject areas, and geographical distribution of the articles,
- in lexical findings explored through text mining,
- in keywords revealed through social network analysis?

Methodology

Research Method and Design

This study adopts a systematic review approach (Gough, Oliver, & Thomas 2012) and uses data mining and analysis techniques (Grinstein & Wierse 2002), including social network analysis (Hansen, Shneiderman, & Smith 2010) and text-mining (Hearst 2003). By employing these approaches, the findings could be triangulated, which served to improve the reliability and validity of the research and provide multidimensional perspectives (Foster 1997).

Sample and Inclusion Criteria

The sample of this study included a total of 666 articles published in peer-reviewed journals. Of these articles, 98 were open access and 568 were closed articles, which were accessed through the accounts of institutions. The inclusion criteria for the sample were as follows: indexed in Scopus database, written in English, published between 1993 and 2019, and included the search terms ("educational technology" "educational technologies" OR "EdTech") in their title. Scopus was selected as the target database because it is known to be the largest database, ensuring that as many articles as possible would be accessed to get representative results. The sample was limited to only English language articles because text-mining can distinguish only one language at a time. The justification for sampling articles published from 1993 onwards was to present educational technology research patterns related to online network technologies that fell within the digital knowledge age. The year of 1993 was intentionally selected because it is acknowledged as the date when the source code of the World Wide Web (WWW) became available to everyone and Web browsers, like Mosaic, were released for public use.

Data Analysis and Research Procedure

The study used three types of analysis. First, descriptive statistics regarding time trend, subject areas, and geographical distribution were used. Second, text-mining was used to analyze lexical relationships in the titles and abstracts of the sampled articles. Last, social network analysis was used to investigate keyword patterns (see Appendix 1 for the full list).

Strengths and Limitations

The main strengths of this study include the methodological approaches used to handle large volumes of data and the complete picture the research presents on educational research trends after the public availability of the world-wide web. In addition to these strengths, however, there were some limitations. First, it is highly likely that important articles published in journals not indexed by Scopus failed to be included in the final sample. Second, as this study aimed to analyze articles capable of creating a research corpus consistent with analyzed units (e.g., titles, keywords, and abstracts), other types of publications, such as books, book chapters and records, which would provide a complementary view, were not included The main reasons for not including these types of publications were that they are not all peer-reviewed and that

it is difficult to analyze such a wide range of published materials and report them in a consistent manner. Third, the final research corpus is created using the following search terms: "educational technology" "educational technologies" OR "EdTech". While the aim for using these keywords was to access more relevant and concentrated publications, the research acknowledges that the field of EdTech is represented with some other key terms (e.g., online learning, e-learning, computer-assisted instruction, etc.), and therefore, the findings of this study provide a partial view. Fourth, as suggested by Fuchs et al. (2010), this study adopts the view that the Web is a "techno-social system that enhances human cognition towards communication and co-operation" (p. 41). The study acknowledges that there isn't any exact timeframe to classify the progress of the Web and further argues that Web 1.0, Web 2.0 and Web 3.0 represent the versions of the Web and that different evolutionary stages of the Web coexist. However, considering simply the technological developments, it can be argued that Web 1.0 roughly refers to the 1990s, Web 2.0 refers to the 2000s and Web 3.0 refers to the 2010s.

Findings and Discussion

Descriptive Analysis

Time Trend

As explained earlier in the study, the year 1993 was selected as a starting point, as this year coincided with the public availability of the WWW, the introduction of online networks and the digital knowledge age. As can be seen in **Figure 1**, there was a steady increase in publications until 2008, at which point a more drastic rising trend began, peaking in 2019. This can be interpreted as a growing interest in educational technology research.

Subject Areas

Analysis of subject areas (See **Figure 2**) indicated that the social sciences (50%), which include education and education-related subcategories, have been the leading subject area. In addition to social sciences, computer sciences (18%) and engineering (8%) constitute 76% of all research areas. When critically examined, it can be seen that these subject areas are already related, or inherent, to education and technology and that there is an unbalanced distribution of subject areas that address educational technology. This can be problematic for educational technology and its mainstreaming, but it can be overcome by conducting interdisciplinary research, which would prevent educational technology from being captive to an echo chamber that articulates its own myths and hypes.

Geographical Distribution

Article contributions to educational technology mostly come from developed countries (see **Figure 3** for geographical representation and see Appendix 2 for the full list), with a fairly diverse range of authors (see Appendix 3 for the full list) and publication sources (See Appendix 4 for the full list). Interestingly, contributions from the US (32.5%) dominate the educational technology literature. The top five countries in terms of article contributions are the US (32.5%), the UK (5.3%), China (4.5%), Australia (3.6%), and Turkey (3.6%), constituting 49.5 of all the sampled articles.

The findings on the geographical distribution are similar to those reported in earlier research. For instance, Hsu et al. (2013) examined six SSCI-indexed journals and reported that the top countries in terms of educational technology publications were, in respective order, the US, England, Taiwan, Australia, the Netherlands, Canada, Turkey, Greece, Singapore, and Germany. Two other systematic review studies and two other bibliometric analyses that only investigated one SSCI indexed journal provided interesting results. In the first one, Zawacki-Richter and Latchem (2018) listed the US (18.9), the UK (18.5), Taiwan (12.4), Spain (4.7%), the Netherlands (4.5%), Canada (4.4%), Australia (3.6%), Turkey (2.7%), Greece (2.2%), and Germany (2%) as the leading contributors to the *Computers and Education* (C&E) journal. In the second one, Bond et al. (2019), who examined the SSCI indexed journal, BJET, and criticized it for being strongly British

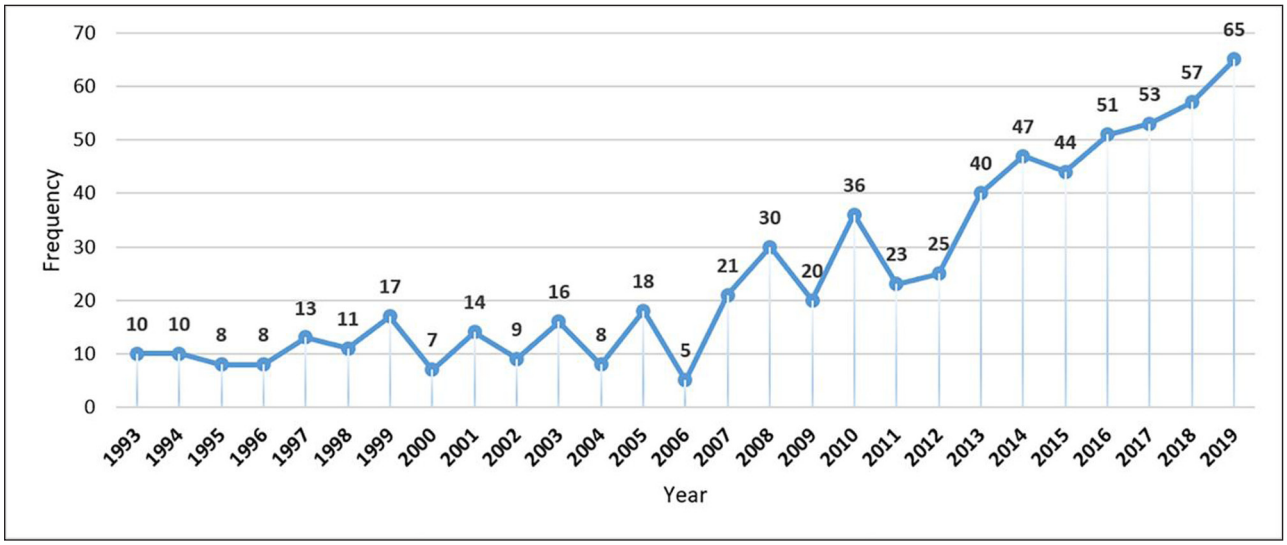


Figure 1: Time trend for educational technology publications (1993–2019).

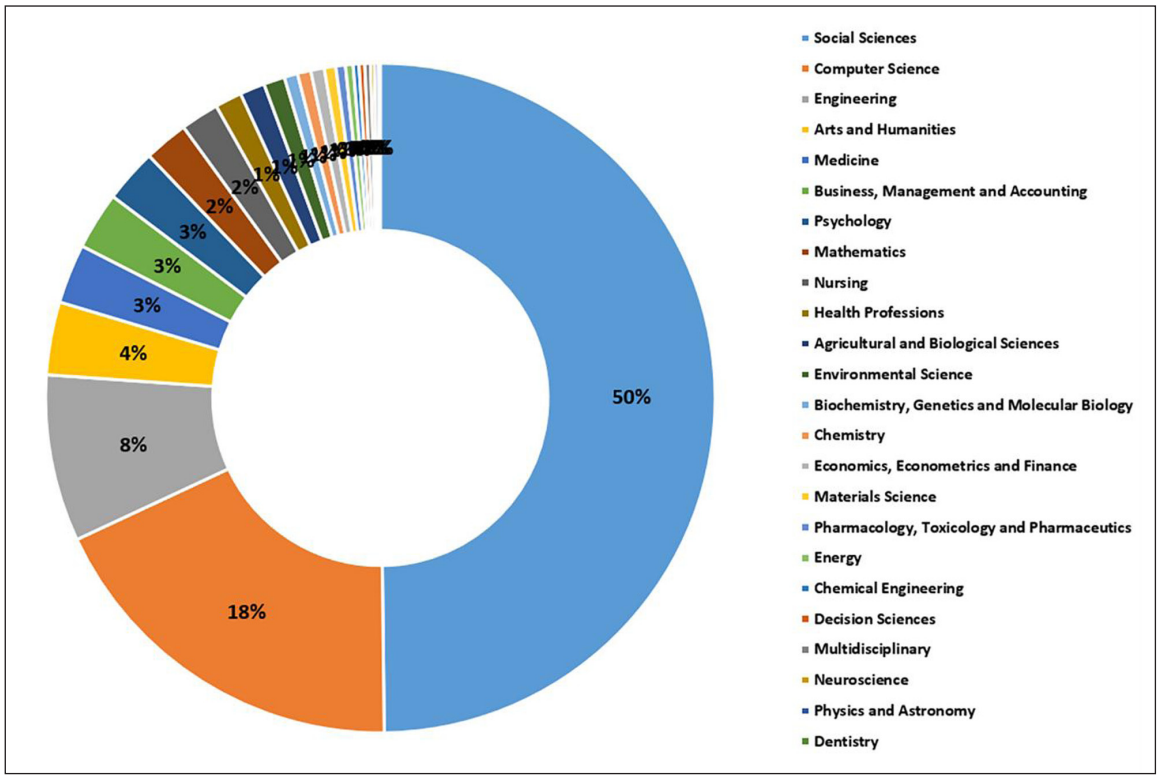


Figure 2: Distribution of educational technology articles according to subject areas (1993–2019).



Figure 3: Geographical presentation of educational technology publications (1993–2019).

(Bond et al., 2019; see also Latchem 2006), reported England (33.1%), the US (16.5%), Australia (8.8%), Taiwan (6.9%), the Netherlands (4.6%), Canada (4.2%), Scotland (3.7%), China (2.6%), South Africa (2.2%), Spain (2.2%), and Turkey (2.1%) as the leading contributors. In the third one, Chen at al. (2019) reported that the US (21.65%), the UK (18.57%) and Taiwan (13.47%) were the most productive contributors. In the final one, Chen et al. (2020) found the most influential contributors by countries were the US (n = 858), the UK (n = 736), Taiwan (n = 534), Spain (n = 210), Netherlands (n = 205), Canada (n = 199), Australia (n = 182), Turkey (n = 117), Germany (n = 111), Greece (n = 90) and Hong Kong (n = 90). Considering the leading countries, it is clear that educational technology research is mostly influenced by the western perspective (Hlynka 2003) and there is a need to have more pluralistic views which can be achieved through international collaborations.

It is interesting, yet unsurprising to see that almost all the countries listed in these studies are largely the same, with the difference being only in where they fall on the list of number of publications. SSCI-indexed journals, like C&E and BJET, tend to be preferred as target publications by countries where academic promotion is heavily decided on the basis of where the articles are indexed (e.g., SSCI). These countries are also known for their rich traditions in these educational fields, that is distance education (DE) and/or open and distance learning (ODL), which

have paved the way for other educational practices that can be categorized under these fields (e.g., e-learning, m-learning, and u-learning). DE and ODL are pragmatic fields that use educational technology to provide meaningful learning experiences and ensure working solutions for learners (Bozkurt 2019a) and "to lessen distance, both physically and psychologically, and to increase interactivity and communication among learners, learning sources and facilitators." (Bozkurt 2019b).

Though there might be some other variables that affect and shape educational technology research patterns, these countries can be regarded as innovators, early adopters, or the early majority (Rogers 2003) in educational technology. Accordingly, innovators or early adopters are characterized by their willingness to take risks and their financial liquidity, and they hold critical positions in opinion leadership. Their common characteristics may however leave them open to certain vulnerabilities, like adopting false assumptions, myths, or hypes, due to the high tolerance they have to becoming absorbed in following innovations. A case in point would be the US, which has already invested a lot of money in educational technology (Hung 2012), a trend that is likely to increase in the near future (Lawless 2016; Watters 2014). The problem is the "blind faith" (Latchem 2014, p. 7) that countries like the US seem to have in the prospect that educational technology will ultimately save corrupted education systems or heal those that are wounded, prompting the governments of developed and developing countries continue to invest money (Latchem 2014). In fact, educational technology has its fair share of failures (Cuban 2001; Lee & Winzenried 2009; Morrison, Ross, & Cheung 2019; Munro 2018; Robertson 2003), and there will continue to be failures so as long as schools are considered a big market.

Text Mining and Social Network Analysis

This section reports findings from four distinct eras based on concept maps visualized through text mining and sociograms created by social network analysis.

1993–1999: Multimedia learning and instructional design

Following the advent of Web 1.0, the widespread use of computers and the public availability of the world wide web from 1993 to 1999, two major themes were identified in the concept map: *(I) multimedia learning (Path: software, computer, system, interactive, multimedia) and (II) instructional design (Path: course, students, school, use, learning, teaching, instructional, design*) (see **Figure 4**). Social network analysis (SNA), which was used to support the text mining, identified *technology, education,* and *computers* as the most significant keywords with high betweenness centrality (See **Figure 5**). The most cited articles in this era indicate that hypermedia (Dillon & Gabbard 1998) inquiry, communication, construction, expression through multimedia (Bruce & Levin 1997) and instructional design (Petraglia 1998) are emerging issues, along with skepticism (Carlson 1998)

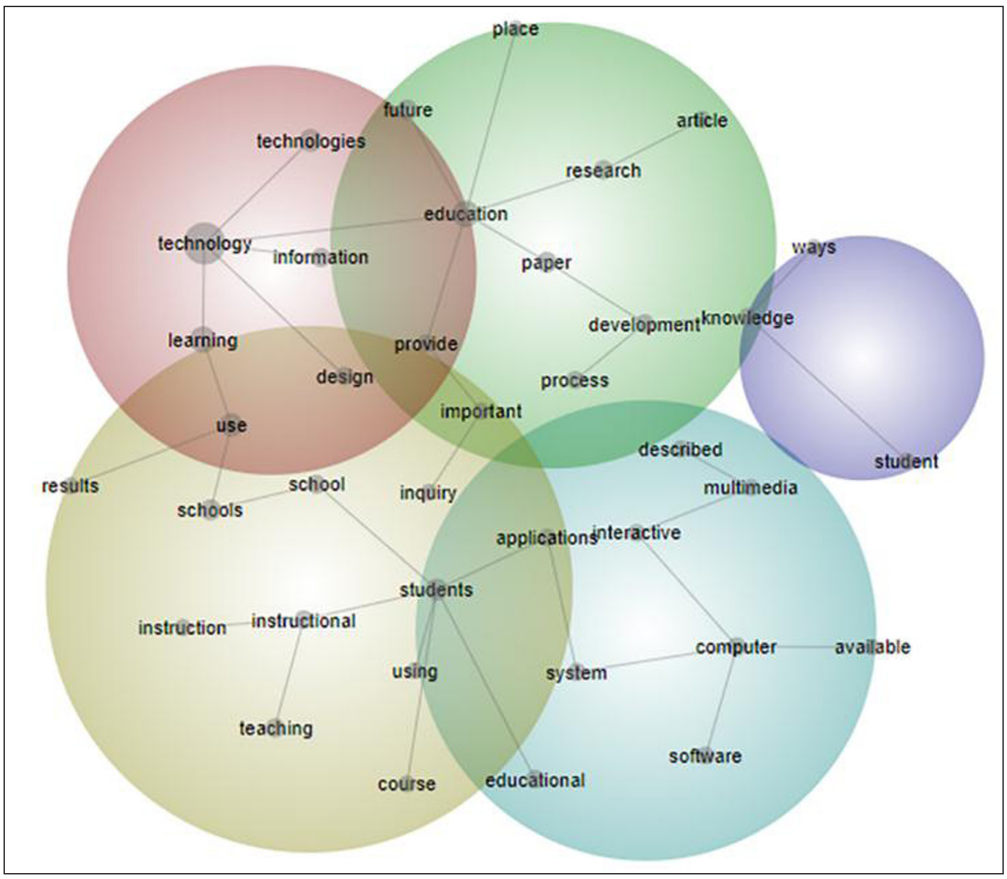


Figure 4: Concept map for the time period between 1993 and 1999.

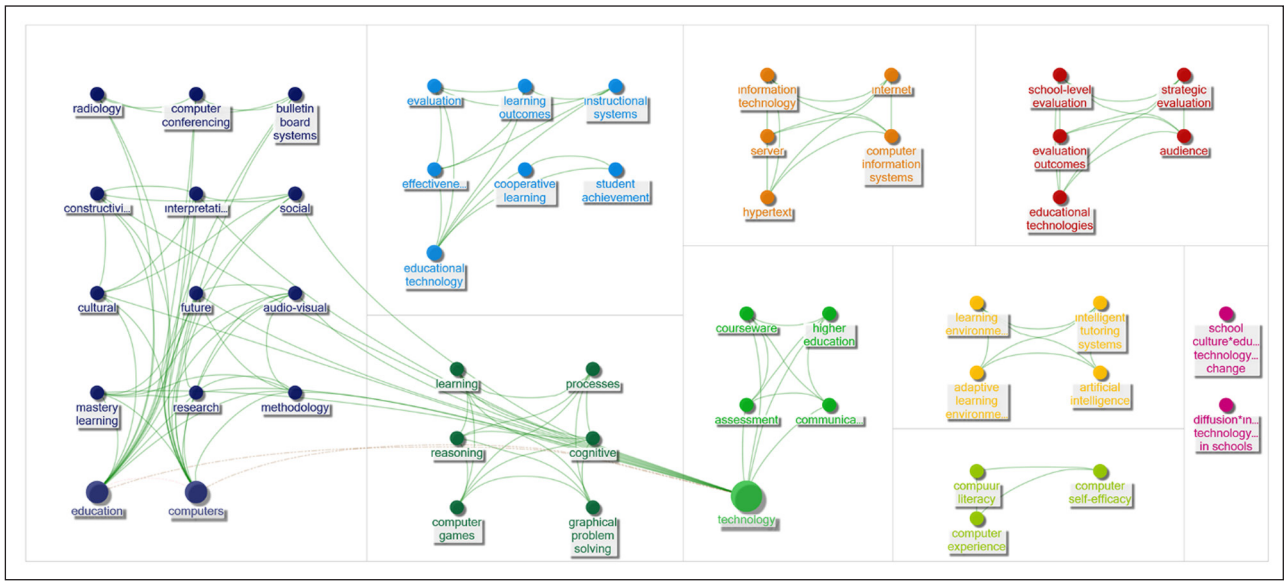


Figure 5: Sociogram for the time period between 1993 and 1999.

and criticism (Noble 1996) on the potential of educational technology.

2000-2004: Convergence of educational technology, distance education and online learning environments, and educational technology integration in traditional learning settings

At the turn of the new millennium, from 2000 to 2004, two significant themes, *(I) the convergence of educational technology, distance education and online learning environments (Path: educational, technology, education, distance) and (II) educational technology integration in traditional learning settings (Path: technology, educational, teaching, teacher, students, schools and technologies, institutions, applications, future)*, form the spine of the concept map (see **Figure 6**). Similarly, the SNA demonstrated that the most significant keywords with high betweenness centrality were *technology, education, educational technology, learning,* and *learning environments* (see **Figure 7**). The most cited articles from the sample confirm that the online learning environments (Gerjets & Hesse 2004; Winn 2002) that resulted from the convergence of two disciplines, that is educational technology and distance education, had a transformative effect (King 2002), affecting the use of educational technology in traditional learning environments and the integration of educational technology in schools and higher educational institutions by focusing on students and educators (Clarke III, Flaherty, & Mottner 2001; Margerum-Leys, & Marx 2002). This process, however, was accompanied by rising concerns on the effectiveness of educational technology (Norris et al. 2003).

2005-2009: Revising curriculum for educational technology, educational technology in higher education and distance education, and the bottleneck of the significant differences in educational technology research

In the transition period from Web 1.0 to Web 2.0 technologies, that is from 2005 to 2009, three major themes were identified, namely, *(I) revising curriculum for educational technology (Path: research, study, design, data, field, practice), (II) educational technology in higher education and distance education (higher, distance, education, learning, educational, teaching), and (III) the bottleneck in educational technology research (Path: based, development, data, analysis, significant)* as the baselines in the concept map (**Figure 8**). SNA confirms the findings derived from text mining. The nodes with high betweenness centrality are *educational technology, technology, teacher training, distance education, teaching and learning, multimedia, educational technology standards, innovation, curriculum, education,* and *computer attitude* appeared as significant between 2005 and 2009 (**Figure 9**). Papers that are most cited in this era confirm the concepts emerged through text mining. For instance, the necessity to recalibrate the curriculum (Vanderlinde, van Braak, & Hermans 2009) with approaches such as TPACK (Koehler, & Mishra 2005) and research methodologies (Amiel, & Reeves 2008) appear to be an important concern between 2005 and 2009. It is also noteworthy to say that researchers in this period used both educational technology and distance education interchangeably (Luppicini 2008; Ozana 2007), and that the convergence of these fields was more apparent. However, criticism about theoretical inadequacy (Albirini 2007) and the heavy reliance on the positivist paradigm, which creates a bottleneck for educational technology, and the tendency to think that each innovative technology would save education, were still very much alive (Mishra et al. 2009).

2010-2014: Online learning and higher education, integration of ICT and full potential of educational technology

In the Web 3.0 period, from 2010 to 2014, two themes emerged, namely *(I) online learning and higher education (Path: courses, online, students, use, learning, educational, technology, and higher, education, educational, technology), and (II) integration of ICT and full potential of educational technology (Path: ICT, educational, technology, integration)*

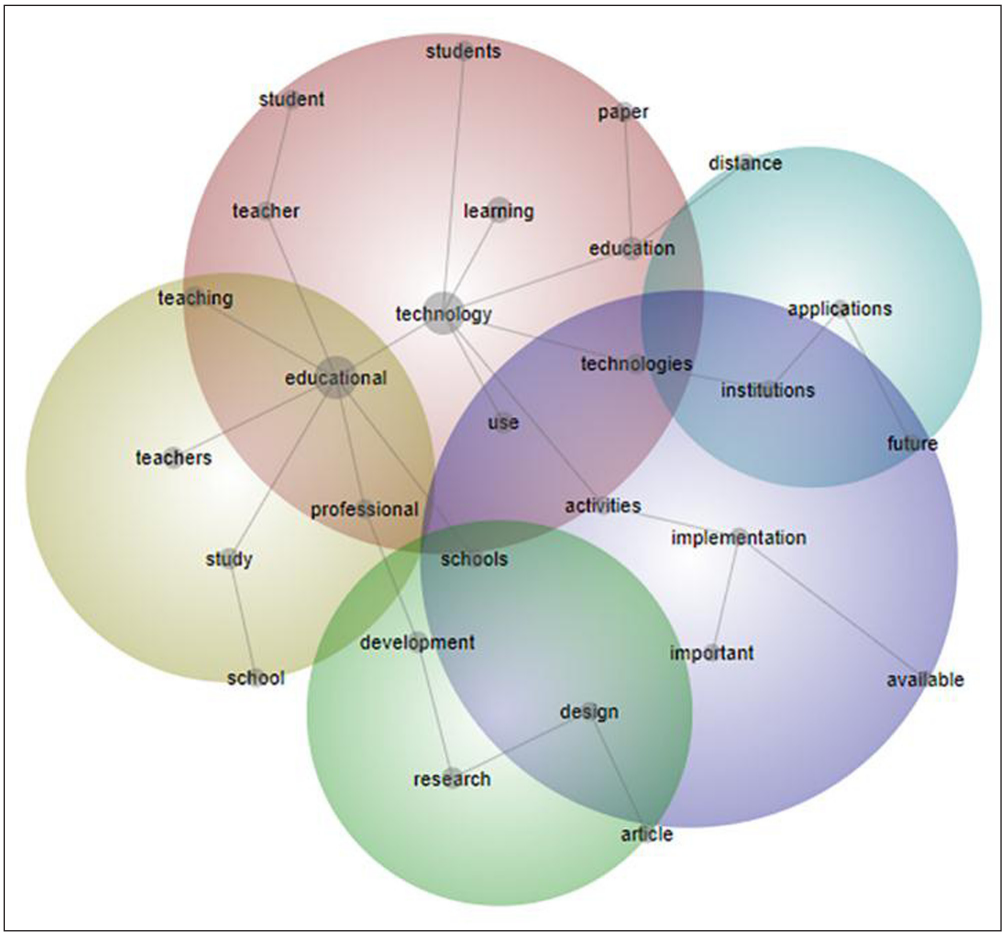


Figure 6: Concept map for the time period between 2000 and 2004.

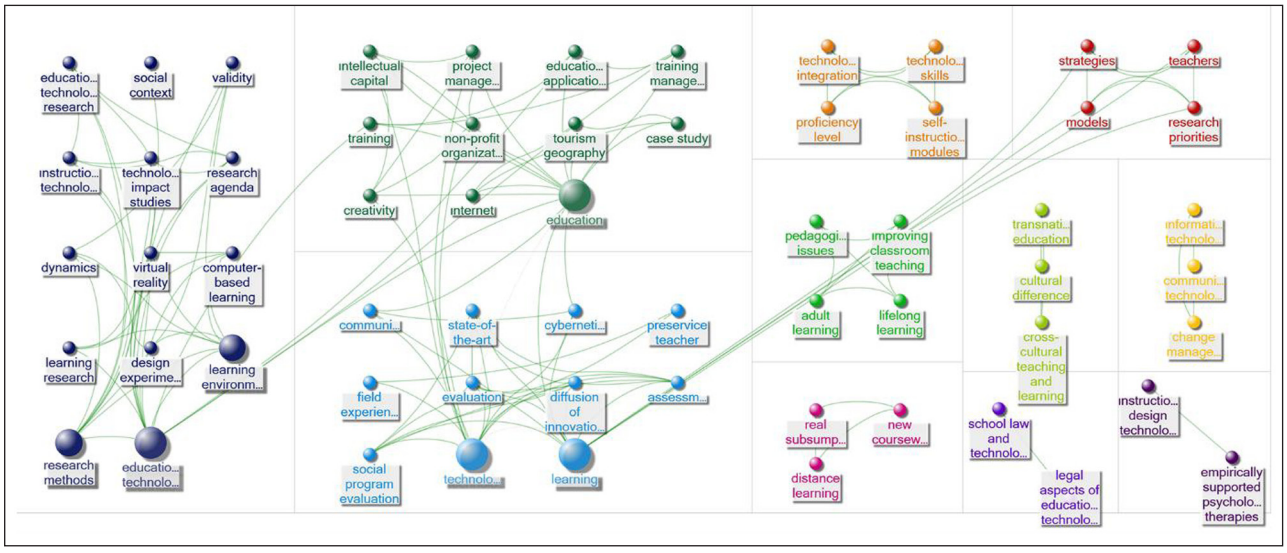


Figure 7: Sociogram for the time period between 2000 and 2004.

(**Figure 10**). When the nodes with high betweenness centrality were investigated, it was found that more keywords, compared to earlier periods, held strategic positions in the sociogram, meaning that educational technology had widened its intellectual landscape. Accordingly, these keywords were *educational technology, e-learning, technology, technology skills, higher education, education, assessment, technology integration, educational technology acceptance,* and *distance learning* (**Figure 11**). The sample articles with the most citations confirm the concepts identified through text mining. Accordingly, online education [market] had substantially grown, and there was a lot of interest for online learning in higher education settings (Fuller et al., 2014). Moreover, these articles highlighted the need to prepare educators for ICT integration for future educational practices (Koc & Bakir 2010; Sang et al. 2010).

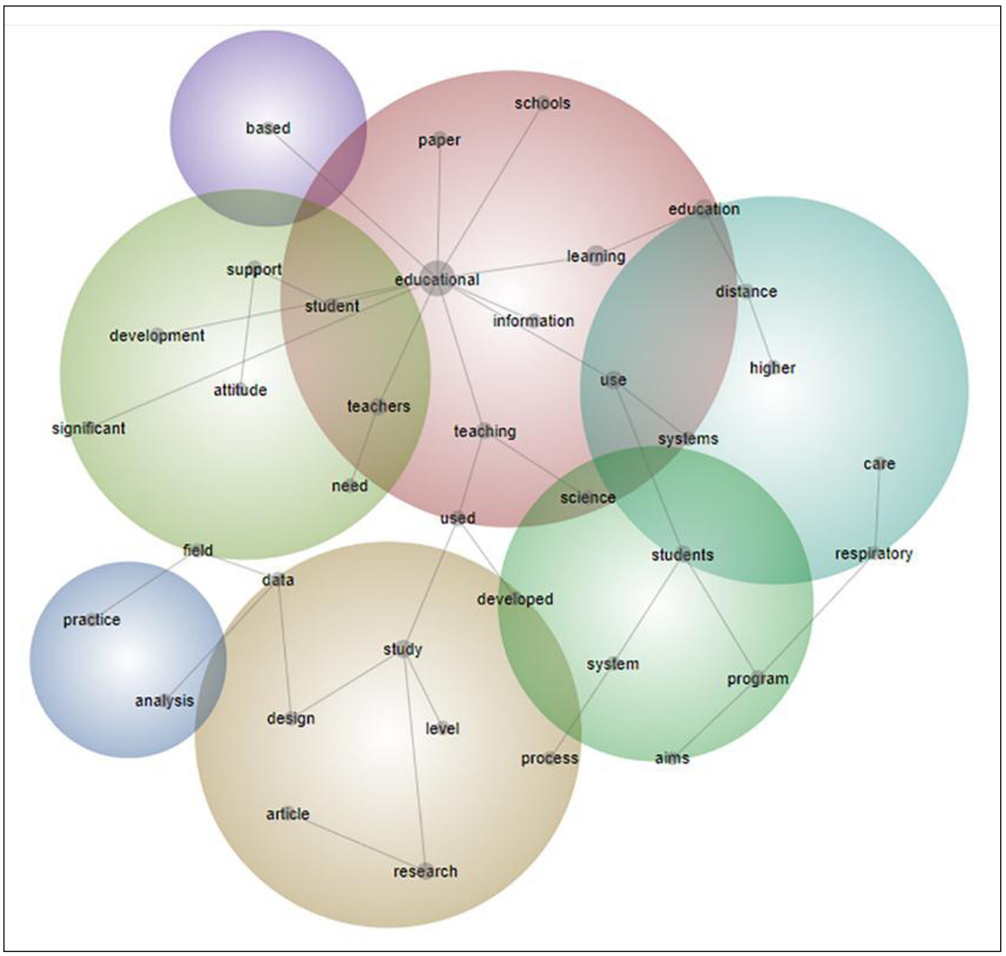


Figure 8: Concept map for the time period between 2005 and 2009.

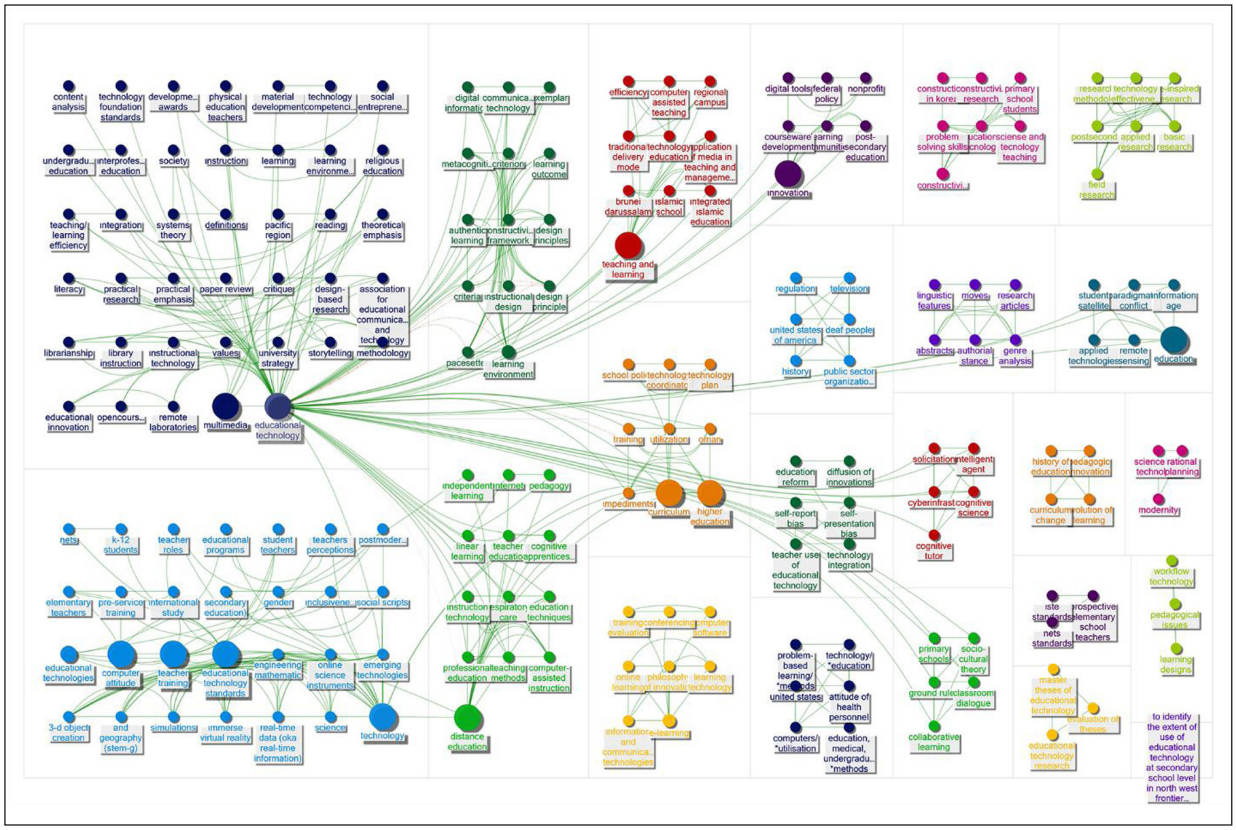


Figure 9: Sociogram for the time period between 2005 and 2009.

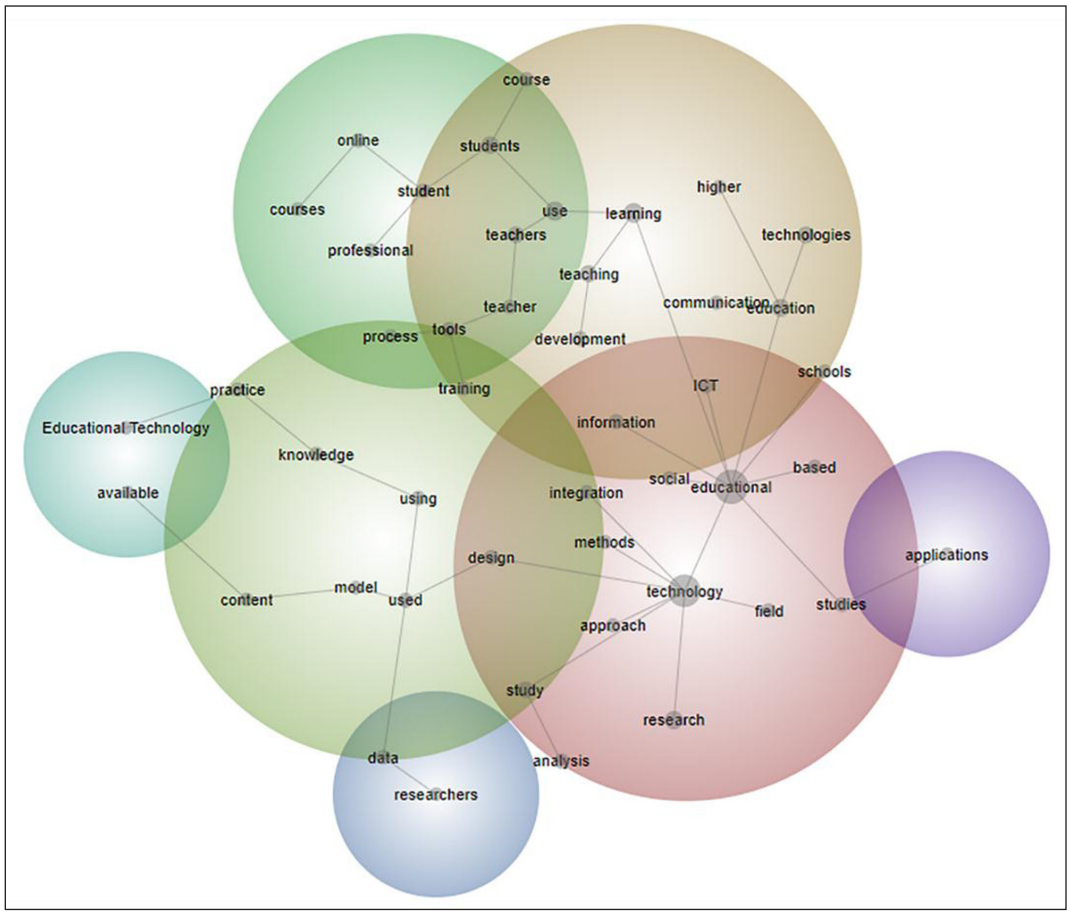


Figure 10: Concept map for the time period between 2010 and 2014.

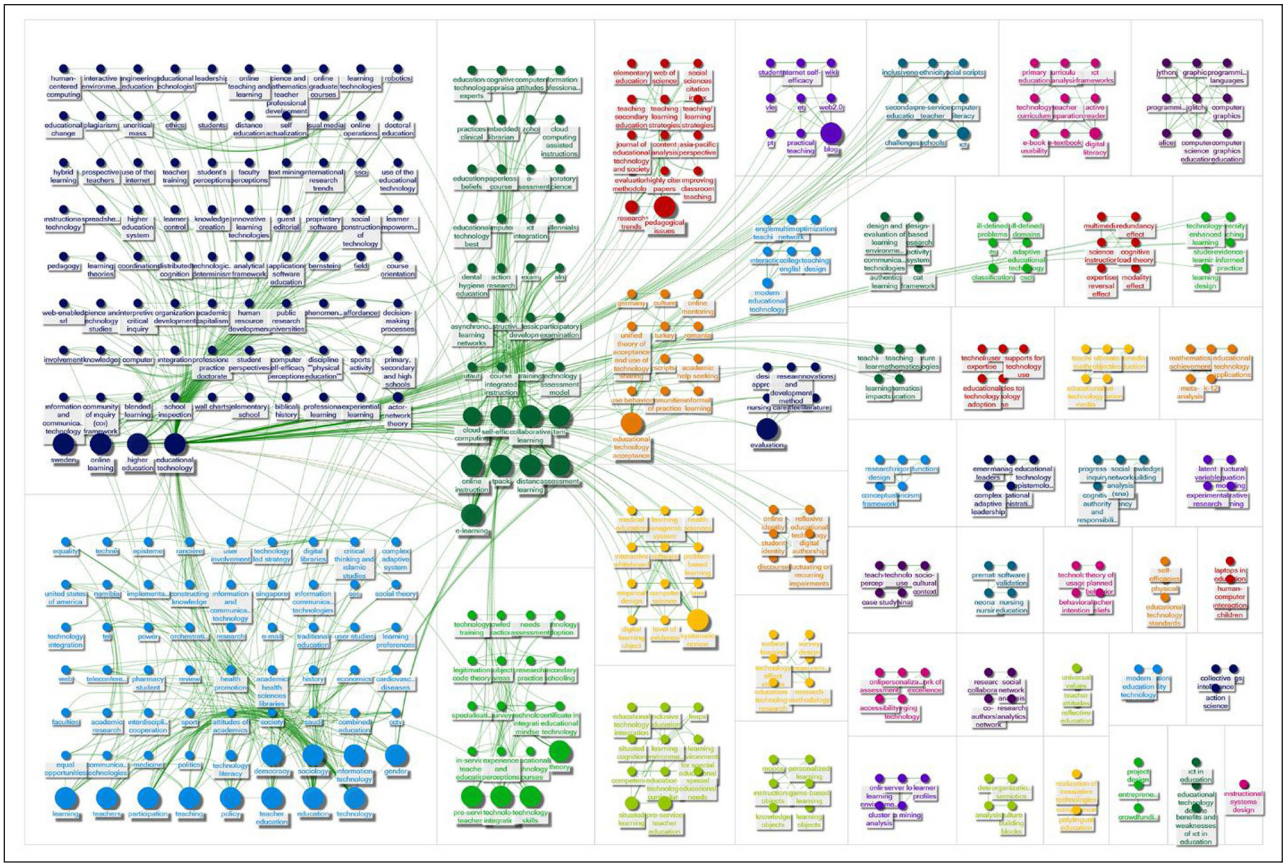


Figure 11: Sociogram for the time period between 2010 and 2014.

However, against all the excitement of educational technology, the critical voices grew louder, claiming that educational technology was socially constructed and a negotiated entity and arguing that the technology should be used to facilitate objective and realistic discourses that bring the issues of democracy and social justice to the forefront (Selwyn 2010). It was further claimed that "many educational technologists are understandably ill-disposed towards anyone whose actions disrupt their own personal faith and optimism" (Selwyn 2011, p. 713). Others argued that educational technology researchers, with their technological determinist stand, overemphasize the influence of technology, and that there was an urgent need to redefine our understanding of the relationship between technology and learning (Oliver 2011).

2015-2019: Data-driven, smart educational technology, big data, and learning analytics

As an extension of e-learning and m-learning, ubiquitous learning not only offered educational technologies but also prompted the idea that more thought should go into educational technology ethics (e.g., consent to access learners' private data, concept of surveillance society). From 2015 to 2019, *data driven smart educational technology and learning analytics (Path: educational, technology, data, based)* were rising themes in educational technology research (**Figure 12**). SNA revealed nodes that supported the results of the text-mining analysis. Accordingly, *educational technology, education, higher education, technology, big data, personalized learning, technology integration, school reform, gaming, artificial intelligence, decision-making, culture, MOOC, TAM,* and *learning analytics* were among the nodes with high betweenness centrality (See **Figure 13**). Among the articles that were most cited, the concepts of educational data mining (Angeli et al. 2017) and intelligent educational systems (Nye 2015) emerged as elements of the new research agenda. Moreover, along with investigation of the topic of ICT integration (Tondeur et al. 2016), the topic of faculty resistance was also examined (Watty, McKay, & Ngo 2016). Research on the personalization of education highlighted the absence of pedagogical perspectives (Bartolomé, Castañeda, & Adell 2018), while studies on mobile technologies looked closely at these technologies in terms of cross-cultural issues (Tarhini, Hone, & Liu 2015), mobile, ubiquitous learning (Domingo & Garganté 2016) and educational distraction (Aagaard 2015).

Besides the rise in critical stances, the tone and discourse on educational technology is somewhat different from those of earlier eras. With the possibilities emerging from e-learning, m-learning, and u-learning, recent concerns have shifted from technology determinism and constant efforts to prove the effectiveness of educational technology to ethical and equity issues. For instance, datafication, justice and equality (Macgilchrist 2019), ethics and privacy in big data and learning analytics (Ifenthaler &

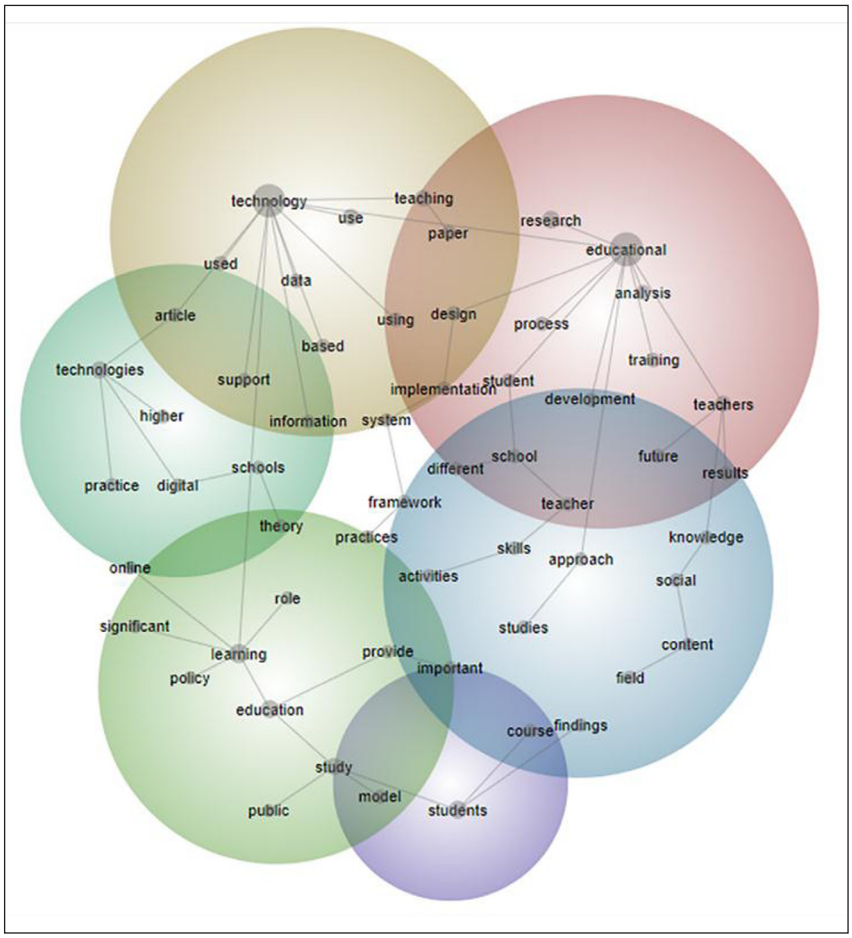


Figure 12: Concept map for the time period between 2015 and 2019.

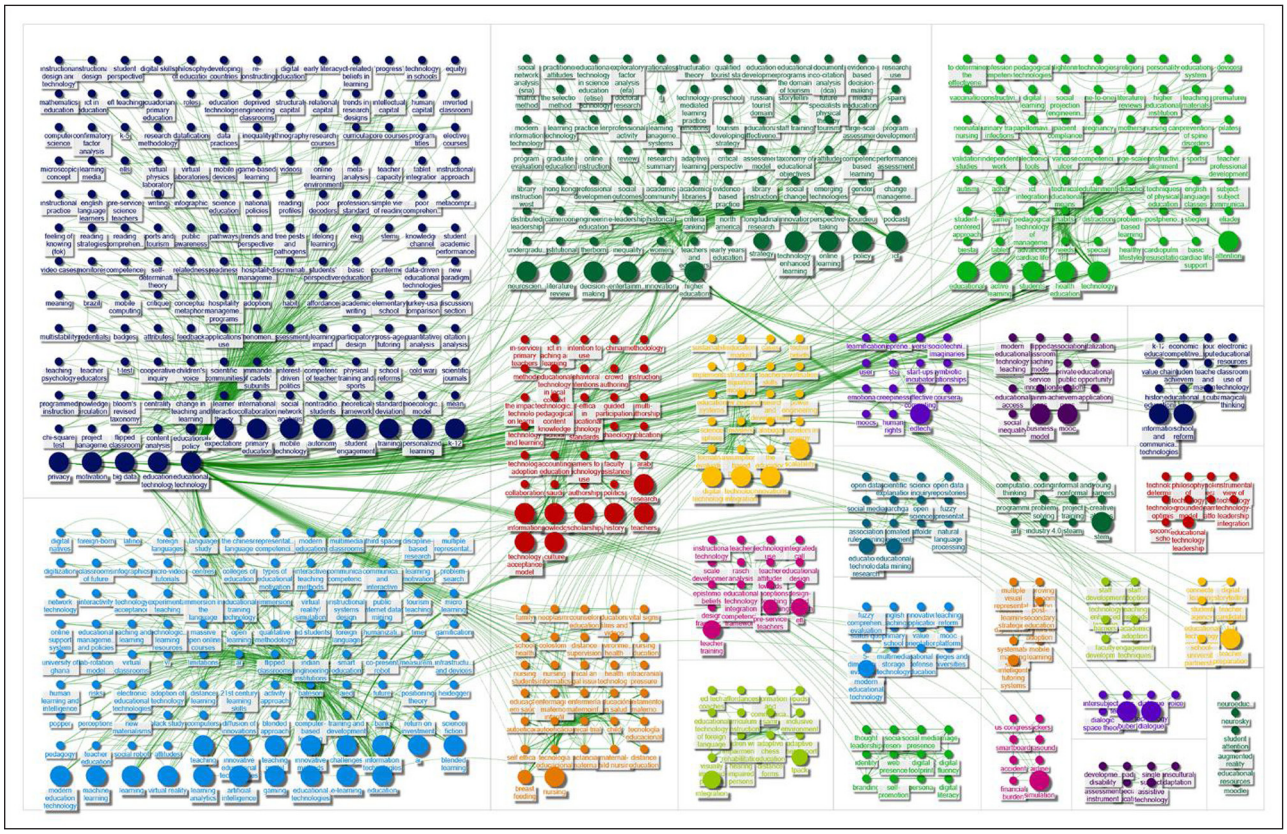


Figure 13: Sociogram for the time period between 2015 and 2019 (isolated nodes were removed).

Tracey 2016; Regan, & Jesse 2018) and ongoing optimistic predictions on the future of educational technology and hypes (Cuban, & Jandrić 2015) were critical issues on the educational technology agenda between 2015 and 2019.

Conclusion and Suggestions

This study concludes that from the inception of the public availability of the World Wide Web, the field of educational technology has grown enormously and has become a more data-driven and technology-centric field (**Figure 14**). The time trend demonstrated that after the first decade of the 2000s, the half-life of the knowledge shortened; and empirical and intellectual growth in the educational technology field doubled. The analysis of subject areas indicated that the educational technology field is dominated by three areas, social sciences, computer science and engineering, with social sciences leading the pack at 50% of all contributions. The geographical presentation of educational technology publications showed an identical pattern with that of earlier studies, with the US and UK being the leading countries hosting the most researchers.

In addition to the above conclusions, there are other important observations to further note. It was observed that *innovative* is a magical word (see SNA figures) and there is a tendency to refer to innovative, exciting technologies as *the next best thing* that will save education; and moreover, as these technologies change, they are expected to transform education, perhaps even replace educators. There are those who are lured by the novelty effect responsible for generating many hypes throughout the history of educational technology and who consider *EdTech as the savior descending from heaven.* While there has been rising awareness about the ethical side of educational technology, especially after 2015, ethics had been only a minor concern for a long time. Now there is an urgent call to further develop the research area of educational technology and ethics. As already echoed in educational technology literature, the lure of innovative technologies has surpassed theoretical bases of the field, prompting a critical warning for the future of educational technology. However, it is also promising to see that critical voices and views are diverse and louder, which is important in terms of improving the field, sustaining it, and mitigating the influence of those who wish to turn educational technology into a technology centric and for-profit initiative.

Another Achilles heel of the educational technology field is its strong belief in the positivist paradigm and a never-ending quest to prove whether educational technology is effective. The related literature features many articles targeting [the highest] effect sizes, which confines the field and only serves to create its own echo chamber, where researchers frantically pursue significant difference and consider such studies as the gold standard.

Another similar pursuit compromising the educational technology field is *technology integration* into the educational processes. Considering that learning is social, contextual, and goes beyond observed behaviors, what's needed is technology adaptation, which is a smooth and natural process, as opposed to integration, which is more about combining two things and involves a planned series of events. It would be worthwhile here to revisit earlier questions: Should we learn with technology or learn from technology?

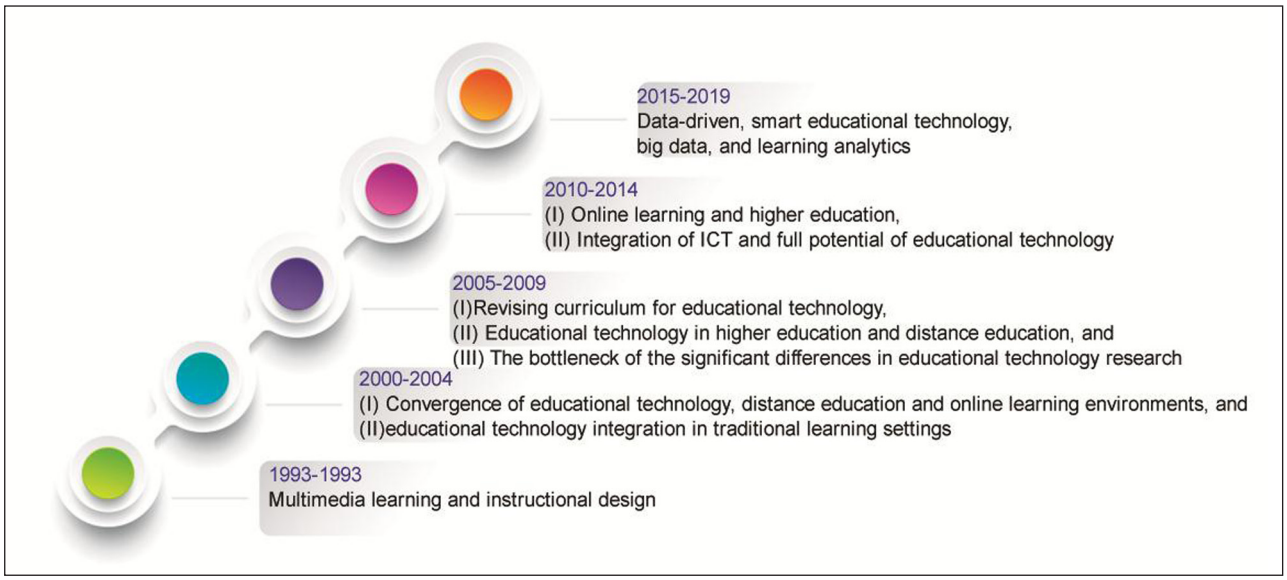


Figure 14: The growth of the educational technology field and emerged themes.

As a final remark, it is quite clear that while technology constantly changes, the discourse remains the same. Some are lured by the technology, whereas others blame technology for making humans fools. The fact that the same terminology and discourse mark each of the periods examined gives one the sense of *deja vu* and is a reminder that history repeats itself, and apparently, will continue to repeat itself.

Additional Files

The additional files for this article can be found as follows:

- **Appendix 1:** Keywords. DOI: https://doi.org/10.5334/jime.570.s1
- **Appendix 2:** Countries. DOI: https://doi.org/10.5334/jime.570.s2
- **Appendix 3:** Authors. DOI: https://doi.org/10.5334/jime.570.s3
- **Appendix 4:** Publication Resources. DOI: https://doi.org/10.5334/jime.570.s4

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Competing Interests

The author has no competing interests to declare.

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