EDUCATIONAL TECHNOLOGY: A COMPARISON OF TEN ACADEMIC JOURNALS AND THE NEW MEDIA CONSORTIUM HORIZON REPORTS FOR THE PERIOD OF 2000-2017

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This exploratory and descriptive study provides an increased understanding of the topics being explored in both published research and industry reporting in the field of educational technology. Although literature in the field is plentiful, the task of synthesizing the information for practical use is a massive undertaking. Latent semantic analysis was used to review journal abstracts from ten highly respected journals and the New Media Consortium *Horizon Reports* to identify trends within the publications. As part of the analysis, 25 topics and technologies were identified in the combined corpus of academic journals and *Horizon Reports*. The journals tended to focus on pedagogical issues whereas the *Horizon Reports* tended to focus on technological aspects in education. In addition to differences between publication types, trends over time are also described. Findings may assist researchers, practitioners, administrators, and policy makers with decision-making in their respective educational areas.

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CHAPTER 1

INTRODUCTION

As quickly as technology seems to change and enhance many aspects of everyday life, the field of education seems to follow a slower trajectory with similar levels of advancement. However, this is not due to a lack of quality research and examples of excellence in practice in the field of educational technology.

There are several major sources to draw from when looking to understand the state of the field: peer-reviewed research, industry reports, and alternative forms of information distribution (e.g. opportunities via the internet such as networked presentations, blogs, and e-books). Managing the amount of information available to synthesize the body of knowledge in the field of educational technology is a massive undertaking. However, this pursuit of sense-making is important when making sound decisions that will impact teaching and learning.

Statement of the Problem

In the 21st century, educational technology has emerged as a vehicle that transforms education and promises to enhance its quality. Many research efforts and substantial funding have been spent on research regarding the role of technology in teaching and learning however, practical application in the field remains challenging. Literature on the topic of educational technology is also plentiful as evidenced by the existence of 270 academic journals focused on this topic alone (Perkins & Lowenthal, 2016). According to Kulkarni, Apte, & Evangelopoulos (2014):

> Academics publish copious quantities of research articles that reflect the state of the art in their respective disciplines. On a broader scale, the combined content of such

> research articles reflects an underlying intellectual structure of the discipline, the understanding of which can help answer such questions as where the field has been, where its key publication outlets have shortcomings, what the contemporary trends in topics and research methods are, and what opportunities lie ahead (p. 972).

With the affordances of technology and the internet, researchers are also using other venues for sharing their work. These venues include networked presentations, e-books, social media, blogs, and industry reports (Johnson, Adams Becker, Cummins, Estrada, Freeman, & Ludgate, 2013). These venues add to the abundance of resources available to those looking to educate themselves about the uses and applications of educational technology. However, with this vast amount of information comes the reality that digesting these resources is no small feat.

Efforts at distilling information about educational technology trends through content analysis have been done previously however, the rapid development of technologies makes for a constantly changing research agenda also possibly influenced by outside factors such as publishing pressures and consumer hype. Robust methods are needed to analyze a large corpus of publications in order to provide a broadened view of the state of the field. Broadening the corpus to include additional publication types also extends the body of knowledge by incorporating relevant voices into the conversation. One way of doing so is to include publications popular with practitioners, such as industry reports, in the field of educational technology to help bridge the gap between theory and practice. In line with the goal of broadening the analysis, industry reports such as the New Media Consortium *Horizon Report*s were included along with academic research journals in this study. The *Horizon Reports* were used as a way to provide the practitioner voice in the analysis of topics and technologies being discussed between researchers and practitioners.

Purpose of the Study

The vast amount of literature and the additional forms of publication outlets makes content analysis a daunting task. Although previous research has been conducted (Natividad, 2016) to resolve some of the stated issues, there is room to expand this work by incorporating additional publications and to extend the periods of investigation. Comparing the topics and technologies published in academic research with those found in industry reports brings forward the shared topics of interest of those publishing in the field. The similarities and differences found between the publication types may also assist educators, education researchers, policy makers, research funders, and practitioners with making more efficient choices in how to focus their respective efforts. In addition, incorporating industry reports into content analysis research that has been traditionally reserved for academic journals only is a step forward in "seeing the forest" (Miller, Gefen, Narayanan, 2016), or having a more holistic view, of educational technology trends and the interplay between the publications intended for research *and* practice audiences.

Research Questions

This research was guided by the following research questions:

1. What topics and technologies in educational technology are evident in the combined corpus of ten academic journals and two types of *Horizon Reports* during the time period of 2000-2017?
2. How do the topics and technologies addressed by the researchers in the academic journals compare to those represented by practitioners in the *Horizon Reports* for the period of 2000-2017?

Assumptions

One challenge with this research was to determine a method for comparing article abstracts to industry reports. While abstracts are intended to provide a concise summary of the academic article industry reports rarely have an equivalent. For this research, one industry report represented the educational technology discussion for a full year. Breaking the report into individual paragraphs provided a mechanism to examine the contributions within one report to all the contributions made for the same year from the collection of academic journals. With this decision also came the assumption that abstracts are written adequately to reflect the content of the article it represents (Natividad, 2016).

Although many academic journals could have been selected, the ten academic journals included in this study, based on specific criteria, were believed to be accurate representatives of those topics and technologies being discussed in the field and therefore, also adequately reflect trends in the field. Likewise, the NMC *Horizon Reports* were selected to represent the industry reporting voice and are believed to accurately represent topics of interest for those in industry. A more specific description of the worthiness of the *Horizon Reports* is provided in the next section of this chapter. Finally, the methodology selected for content analysis was also considered to be an adequate means to derive the topics and technologies found in the corpus as supported by previous research using similar methodologies for similar purposes (Natividad, 2016; Winson-Geideman, & Evangelopoulos, 2013).

Rationale

Academic Journals

This study was inspired by the research previously conducted by Natividad (2016). She systematically identified ten top journals in the field of educational technology to examine closely. To narrow the journals for examination, she began with a pool of possible journals that was a combination of journals selected by editors associated with the National Technology Leadership Coalition (see http://ntlcoalition.org) and a comprehensive list published by J. Michael Spector as part of the Association for Education Communications and Technology (AECT) Tenure and Promotion Guide (see http://aect.site-ym.com/?publications_landing). The selection criteria to narrow the original list to ten final journals was based on five criteria:

- Impact factor: The five-year impact factor was considered a critical indicator, but it was not necessarily considered a reason to rule out certain journals that clearly published research and had a significant impact of the field.
- Scope: The scope of the journal should not be too narrow (e.g., distance learning) or too broad (e.g., teacher education); the scope should encompass all aspects of educational technology research, implementation, and deployment.
- Focus: The focus should be primarily on research findings rather than on anecdotal evidence or product reports.
- Readership: The readership should be broadly representative of educational technology research on a global level rather than on research in a particular country or region.
- Authorship: Authorship should be open to researchers around the world and not those associated with one group or professional association (Natividad, 2016, p. 8).

This research concurs that the set of ten journals selected by Natividad (2016) was appropriate to use in this expanded study.

Top Ten Journals

The ten journals selected for this study were:

1. *British Journal of Educational Technology*
2. *Computers and Education*
3. *Educational Technology: The Magazine for Managers of Change in Education*
4. *Educational Technology Research and Development*
5. *Instructional Science*
6. *Journal of Educational Computing Research*
7. *Journal of Educational Technology & Society*
8. *Journal of the Learning Sciences*
9. *Journal of Research on Technology in Education*
10. *TechTrends*

A brief description of each of the ten journals is provided to describe the journal's stated aims, publishing schedule, and examples of special issue topics.

1. British Journal of Educational Technology. This journal publishes "theoretical perspectives, methodological developments and high quality empirical research" (British Journal of Educational Technology, 2017, para. 1). Areas of interest include the investigation of instructional and educational technology in formal and informal settings at all levels. The selection process for papers accepted to this journal are based on rigor and "its potential to make a substantive and original contribution to the field, with explicit reference to international significance (British Journal of Educational Technology, 2017). This journal publishes on a bi-monthly schedule that includes special issues during the year on topics such as emerging technologies and transforming pedagogies in 2016, open data in learning technology in 2015, and technology enhanced learning in the workplace in 2014.

One distinguishing characteristic of the *British Journal of Educational Technology* is the request they make of authors to include "practitioner notes" with their paper submissions. According to Veletsianos (2010b), this journal is the only academic journal making this type of request of their submitting authors. Notes should include three or four bullet points that address the following questions:

- What is already known about this topic?
- What this paper adds?
- Implications for practice and/or policy? (Veletsianos, 2010b)

2. *Computers and Education*. This journal "aims to increase knowledge and understanding of ways in which digital technology can enhance education" with a specific focus on the "pedagogical uses of digital technology" (Computers and Education, 2017, para. 1). In 2000, this journal published seven issues per year but has gradually increased to a monthly schedule. Past special issue topics have included augmented reality learning in 2013, serious games in 2011, and learning with ICT in 2009.

3. *Educational Technology: The Magazine for Managers of Change in Education*. This bi-monthly magazine is focused on the research, development, and application of educational technology in a variety of environments (Educational Technology, 2017). Focus areas include private and public sectors, K-12 and higher education, and the issues and challenges associated with educational technology from a worldwide perspective. Special issues topics have included educational technology in Europe in 2012, ICT and e-learning in the Middle East in 2010, and learning via smart objects in 2008. This magazine includes a series of regular features that are contributions from established researchers and authorities in the field. While this magazine was not indexed, it has been one of the most influential publications in the field since the early

1960s. As it happens, this journal has now ended its long period of leadership in the field due to the death of the editor and owner.

4. *Educational Technology Research and Development.* This journal claims to be the only journal focused entirely on research and development in educational technology. The research section is focused on original research relating to “applications of technology or instructional design in educational settings” whereas the development section “publishes research on planning, implementation, evaluation and management of a variety of instructional technologies and learning environments (Educational Technology Research and Development, 2017, para. 1). A third section focuses on the cultural and regional perspectives (previously called international perspectives) that are being used in educational technology contexts. This bi-monthly publication has published special issues on the topic of ethics and privacy in 2016, virtual environments in 2015, and game based learning in 2014.

5. *Instructional Science*. The aim of this journal is to promote “a deeper understanding of the nature, theory, and practice of learning and of environments in which learning occurs” (Instructional Science, 2017, para 1.). This publication is primarily interested in empirical research but in all areas of curriculum, demographics, and contexts. Operating on a bi-monthly publication schedule, special issues are typically published once per year and have focused on topics such as teachers’ professional and vision and discourse abilities in 2016, participatory design in 2014, and collaborating with digital tools and peers in medical education in 2012.

6. *Journal of Educational Computing Research*. This journal is an “interdisciplinary scholarly journal that publishes research reports and critical analyses on educational computing to both theorists and practitioners” (Journal of Educational Computing Research, 2017, para. 1).

This journal states four primary areas of research interests: the outcome of effects of educational computing applications, the design and development of innovative computer hardware and software, the interpretation and implications of research in educational computing fields, and the theoretical and historical foundations of computer-based education (Journal of Educational Computing Research, 2017). The journal claims to feature useful articles for practitioners as well as theorist publishing eight times per year.

7. *Journal of Educational Technology & Society*. This publication is interested in “the issues affecting the developers of educational systems and educators who implement and manage such systems” (Journal of Educational Technology & Society, n.d., para. 2). Working on a quarterly publishing schedule, this journal aims to help the developer and educator communities better understand each other and how to support each other. Special issues have included topics such as intelligent and affective learning environments in 2016, managing cognitive load in 2015, and game-based learning in 2014. This journal is also coming to an end in the near future, which represents the loss of an important online, open access refereed journal.

8. *Journal of the Learning Sciences*. This journal operates on a quarterly publishing schedule and “provides a multidisciplinary forum for research on education and learning that informs theories of how people learn and the design of learning environments” (Journal of the Learning Sciences, 2017, para. 1). Special issues have focused on topics such as cultural-historical activity theory approaches to design-based research in 2016, learning analytics and computational techniques for detecting and evaluating patterns in learning in 2013, and modalities of body engagement in mathematical activity and learning in 2012.

9. *Journal of Research on Technology in Education*. This quarterly publication focuses on research that "defines the state of the art, and future horizons, of learning and teaching with technology in educational environments" (Journal of Research on Technology in Education, 2017, para, 1). Special issues have focused on computer-mediated communication in 2003, educational computing research and development in 1999, and the assessment of the impact on computer-based learning in 1996.

10. *TechTrends*. This journal claims to be the "leading journal for professionals in the educational communication and technology field" with the purpose of specifically linking research and practice to improve learning (TechTrends, 2017, para. 1). The journal publishes articles on a bi-monthly schedule that contribute to "the advancement of knowledge and practice in the field" (TechTrends, 2017, para. 1). Of the ten journals selected, this journal has the most inclination toward professional practitioners.

A list of the journal names, description, publishing schedule, and H-Index is provided in Table 1 as a summary.

Table 1

Ten Selected Journals, Description, and H Index as Designated by Scimago Lab (2016)

Journal Title	Publisher / Country	Publishing Schedule	H Index
British Journal of Educational Technology (BJET)	Blackwell Publishing Inc. / United Kingdom	Bi-monthly	63
Computers and Education (CE)	Pergamon Press Ltd. / United Kingdom	Monthly	109
Educational Technology: The Magazine for Managers of Change in Education (ETMAG)	Association for Educational Communication and Technology (AECT) / United States	Bi-monthly	N/A
Educational Technology Research and Development (ETRD)	Association for Educational Communication and Technology (AECT) / United States	Bi-monthly	63
Instructional Science (IS)	Kluwer Academic Publishers; / Netherlands	Bi-monthly	51
Journal of Educational Computing Research (JECR)	Baywood Publishing Co., Inc. / United State	8 times / year	42
Journal of Educational Technology & Society (JETS)	IEEE Computer Society / United State	Quarterly	55
Journal of the Learning Sciences (JLS)	Lawrence Erlbaum Associates Inc. / United States	Quarterly	70
Journal of Research on Technology in Education (JRTE)	Taylor & Francis Ltd. / United States	Quarterly	6
TechTrends (TETR)	Association for Educational Communication and Technology (AECT) / United States	Bi-monthly	22

Horizon Reports

A second branch of established publications also significant to the field of educational technology are industry reports. While not indexed or peer-reviewed, several industry reports serve as information resources to stakeholders in educational environments. Open, digital access allows for wide dissemination and high readership of these industry reports. The selected resource for comparison in this study was the New Media Consortium's *Horizon Reports.*

The New Media Consortium (NMC), a not-for-profit organization, originated in 1993 when a group of hardware manufacturers, software developers, and publishers from companies including Apple Computer, Adobe Systems, Macromedia, and Sony realized that gaining mainstream acceptance would be enhanced by greater involvement with the higher education community. The group conducted a strategic search which resulted in adding twenty-two higher education institutions "chosen for their demonstrated competence in using new media technologies, as well as their geographic distribution and breadth of academic specialties" (NMC Horizon, n.d., para. 3). By 1994, the group of institutions formed a non-profit organization known as the New Media Center, headquartered in San Francisco. The Center served as a hub to facilitate conversation and collaboration between academic institutions, publishers, legal experts, and other interested parties on matters such as key pedagogical, technological, and legal issues among centers (para 4). By 1998, the Center expanded internationally and included over 200 colleges, universities, and museums.

The Horizon Project, "a forward-looking ongoing research project" (para. 7) was started in 2002 with the help of industry leaders to address teaching and learning challenges. In 2004, the NMC published the first *NMC Horizon Report*, an annual report intended to "identify important developments, technologies, challenges and trends" (para. 8) with editions focused on higher education. Through 2007, the reports had been primarily focused on the U.S. market but beginning in 2008, the reports began reaching a global market by incorporating regionally specific, Australia – New Zealand and Iberoamerican editions. Beginning in 2009, K-12 focused editions were added to the annual publications. The scope of the reports is to chart the landscape of emerging technologies for teaching, learning, and creative inquiry.

The reports are publicly and freely available worldwide. To date, 50 editions have been published with readership in over 160 countries and 50 foreign language translations. At the time of this writing, the NMC reported over 500,000 report downloads and over one-million readers. Although the *Horizon Reports* do not have an impact factor that can be compared against those of the academic journals, the number of downloads and readership is a measure of the frequency in which the reports are accessed. In total, the Higher Education *Horizon Report* began in 2004 with ongoing publications through 2017 and the K-12 *Horizon Report* began in 2009, also with ongoing publications through 2017 (see Table 2).

Table 2

Breakdown of Horizon Reports by Type

Type	Years Published	Number of Reports
Higher Education	2004-2017	14
K-12	2009-2017	9

The methodology for the annual report uses a Delphi-based voting cycle to initiate the process. Input is gathered from an international expert panel made up of education and technology experts from both public and private sectors. To maintain a fresh perspective, one-third of the panel members are new to the research project each year. Member selection is based on a nomination process where those interested can nominate themselves or a colleague (see http://www.nmc.org/nmc-horizon-project-expert-panel-nomination/). After the panel is assembled, they begin a systematic review of the literature which also includes "press clippings, reports, essays, and other materials – that pertains to technology developments, trends and challenges, current research and reports" (p. 50). Submissions are also solicited on the NMC website (see http://www.nmc.org/nmc-horizon-project-submission-form/) for anyone with a "creative application of emerging technologies and new approaches to teaching and learning" ("NMC Horizon Project," n.d.). Selected projects are included in the final report and are responsible, although indirectly, for report authorship. Following the review, the panel engages in a discussion intended to address four research questions: 1) Which of the important developments in educational technology catalogued in the NMC Horizon Project Listing will be most important to teaching, learning, or creative inquiry for higher education within the next five years? 2) What important developments in educational technology are missing from our list? 3) What key trends do you expect to accelerate educational technology uptake in higher education? And 4) What do you see as the significant challenges impeding educational technology uptake in higher education during the next five years? (Adams Becker et al., 2017, p. 50).

Responses to the research questions include importance and adoption Horizon category (i.e. 1 year or less, 2 to 3 years, or 4 to 5 years) which helps to identify weight and rank. These semi-finalist topics of top trends, challenges, and developments in technology are then researched further to discover teaching and learning implications in addition to exploring "real and potential applications for each of the topics that would be of interest to practitioners" (p. 51). Finally, the list is ranked again to determine the topics for inclusion in the final annual report.

The worthiness of the *Horizon Reports* as a reasonable candidate for inclusion in this study was assessed using Natividad's (2016) five-point criteria. The reports match four of the five criteria: impact factor, scope, readership, and authorship as discussed previously. Focus was the criterion in which the *Horizon Reports* do not fit, however, this was precisely the reason for including them in this study. The academic journals focus primarily on research findings rather than on anecdotal evidence or product reports. Although the *Horizon Reports* are also not intended to provide product reports, they do include specific examples of new approaches to educational technology being applied in the field. This focus area for the reports served as the means for justifying the *Horizon Reports* as a reasonable candidate for representing the practitioner perspective in this study. Table 3 provides a summarized comparison of the *Horizon Report*s to Natividad's (2016) original five-point criteria.

In Natividad's (2016) study, the period of investigation was 1995-2014. However, for the purpose of this study, only articles published since 2000 were examined. The rationale is that the *Horizon Reports* were first published in 2004. It is possible that trends in the academic journals may precede what is reported in the *Horizon Report*s. To account for this time delay, journal articles dating back to 2000 may help to identify leading trends first identified in the academic research and prior to the first *Horizon Report*.

Table 3

Summarized Comparison of the Horizon Reports against the Publication Selection Criteria

Criteria	Horizon Report
Impact Factor	Over 1 million readers and 500,000 report downloads
Scope	Chart the landscape of emerging technologies for teaching, learning, and creative inquiry.
Focus	*The departure from this criterion supports the main purpose of this research project.*
Readership	Publicly and freely available worldwide; Downloaded in 195 countries
Authorship	Submissions are openly accepted from anyone with examples of use in the field

Research Methods

Latent semantic analysis (LSA) is both a theory of meaning and a methodology for performing content analysis. Content analysis has the potential to extract explicit meaning and uncover hidden meaning in large sets of text (Landauer & Dumais, 1997). Because "word associations are created by the writer or speaker, not the reader" (Miller et al., 2016, p. 63), LSA is especially valuable in examining large sets of academic publications in educational technology because it helps illuminate how the discussion within the body of knowledge has changed over time.

LSA was the methodology used in the original research conducted by Natividad (2016) and the continued use of this method keeps further analysis consistent. Interest in this approach has increased over the last two decades since its first appearance in published research in the late 1980s (Evangelopoulos, Zhang, & Prybutok, 2012). According to

Evangelopoulos et al. (2012), “content analysis offers a bridge between textual data and quantitative analysis and has been employed in IS (Information Systems) research extensively” (p. 71). The value of LSA, rather than a qualitative approach, in content analysis is the ability to analyze large volumes of data that allows for coding textual data into categories or as a methodological aid in knowledge acquisition and retrieval.

The collections of corpora represent the communication system and underlying intellectual structure within a corpus-creating community (Landauer & Dumais, 1997). For this study, the communities that were analyzed are a) the research community responsible for the academic journal articles and b) the expert panel and authors of the *Horizon Reports*. The full corpus was represented by the article abstracts for the period of 2000 to 2016 for the ten selected journals and the paragraphs for the *Horizon Reports* for the period of 2000-2017.

Operational Definitions

- Academic journals - An academic journal is a periodical publication specific to an academic discipline containing scholarly articles in the form of original research, review articles, and book reviews. They serve as the main forum in which research is presented, examined, and discussed. The combination of academic journals for a particular discipline makes up the body of knowledge for that discipline.
- Correspondence analysis - Correspondence analysis can be used to describe multivariate data for the purpose of “estimation in latent variable models” (Lynn & McCulloch, 2000, p. 561). According to Evangelopoulos (2016), “correspondence analysis extracts principal components from a contingency table (cross-tabulation) that lists frequencies of occurrence of

all levels of a row factor across the levels of a column factor" (Evangelopoulos, 2016, p. 42). In this study, correspondence analysis was used to illustrate relationships between the academic journals and the *Horizon Reports* using topics and publications as factors.

- Documents - The data used in this study was made up of a collection of documents. Article abstracts were used to represent the articles from the academic journals. Paragraphs were used to represent the contents of the *Horizon Reports*. The term *documents* was used to generally describe both the abstracts and paragraphs. A more specific reference was used when it was accurate to do so. For example, *abstracts* were referred to when discussion was specific to the academic journal documents and *paragraphs* were referred to when discussion was specific to the *Horizon Report* documents. When discussion referred to both journal abstracts and report paragraphs, the term *documents* was used.

- Emerging technologies - For the purpose of this paper, the following definition of emerging technologies was adapted. Further discussion is provided in Chapter 2.

> Emerging technologies are tools, concepts, innovations, and advancements utilized in diverse educational settings to serve varied education-related purposes. Additionally, I propose that ("new" and "old") emerging technologies are evolving organisms that experience hype cycles, while at the same time being potentially disruptive, not yet fully understood, and not yet fully researched. (Veletsianos, 2010a, p. 3)

- Industry reports - An industry report is a comprehensive account, either private or public, paid or free, of a particular industry. According to Economywatch.com (2010), industry reports often include an industry definition, industry players, market share, historical and current trends, employment statistics, SWOT analysis, and outlook. These reports are often written in a manner in which non-industry professionals can understand. For this research, the NMC *Horizon Reports* were specifically selected to serve as the representative voice for the industry perspective. These reports focus on the historical and current trends, analysis, and outlook in the field of educational technology. Authors also report on use cases by sharing how specific technologies are being used in the field and by whom.

- Latent semantic analysis - Latent semantic analysis (LSA) is a theory and a form of text mining for extracting and representing the contextual-usage (semantic) meaning of words by statistical computations applied to a large corpus of text (Kantardzic, 2011, Landauer and Dumais, 1997). According to Miller et al. (2016), “LSA is a useful method to take advantage of large amounts of available text, discern meaning within the text, and see how meanings change over time” (p. 62) where meaning is derived from relationships between words, as concepts, rather than dictionary definitions.

- Publications - For the purpose of this research, publications refer to the twelve sources in which article abstracts and industry reports were collected. In this regard, publications are equivalent to the *sources* that provided the data for this study.

- Scree plot - A scree plot was used to determine the number of extracted topics in the data. According to the *Oxford Dictionary of Statistics*, a scree plot is:

> A plot, in descending order of magnitude, of the eigenvalues of a correlation matrix. In the context of factor analysis or principal components analysis a scree plot helps the analyst visualize the relative importance of the factors—a sharp drop in the plot signals that subsequent factors are ignorable. (Upton & Cook, 2016)

- Singular value decomposition - Singular value decomposition (SVD) is the factorization of a matrix. According to Kulkarni et al. (2014):

> In LSA, the term frequency matrix, **A**, is subjected to SVD, $\mathbf{A} = \mathbf{U \Sigma V}^{T}$, where **U** are the term eigenvectors, **V** are the document eigenvectors, **∑** is a diagonal matrix of singular values (i.e., square roots of common eigenvalues between terms and documents in the least-squares sense), and the superscript ^{T} denotes transposition. (p. 974)

Limitations

Several limitations exist as part of this research that should be acknowledged. First, if the number of actual academic journals is the 270 estimated by Perkins and Lowenthal (2016) then the number of journals included in this research represent just 4% of the total collection. Because of this, many trends or topics may not be addressed in the research due to articles missed that were published in other journals or alternative publication venues. However, the 270 journals have varying impact within the research community and the ten journals selected are among those with a high impact and are highly respected. They were carefully selected using systematic criteria (Natividad, 2016) in order to provide a broad overview of the greatest contributions to the international research community. Therefore, it is believed that they are sufficiently representative of the larger corpus and the research reported in them.

Authors and researchers have varying demands and motivations for publishing work. The studies included in the selected journals may be the result of areas that helped the authors with career advancement such as tenure and promotion rather than choosing to report on topics of greater relevance to teaching and learning (Carr-Chellman, 2006; Holcomb, Bray, and Dorr, 2003; Winson-Geideman & Evangelopoulos, 2013). This motivation may affect the resulting research trends due to a bias towards research on topics that have less relevance to practice and more toward topics with a greater potential for publication.

There are several industry reports that could have been chosen instead of or in addition to the *Horizon Reports*. Including a broader range of industry reports may provide greater insight into the emerging technology trends according to a larger representation of practitioners in the field. Some examples of other publications are *The Chronicle of Higher*

Education, which publishes a weekly print edition, *THE Journal*, which publishes six print editions a year, and the *EDUCAUSE Review*, another bi-monthly publication. These publications could be included in a future study to provide an elaboration of the contribution made by industry reports to the overall corpus.

This study may also benefit from a qualitative approach to better understand researchers, editors, and authors' intentions or process outside of what is provided in the publications or stated on the publication websites. Similarly, the quantitative approach used here includes the necessity of labeling topics that result from the LSA factor analysis. The process of labeling is subjective in nature regardless of the systematic approach used in determining topic labels.

Summary

According to Carr-Chellman (2006), "a deep understanding of any field rests upon a careful examination of its theories, research, and scholarship from many angles" (p. 5). This research intended to deepen the understanding of the field of educational technology by including the industry perspective in the examination of academic research. The combined corpus of ten academic journals and the NMC *Horizon Reports* served as a representation of the conversations happening in the field of educational technology between the academic and industry perspectives. LSA was the selected methodology to best manage the large quantities of information in the dataset to extract the topics and technologies of interest shared by both publications and then to compare the publication types for similarities and differences in their approaches to the topics. Recognizing limitations in the study, the contribution to the field remains in providing educators, education researchers, policy makers, research funders, and practitioners a view of the publications that may assist in decision-making and practical application in their respective areas of responsibility. The next chapter provides a review of the related literature to educational technology, educational technology research, and LSA.

CHAPTER 2

RELATED LITERATURE

The purpose of this study was to compare the topics and technologies published in academic research with those found in industry reports to bring forward the shared topics of interest of those publishing in the field of educational technology during the period of 2000-2017 and to compare how the topics are addressed in each type of publication (i.e. journals vs. reports). This literature review addresses the importance of educational technology research and previous efforts using content analysis to examine academic research. Summaries of the annual *Horizon Reports* are provided in addition to a brief explanation of latent semantic analysis as both a theory and a method.

Global agreement on the purpose and priority of education in most developed and developing nations can be commonly stated as including “(a) developing basic knowledge and skills, (b) developing problem solving skills in various domains and specialties, (c) developing critical reasoning skills, (d) developing responsible and productive behaviors and habits as a citizen, and (e) developing a capacity for life-long learning” (Spector, 2015, p. 2; Spector & Ren, 2015). One area in the field that has developed as a promising pathway for positive impact on education is educational technology that, according to Januszewski & Molenda (2008), is a discipline defined as “the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources” (p. 1). However, the debate over impact continues as spending remains high and learning outcomes questionable. Reported figures on educational technology spending in the U.S. vary but tend to be in the billions per year (Koba, 2015, McCandless, 2015) with one source predicting global spending to reach $252 billion by the year 2020 (PR Newswire, 2016). Not only is spending increasing but changes in the educational technology market have been dramatic.

Educational Technology

Technology can be defined as “the systematic application of knowledge to achieve a purpose valued by individuals or groups” (Spector & Ren, 2015, p. 2). This definition highlights the importance of application over actual hardware and software. In 1977, the Association for Educational Communication (AECT), after 14 years of work, acknowledged the difficulty in defining educational technology by calling it a “lonely and high-risk activity” (p. 10). However, the AECT task force offered a definition of educational technology that was comprised of 16 parts where all parts were “meant to be taken as a whole; none alone constituting an adequate definition of educational technology” (Association for Educational Communications and Technology, 1977, p. 19). Complexity of the definition was, in part, due to the effort made in acknowledging educational technology as a theory, a field, and a profession. In 2004, AECT offered the following shortened definition:

> Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources. (Januszewski & Molenda, 2008, p. 1)

The National Education Technology Plan provided by the U.S. Department of Educational Technology (2017), an educational technology policy document for the United States, was previously updated every five years. However, to keep pace with the rate of change and to respond to feedback from stakeholders, the department has increased its update cycle to once every year (p. 8). According to the 2017 report, “higher education has never mattered so much and to so many" (p. 6). As part of this shift, there is also a "new normal" in what the typical undergraduate student looks like. Using figures from the National Center for Education Statistics (2015), "74% of all undergraduate students have at least one nontraditional characteristic" (U.S. Department of Educational Technology, 2017, p. 7). They have characteristics such as working part or full time, being a first-generation college student, having at least one dependent, attending a two-year college, transferring between institutions before graduating or enrolling as a part time student (p. 7). Technology is an important factor in addressing the demands required to adequately accommodate this broad range of students. The report claimed that technology has the power "to revolutionize the delivery of education" with more student-centered approaches while offering "the opportunity to catalyze more significant reforms to educational structures and practices" (U.S. Department of Educational Technology, 2017, p. 9).

Practical application can be difficult despite the potential a technology has in learning. According to Spector and Ren (2015), as a new technology is introduced to mainstream society, it is slowly adopted into educational use but often without clear application. For example, overlooking pedagogy when attempting to apply the new technology can contribute to failed technology integration in the classroom. Accuosti (2014) discussed the importance of the social environment, teacher facilitation, and teacher skills in addition to the technology itself as important factors in technology integration. Others have identified demographics (Ghavifekr & Mahmood, 2017), performance expectancy, hedonic motivation, and habit and trust (El-Masri & Tarhini, 2017) as important factors in successful technology adoption efforts.

Emerging Technologies

Although the term, emerging technology, was not used in the 2017 U.S. Department of Educational Technology report, phrases like 'rapidly changing technology,' 'leveraging technology,' and 'new technologies' were. One reason those compiling the report may have avoided using the popular term "emerging" could be the difficulty researchers have had in defining it; although it would not be the only term in education with a reputation of being difficult to fully understand. Siemens (2008) stated that "terms like 'emergence,' 'adaptive systems,' 'self-organizing systems,' and others are often tossed about with such casualness and authority as to suggest the speaker(s) fully understand what they mean" (para. 1).

Similar to Siemens (2008), Veletsianos (2010a), noted that 'emerging technology' is "often used without a clear meaning or definition" (p. 3). He then dedicated a 20-page book chapter to address "the often-misused, haphazardly defined, ill-applied, and all-encompassing term of "emerging technologies" as used in educational contexts in general, and distance education in particular" (p.4). His definition of emerging technologies is adopted for the purpose of this paper and is stated as:

> Emerging technologies are tools, concepts, innovations, and advancements utilized in diverse educational settings to serve varied education-related purposes. Additionally, I propose that ("new" and "old") emerging technologies are evolving organisms that experience hype cycles, while at the same time being potentially disruptive, not yet fully understood, and not yet fully researched. (Veletsianos, 2010a, p. 3)

To address the gap in defining emerging technology, Rotolo, Hicks, and Martin (2015) attempted to operationalize the term by identifying "five attributes that feature in the emergence of novel technologies: (i) radical novelty, (ii) relatively fast growth, (iii) coherence, (iv) prominent impact, and (v) uncertainty and ambiguity" (p. 1). A key point in their definition states that an emerging technology's greatest impact "lies in the future and so in the emergence phase is still somewhat uncertain and ambiguous" (p. 4).

The promise of emerging technologies to positively affect, in some cases radically, a variety of industries, fields and disciplines has been an ongoing hope for administrators, policy makers, researchers, and practitioners. Some examples include Agriculture, Marketing, and Special Education (Angehrn & Nabeth, 1997; Atanu, 1994; Ashton, & COSMOS Corp., 1992). However, higher education is one of the more relevant domains in which emerging technologies has the potential for positive impact with both learning and the administration of learning (Angehrn & Nabeth, 1997; Leonard, Fitzgerald, & Bacon, 2016). A recent review of literature revealed that although the list of educational technologies considered 'emerging' may have changed over time, the driving force remains the same: to increase the quality and efficiency of education. For example, when exploring a particular technology, researchers should examine the "pedagogical perspectives and theoretical frameworks" influencing the use of the technology (Balderrain, 2016, p. 139) in addition to the technology itself. For example, two prominent technology integration models, SAMR (Puentedura, 2013) and TPACK (Mishra, Koehler, & Herring, 2016), both emphasize the *use* of technology alongside the technology itself. The research on emerging technologies is ongoing, each step helping us to better understand new ways of learning and new models for teaching (Leonard et al., 2016).

Researchers often focus on specific technologies rather than the phenomenon of emerging technology in their research (Angehrn & Nabeth, 1997; Ashton, & COSMOS Corp., 1992; Balderrain, 2016; Leonard et al., 2016). The timing of previous research is important because what was once an emerging technology often changes over time to an emerged technology, dating the technology, and therefore the research. Rotolo et al., (2015) referred to this as a “state of flux” that results from changes as new categorizations, vocabularies, and classes are created making it difficult to identify the exact nature of examination in research endeavors (p. 2). For example, the Internet was one example of an emerging technology being explored (Angehrn, 1997) that is now considered *emerged*.

Educational Technology Research

Educational technology research is important to understanding how best to positively affect education, though it remains a broad, complex, and challenging area. Januszewski (1996) claims “a discussion of the theories and methods of historical study can identify the alternatives that individuals can adopt or adopt for their own specific needs” (p. 285). A framework for educational technology research, provided by Spector, Johnson, and Young (2014) includes,

> (a) the processes involved in design, development and deployment, (b) the people involved in various aspects of supporting learning, instruction and performance, (c) the various components involved in a learning environment, (d) the typical constraints encountered in designing, developing, deploying, managing and evaluating learning, instructional and performance environments and systems, and (e) general foundational areas related to educational communications and technology. (p. 2)

General foundation areas that might influence one’s research focus are communication, interaction, environment, culture, instruction, and learning. According to Spector et al. (2014), these “are areas in which technology might be deployed and which are likely to have an impact on learning outcomes, cost-effectiveness, reusability, applicability, generalizability and other such factors on which research might focus” (p. 7). Spector et al. (2014) supported interconnections as a means for productive research efforts – specifically, “By linking our work to that of others, we build on their work and extend ours thereby bringing about a connection of knowledge." (p. 7).

The phenomenon of emerging technology as being a broad collection of tools and ideas that are also not yet fully understood or not yet fully researched (Siemens, 2008) would then present a challenge when determining where to apply efforts and resources in education. Yet, the literature discussing emerging technology trends in both published empirical research and practitioner publications is plentiful (Rotolo et al., 2015), arguably dating back to 1958, when the U.S. Department of Defense created the Defense Advanced Research Projects Agency (DARPA), the agency responsible for the development of emerging technologies for use by the military. The body of knowledge pertaining to educational technology adoption across a broad range of geographic locations (Agbo, 2015; Buchanan, Sainter, & Saunders, 2013; Cegarra-Navarro, & Rodríguez, 2012; Rosaline & Wesley, 2017; Al-Hujran, Al-Lozi, & Al-Debei, 2014) is also difficult to reconcile when attempting to address cultural differences. To add to the complexity, Kirkwood and Price (2013) suggested that the assumptions and limitations underpinning the methods used in emerging technology research is "underplayed in discourses about the effectiveness of educational technology" (p. 536).

Approaches to measurement and analysis in empirical research may differ if researchers operate with varying understandings of emerging technologies; this could contribute to a deterioration in good research design (Rotolo et al., 2015). A possible result, and one that could affect how change agents make educational decisions, is the level of hype associated with a particular technology. This is especially true with emerging technologies because the potential impact is in the future and therefore comes with inherent uncertainty. Spector (2015) noted, “fragmentation of efforts at many levels” is also a persistent issue blocking the potential for positive impact for the transformation of education (p. 2). The question becomes “how should administrators, policy makers, researchers, and practitioners filter through the trends to discern the most applicable to the educational problems they are trying to solve?” Traditionally, turning to the literature would be a natural solution. Being that investments in education are justified largely on the discussions reported in research literature it is imperative that decision makers have the ability to discern appropriate application, determine potential impact, and calculate return on investment. Unfortunately, despite the efforts toward research and development, a substantial impact on learning and instruction has yet to be made as “there are only a very few instances when educational research and development efforts have managed to have a lasting positive impact on learning and instruction on a large scale well beyond the boundaries of the initial effort” (Spector, 2015, p. 2). Interestingly, Hooper (1969) observed a major obstacle to the introduction of technology into education seemed to be that educational institutions themselves were “designed to resist change and that teachers had few incentives to alter their ways” (p. 245). Forty years later, institutional barriers, resistance to new models of education, and the lack of teacher rewards are still recognized as an ongoing challenge for moving educational technology forward (Johnson, Adams, & Cummins, 2012).

One explanation could be that managing literature pertaining to emerging trends in the field of educational technology is a laborious effort made easier with digital access but still difficult due to the volume of information. Perkins and Lowenthal (2016) estimate 270 academic journals pertaining to educational technology in existence. Adding to this body of knowledge is the expanding number of avenues in which researchers have to publish their work. In addition to traditional publishing outlets, researchers are also using blogs, electronic books, networked presentations, and other alternative forms of expression to disseminate their work (Johnson, 2011). Synthesizing both the literature and the alternative outlets for the purpose of effective decision making and practical application is daunting partly due to the copious amounts of research, but also the rapidly changing environment and subjective nature of the task. In a time when advances in technology should deliver options for a drastically improved educational experience, notable differences have yet to be realized, though quality work and a high level of support have been provided (Spector, 2015).

Content Analysis

When it comes to determining trends in a particular field, many approaches could be taken however, as Ely (1992) points out, using the literature of the field is "the best comprehensive coverage of current thinking and events in the field" (p. 7). One such approach is through content analysis, a research technique for the objective, systematic, and quantitative description of the manifest content of communication (Berelson, 1952). Studies using content analysis usually aim at achieving one of the following objectives:

- Producing descriptive information
- Cross-validating research findings
- Testing hypotheses (Borg & Gall, 1983)

Previous content analysis research involving journal analysis has been conducted with the aim of analyzing trends in educational technology. West (2011) noted "it can be helpful to review some of the journals in our field to see what conversations are being held, research being conducted, tools being developed, and theories being accepted" (p. 60). A major attempt at journal analysis was conducted by Torkelson (1977) when he analyzed 25 years of articles published by the *Audiovisual Communication Review* (AVCR), now known as *Educational Technology Research and Development*. For the period of 1953 – 1977, he collected 553 major articles for review with approximately 231 of them reporting research results. The first five years of the period showed an emphasis on articles focused on establishing policy and direction, the middle fifteen years focused on research, with the last five years showing "…the growing maturity of the field and a major emphasis on the reporting of research" (p. 319). Torkelson (1977) acknowledges his own potential bias and the challenge of summarizing the amount of data available by choosing to "search for the flavor and character of AVCR, not to attempt a fine-tooth cataloging of detail" (p. 318). However, his work helped to synthesize 25 years of contributions to the field of educational technology including a shift in terminology as the field developed (Masood, 1997). Torkelson's (1977) reports that although progress has been made in the profession overall there is still work to do with applying technique practically, creating cohesion between professionals so that energies can be combined to solve common problems, and increasing organization and integration for judgment and future research pathways to benefit the body of theory (p. 356).

Twelve years later, Ely (1992) began a series of publications in 1989 focused on one-year time periods using content analysis to analyze trends in educational technology. Sources for the analysis included a seemingly random collection of publications. Source selection was based on a survey conducted by Moore and Braden (1988) which included five leading professional journals in educational technology, papers given at annual conventions of three professional associations, dissertations from five universities that have a high level of doctoral productivity, and the educational technology documents that had been entered in the ERIC database for the specific publication year (Ely, 1992). Researchers observed the following ten educational technology trends for the period of October 1, 1990-September 30, 1991:

- The creation of technology-based teaching/learning products is based largely upon instructional design and, development principles.
- Evaluation has taken on greater importance as the concept of performance technology has been further developed.
- The number of ET case studies is growing, and they provide general guidance for potential users.
- Distance education is evident at almost every educational level and in almost every sector.
- The field of ET has more and better information about itself than ever before.
- Computers are pervasive in K-12 schools - virtually every school in the United States had microcomputers at the time.
- Telecommunications is the link that connects education to the world.
- The teacher's role in the teaching and learning process is changing as new technologies are introduced into the classroom.
- There is increasing pressure for schools to consider the adoption of technology, while at the same time concern is expressed for the impact of technology on children in the society at large; and
- Professional education of educational technologists has stabilized in size and scope. (Ely, 1992)

The study contains several weaknesses, many of which are recognized by the authors, which include a relatively short time period for publications, idiosyncratic sources, and subjectivity by the author. However, one relevant and illuminating finding was that "educational technology is being shaped more by external forces than by the internal influence of its own professionals" (p. 40). For example, in the introductory article for the first issue of *Educational Technology Research and Development*, (at the time a new journal resulting from combining *Educational Communication and Technology Journal* with the *Journal of Instructional Development*), authors surveyed AECT members to determine the topics and types of articles of interest (Higgins, Sullivan, Harper-Marinick, Lopez, 1989). Of the 161 respondents, seven topics were identified and are listed in order of preference: interactive video, computer applications in education, effective instruction, instructional development, media selection and utilization, CD ROM and data bases in education, and distance learning and telecommunications. Five article types were identified and are also listed in order of preference: case studies of educational technology use, applied research studies, literature reviews of educational technology use, literature reviews of research and development, and theory-based research studies were identified. When compared to what the journals were actually publishing in terms of types of articles (Dick & Dick, 1989), authors found some correspondence but a larger discrepancy with audience preference on what had been published. This study reinforces the challenge that journal editors have in balancing the goals of the journal while maintaining high levels of scholarship that also appeal to a broad audience (which may or may not always be an achievable task).

Both Klein (1997) and Masood (2004) also conducted content analysis studies using articles from *Educational Technology Research & Development*. Klein (1997) reviewed 100 articles published between 1989 and 1997 to determine main topics of publication. Articles were classified based on the categories established by Dick and Dick (1989) and Higgins et al. (1989) which were: case study, description, empirical research, and literature review. Findings included nine main topics with instructional design for computer technologies accounting for 26% of the articles published followed by instructional design and development at 23%. Remaining topics were: computers and technology applications (14%), ID and technology in schools (8%), professional and curricular issues (7%), distance learning (6%), effective instruction (6%), social and cultural issues (5%), and other (5%) (Klein, 1997, p. 59). Masood (2004) chose the time period of 1993-2002, a time in which the internet was emerging into widespread use, to analyze a total of 200 articles from both the research and development sections of the journal. Five major themes were identified:

- Delivery systems revolutionized through new technologies.
- Instructional development renewed.
- Regained interest in instructional methods.
- Burgeoning interest in collaboration and learning communities.
- Cultural and social aspects of instructional design. (Masood, 2004, p. 85-86)

Infrequent in the literature was the reporting of downward trends, however, Masood (2004) reported a "decreasing interest in production variables, learner variables, and teacher variables" (p. 87) as part of the article review between 1993 and 2002.

As part of a course project for students, West (2011) began a five-year journal analysis series in 2011 that reviewed 23 of the most popular journals in the field of educational technology. Each analysis reviewed one journal over an extended period of time beginning in a year ranging from 2000 through 2010. Researchers reviewed article topics, research methods, authorship and citation frequency. Researchers also compared the stated aims of the journal with its actual published articles to determine the level of alignment between the two. Of the 23 journals reviewed in the *Educational Technology Magazine* review series, 8 were those included in this research. *Educational Technology Magazine* and *TechTrends* were the two not included in the review series that were included in the ten journals selected for this research.

The review series examined *Educational Technology Research and Development,* the *Journal of the Learning Sciences,* the *Journal of Research on Technology in Education*, and the

British Journal of Educational Technology during the period of 2001-2010. Examples of top keywords and phrases during this period for these publications were problem solving, instructional design, learning environment/s, technology integration, distance education, teacher education, and computers in testing. *Instructional Science* and *Computers and Education* were investigated during the period of 2002-2011 with keywords such as cognitive load, computer-mediated communication, collaborative learning, teaching/learning strategies, interactive learning environments, and pedagogical issues. Generally, the key words and phrases identified for each journal show broad representations of topics of interests during the investigation periods. The *Journal of Educational Computing Research* was examined during the period of 2003-2012 and the *Journal of Educational Technology & Society* was examined during the period of 2010-2014. Both journals were identified as using computer assisted instruction in their top three phrases. Table 4 lists the journal, the period of investigation, and the top three findings for the word and phrase frequencies for the eight journals also included in this research. Appendix B provides the full list of 23 journals analyzed in the *Educational Technology Magazine* journal review series.

Although Torkelson (1977), Ely (1992), and the *Educational Technology Magazine* journal review series made significant contributions in helping to understand the field of educational technology with their studies, their work is now dated. Additionally, these analyses only offer a partial look into the body of knowledge due to limiting their reviews to individual journals, as with Torkelson (1977) and the *Educational Technology* series, and shortened time frames, as with Ely (1992). West (2016) noted that moving content analysis beyond a single journal or domain provides “a strong combined database to look across the field as a whole” (p. 43).

Table 4

Top Three Word and Phrase Frequencies for the Journals Included in the Educational Technology Magazine Review Series

Journal	Investigation Period	Top Three Findings for Word and Phrase Frequencies
Educational Technology Research and Development	2001-2010	problem solving, instructional design, learning environment/s
Journal of the Learning Sciences	2001-2010	Science related topics, Mathematics-related topics, Cognitive-related topics
Journal of Research on Technology in Education	2001-2010	technology integration, distance education, teacher education
British Journal of Educational Technology	2001-2010	attitudes, English Language, computers in testing
Instructional Science	2002-2011	cognitive load, computer-mediated communication, collaborative learning
Computers and Education	2002-2011	teaching/learning strategies, interactive learning environments, pedagogical issues
Journal of Educational Computing Research	2003-2012	educational technology, computer assisted instruction, learning
Journal of Educational Technology & Society	2010-2014	computer assisted instruction, computer and video games, elementary school students

In an effort to expand efforts beyond content analysis, Ross, Morrison, and Lowther (2010) reviewed research trends to examine “the role and contribution of research evidence for informing instructional practices and policies to improve learning in schools” (p. 17). In addition to reviewing historical trends in research topics and research methods, researchers examined the internal and external validity in the studies along with usefulness of findings. A cause for concern highlighted by the researchers was a significant decline in experimental and quasi-experimental studies from 1983 to 2004, dropping from 75% to 35% respectively, which could result in a drop in rigor in studies that may directly influence application of technology in schools or policy decisions (Ross et al., 2010). Five years later, in a 2015 publication, Delgado, Wardlow, McKnight, & O'Malley also found that despite large investments being made in the K-12 classrooms to incorporate technology in learning, the number of conflicting results with actual effectiveness could be directed at "several inherent methodological and study design issues" (p. 397).

Another worthy component of educational technology publishing trends is the motivation for scholars when making decisions about where and on what topics to pursue (Holcomb, Bray, and Dorr, 2003). Carr-Chellman (2006) found that emerging scholars (i.e. recently tenured faculty) are publishing in a wide variety of publications, many of which are not considered in the highest ranked journals. Because of this variety, emerging scholars are publishing in venues where more experienced tenured faculty may not consider publishing. The implication for the field is a positive one in that wider audiences are being reached because of a wider dissemination of scholarly work. However, as Carr-Chellman (2006) points out, the drawback of this broad publicizing "is that less work is done on narrowing the field's identity" (p. 13). In order for research to have value in solving instructional challenges and improving education overall, research agendas should continue to focus on topics of inquiry involving cognition and learning with technology while also constructing strong research designs and careful interpretation of findings (Ross et al., 2010). With these priorities, practitioners may also improve in the application of research findings to their relevant contexts in informed manners.

Expanded Content Analysis

Previous literature reveals extensive efforts in an attempt to understand trends and applications with emerging educational technology. Researchers have gathered large collections of published articles through extended periods of time to perform various approaches to content analysis. Contributions to the field include authorship, research topics of interest, research design, and concise lists of emerging trends. However, despite these efforts, weaknesses in the studies are that many are isolated to single journals, often focusing on brief time periods of review, and applying less than rigorous methodologies for analysis. To overcome this combination of weakness in the literature, Natividad (2016) performed an exploratory and descriptive study that examined twenty years of publications, from January 1995 – December 2014, in ten highly recognized journals in educational technology. Using this criteria, her review included a total of 9,969 articles for review which was intended to answer six specific research questions:

1. Who has published research papers in Educational Technology in each of the ten selected journals for the study during the past 20 years (Jan 1995-Dec 2014)?
2. Who has published research papers in Educational Technology in more than one of these ten journals during the past 20 years (Jan 1995-Dec 2014)?
3. What trends in Educational Technology research areas have these top ten journals followed in their publications during the past 20 years (Jan 1995-Dec 2014)?
4. Which specific journals were cited most frequently during the time period determined for this study (Jan 1995-Dec 2014)?
5. What specific research articles were cited more frequently overall and in particular 5-year periods of time in each journal during the last twenty years (Jan 1995-Dec 2014)?
6. Which specific authors were cited most frequently overall, and which ones were most frequently cited in each journal during the past 20 years (Jan 1995-Dec 2014)? (Natividad, 2016, p. 4)

Natividad's (2016) findings offer a more complete view of educational technology for an extended time period from a larger collection of published work. Having a broader perspective provides information that may allow researchers, practitioners, administrators, and policy makers to make decisions without having to assemble fragments of relevant information found in subset collections of research. Natividad's (2016) research also contributed to the body of knowledge by providing comprehensive information pertaining to authorship, most cited journals, most cited articles, most cited authors, and educational technology trends in the form of 22 factors identified through latent semantic analysis and singular value decomposition.

Horizon Reports

Natividad's (2016) findings showed a similarity with technology trends reported in the New Media Consortium's *Horizon Reports,* a highly distributed publication aimed at practitioners and policy makers, that were strong enough to suggest a similar analysis to compare her findings with the findings of the *Horizon Report* as a recommendation for future research (Natividad, 2016, p. 125). This research is the result of recognizing the value in Natividad's (2016) suggestion.

The standard structure for the report content has evolved into the identification of specific emerging technologies topics. Authors report key trends, significant challenges, and important developments. Three "movement-related categories" are considered in the research: near-term, mid-range, and long-term (Adams Becker, Cummins, Davis, Freeman, Hall Giesinger, & Ananthanarayanan, 2017, p. 8). Adoption timeframes are also provided for technologies with one, three-five, and four-five year expectations.

In the higher education reports, the reoccurring mention of digital literacy was identified each year spanning back to 2006 although originating as information literacy, evolving to technology literacy in 2009, and digital media literacy in 2010. New models of education, the roles of educators, and various issues pertaining to personalized learning also tended to appear as recurring significant challenges for higher education throughout the reports. Technologies of persisting interest were games and learning from 2013-2014 and the flipped classroom from 2014-2015. Mobile first appeared in the reports in 2007 as mobile phones and then varied in representation with topics such as mobile broadband (2008), mobiles (2009 and 2011), mobile computing (2010), mobile apps (2012), tablet computing (2013), Bring Your Own Device (BYOD) (2015-2016), and most recently mobile learning (2017). In the K-12 sector, digital media literacy first appeared in 2010 as a significant challenge and persisted through 2012. It later reappeared in the most recent 2017 report. Authentic learning experiences and the achievement gap were also identified as reoccurring significant challenges. Technologies of interest were wearable technologies which appeared from 2014-2016, makerspaces between 2015-2017, and robotics in the 2016 and 2017 reports. In the K-12 reports, game-based learning first appeared in 2010, persisted through 2012, and then reappeared in 2014. The concept of *personal* first appeared in 2009 as the personal web and then transitioned to personal learning environments for the 2011 and 2012 reports. Summary tables for both the Higher Education (2004-2017) and K-12 *Horizon Reports* (2009-2017) are provided in Appendix C and D, respectively.

Latent Semantic Analysis

As a theory, latent semantic analysis (LSA) is concerned with meaning that is derived from how words and passages are used within any language and that language learning is a function of one's experience or exposure to language (Landauer, 2007). Theorists claim that humans are surrounded by language but do not need to be exposed to every word in that language to function comfortably within it. Rather, there must be a shared human computational system that uses compositionality to determine meaning beyond dictionary definitions (Landauer, 2007). Simply put, "the representation of any meaningful passage must be composed as a function of the representations of the words it contains" (Landauer, 2007, p. 13). Just as maps are used to represent physical spaces using coordinates to measure distances and locations, LSA creates "underlying points in a coordinate system" to relate meaning in a corpus of work (Landauer, 2007, p. 7).

Using LSA theory as a foundation, psychologists pioneered LSA as a methodology by mathematically describing cognitive functions of the human mind. Specifically, LSA is an interdisciplinary, quantitative computational approach used to analyze textual data by describing semantic content as a set of vectors (Evangelopoulos et al., 2012). According to Evangelopoulos et al. (2012), LSA lies "at the intersection of automated content analysis and information retrieval" and provides "for more objective approaches to the analysis of textual data" (p. 71). Interest in this approach has increased over the last two decades since its first appearance in published research in the late 1980s (Evangelopoulos et al., 2012).

The value of LSA comes from its ability to analyze large volumes of data that allows for coding textual data that can be clustered into larger categories and may act as a methodological aid with knowledge acquisition and retrieval. Additionally, LSA has the ability to discover hidden topics in the text (Kulkarni et al., 2014; Valle-Lisboa & Mizraji, 2007) and to potentially show how meanings have changed over time in a particular sector (Miller et al., 2016). Evangelopoulos et al. (2012) offer two potential benefits of LSA: "(1) avoiding human subjectivity when the categories are pre-existing and (2) distilling new, data-driven categories when there is absence of well-established theories that anticipate the coding categories" (p. 71).

Summary

Educational technology, whether a definition of the term, theory, practice, or profession, has been a subject with plentiful discussion since the 1960s. However, despite the varying research approaches, findings, and conclusions educational technology continues to be a broad, complex, and challenging area. The content analyses pertaining to educational technology research have provided a series of launch points for subsequent research efforts (Natividad, 2016; West, 2011).

A systematic comparison of academic journal outcomes with the information contained in the *Horizon Reports* is a project that has not been attempted in prior studies. Therefore, understanding how these collections of publications compare to each other with regard to claims about effective and innovative educational technologies is unknown – at least from the standpoint of a systematic approach. To close this gap, latent semantic analysis was used to analyze a corpus made up of abstracts from ten journals published between 2000 and 2016 and all published Horizon Reports. This research intended to provide an additional angle of examination (Carr-Chellman, 2006) by adding the industry reporting perspective. The next section describes the use of latent semantic analysis to examine the topics and technologies in the combined corpus of academic journals and *Horizon Reports*.

CHAPTER 3

METHODS

This study was IRB exempt (IRB 17-306) due to a methodology that did not involve human subject research (see Appendix A). The core logic of the methodology used in this research was to meet the purpose of extracting the topics and technologies found in ten academic journals and the *Horizon Reports* during the period of 2000-2017. After specifying the research intent, the first task was to identify the set of publications to be included in the study, the relevant data (Borg & Gall, 1983) and then to prepare the summary data for analysis. The methodology described in this chapter also allowed for opportunities to compare the differences and similarities between publications specific to the extracted topics of interest. Content analysis provided the basis for the examination whereas latent semantic analysis (LSA) provided the specific approach for analysis of the content.

Data Collection and Formatting

The complete data set for this study included a) the abstracts of journal articles from ten highly recognized journals in the field of educational technology from 2000 through 2016 b) the *NMC Horizon Report: Higher Education Edition* paragraphs from 2004 through 2017, and c) the *NMC Horizon Report: K-12 Edition* paragraphs from 2009 through 2016.

Journal Abstracts 2000-2014

The beginning year of 2000 for the journal abstracts was to account for a possible timing issue with the *Horizon Report*s in that topics or technologies may have emerged in the journals prior to when they first appeared in the *Horizon Report*s. Natividad (2016) graciously provided her complete data set as a place to begin with this research. In some instances, Natividad (2016) chose to write her own abstract information when an abstract was not available for an article. However, the original data set, provided in Microsoft Excel, did not have any indication for which articles used author supplied abstracts or for those written by Natividad (2016). To ensure consistency in the dataset used for this research, a decision was made to only use abstracts that were publicly available either as an author supplied abstract or one that could be obtained from a credible online source. To begin, the Excel file was organized by journal, year, volume, issue, and page number. Beginning with the *British Journal of Educational Technology*, each abstract in the Excel file was cross-referenced with the article using the publisher's website. If the abstract matched the abstract provided on the publisher's website, it was marked as "Good." If the abstract did not match but an author provided abstract was available on the publisher's website, it was replaced in the Excel file. If the article on the publisher's website did not have an abstract, the Excel file was marked "Not Available." In following Natividad's (2016) rationale, "editorials, introductions to special issues, conference reports, book reviews, paper discussion commentaries, and responses to such commentaries" (p. 44) were excluded from the data file. The check against the publisher's website also allowed a check for any articles that were missed as part of Natividad's (2016) data collection. If an article was found to be missing from the original data set it was inserted into the Excel file. This process continued for all of the remaining articles journal by journal for the period of 2000-2014. In the case of the *British Journal of Educational Technology*, 71 articles did not have an author supplied abstract. It was also found that the journal had additional articles available on the publisher website that were not included in the original dataset. Between 2010 and 2013, 132 articles with page numbers beginning with “E” were not included in the original dataset but were added to this research. Additionally, 10 articles were added that were also not included in the original date set.

The article review for *Computers and Education* in the original data set only had one article that did not have an author supplied abstract and two others that were deleted because they were categorized as opinion papers. As for *Educational Technology Research and Development*, 56 articles did not have an author supplied abstract, one was deleted because it was an introduction to the issue, and one article whose author supplied abstract was found on the author’s digital commons university website (Gunn & Recker, 2001). *Instructional Sciences* had four articles deleted because two were introductions to the issue, another was a book review, and the fourth was an editorial. The *Journal of Educational Computing Research* and the *Journal of Research on Technology in Education* were perfect matches and had no changes to the 2000-2014 dataset. The *Journal of Educational Technology & Society* was nearly close to perfect with only one article having a manually entered abstract. The *Journal of the Learning Sciences* had one article added and 12 articles removed due to being introductions to the issue or opinion pieces.

As Natividad (2016) indicated in her study, all articles were available electronically except for the articles in *Educational Technology: The Magazine for Managers of Change in Education,* which was only available in print. The Texas State University library had a complete set of the magazine in print form. To reconcile the abstracts in this magazine, the Excel file abstract entries were compared against the print copies. Abstracts were manually entered or corrected when needed. In some cases, the original data set had entries that were cut short and simply needed the last few sentences added. This was usually due to the abstract continuing onto another column or page in the print magazine. The information in the second column had to be added to the Excel file. A decision also had to be made with the *Regular Features* section of *Educational Technology Magazine.* The decision to exclude the articles in this section was made because most of the articles in this section were book review, interviews, and editorials. Consequently, these articles did not have associated abstracts; however, this was not true of all of the articles in this section. As a result, the 23 articles written as part of the journal review series described earlier were excluded from the data set because these articles were included as part of the *Regular Features* section.

Prior to 2007, the use of abstracts with the articles in *Educational Technology Magazine* was inconsistent. For this reason, of the 407 potential articles between 2000-2006, only 92 had author supplied abstracts. Ten articles were deleted because they were either regular features or an introduction to the issue. The remaining 305 articles during this time period had articles that needed abstracts from an alternative source and were marked as "Not Available." Beginning in 2007, all of the articles in the magazine selected for inclusion in the dataset included an abstract. From the original data set, 13 articles were removed due to being a regular feature, one because it was an opinion piece, and one because it was an introduction to a special issue.

TechTrends was the other publication that had an inconsistent use of abstracts especially before 2010. Each article was compared against the publisher's website to check for an author supplied abstract. During the period of 2000-2014, one previously missed article was added to the original dataset, 139 were deleted because they were considered editorial columns or conference updates, 181 were found to be good as is, and 791 articles contained manually entered abstracts that were marked as "Not Available" so they could be replaced with abstracts retrieved from the library databases. This publication also had one article where the author supplied abstract was found on the author's university biography page (Tracey, 2009).

To reconcile the articles that did not have an author supplied abstract, those marked "Not Available," the university library databases were used to retrieve an abstract. The order of searching began with ERIC (https://eric.ed.gov/) followed by EBSCOhost (via the University of North Texas library or Texas State University library). The decision to replace Natividad's (2016) manual entries was made in an effort to create a data gathering process that could be replicated using publicly available information. Using this rationale, 28 articles were removed from the dataset between 2000-2014, that would have otherwise been included, because a replacement abstract could not be found in any database or from a credible source.

Journal Abstracts 2015-2016

Journal articles were collected for the years 2015 and 2016 in order to extend the investigation period of the original study and to match the time frame of available *Horizon Reports*. To do so, all articles published in 2015 and 2016 were collected from the ten academic journals reviewed in the original study and added to the working data file. Each journal article citation (article title, authors' names, keywords, publication year, volume, issue, and page numbers) and abstract were exported from the library database to an Excel file. The file was sorted by year, volume, issue, and start page. First, the file was reviewed for missing pages.

Page numbers were used to identify short articles and gaps in page numbers. Short articles (less than three pages) were reviewed individually to ensure they belonged in the data file. The publisher website was used to search for articles that were possibly missing by reviewing gaps in page numbers and other database errors. Then, the file was filtered for missing abstracts. The publisher's website was used to search for each article with a missing abstract. If the abstract was found it was added to the data file. If the abstract could not be found the article was marked as "Not Available." As with the 2000-2014 dataset, articles without abstracts were typically memorandums, introductions to issues, editorials and other opinion pieces and were removed from the data file.

The articles in *Educational Technology: The Magazine for Managers of Change in Education* were collected using the print sources from the university library. The data needed for articles from this publication were added to the Excel file manually using a scanned PDF of the article, converted to Microsoft Word and then copy and pasted into Microsoft Excel. Once in Excel, the citation information and the abstract were checked against the original print article for accuracy.

Once the 2015-2016 files had been cleaned, they were combined with the 2000-2014 data file. The data set for the academic journals was organized with the following column headers: *Article ID, Authors, Title, Journal, Year, Month, Volume, Issue, Start Page, End Page, Keywords,* and *Abstract*. Although Natividad (2016) had provided article identification in her original data file, the final dataset for this research changed enough to warrant a new approach to article identification. The *Article ID* in this research was comprised of the journal abbreviation, the year, and the abstract number. For example, the first article for the *British*

Journal of Educational Technology is identified by *BJET2000A1* and the last article for the same journal is *BJET2016A89*. The final count of journal abstracts was 9,687 with contributions from individual journals ranging between 240 and 2,533 abstracts. The highest contributors were *Computers and Education*, the *Journal of Educational Technology & Society*, the *British Journal of Education*, and *TechTrends*. Moderate contributors were *Educational Technology Magazine*, the *Journal of Educational Computing Research*, and *Educational Technology Research and Development*. *Instructional Science*, the *Journal of Research on Technology in Education*, and the *Journal of the Learning Sciences* contributed the least to the corpus. Table 5 lists the journal, journal abbreviation, and the count of contributions for each journal.

Table 5

Number of Published Articles Analyzed from Each of the Ten Journals Included in this Study (Total Number of Published Articles from January 2000 to December 2016: 9,687)

	Journal Title	Journal Abbreviation	Published Articles 2000-2014	Published Articles 2015-2016	Total Articles 2000-2016
1	British Journal of Educational Technology	BJET	1,181	204	1,385
2	Computers and Education	CE	2,137	396	2,533
3	Educational Technology: The Magazine for Managers of Change in Education	ETMAG	733	85	818
4	Educational Technology Research and Development	ETR&D	528	103	631
5	Instructional Science	IS	443	64	507
6	Journal of Educational Computing Research	JECR	645	94	739
7	Journal of Educational Technology & Society	JETS	1,200	218	1,418
8	Journal of the Learning Sciences	JLS	206	34	240
9	Journal of Research on Technology in Education	JRTE	334	36	370
10	TechTrends	TETR	916	130	1,046
	TOTAL		8,323	1,364	9,687

Horizon Reports

All *NMC Horizon Reports* included in the study were available in PDF form on the New Media Consortium's website (https://www.nmc.org/nmc-horizon/) . The Higher Education reports began in 2004 and were available through 2017. Beginning in 2009, the NMC added a second report focused on K-12 which was available through 2016. The 2017 K-12 report was not published in time for inclusion in the corpus. Other sector specific reports were available (e.g. museum, library, and region specific), but were also not included in this study because they were considered outside the scope of the study.

Each report was transferred to an Excel spreadsheet and organized by paragraph. Each paragraph was given an identification code made up of the report type, report year, and paragraph number. For example, the first paragraph in the executive summary section of the 2017 Higher Education report has the identification code HE2017P1. Likewise, the 10th paragraph in the 2016 K-12 report has the identifier K2016P10. The section title found in the report was also recorded in the spreadsheet for each paragraph to help with manual reference to the paragraph in any particular report (e.g. Executive Summary, Introduction). Each report was transferred to an individual worksheet and then combined to one file. One workbook was created for higher education reports and a separate workbook was created for the K-12 reports. The final data set for the *Horizon Report* articles was one Excel file organized by *Article ID, Report Type, Report Year, Section Title, Paragraph Number and Paragraph Text*. To reduce redundancy, the file was sorted by paragraph and reviewed for duplicate phrasing. Duplicate phrasing tended to identify report style and formatting more than report content. For example, one-sentence paragraphs such as "For further reading about...." or "A sampling of applications...." were removed. Additionally, the *Methodology* section for each report was removed because it was a duplication from year to year describing the process the authors used to create the report contents and was believed to skew the data. Table 6 shows the total count of *Horizon Report* paragraphs and journals abstracts by year. Paragraph counts for each annual report ranged between 165 and 301 paragraphs. The reports have generally increased in length year over year. As with the *Horizon Reports*, article counts have also generally increased with each year, ranging between 402 and 790 abstracts per year. The final count of documents analyzed (paragraphs and abstracts) was 14,404.

Table 6

Number of Horizon Report Paragraphs and Article Abstracts Included in this Study (Total Number of Documents Analyzed from 2000 to 2017: 14,404)

Year	Higher Ed	K – 12	Published Articles 2000-2016	Total Documents Analyzed 2000-2017
2017	301	NA	NA	301
2016	288	286	634	1208
2015	286	288	730	1304
2014	281	280	663	1224
2013	204	199	790	1193
2012	182	165	715	1062
2011	190	190	666	1046
2010	183	190	715	1088
2009	169	171	651	991
2008	177	NA	646	823
2007	175	NA	544	719
2006	166	NA	436	602
2005	166	NA	445	611
2004	180	NA	412	592
2003	NA	NA	402	402
2002	NA	NA	458	458
2001	NA	NA	385	385
2000	NA	NA	395	395
	2,948	1,769	9,687	14,404

The data file used for analysis was a simplified version of the detailed file, consisting of only the *Article ID* and the *Abstract* (or *Paragraph Text* in the case of the *Horizon Reports*). The detailed file served as a reference during analysis because it provided the full citation information for each abstract and paragraph.

Analysis

Depending on research intent, LSA can either produce interpretations of thematic dimensions or conversions of text into numerical data. After extracting the latent semantic factors, post-LSA analysis can be performed. Evangelopoulos et al. (2012) stated that if the analytic goal is comparisons, assessment, classification, or coherence among documents, then cosine similarity (queries) post-LSA method should be utilized. However, if the analytic goal is document categorization or document summarization, then the post-LSA method of clustering and factor analysis should be utilized. In this study, the initial goal was document categorization and thus, warranted factor analysis.

Once the final data set had been consolidated and cleaned, it was analyzed using commercially available software, SAS® Enterprise Miner™ (Version 14.1; 2015), licensed at the University of North Texas. Dr. Nicholas Evangelopoulos served as the methodology mentor for this research study. Data analysis followed the guidelines offered in Evangelopoulos et al. (2012) and the data analysis followed the steps outlined in Kulkarni et al. (2014).

A topic-by-document matrix output was created using an iterative process of relevant term filtering to assist in a factor analysis to determine major topics within the data. After the topics had been labeled, they were analyzed by timestamp to examine educational technology topics and technologies for each type of publication followed by an examination of how these topics and technologies compare between publication types. The steps for producing the topic-by-document matrix output and topic labeling is detailed in the following section.

Clean the Data File

Step 1: The data file was cleaned once more prior to data analysis. Journal articles that were one-page were sorted and read to ensure they should be included in the study. Of the 92 identified, 50 abstracts were removed because they described conference events or were personal narratives.

Step 2: Non-ASCII characters were replaced with their simpler versions using a word substitution macro.

Step 3: Carriage returns were replaced with a simple space (using the Find and Replace feature in Excel using Ctrl+j) to remove multiple lines in the same document.

Topic Extraction

To determine the number of topics in the data, topic extraction was performed using SAS® Enterprise Miner™ (Version 14.1; 2015), a commercial data mining package.

Step 1: The Excel file was converted to a SAS file by importing it to a temporary SAS library and converting it to a .csv data file.

Step 2: Using the Text Parsing node, the 398 multi-word terms list and the 509 trivial English words stop-list, both SAS-provided, were applied. Preliminary extractions were performed to create a customized stop-list consisting of 22 additional stop words specific to the corpus vocabulary. These were words believed to be high-frequency but not expected to be associated with useful topics. See Appendix E for the list of additional stop words. Knowing that the data also included documents written in British English, a synonym table with 1730 British to American English conversions was applied.

Step 3: Using the Text Filter node, the Term Weight was set to Term Frequency – Inverse Document Frequency (TD-IDF), a common term weighting function (Evangelopoulos et al., 2012). This function discounts the weight of frequent terms and boosts the weight of infrequent. The minimum number of documents was set to ten meaning that a term must appear in a minimum number of ten documents before it can be considered in the analysis.

Step 4: Using the Text Cluster node, a scree plot was created to identify an appropriate dimensionality. The fewer the dimensions, the higher the abstraction level whereas too many dimensions and explained variance passes the point of diminishing returns. To create the scree plot, eigenvalues were calculated by performing Singular Value Decomposition (SVD) where each document is represented in a space of concept dimensions. SVD is used to "find direct and indirect association as well as higher-order co-occurrences among the terms that result from the LSA" (Natividad, 2016). Excel was used to produce a plot of the eigenvalues λ (where $\lambda = s^2$) to help determine candidate dimensionalities. According to Kulkarni et al. (2014), a tabulation of 49 studies resulted in optimal factor numbers ranging from six to over 1,000. Natividad (2016) found 3, 10, and 22 as potential factors and opted for 22 because "22 factors would be more descriptive of the elements of the intellectual structure in the field of Educational Technology" (p. 51). In this research, the scree plot (see Figure 1) produced two candidate dimensionalities: 9 factors and 25 factors. Based on a review of the two dimensionalities, the list of 25 factors was chosen because, in following Natividad's (2016) rationale, it was considered to be the most descriptive of the topics and technologies described in the corpus. Based on the scree plot, the Text Cluster node step is responsible for creating the topic order (e.g. F25.1, F25.2, F25.3, etc.). This topic order is in descending order by principal component (or eigenvalue). Meaning the first topic explains the most variance within the corpus, topic 2 is second in explaining variance, and topic 25 is least in explaining variance.

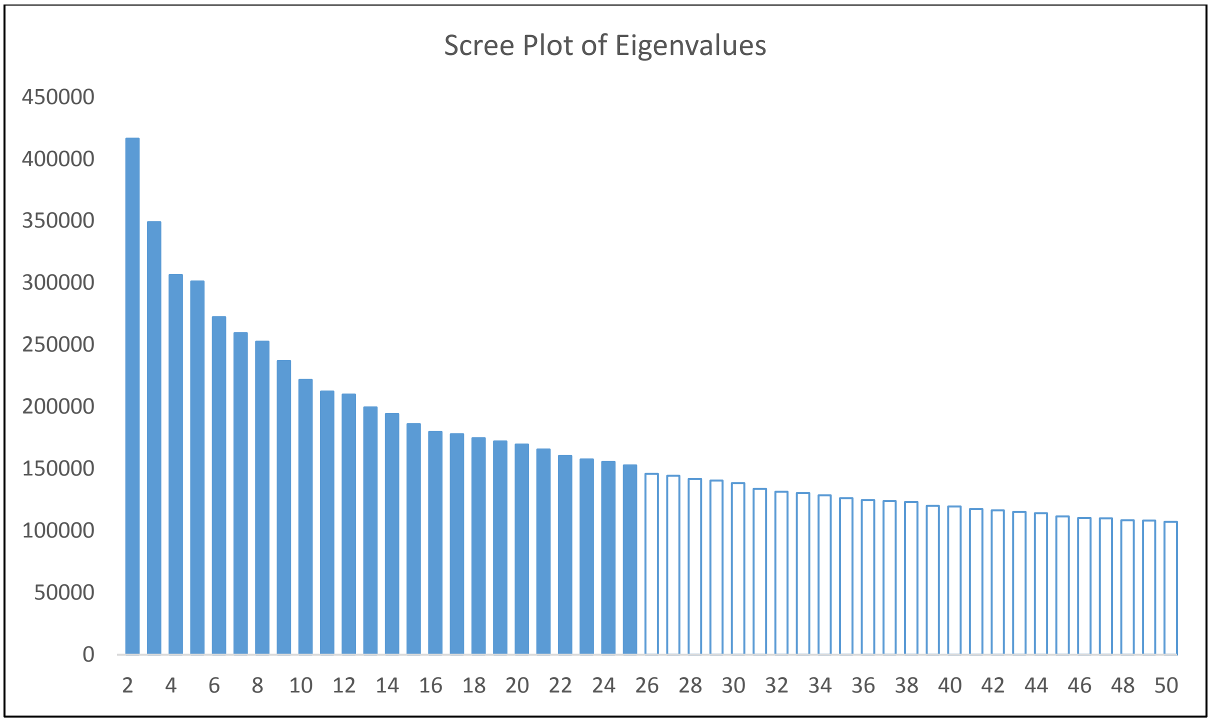

Figure 1. A scree plot of eigenvalues used to determine the candidate dimensionalities. Although nine was an option, 25 were more descriptive of the topics and technologies in the corpus.

Factor Labeling

After the dimensionality was chosen the factors could be extracted and labeled. The latent semantic factors were labeled by examining the documents using the high-loading terms (see Table 7 for the top five terms for Topics 1-6) and the content of the associated high-loading documents. Appendix F provides the complete list of high-loading terms for all 25 topics. Some terms were more broad in their associations. For example, terms associated with topic 1 were *student, class, classroom, lecture*, and *university* whereas terms associated with topic 3 were redundant as evidenced by the multiple appearances of *mobile* and *device*.

Table 7

Top 5 High-Loading Terms (Topics 1-6)

F25.1	F25.2	F25.3	F25.4	F25.5	F25.6
student	teacher	mobile	design	online	game
class	classroom	device	instructional	discussion	game
classroom	preservice	mobile device	instructional design	forum	game
lecture	professional	mobile	designer	online learn	video
university	integration	phone	theory	online discussion	play
				instructor	player

The list of the 25 topics, their labels, and the count of associated high-loading documents (Evangelopoulos, 2013) is shown in Table 8. Examples of the document content for Technology-Enhanced Learning Environments (F25.1), were online and blended learning environments, flipped learning, video-based learning environments, and intelligent tutoring systems. Technology specific discussions centered on the use of enhancements in the classroom such as electronic voting systems, learning objects, computers games, and interactive whiteboards. The technology specific topics were easier to label because the documents were more clearly aligned to these topics. These topics were Mobility and Mobile Devices (F25.3), Games and Learning (F25.6), Social Media (F25.9), Learning Systems (F25.10), Information and Communication Technology (ICT) (F25.15), The Internet and the Internet of Things (F25.16), Virtual and Augmented Reality (F25.18), Digital Literacy (F25.19), and Learning Analytics (F25.25). Those less technology specific but also fairly homogenous were Teacher Preparation and Professional Development (F25.2), Instructional Design (F25.4), Online

Learning (F25.5), Knowledge Management (F25.17), Childhood Education (F25.20), Problem Solving (F25.21), Assessment and Feedback (F25.22), and Collaboration (F25.24).

Table 8

The 25 Topic Labels and Count of High-Loading Documents

Topic	Label	Document Count
F25.1	Technology-Enhanced Learning Environments	2222
F25.2	Teacher Preparation and Professional Development	1416
F25.3	Mobility and Mobile Devices	1042
F25.4	Instructional Design	1350
F25.5	Online Learning	1376
F25.6	Games and Learning	757
F25.7	Learner and Teacher Behaviors	1657
F25.8	Innovation in Education	1888
F25.9	Social Media	1159
F25.10	Learning Systems	1384
F25.11	Trends in Educational Technology	940
F25.12	Attitudes Toward Computers	1107
F25.13	Instructional Strategies	1734
F25.14	New Models and Policies in Education	1663
F25.15	Information and Communication Technology (ICT)	471
F25.16	The Internet and The Internet of Things	1636
F25.17	Knowledge Management	1166
F25.18	Virtual and Augmented Reality	1259
F25.19	Digital Literacy	1185
F25.20	Childhood Education	633
F25.21	Problem Solving	1247
F25.22	Assessment and Feedback	1114
F25.23	Learner Support	1923
F25.24	Collaboration	1618
F25.25	Learning Analytics	1431

The topics most difficult to label were those with the broadest areas of discussion. Those were Innovation in Education (F25.8), Trends in Educational Technology (F25.11), and New Models and Policies in Education (F25.14). However, after careful examination of the documents, Innovation in Education (F25.8) was the most forward looking in the discussion around educational technology whereas Trends in Educational Technology (F25.11) focused on how the field has evolved over time, and New Models and Policies in Education (F25.14) discussed organizational structure (e.g. charter schools) and policy for BYOD (bring your own device) initiatives, as an example.

Another topic that was difficult to label was Learner and Teacher Behaviors (F25.7). Interestingly, the contributing documents in this topic had some overlap with Learning Systems (F25.10). The behaviors seemed to be in response to how learners and teachers interact with learning systems, specifically, the behavioral factors affecting user acceptance of learning systems. Closely related was Attitudes Toward Computers (F25.12). Rather than behaviors, this topic focused discussion around constructs such as attitudes, anxiety, and experience with computers. Gender differences was also an area of interest in this topic. Instructional Strategies (F25.13) centered discussion on instructional interventions and the resulting effects whereas Learner Support (F25.23) was interested in learner models and learning styles. Labels were evaluated and approved by two research professionals in the field.

The number of documents associated with a topic revealed the level of dedication to a topic. For example, Games and Learning (F25.6) was addressed in 757 documents and Innovation in Education (F25.8) was addressed in 1,888 documents. However, despite the number of associated documents, Games and Learning (F25.6) explained more of the variance in the corpus than Innovation in Education (F25.8) because Games and Learning (F25.6) appeared in the topic list prior to Innovation in Education (F25.8). The number of associated documents, however, addressed the homogeneity within the topic. Topics with fewer documents were more consistent in how the topic is addressed whereas a topic with more documents was less agreeable in how to address the topic. As mentioned earlier, this was also evident in the level of specificity with the topic labels.

Contingency Table

The final step in analysis, after topic extraction and factor labeling, was to create a contingency table, or cross-tabulation, to determine the documents counts for each topic by publication. The purpose of this table was to provide a basis for additional post-LSA analysis and is described in further detail in the next chapter. Tables 9 shows the cross-tabulation for the first seven topics. Appendix G provides the contingency table (cross-tabulation) for all 25 topics by publication for each topic. For a different view, Appendix H provides the cross-tabulation by topic for each publication.

Table 9

Contingency Table (Cross-Tabulation) of Document Counts by Journal and Topic (Topics 1-7)

	F25.1	F25.2	F25.3	F25.4	F25.5	F25.6	F25.7
All Publications	2222	1416	1042	1350	1376	757	1657
BJET	242	125	59	137	196	81	224
CE	684	326	120	184	310	185	664
ETMAG	32	62	36	227	70	33	16
ETRD	123	81	12	197	70	42	105
IS	156	76	0	71	38	3	62
JECR	176	119	21	58	103	39	214
JETS	283	144	70	171	162	58	257
JLS	65	40	1	41	11	9	6
JRTE	90	144	9	43	45	12	68
TETR	110	153	44	173	126	26	29
HE	154	13	423	32	162	162	8
K	107	133	247	16	83	107	4

Summary

Data collection began by reviewing the original data set for the articles published during the period of 2000-2014 provided by Natividad (2016). In an effort to maintain consistency, all abstracts were checked against the original article using the publication's website or the university library. The articles published between 2015-2016 were downloaded from the university library databases and also checked against the publication's website. In the case of *Educational Technology Magazine*, the print copies were used to create manual entries into the data file. All abstracts were either author supplied or taken from a database description. The *Horizon Report* data was taken directly from the reports provided on the NMC's website and organized by paragraph in the data file.

After the data was cleaned, LSA and SVD were used to completed topic extraction. Of the two candidate dimensions (9 and 25), 25 dimensions were used to provide the more detailed analysis of the underlying structure of the corpus. To create the labels, the high-loading terms and documents were evaluated to determine themes within the topics. Some topics were more homogenous than others but overall, the topics were labeled with a high degree of confidence that the labels were reasonable descriptions of the contents within each topic.

CHAPTER 4

RESULTS

The purpose of this study was to examine the topics and technologies being discussed in the combined corpus of academic journals and industry reports. This section reviews the 25 topics extracted from the corpus as well as provides an analysis of how the publication types contributed to the topics to address the following research questions:

1. What topics and technologies in educational technology are evident in the combined corpus of ten academic journals and two types of Horizon Reports during the time period of 2000-2017?
2. How do the topics and technologies addressed by the researchers in the academic journals compare to those represented by practitioners in the Horizon Reports for the period of 2000-2017?

Rationale for Addressing the Research Questions

With the abundance of data to manage, certain decisions were made to organize the data and findings in a manner that was clear yet thorough in addressing the research questions. To address the first research question, the list of 25 extracted topics and a description of how the topics were labeled was provided to identify what the topics and technologies in the corpus were. Relative interest in the topics between publications was provided to assist with investigating how topics were related to each other using the publications as a characteristic of that topic. This decision was made in an effort to provide some context for the topics based on which of the publications were contributing and to what extent. The organization of these findings by high and low topics of interest was an effort to make the information consumable.

Other observations within the topics and the contributing publications were included to provide an additional level of context for the topics. Threshold values of 25% for high interest and 10% for low interest topics were somewhat arbitrary in that other threshold values could have been assumed. However, when evaluating the percent figures that represented the levels of contribution between the publications, the thresholds chosen needed to be high and low enough to create some distance between topics of lesser and greater interest. After evaluating the overall contributions between publications, the threshold values used in this step of investigation seemed to highlight distinct differences between high, low, and consequently middle interest topics (although middle interest topics were not specifically identified in this section of the write-up).

The broad nature of the second research question required a more complex approach when attempting to address how the academic journals compared to the *Horizon Reports*. The strategy was divided into Chi-square tests, correspondence analysis, and time plot comparisons. The three angles of analysis served to provide multiple views into the similarities and differences between the publication types (academic journals and *Horizon Reports*) in order to provide more detail and balance between the data (Altrichter, 2008). The Chi-square tests served to test independence between the topics and publications and to describe the expected and observed frequencies. The results of these tests provided results pertaining to comparisons between the publications and topics in the most general of terms, specifically the topics that were being under- and overemphasized for the journals, as a group, and the *Horizon Reports,* also as a group. The correspondence analysis and resulting symmetric plot provided a second level examination that showed the distance, using a visual representation, between the 25 topics and the 12 publications. This examination served to provide a more detailed view of the relationships between topics, between publications, and between topics *and* publications. Lastly, the time plot comparisons added a third level of detail to the examination by adding the variable of time to the already established variables of topics and publications. The purpose of this third variable provided a view of how the topics changed over time between the two types of publications (academic journals and *Horizon Reports*). In addition to general similarities and differences between publications and topics that were identified using the previously described approaches, the time plots provided a next level of detail based on changes year over year.

Topics and Technologies in Educational Technology

As described in the previous chapter, 25 topics were extracted from the combined corpus of ten academic journals and two industry reports (14,404 documents) for the period of 2000-2017 using latent semantic analysis. The topic labels for each topic are presented in Table 10. The topics with the associated number of high-loading documents was provided in the previous chapter (see Table 8).

Before providing the results of the analysis it is important to provide two points of clarification in how the data was treated and calculated. These points can be described in two main categories: Multiple Contributions across Topics and Document Count vs. Percent Contribution.

Multiple Contributions across Topics

A variety of algorithms exist to perform the function of cluster analysis. Some approaches to cluster analysis organize items using *hard clustering* (as opposed to *soft clustering*) so that each object either belongs to a cluster or not (Wang, Shi, Yang, & Ju, 2015). In some cases, items may belong to exactly one cluster, in addition to the option of being considered an outlier so that the item does not belong to any cluster at all. However, *soft clustering* assumes that each item belongs to a cluster by some degree, in addition to the possibility of not belonging to any cluster (Rajathi, Shajunisha, & Caroline, 2013).

Table 10

Topic List and Labels (25 factors)

Topic	Label
F25.1	Technology-Enhanced Learning Environments
F25.2	Teacher Preparation and Professional Development
F25.3	Mobility and Mobile Devices
F25.4	Instructional Design
F25.5	Online Learning
F25.6	Games and Learning
F25.7	Learner and Teacher Behaviors
F25.8	Innovation in Education
F25.9	Social Media
F25.10	Learning Systems
F25.11	Trends in Educational Technology
F25.12	Attitudes Toward Computers
F25.13	Instructional Strategies
F25.14	New Models and Policies in Education
F25.15	Information and Communication Technology (ICT)
F25.16	The Internet and The Internet of Things
F25.17	Knowledge Management
F25.18	Virtual and Augmented Reality
F25.19	Digital Literacy
F25.20	Childhood Education
F25.21	Problem Solving
F25.22	Assessment and Feedback
F25.23	Learner Support
F25.24	Collaboration
F25.25	Learning Analytics

In contrast, and in the case of this research, items are assigned to a topic based on a factor loading using LSA and dimension reduction to create topics. The potential result is an item loading to zero topics, one topic, or several topics. Although the corpus consisted of a total of 14,404 documents, many documents loaded to more than one topic.

In the case of this research, 33,378 document-to-topic associations were made, meaning that, on average, each document loaded to 2.32 topics. A count of documents by the number of contributions to a topic is provided in Table 11. For example, 208 *British of Journal of Educational Technology* (BJET) documents contributed to four topics and three articles from the *Journal of Educational Technology & Society* (JETS) contributed to nine topics. Although the majority of documents contributed to one or two topics, it is interesting to note that 1,450 documents did not contribute to *any* of the 25 extracted topics. Conversely, 119 documents contributed to seven or more topics where *Computers and Education* published 32 articles that loaded to seven topics and the *Journal of Educational Technology & Society* published 20 articles that loaded to seven topics. This journal also published three articles that contributed to nine of the 25 topics. The *British Journal of Educational Technology*, *Computers and Education*, and the *Journal of the Learning Sciences* also each had one document that contributed to nine of the 25 topics. On the other end of the spectrum, the *Horizon Reports* had 826 documents that did not load to any of the 25 extracted topics. *Educational Technology Magazine* and *Tech Trends* also had over 15% of their contributions not load to any of the 25 topics (15% and 20% respectively). The next highest journal with documents with zero contributions to a topic was the *Journal of the Learning Sciences* with 7% of the abstracts included.

Table 11

Counts of Document Contributions to a Topic

Publication	0	1	2	3	4	5	6	7	8	9	Total
BJET	84	268	351	336	208	92	36	8	1	1	1385
CE	62	269	580	663	533	286	99	32	8	1	2533
ETMAG	125	276	229	131	38	14	5				818
ETRD	23	102	152	149	109	60	27	7	2		631
IS	14	78	147	129	89	38	8	3	1		507
JECR	16	93	167	226	151	59	17	7	3		739
JETS	58	210	326	342	270	133	56	20		3	1418
JLS	16	55	52	57	25	23	4	6	1	1	240
JRTE	15	54	91	110	66	27	4	2	1		370
TETR	211	281	279	156	93	14	10	1	1		1046
HE	564	1157	746	315	120	32	10	2	2		2948
K	262	584	426	271	139	63	19	5			1769
Total	1450	3427	3546	2885	1841	841	295	93	20	6	14404

Document Count vs. Percent Contribution

Although it is tempting to analyze the topics based on document count to assess relative importance, each publication contributed a unique and dissimilar number of documents to the overall corpus. For example, *Computers and Education* and the Higher Education *Horizon Report* contributed well over 2,000 documents to the overall corpus (2,533 and 2,948 documents respectively). The *Journal of Learning Sciences* and the *Journal of Research on Technology in Education* contributed the least with 240 and 370 documents respectively. To compare the document counts as a means for determining the importance a publication placed on a particular topic would erroneously inflate the contributions of the high-count contributors and therefore, deflate the contributions of the low-count contributors. A better, and more accurate, means for discussing publication contribution to a particular topic was to evaluate contribution as a ratio of documents contributed to the topic to the total number of documents contributed to the corpus. In this way, comparisons were made to assess how much focus a publication gave to a particular topic versus the contributions it *could* have made to a topic during the period of investigation.

Figures 2 and 3 provide a comparison of how the trends change when the means for comparison is adjusted from document count to percent contribution. Notice the difference in placement of the all journals trend line (denoted in red)as well as the shift in trend lines for the individual publications.

For example, if only assessing contribution based on count (see Figure 2), *Computers and Education* was the largest contributor to each topic which is logical based on the total documents (2,533) this publication contributed to the corpus. However, this trend line does not reveal the relative importance it gave to any particular topic over the other 24 extracted topics.

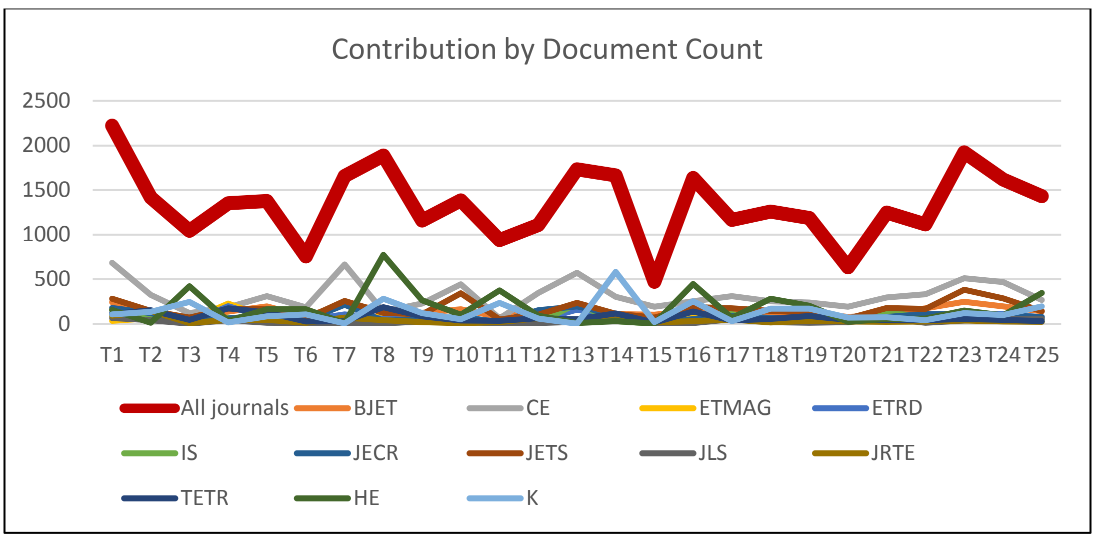

Figure 2. The document counts for each journal are shown by topic. The All Journals (shown in red) is the total count of documents contributed to the topic. Organization by document count was a poor way to represent the contributions of a publication to a topic.

In comparison, Figure 3, shows the percent contribution of a publication to any given topic relative to the total publication's contribution. The rationale for examining the data in this way is to account for the varying numbers of document contributions for each publication. High contributing publications (e.g. the *Higher Education Horizon Report* and *Computers and Education*) would seemingly place a higher importance on the topics throughout whereas the low contributing publications (the *Journal of the Learning Sciences* and the *Journal of Research on Technology in Education*) would seemingly place less importance on topics. As an example, this figure shows that the *Journal of Research on Technology in Education* made a 39% contribution to Teacher Preparation and Professional Development (F25.2), a noticeable peak that is lost when only focusing on document count (see Figure 2).

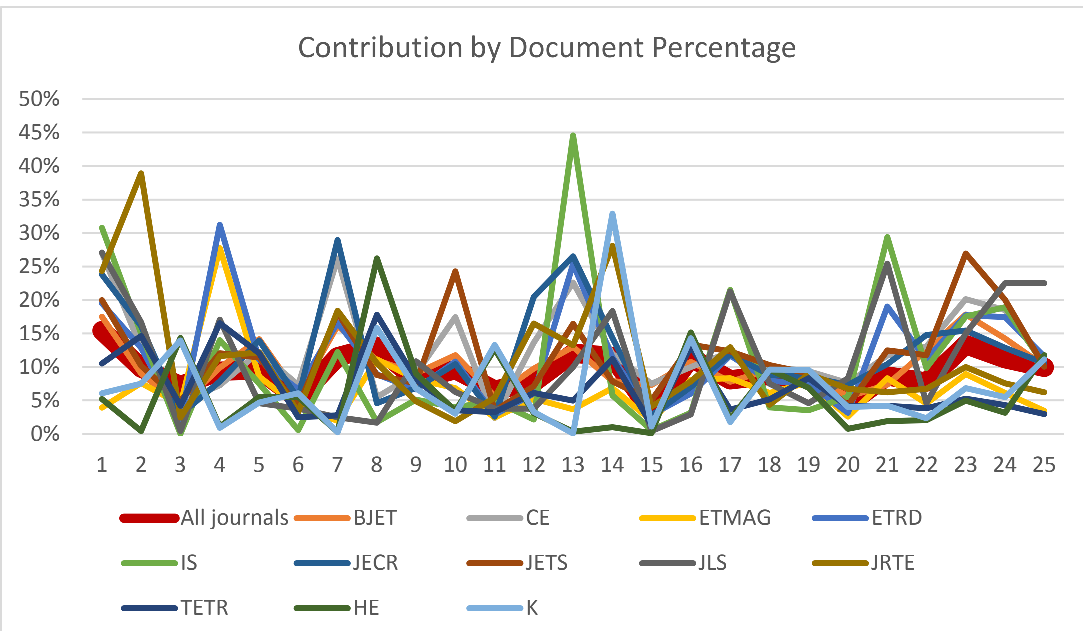

Figure 3. The percent contribution of each publication to a topic was a better way to normalize contribution. The underlying patterns of interest in a topic for each publication was more apparent.

Building from the point where the interest in a topic is shown by the percentage of contributions to that topic relative to the contributions of that publication to the remaining topics, general differences between topics can be observed. A recalculation of the contingency table to percent contribution helps with the examination of two categories of interest: high interest topics and low interest topics. The contingency table was converted to percent contributions to examine the relative importance publications gave each topic. An example of this conversion for Topics 1-6 is shown in Table 12 and the full table is provided in Appendix I. High interest topics contained at least one publication with 25% or greater contribution whereas low interest topics were those that had less than 10% contribution from each of the publications. Those topics falling in between had contributions between 10% and 24% contribution from each of the contributing publications. A deeper analysis of the percent contributions by the publications is discussed in the following sections.

Table 12

Percent Contribution to Each Topic by Publication (Topics 1-6)

	F25.1	F25.2	F25.3	F25.4	F25.5	F25.6
All journals	15%	10%	7%	9%	10%	5%
BJET	17%	9%	4%	10%	14%	6%
CE	**27%**	13%	5%	7%	12%	7%
ETMAG	4%	8%	4%	**28%**	9%	4%
ETRD	19%	13%	2%	**31%**	11%	7%
IS	31%	15%	0%	14%	7%	1%
JECR	24%	16%	3%	8%	14%	5%
JETS	20%	10%	5%	12%	11%	4%
JLS	**27%**	17%	0%	17%	5%	4%
JRTE	24%	**39%**	2%	12%	12%	3%
TETR	11%	15%	4%	17%	12%	2%
HE	5%	0%	14%	1%	5%	5%
K	6%	8%	14%	1%	5%	6%

Note. The highest contribution made by each publication is in boldface.

High Interest Topics

Based on the dispersion of the contributions of the entire corpus, topic interest was moderately balanced. For example, the range of interest was 15% for the highest topic, technology enhanced learning environments (F25.1) and 3% for the lowest, information and communication technology (ICT) (F25.15). The next highest topics shared 13% interest, innovation in education (F25.8) and learner support (F25.23), and three shared 12% interest, learner and teacher behaviors (F25.7), instructional strategies (F25.13), and new models and policies in education (F25.14).

Nine topics met the 25% or greater contribution threshold by an individual publication. The first five topics are those with high interest from multiple publications. Technology-enhanced learning environments (F25.1) had high contributions from *Instructional Sciences* (31%), *Computers and Education* (27%), and the *Journal of the Learning Sciences* (27%). Only one other topic, instructional strategies (F25.13), had three journals meeting the threshold for contribution. This was the second of three topics *Instructional Sciences* (45%) was highly interested in along with the *Journal of Educational Computing Research* (27%), and *Educational Technology Research and Development* (25%). The third topic of interest for *Instructional Sciences* (29%) was problem solving (F25.21) followed by the *Journal of the Learning Sciences* (25%). The second, and only other, high interest topic for *Computers and Education* (26%) was learner and teacher behaviors (F25.7) which was joined by the *Journal of Educational Computing Research* (29%) who contributed highly. *Educational Technology Research and Development* (31%) and *Educational Technology Magazine* (28%) were the two journals highly interested in instructional design (F25.4).

The remaining four topics are those where only one publication met the high interest threshold of a 25% or greater contribution. The *Journal of Research on Technology in Education* (39%) was highly interested in teacher preparation and professional development (F25.2). The publications for these topics did not meet the high interest threshold for any of the other high interest topics. The interest in this topic by the *Journal of Research on Technology in Education* was more than double that of the other eleven publications. Learner support (F25.23) had its greatest contribution from the *Journal of Educational Technology & Society* (27%). The *Horizon Reports* were split in where their highest contributions were made. The Higher Education reports (26%) were distinctly interested in innovation in education (F25.8) whereas the K-12 reports (33%) were distinctly interested in new models and policies in education (F25.14). The high interest areas for the *Horizon Reports* were more than double that of any of the other topics. Additionally, the journals with a higher interest in one topic seemed to be distinctly interested in that topic far more than the others.

Low Interest Topics

The three topics of least interest from the full corpus perspective were, not surprisingly, were also those that met the low interest threshold of less than 10% interest from any one publication. Games and learning (F25.6), information and communication technology (F25.15), and childhood education (F25.20) did not have any one publication contribute at least 10% of the documents within the corpus. Where most publications contributed at least 3% to these topics, some publications had even less interest in these topics. *Instructional Sciences* (1%) and *TechTrends* (2%) were the least contributing to games and learning (F25.6). The Higher

Education *Horizon Report* contributed the least to information and communication technology (F25.15) and childhood education (F25.20). The *Journal of the Learning Sciences* also made a minimal contribution to information and communication technology (F25.15) by contributing only one abstract to the topic.

Other Observations by Publication

There were several notable points in contribution based on specific publications. For example, the *British Journal of Educational Technology* and *TechTrends* were the only two publications that did not have a topic that met the threshold for high interest (25% contribution). Both publications made moderate contributions to each topic however the *British Journal of Educational Technology* made its highest contributions to learner support (F25.23), technology-enhanced learning environments (F25.1), and learner and teacher behaviors (F25.7) which were all recognized as high interest topics. The topic of least interest was mobility and mobile devices (F25.3) which was designated neither a high or low interest topic. *TechTrends* was the most highly interested in innovation in education (F25.8) and instructional design (F25.4) also both recognized as high interest topics. *TechTrends* was least interested in information and communication technology (ICT) (F25.15) and games and learning (F25.6) also both previously recognized as low interest topics.

There were several publications that had less than 1% contribution to a topic. This was true for both *Horizon Reports* with the topics of learner and teacher behaviors (F25.7) and instructional strategies (F25.13). Interestingly, these were recognized as high interest topics for other publications. Additionally, the *Higher Education Horizon Report* also had less than 1%

contribution to teacher preparation and professional development (F25.2) and information and communication technology (ICT) (F25.15). Although teacher preparation and professional development (F25.2) was previously recognized as a high interest topic and information and communication technology (ICT) (F25.15) was previously recognized as a low interest topic. The *Journal of the Learning Sciences* had two topics of extremely low interest, or less than 1% contribution. These were mobility and mobile devices (F25.3) and information and communication technology (ICT) (F25.15) however, both topics were also previously recognized as low interest topics. Lastly, all topics were represented by every publication on some level with the exception of mobility and mobile devices (F25.3). *Instructional Science* did not publish one article related to mobility and mobile devices during the period of 2000-2016.

Comparison of Journals and *Horizon Report*s

This section shifts the analysis away from a discussion of the individual topics by focusing the analysis on what can be observed between the academic journals and the *Horizon Reports*. This section begins with a series of chi-square tests followed by a correspondence analysis of the topics and publications visualized over two dimensions. This analysis concludes with a comparison of topic trends between academic journals and *Horizon Reports* using time series plots for each topic.

Chi-Square Tests

The process of comparing the journals with the *Horizon Report*s began with a chi-square test for independence across column and row factors in the contingency table presented in

Table 9 (and provided in full in Appendix G). The purpose of performing a chi-square test was to examine the homogeneity between publications and served as a first step in determining possible differences and similarities in topic emphasis between the academic journals and *Horizon Reports*. First was a test of the hypothesis for independence across all 12 sources:

- H1: the 12 publication sources are homogeneous (i.e., equally distributed) across the 25 topics.

To test Hypothesis H1, a chi-square test was performed that compared the observed frequencies in Table 13 to the expected frequencies in Table 14.

Table 13

25 Topics by 12 Sources: Expected Frequencies under the Assumption of Independence

Topics	BJET	CE	ETMAG	ETRD	IS	JECR	JETS	JLS	JRTE	TETR	HE	K	Total
T01	236.9	524.0	91.8	120.9	92.0	145.1	275.3	41.8	67.3	121.4	287.9	217.6	2222
T02	151.0	333.9	58.5	77.0	58.6	92.4	175.5	26.6	42.9	77.4	183.4	138.7	1416
T03	111.1	245.7	43.0	56.7	43.1	68.0	129.1	19.6	31.6	56.9	135.0	102.1	1042
T04	143.9	318.3	55.8	73.4	55.9	88.1	167.3	25.4	40.9	73.8	174.9	132.2	1350
T05	146.7	324.5	56.8	74.9	57.0	89.8	170.5	25.9	41.7	75.2	178.3	134.8	1376
T06	80.7	178.5	31.3	41.2	31.3	49.4	93.8	14.2	22.9	41.4	98.1	74.1	757
T07	176.7	390.7	68.5	90.2	68.6	108.2	205.3	31.2	50.2	90.5	214.7	162.3	1657
T08	201.3	445.2	78.0	102.7	78.2	123.3	233.9	35.5	57.2	103.2	244.6	184.9	1888
T09	123.6	273.3	47.9	63.1	48.0	75.7	143.6	21.8	35.1	63.3	150.1	113.5	1159
T10	147.6	326.4	57.2	75.3	57.3	90.4	171.5	26.0	41.9	75.6	179.3	135.5	1384
T11	100.2	221.7	38.8	51.1	38.9	61.4	116.5	17.7	28.5	51.4	121.8	92.1	940
T12	118.0	261.0	45.7	60.2	45.8	72.3	137.2	20.8	33.5	60.5	143.4	108.4	1107
T13	184.9	408.9	71.6	94.3	71.8	113.2	214.9	32.6	52.5	94.8	224.6	169.8	1734
T14	177.3	392.2	68.7	90.5	68.9	108.6	206.1	31.3	50.4	90.9	215.4	162.9	1663
T15	50.2	111.1	19.5	25.6	19.5	30.7	58.4	8.9	14.3	25.7	61.0	46.1	471
T16	174.4	385.8	67.6	89.0	67.7	106.8	202.7	30.8	49.6	89.4	211.9	160.2	1636
T17	124.3	275.0	48.2	63.4	48.3	76.1	144.5	21.9	35.3	63.7	151.1	114.2	1166
T18	134.2	296.9	52.0	68.5	52.1	82.2	156.0	23.7	38.1	68.8	163.1	123.3	1259
T19	126.4	279.4	49.0	64.5	49.1	77.4	146.8	22.3	35.9	64.8	153.5	116.1	1185
T20	67.5	149.3	26.2	34.4	26.2	41.3	78.4	11.9	19.2	34.6	82.0	62.0	633
T21	133.0	294.1	51.5	67.8	51.6	81.4	154.5	23.5	37.8	68.1	161.5	122.1	1247
T22	118.8	262.7	46.0	60.6	46.1	72.7	138.0	21.0	33.7	60.9	144.3	109.1	1114
T23	205.0	453.5	79.4	104.6	79.6	125.5	238.3	36.2	58.2	105.1	249.1	188.3	1923
T24	172.5	381.5	66.8	88.0	67.0	105.6	200.5	30.4	49.0	88.4	209.6	158.5	1618
T25	152.6	337.4	59.1	77.9	59.2	93.4	177.3	26.9	43.3	78.2	185.4	140.2	1431
Total	3559	7871	1379	1816	1382	2179	4136	628	1011	1824	4324	3269	33378

The calculated test statistic was $\chi^2 = 12431.3$. This was highly significant (p-value < 0.0001), which indicated significant differences in the way the 12 sources are distributed across the 25 topics.

Table 14

25 Topics by 2 Source Categories: Observed and Expected Frequencies

	Observed frequencies		Expected Frequencies	
Topics	Academic Journals	Horizon Reports	Academic Journals	Horizon Reports
T01	1961	261	1716.5	505.5
T02	1270	146	1093.9	322.1
T03	372	670	805.0	237.0
T04	1302	48	1042.9	307.1
T05	1131	245	1063.0	313.0
T06	488	269	584.8	172.2
T07	1645	12	1280.1	376.9
T08	835	1053	1458.5	429.5
T09	774	385	895.3	263.7
T10	1229	155	1069.2	314.8
T11	332	608	726.2	213.8
T12	958	149	855.2	251.8
T13	1723	11	1339.5	394.5
T14	1051	612	1284.7	378.3
T15	449	22	363.9	107.1
T16	936	700	1263.8	372.2
T17	1069	97	900.8	265.2
T18	806	453	972.6	286.4
T19	813	372	915.4	269.6
T20	540	93	489.0	144.0
T21	1117	130	963.3	283.7
T22	1013	101	860.6	253.4
T23	1655	268	1485.5	437.5
T24	1428	190	1249.9	368.1
T25	888	543	1105.5	325.5
Totals	25785	7593	25785	7593

Next, the contingency table was collapsed to a 25-by-2, topic-by-source category table to test the collection of journals with the *Horizon Reports*.

- H2: the 2 publication types (i.e., academic journals vs. Horizon reports) are homogeneous (i.e., equally distributed) across the 25 topics.

In order to test Hypothesis H2, a chi-square test was performed that compared the observed to expected frequencies, as shown in Table 14. The calculated test statistic is χ^2 = 6554.4. This is highly significant (p-value < 0.0001), indicating significant differences in the way the 2 publication types are distributed across the 25 topics.

To identify specific topics that differed between the journals and the *Horizon Reports*, the percent difference between the observed and expected frequencies was calculated for each publication type (see Table 15). Those contributions that were higher (denoted in green) and those that were lower (denoted in red) than expected could be easily identified for each topic.

Selecting the top three higher than expected topics for each publication type identified the topics that were emphasized by that publication type. For example, the academic journals emphasized instructional design (F25.4), learner and teacher behaviors (F25.7), and instructional strategies (F25.13) over the period of investigation. In contrast, these three topics were the top three topics deemphasized by the *Horizon Reports*. The same situation occurs when looking from the *Horizon Reports* perspective. The top three topics of interest were mobility and mobile devices (F25.3), innovation in education (F25.8), and trends in educational technology (F25.11). These topics were the three the academic journals deemphasized the most. This general comparison of topics emphasized versus topics deemphasized suggests the academic journals and the *Horizon Report*s fundamentally differ in their topics of interest. This is further supported by the recognition that for every positive percentage listed in Table 15 for the journals, the *Horizon Reports* show a negative percentage. To summarize, over the period of 2000-2017, the academic journals and the *Horizon Reports* differ in their levels of interest for every topic.

Table 15

Difference in Observed versus Expected Contributions

	Topic	Difference in Observed / Expected	
		Journals	Horizon Reports
T01	Technology-Enhanced Learning Environments	14%	-48%
T02	Teacher Education and Professional Development	16%	-55%
T03	Mobility and Mobile Devices	-54%	183%
T04	Instructional Design	25%	-84%
T05	Online Learning	6%	-22%
T06	Games and Learning	-17%	56%
T07	Learner and Teacher Behaviors	29%	-97%
T08	Innovation in Education	-43%	145%
T09	Social Media	-14%	46%
T10	Learning Systems	15%	-51%
T11	Trends in Educational Technology	-54%	184%
T12	Attitudes Toward Computers	12%	-41%
T13	Instructional Strategies	29%	-97%
T14	New Models and Policies in Education	-18%	62%
T15	Information and Communication Technology (ICT)	23%	-79%
T16	The Internet and The Internet of Things	-26%	88%
T17	Knowledge Management	19%	-63%
T18	Virtual and Augmented Reality	-17%	58%
T19	Digital Literacy	-11%	38%
T20	Childhood Education	10%	-35%
T21	Problem Solving	16%	-54%
T22	Assessment and Feedback	18%	-60%
T23	Learner Support	11%	-39%
T24	Collaboration	14%	-48%
T25	Learning Analytics	-20%	67%

The next section discusses correspondence analysis, a function used to help provide more detail to explain the differences identified above.

Correspondence Analysis

The process of comparing the journals with the *Horizon Report*s continued with a correspondence analysis using the Simple Correspondence Analysis function in the statistical software package Minitab (Version 17; 2014), licensed at the University of North Texas. Correspondence analysis has been used to visualize relationships between journals and research topics in the information systems research (Evangelopoulos 2016). This form of analysis is similar to principal component analysis, but uses a contingency table (cross-tabulation) as its input. Its main function is to project the rows and columns of a contingency table on a plane defined by the first two principal components, which explain as much variance in the contingency table as possible. The table below provides the explanation of variance by number of dimensions. With a dimensionality of 12-by-25, 11 dimensions are required to visualize 100% of the variance whereas two dimensions explain 72.67% of the variability in the contingency table (see Figure 4).

Analysis of Contingency Table

Axis	Inertia	Proportion	Cumulative	Histogram
1	0.2167	0.5819	0.5819	******************************
2	0.0540	0.1449	0.7267	*******
3	0.0441	0.1185	0.8453	******
4	0.0248	0.0666	0.9119	***
5	0.0171	0.0460	0.9579	**
6	0.0055	0.0147	0.9726	
7	0.0040	0.0107	0.9833	
8	0.0026	0.0071	0.9903	
9	0.0015	0.0040	0.9943	
10	0.0011	0.0030	0.9973	
11	0.0010	0.0027	1.0000	
Total	0.3724			

Figure 4. An explanation of variance with 11 degrees of freedom. With two dimensions, 72.7% of the variance was explained.

The following correspondence map (symmetric plot) was produced using two projection dimensions (see Figure 5). This symmetric plot provides a visualization of the topics and publications in the contingency table in two dimensions to help identify relationships of topics and publications in space. For example, it can be observed that the Higher Education *Horizon Report* (HE) is associated with topics T08 (innovation in education), T03 (mobility and mobile devices), and T11 (trends in educational technology). The K-12 *Horizon Report* (K) seems to balance between the Higher Education topics and topic T14 (new models and policies in education). *Educational Technology Magazine* (ETMAG) strikes a balance between both dimensions on the plot whereas *Instructional Science* (IS) falls to the far right of the horizontal dimension.

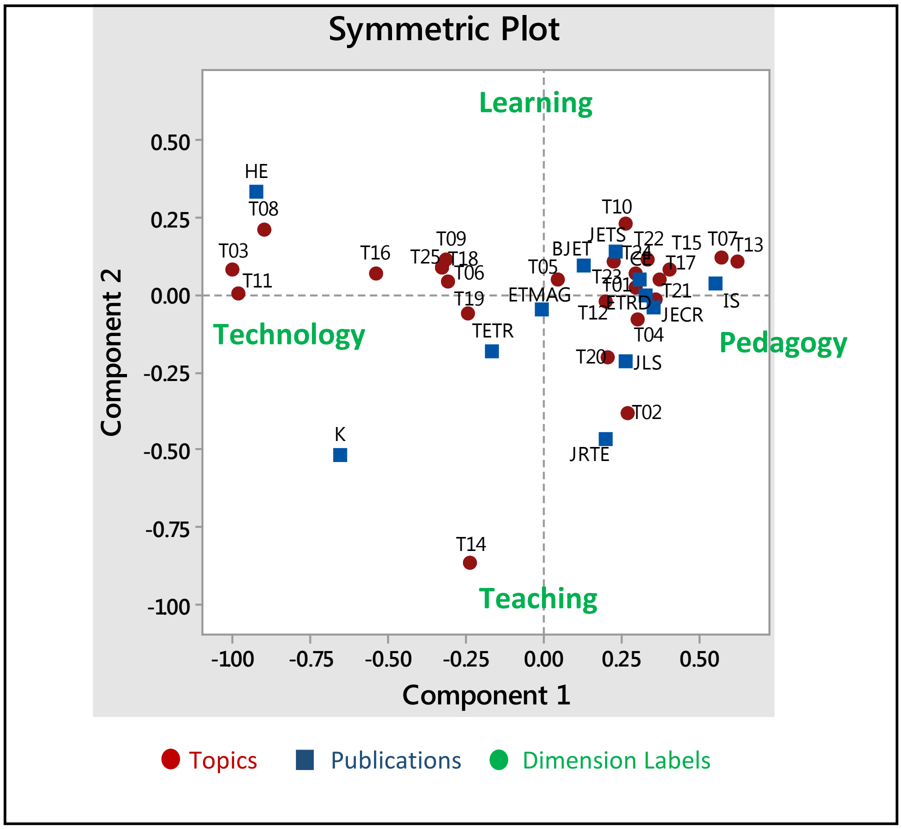

Figure 5. A graphical analysis of associations between topics and publications. The horizontal axis was named the technology-pedagogy dimension. The vertical axis was named the Learning-Teaching dimension.

The plot became more meaningful when the two dimensions were labeled. To do so, the contrasting coordinates were evaluated to determine possible explanations for each dimension. For the horizontal dimension it can be observed that topics T03 (mobility and mobile devices), T11 (trends in educational technology), and T08 (innovation in education) contrast with topics

T07 (learner and teacher behaviors) and T13 (instructional strategies). On the same dimension, publications HE (Higher Education *Horizon Report*) and K (*K-12 Horizon Report*) on the far left contrast with IS (*Instructional Science*) and JECR (*Journal of Educational Computing Research)* on the far right. This dimension seems to be distinguished by the level of innovation inherent in the topic or focus of the publication. For example, the far left, or more innovative end of the dimension, could be characterized as the forward looking, technology-focused end. The far right, or more stable end of the spectrum, could be seen as the research-based, pedagogical contrast to the technology orientation. For this reason, the horizontal dimension is labeled the technology-pedagogy dimension.

The vertical dimension has new models and policies in education (T14) and teacher education and professional development (T02) at the bottom end of the dimension whereas innovation in education (T08) and learning systems (T10) fall on the top end of the dimension. The vertical dimension also has (JRTE) *Journal of Research on Technology in Education* and the K (K-12 *Horizon Report)* on the bottom end with HE (Higher Education *Horizon Report*) toward the top end. When reviewing the topics associated most with the Higher Education *Horizon Report* versus the K-12 *Horizon Report*, the higher education topics appeared to be more learning oriented while the topics associated with the K-12 report seem to be more inclined toward teaching. Likewise, the *Journal of Research on Technology in Education* (JRTE) claims to publish papers that “relate to the efficacy of instructional uses of educational technology” (Journal of Research on Technology in Education, 2017) or perhaps otherwise described as *teaching strategies*. For these reasons, the vertical dimension is labeled the teaching-learning dimension.

The symmetric plot confirms the differences noted in the previous discussion regarding chi-square test results. The *Horizon Reports* and the academic journals are mostly placed in opposite positions on the plot however, this view helps to show *TechTrends* and *Educational Technology Magazine* as the closest of the academic journals to the *Horizon Reports*.

Time Plot Comparison

To conclude the comparison of academic journals and *Horizon Report* publications, time series plots were created for each of the 25 topics for the time period of 2000-2017. The *Journals* line is a total percent for all academic journal contributions compared with the percent contribution of the two *Horizon Reports* year over year. The time series plots provide a visual comparison of the contributions to the topic, or level of importance the publication gave a particular topic for a specific year. After reviewing the individual time series plots, the two main categories that emerged were a) those time series plots where trend lines were mostly similar and b) those time series plots where trends lines were vastly different. A third category of time series plots is separated as Horizon centric, a group that highlights specifically how the *Horizon Reports* focused interest on topics characterized by some dramatic points in the trend lines. The next section discusses the time series plots using these characterizations. Specific points in the timelines are highlighted to help illuminate time periods of interest between publication types.

Mostly Similar

There were seven time series plots where trend lines were mostly similar between the academic journals and the *Horizon Reports*. Generally, the trend lines followed similar patterns with peaks and valleys at similar points in time, however, there were distinct periods where the publication types differed. The topics falling into the mostly similar category were learning systems (F25.10), attitudes toward computers (F25.12), knowledge management (F25.17), childhood education (F25.20), problem solving (F25.21), assessment and feedback (F25.22), and learner support (F25.23) (see Figure 6). Learning systems (F25.10) and learner support (F25.23) shared similar differences in that during the period of 2004 to 2006 the *Horizon Reports* showed a declining interest in the topics where the academic journals showed an increase. After 2006 learner support (F25.23), continued on a mostly similar trajectory except for a peak in *Horizon Report* interest in 2011 where the academic journals continued to climb at a steady level. In contrast, two additional divergences can be observed with learning systems (F25.10) when the *Horizon Reports* show a marked increase that begins in 2009 lasting through 2012 where the academic journals continue a decline through 2011 that began in 2008. A smaller but similar divergence appears again when the *Horizon Reports* pick up in interest in 2014 and the academic journals decline.

Problem solving (F25.21), knowledge management (F25.17), and attitudes toward computers (F25.12) show trend lines that follow similar increases and decreases in interest however the academic journals line precedes the line for the *Horizon Reports*. For example, a peak in interest in problem solving (F25.21) for the academic journals appears in 2004 where it is followed the next year by the *Horizon Reports* in 2005. For knowledge management (F25.17), the initial delay period is longer in that the academic journals peak in interest in 2005 and the *Horizon Reports* follow three years later whereas attitudes toward computers (F25.12) had a shorter delay from 2007 to 2009 for the *Horizon Reports* to peak.

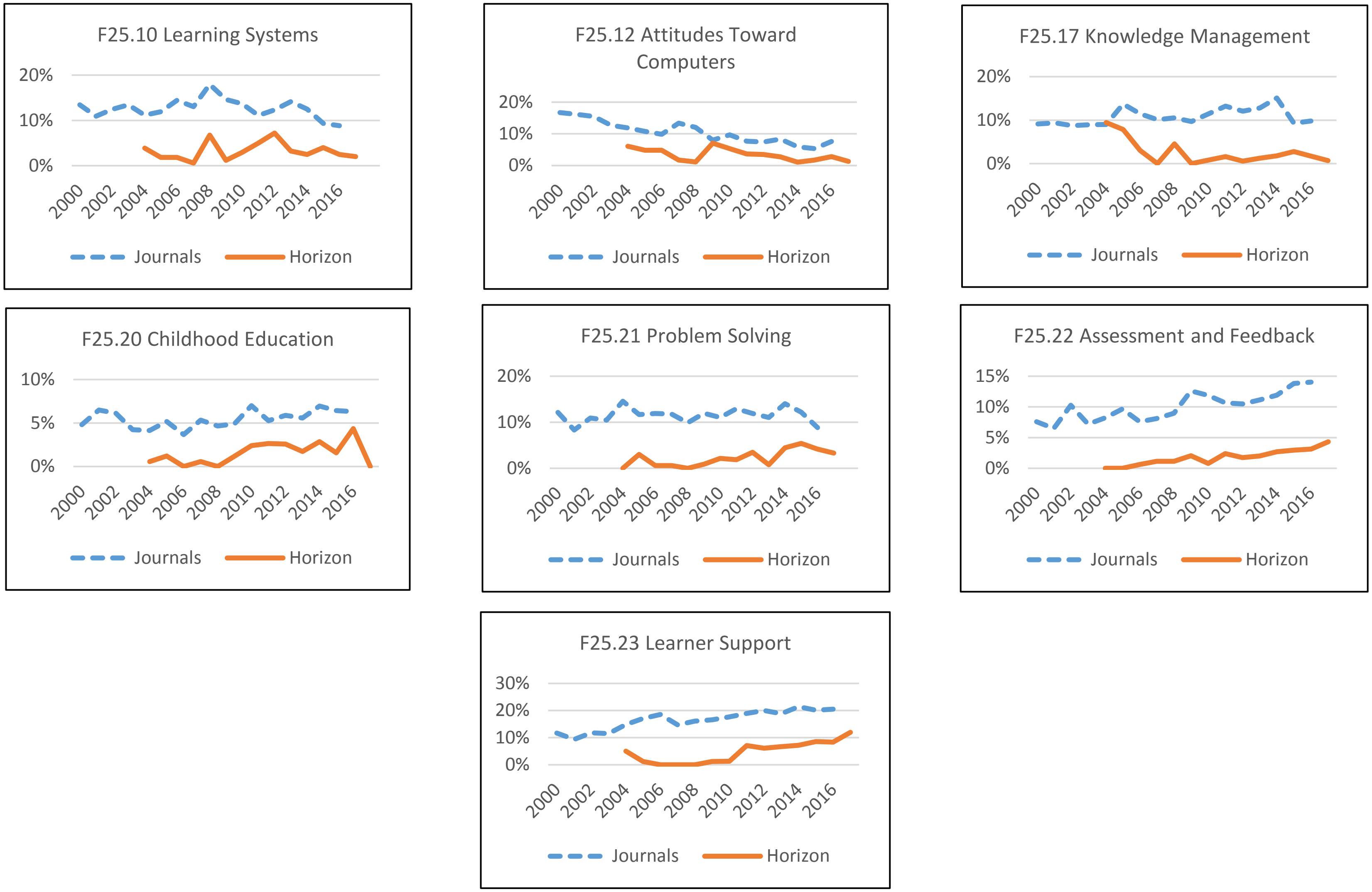

Figure 6. Learning systems (F25.10), attitudes toward computers (F25.12), knowledge management (F25.17), childhood education (F25.20), problem solving (F25.21), assessment and feedback (F25.22), and learner support (F25.23) aligned with the mostly similar category. In this category, trends lines between the journals and *Horizon Reports* had more similarities to discuss than differences. Differences were observed at specific points in time rather than ranges of time.

A second appearance occurs for all three topics where the academic journals peak and are then followed by the *Horizon Reports* one year later beginning in 2013 for attitudes toward computers (F25.12) and in 2014 for both problem solving (F25.21) and knowledge management (F25.17).

The remaining two topics tell a slightly different story from the others in the mostly similar category. Childhood education (F25.20) and assessment and feedback (F25.22) show differences in the publication types by the level of increased interest for the topic. For example, the academic journals show a greater increase in interest in 2009 and 2015 where the *Horizon Reports* show a moderately increasing interest throughout the period of investigation. With childhood education (F25.20), 2016 shows a difference in level of interest where the academic reports have generally declined and the *Horizon Reports* took a stronger interest in the topic.

Vastly Different

There were eight time series plots that revealed trend lines that were vastly different between the academic journals and the *Horizon Reports*. The trend lines in these plots showed very little overlap in how the topic changed over time. The topics in this category were technology-enhanced learning environments (F25.1), teacher education and professional development (F25.2), instructional design (F25.4), online learning (F25.5), learner and teacher behaviors (F25.7), instructional strategies (F25.13), information and communication technology (ICT) (F25.15), and collaboration (F25.24). This category can be further divided into a group with high activity and a group with minimal activity on the part of the *Horizon Reports*. As partially addressed in the low interest topics discussion, the *Horizon Reports* took very little interest in several topics where the academic journals showed higher interest and greater activity during the period of investigation. These were instructional design (F25.4), learner and teacher behaviors (F25.7), instructional strategies (F25.13), and information and communication technology (ICT) (F25.15) (see Figure 7).

This group of topics was also the four topics identified in the chi-square tests as being the top four that the academic journals emphasize more than would be expected in their publications. *Educational Technology Research and Development* and *Educational Technology Magazine* were the two publications contributing the highest to instructional design (F25.4) with interest peaking in 2004 and 2006 and then again in 2016 after a period of stabilization.

The *Journal of Educational Computing Research* was the journal contributing the most to learner and teacher behaviors (F25.7). From the journal perspective, this topic continued to increase in interest after its lowest point in 2003. *Instructional Science* was the highest contributor to instructional strategies (F25.13), another topic that continued to increase in interest for the academic journals since its lowest point in 2006. Of the four in this category, information and communication technology (ICT) (F25.15) had the least contributions overall from the publications (this topic was previously identified *as low interest*) but *Computers and Education* and the *British Journal of Educational Technology* were the highest to contribute. This topic has had generally consistent contributions throughout the period of investigation of this study. Interestingly, when the academic journals had a slight decrease, the *Horizon Reports* had a slight increase.

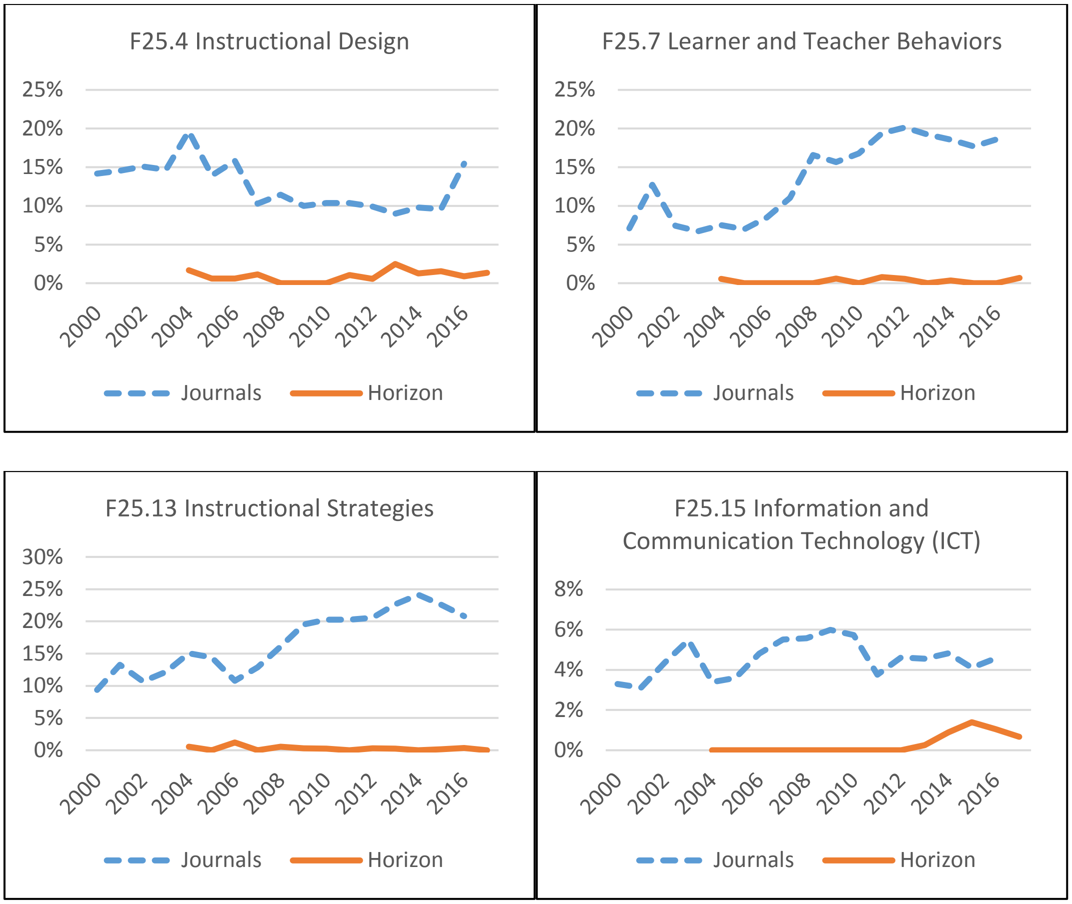

Figure 7. Instructional design (F25.4) learner and teacher behaviors (F25.7), instructional strategies (F25.13), and information communication technology (ICT) (F25.15) were topics where the *Horizon Reports* had minimal interest compared to the academic journals.

The remaining four topics categorized in the vastly different category were technology-enhanced learning environments (F25.1), teacher education and professional development (F25.2), online learning (F25.5), and collaboration (F25.24) (see Figure 8).

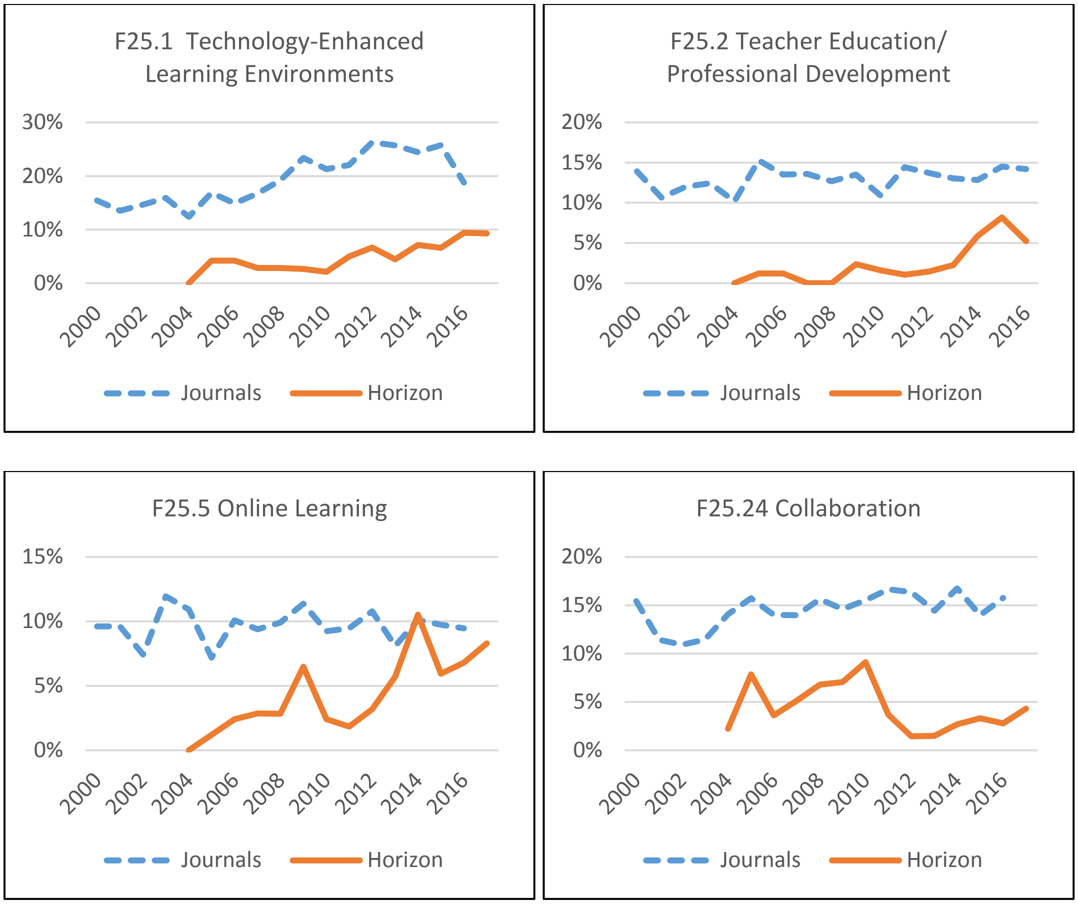

Figure 8. The times series plots for technology-enhanced learning environments (F25.1), teacher educational and professional development (F25.2), online learning (F25.5), and collaboration (F25.24) showed distinctly different patterns between the publications and the *Horizon Reports* where trend lines progressed in opposite directions for longer periods of time.

Technology-enhanced learning environments is admittedly the least dramatic of the four topics in this sub-category in that the most striking difference between the academic journals and the *Horizon Reports* is the diverging interest that begins in 2006. The academic reports begin taking an interest that lasts through 2009 whereas the *Horizon Reports* begin a gradual decline that lasts through 2010. The three remaining time series plots show a more dramatic difference. For example, both teacher education and professional development (F25.2) and online learning (F25.5) show sustained periods of interest by the *Horizon Reports* beginning in 2011. In contrast, the *Horizon Reports* show a substantial decrease in interest after peaking in 2010 followed by a brief leveling out where the academic reports continue a pattern of changing interest during that same time.

Horizon Centric

The remaining time series plots, ten in total, revealed trend lines that were also vastly different between the academic journals and the *Horizon Reports*. However, this category is characterized by time series plots where the *Horizon Reports* show trends lines that are especially dynamic and more intent at specific times on a particular topic. In contrast, the trend lines for the academic journals in this category all show a moderate and sustained level of interest either increasing or decreasing slightly throughout the period of investigation. The topics in this category were mobility and mobile devices (F25.3), games and learning (F25.6), innovation in education (F25.8), social media (F25.9), trends in educational technology (F25.11), new models and policies in education (F25. 14), the internet and the internet of things (F25.16), virtual and augmented reality (F25.18), digital literacy (F25.19), and learning analytics (F25.25). Innovation in education (F25.8) and digital literacy (F25.19) are two examples where the *Horizon Reports* have sustained an increasing interest throughout the period of investigation and then characterized by a substantial increase beginning in 2012 and 2013 respectively (see Figure 9).

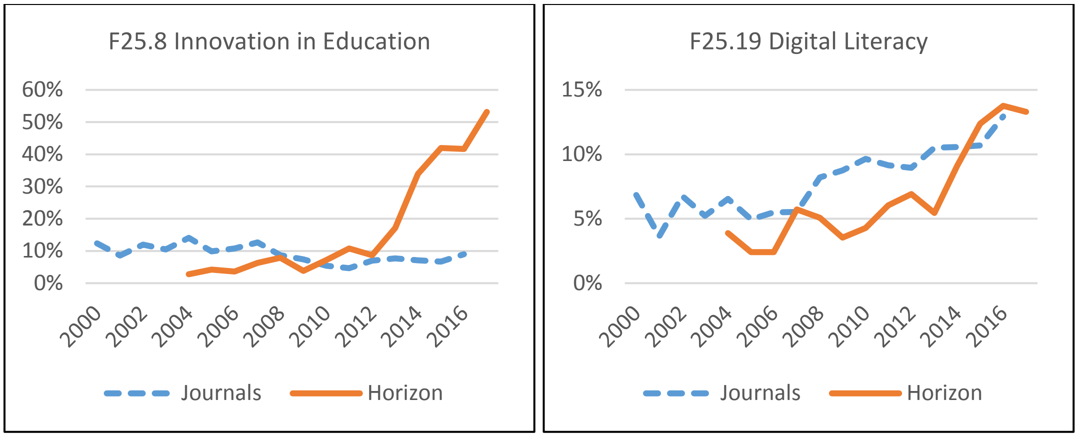

Figure 9. The topics of innovation in education (F25.8) and digital literacy (F25.19) were topics where the *Horizon Reports* showed dramatic increased interest beginning in 2012.

The next subcategory of observed interest was a collection of topics where the *Horizon Reports* show a growing interest in a topic where a marked peak is evident, followed by a striking, and sustained decrease in the topic. These topics are listed in ascending order of the year of their peak beginning with social media (F25.9) in 2008, the internet and the internet of things (F25.16) in 2009, mobility and mobile devices (F25.3) in 2012, and new models and policies in education (F25.14) in 2014 (see Figure 10). In contrast, the academic journals sustained a moderately increasing interest in three of the four topics with the journals showing a sustained decrease in the internet and the internet of things (F25.16). Three of the topics also show a convergence between the academic journals and the *Horizon Reports* by the year 2016. The exception is with social media (F25.9) where the *Horizon Reports* seem to begin a decreasing trend in interest while the academic journals continue a gradual increase in interest. Of the 12 publications, the *Journal of the Learning Sciences* contributed the most to the topic of social media (F25.9).

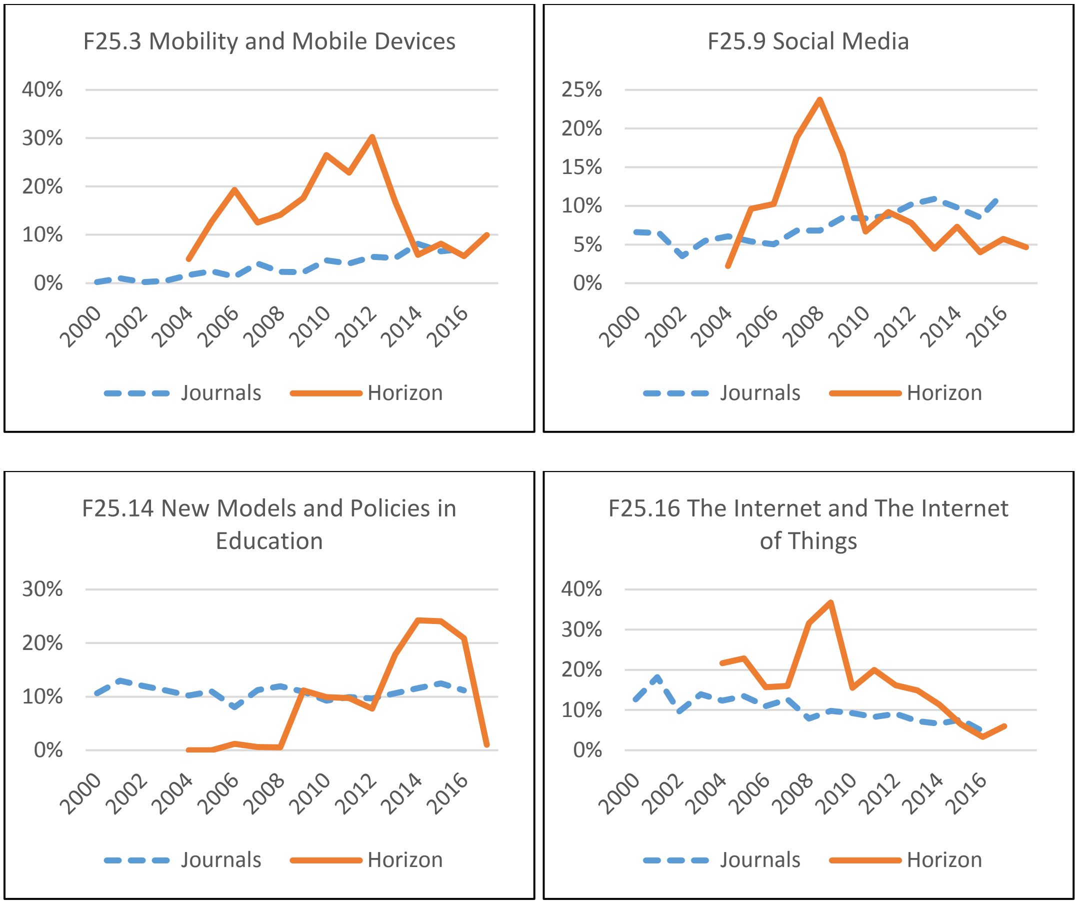

Figure 10. Mobility and mobile devices (F25.3), social media (F25.9), new models and policies in education (F25.14), and the internet and the internet of things (F25.16) were the topics where the *Horizon Reports* peak in interest followed by a distinct decrease. In contrast, the trend lines for the academic journals are steady throughout the period of investigation.

The last group within the category of horizon centric includes games and learning (F25.6), trends in educational technology (F25.11), virtual and augmented reality (F25.18), and learning analytics (F25.25) (see Figure 11). The trend lines for the *Horizon Reports* in this group was categorized by periods of extreme increases and decreases in interest throughout the period of investigation. Three of the four topics peak first in 2007 with learning analytics (F25.25) following in 2008. Virtual and augmented reality (F25.18) and games and learning (F25.6) both have a severe decrease the following year. Trends in educational technology (F25.11) and learning analytics (F25.25) both show a two-year period before a substantial drop in interest. All four topics show subsequent cycles of dramatic peaks followed by a severe drop in interest. Games and learning and virtual and augmented reality both repeat this cycle in 2012 although virtual and augmented reality has an additional cycle in 2010. Learning analytics (F25.25) also has a total of three cycles with the second in 2011 followed by the third in 2013. Trends in educational technology (F25.11) has a smaller cycle in 2011 and then another beginning in 2015.

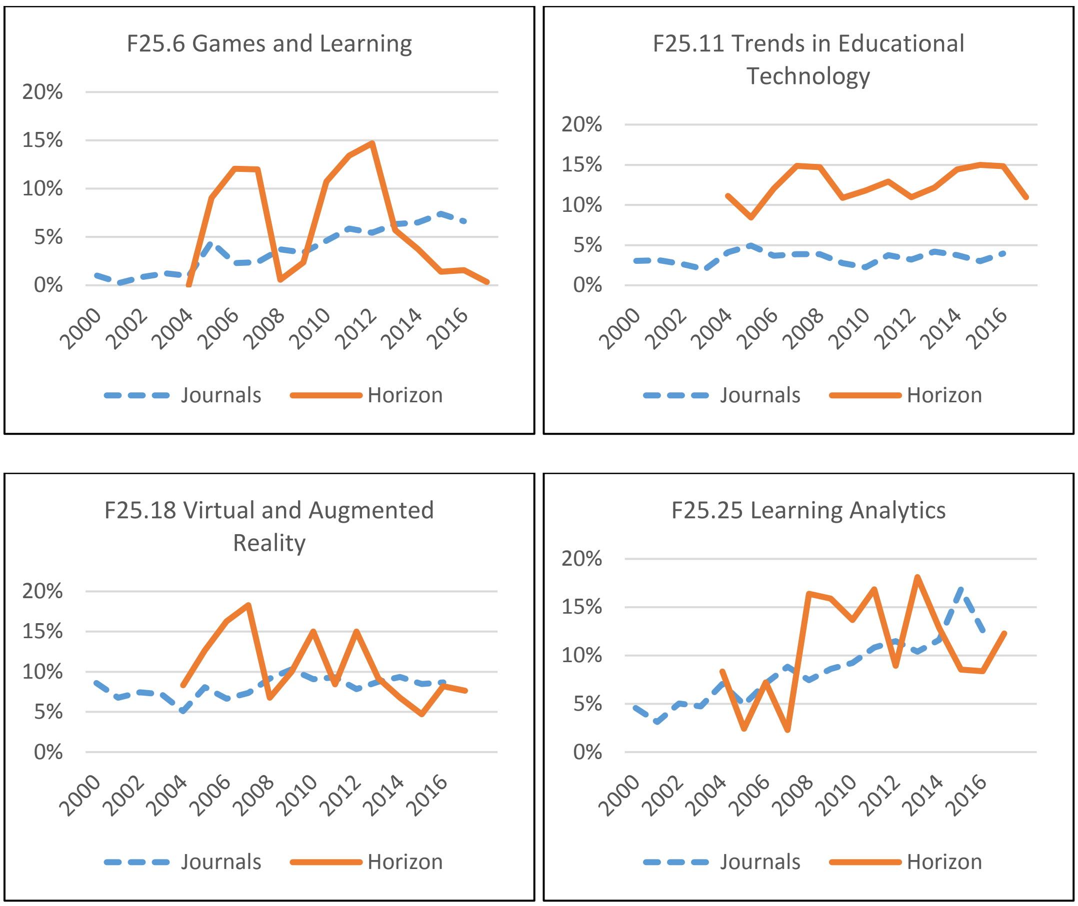

Figure 11. Games and learning (F25.6), trends in educational technology (F25.11), virtual and augmented reality (F25.18), and learning analytics (F25.2) were noted for the dramatic increases and decreases in interest by the *Horizon Reports* throughout the period of investigation.

The journals showing the greatest interest in games and learning (F25.6) were *Computers and Education* and *Educational Technology Research and Development* with a small peak in 2005 followed by a slight, but continued, increase beginning in 2006. The *British Journal of Educational Technology* was the highest contributor to trends in educational technology (F25.11). This topic had a steady trend of interest but it was also one of the two topics that the chi-square tests showed the journals as underemphasizing the most (the other being mobility and mobile devices (F25.3).

Summary

After identifying the 25 extracted topics in the combined corpus of academic journals and *Horizon Reports*, nine high interest topics and three low interest topics emerged. The journals and *Horizon Reports* generally agreed in the topics least favored. However, the high interest topics were generally due to a small group or single publication contributing highly to the topic. Based on a review of the individual publications contributing to the topics, it seems that most publications have one high area of interest relative to the other topics and technologies.

Generally, the academic journals have opposing interests when compared to the *Horizon Reports* based off the expected versus observed frequencies in the chi-square test (Table 14). Two topics, mobility and mobile devices (F25.3) and trends in educational technology (F25.11), were the topics the *Horizon Reports* overemphasis. These were also the two topics the journals most underemphasize.

The interests were further examined using the correspondence analysis and a symmetric plot (see Figure 6), a visual representation of the relationships between topics and publications, on two dimensions. The process of labeling the dimensions revealed two important spectrums that are general areas of discussion within educational technology research: technology-pedagogy and teaching-learning. The *Horizon Reports* were not only placed away from the group of journals they were also distanced between each other. For example, the Higher Education report was in the technology-learning quadrant and the K-12 report was in the technology-teaching quadrant. The majority of the academic journals were clustered in the pedagogy-learning quadrant with a few outliers being *TechTrends* in the technology-teaching quadrant and the *Journal of Research on Technology in Education* and the *Journal of the Learning Sciences* in the pedagogy-teaching quadrant.

Examining the relationships between the journals and the *Horizon Reports* over time also revealed a second layer of differences and similarities where there are some topics where the reports seem similar to the journals, topics of distinct difference, and those topics in which the *Horizon Reports* are especially charged. The next chapter offers an interpretation of the findings as well as provides possible implications for the field of educational technology and those invested in it.

CHAPTER 5

DISCUSSION

To meet the aim of identifying the topics and technologies being discussed in academic research and industry reports, latent semantic analysis (LSA) and singular value decomposition (SVD) was used to extract 25 factors from a combined corpus of 14,404 documents. The corpus was derived from two publication sources and specifically interested in investigating the period of 2000-2017. The first publication source was a collection of article abstracts from ten highly recognized academic journals in the field of educational technology. The second publication source was the paragraphs from the NMC *Horizon Reports* for both the Higher Education and K-12 editions. After examining the high-loading terms for each factor, a label was given to each factor that best described the document contents within the factor. The first research question was addressed with the final list of labeled factors and associated high-loading documents. This list of topics and technologies evident in the corpus of combined publications served as the foundation for comparing the publication types, the second research question in this study.

Review of Findings

The journals and *Horizon Reports* were found to generally focus on different topics of interest. The journals tended to focus on pedagogical issues whereas the *Horizon Reports* tended to focus on technological aspects in education. However, being that technology and related pedagogical issues are often difficult to separate, agreement on the levels of interest on some topics between the publication types were observed at specific points in time.

Of the 25 topics, nine seemed to be of higher interest to the group of publications. These were technology-enhanced learning environments (F25.1), teacher education and professional development (F25.2), instructional design (F25.4), learner and teacher behaviors (F25.7), innovation in education (F25.8), instructional strategies (F25.13), new models and policies in education (F25.14), problem solving (F25.21), and learner support (F25.23). For each of these topics, however, select publications showed an especially high interest in a specific topic. For example, 9 of the 12 publications were uniquely interested in a specific topic; meaning, each of the 9 publications had a high interest in 9 different topics. This could suggest that each of these journals has a specific inclination toward articles about a particular topic. There were, however, three situations were two journals made their highest contributions to the same topic. *Computers and Education* and the *Journal of the Learning Sciences* both made their highest contributions to technology-enhanced learning environments (F25.1). *Educational Technology Magazine* and *Educational Technology Research and Development* made their highest contributions to instructional design (F25.4). *Tech Trends* and the Higher Education *Horizon Report* both made their highest to the innovation in education (F25.8). And lastly, the *British Journal of Educational Technology* and the *Journal of Educational Technology & Society* both made their highest contributions to learner support (F25.23). This could suggest other similar areas of interest for these pairs of publications however further investigation would be needed.

Three topics, games and learning (F25.6), information and communication technology (ICT) (F25.15), and childhood education (F25.20) showed relatively low interest within the collection of publications, however, there was no pattern between the publication types when examining the time series plots, at this level of analysis. For example, each topic was sorted into a different category of time series plots. Games and learning (F25.6) was in the horizon centric group, information and communication technology (ICT) (F25.15) was in the vastly different group, and childhood education (F25.20) was in the mostly similar group. Based on this inconsistency, the differences in being a low interest topic does not seem to be a reflection of differences in interest between the academic journals and the *Horizon Reports* when evaluating the group of publication as a whole.

Between the academic journals and the *Horizon Reports*, it seems that although there are topics of interest that are shared between the publication types (with varying levels), the topics of far greatest interest to the *Horizon Reports* and those that are of greater interest to the academic journals tells more of the story. The results of the chi-square tests confirm that the three topics of emphasis for one group were the lowest for the other and that this oppositional relationship was consistent throughout for the remaining topics, but at varying degrees. The difference in emphasis for trends in educational technology (F25.11) was a likely departure between publication types given the nature and scope of each. However, the extreme difference in mobility and mobile devices (F25.3) was unexpected. The time plot for this topic (see Figure 10) helps describe the differences between the publications. The academic journals have contributed a moderately steady trend line that has increased incrementally over the period of investigation. The *Horizon Reports*, however, have contributed significantly higher to this topic especially in the years of 2006, 2010, and 2012. However, in 2014, the *Horizon Reports* show a significant decrease in this topic with the most recent years matching the contributions of the academic journals. Analysis of this topic in future years may tell a different story with how the *Horizon Reports* differ from the academic journals.

Interestingly, even the two types of *Horizon Reports* shared similar topic interests but showed a departure in specific interest with innovation in education (F25.8), where the Higher Education report contributed almost twice as much as it did with all the other topics and the K-12 report showed moderate interest. The K-12 report was especially interested in new models and policies in education (F25.14), where it contributed twice as much as its next highest topic and three times as much as every other topic. In contrast, the Higher Education report hardly made a contribution to this topic at all.

The correspondence analysis shown earlier (see Figure 6) seems to offer an explanation that is consistent with other findings in the analysis. By describing the publications and the topics across two dimensions, teaching-learning and technology-pedagogy, the majority of the academic journals fell within the learning–pedagogy quadrant. The technology oriented publications and topics fell within the learning–technology quadrant with the exceptions of *Tech Trends*, the K-12 *Horizon Reports*, Digital Literacy (F25.19), and new models and policies in education (F25.14) which all fell within the teaching –technology quadrant. *Educational Technology Magazine* seemed to be perfectly balanced between both dimensions along with online learning (F25.5).

TechTrends and *Educational Technology Magazine* were the two publications closest on the symmetric plot to the *Horizon Reports* which was unsurprising given these publications' inclination toward practice. Perhaps what was less expected was the position of the *Journal of the Learning Sciences* and the *Journal of Research in Technology in Education* in the pedagogy-teaching quadrant given that both journals showed higher interests in technology enhanced learning environments (F25.1). However, these journals also showed high interest in collaboration (F25.24) and learning analytics (F25.25) in the case of the *Journal of the Learning Sciences* and teacher education and professional development (F25.2) and new models and policies in education (F25.14) in the case of the *Journal of Research on Technology* in Education which were more aligned with positions on the symmetric plot.

The time series plots seem to depict a few scenarios for how the *Horizon Reports* and the academic journals interplay. The most similar time series plots all seem to show a pattern in which the *Horizon Reports* follow the journal interest levels but with a time lag. Even with the time series plots that vastly differed between the publications, the trend lines for the *Horizon Reports*, especially those that show extreme highs and lows, seem to have the potential of leveling out and even aligning with the academic journals. This potential seemed the greatest with social media (F25.9), the internet and the internet of things (F25.16), virtual and augmented reality (F25.18), digital literacy (F25.19), and learning analytics (F25.25). Lastly, the topics where the *Horizon Reports* show consistently minimal interest seem to be those topics in which the *Horizon Reports* will continue to have minimal interest. These topics were instructional design (F25.4), learner and teacher behaviors (F25.7), instructional strategies (F25.13), and information and communication technology (ICT) (F25.15).

Interpretation

Based on a synthesis of the findings, the summary conclusions drawn from this research were:

1. The *Horizon Reports* have a different general focus on educational technology topics than the group of academic journals used in this study.
2. Individual educational technology publications had specific areas of high interest with regard to research areas and this increased interest was not necessarily shared by other journals in the field.
3. The *K-12 Horizon Reports* had specific interests that do not necessarily align with the *Higher Education Horizon Reports*.
4. With the shared interests between publication types, the *Horizon Reports* seemed to be on a timeline that followed the academic journals rather than preceding them.
5. If the *Horizon Reports* did show some interest in the topics in which they did not agree with the academic journals, they did so by showing a pattern that was counter to the academic journals. For example, when the journals were decreasing in interest, the reports seemed to be gaining interest.
6. The *Horizon Report*s showed the least interest in topics most closely aligned to pedagogy and the most with technology innovations.
7. When the *Horizon Reports* addressed a topic they seem to do so with greater interest at very specific points in time rather than as gradual interests over time.

Comparison to Previous Research

Previous research that is most related to this study was the research conducted by Natividad (2016) where she extracted 22 topics using LSA and SVD for the period of 1995-2004. A comparison of her 22 topics against the 25 topics extracted in this research reveal a 52%

match. Thirteen of the 22 topic labels match between the studies. The remaining 12 topics in this research without a match could be the result of differences in label choices between researchers or more dramatically, a shift in topics due to the inclusion of the *Horizon Reports*. See Table 16 for a side-by-side comparison of Natividad's (2106) topics with the topics found in this research. Those without a match are italicized along with a designation for the *Horizon Reports* interest level. Those topics of high interest to the *Horizon Reports* are shown in bold.

Although some of the unmatched topics were topics in which the *Horizon Reports* took a high interest, only four of the 12 matched this criterion. These topics were innovation in education (F25.8), trends in educational technology (F.2511), new models and policies in education (F25.14), and the internet and the internet of things (F25.16). This suggests that it may not have been the inclusion of the *Horizon Reports* that caused a difference in topic listings between the two studies. Surprisingly, there were six topics that were of low interest to the *Horizon Reports* and of higher interest to the academic journals that did not have a match to Natividad's (2016) topics list. These were instructional design (F25.4), learner and teacher behaviors (F25.7), attitudes toward computers (F25.12), knowledge management (F25.17), learner support (F25.23), and collaboration (F25.24). Based on the nine topics of Natividad's (2016) that also did not have a corresponding topic in this research, it is likely that labeling differences between researchers could explain the gap in counterparts between the two lists. However, further research would need to be conducting in order to better understand the discrepancies between topics lists.

Table 16

A Comparison of Topic Labels with Natividad (2016)

Label	Natividad (2016)
F25. 1 Technology-Enhanced Learning Environments	F22.8 Learning Environments
F25.2 Teacher Preparation and Professional Development	F22.7 Teacher Preparation and Professional Development
F25.3 Mobility and Mobile Devices	F22.13 Mobile learning
F25.4 Instructional Design	*LOW*
F25.5 Online Learning	F22.6 Online Learning
F25.6 Games and Learning	F22.10 Game Based Learning
F25.7 Learner and Teacher Behaviors	*LOW*
F25.8 *Innovation in Education*	***HIGH***
F25.9 Social Media	*AVERAGE*
F25.10 Learning Systems	F22.3 Learning Systems and Tools
F25.11 Trends in Educational Technology	***HIGH***
F25.12 Attitudes Toward Computers	*LOW*
F25.13 Instructional Strategies	F22.1 Learning and Instruction
F25.14 New Models and Policies in Education	***HIGH***
F25.15 Information and Communication Technology (ICT)	F22.18 ICT in Learning and Instruction
F25.16 The Internet and The Internet of Things	***HIGH***
F25.17 Knowledge Management	*LOW*
F25.18 Virtual and Augmented Reality	F22.Virtual Environments
F25.19 Digital Literacy	F22.11 The Internet and Digital Literacy
F25.20 Childhood Education	F22.16 Childhood Education
F25.21 Problem Solving	F22.14 Problem Solving
F25.22 Assessment and Feedback	F22.15 Assessment and Feedback
F25.23 Learner Support	*LOW*
F25.24 Collaboration	*LOW*
F25.25 Learning Analytics	*AVERAGE*
	F22.2 Student Learning
	F22.4 Learning Experiences
	F22.5 Faculty Training and Adult Education
	F22.9 Distance Education
	F22.12 Professional meetings and Associations
	F22.17 Learning with Multimedia
	F22.19 Experiential Learning
	F22.20 Reading Comprehension
	F22.22 Concept Mapping

To compare findings of individual publications with those of past studies, the journal review series published in *Educational Technology Magazine* offers a comparison opportunity for eight of the journals in this study. The periods of investigation for the journal review series were a subset of the time period for this study. For example, most of the journal review series studies were conducted using ten-year time periods beginning in 2001, 2002, or in 2003, all ranges falling within the time period of this study. In one case, the journal review series used the shorter time period of 2010-2014 for the content analysis focused on the *Journal of Educational Technology & Society*. A review of Table 4 reveals that many of the topics in this study were identified in the top word and phrase frequencies found in the journal review series. For example, in the review series, *Educational Technology Research and Development* used problem-solving and instructional design which were topics F25.21 and F25.4 respectively. In this study, *Educational Technology Research and Development* was the highest contributor to the topic of instructional design (F25.4). In addition to *Educational Technology Research and Development, Computers and Education* also mentioned learning environments but specified it as "interactive learning environments" which was most closely aligned with technology-enhanced learning environments (F25.1). *Computers and Education* was also one of the highest contributors to technology-enhanced learning environments (F25.1) in this study.

There was alignment between the *British Journal of Educational Technology* in the review series and in this study with the use of the term "attitudes" and the topic of attitudes toward computers (F25.12). This journal also had alignment with the topic assessment and feedback (F25.22) with the phrase "computers in testing." *Instructional Science* created alignment with the phrase "collaborative learning" and the topic collaboration (F25.24) in this study. The phrase "teacher education" was identified as a top phrase in the *Journal of Research on Technology in Education* in the review series. This journal was also the highest contributing to this topic, teacher education and professional development (F25.2), in this study. The *Journal of Educational Technology & Society* used the phrase "computers and video games" which is aligned most closely with the topic games and learning (F25.6) in this study. Interestingly, this journal was only a moderate contributor to this topic in this study. The last alignment to discuss was the most prevalent amongst the ten journals in the review series and aligned best with online learning (F25.5). The *Journal of Research on Technology in Education* and the *Journal of Educational Technology & Society* both used the phrase "distance education," where the *Journal of Educational Computing Research* used "computer assisted instruction" and *Instructional Sciences* used the phrase "computer-mediated communication" which, which may be loosely related to the topic of online learning (F25.5).

Although not included in the publications selected for this study, there were other journals studied in the review series that used word and phrase frequencies that aligned with topics found in this study (see Appendix B). They were "interactive learning environments" with the phrase "virtual learning environments" (aligned to virtual and augmented reality, F25.18), the *Journal of Computing in Higher Education* with the phrase "mobile technology" (alignment to mobility and mobile devices, F25.3), and "the internet and higher education" with the terms social/network/environment (alignment to social media, F25.9). This suggests that the topics extracted from the corpus of the specific publications in this study also may extend to publications not included in this study.

To summarize the review of this study against the findings with the same set of journals used in the *Educational Technology Magazine* journal review series, many alignments existed between the 25 extracted topics and the word and phrase frequencies. Additionally, the journals recognized as contributing highly to a particular topic in this study also aligned with the word and phrase frequencies in the review series. In cases where comparisons and alignments were difficult to make it was usually due to the use of broad terms in the word and phrase frequencies, examples of which were "educational technology" and "learning."

Limitations

As with any research study, efforts were made to reduce the number of errors, biases, and other limitations within this study. However, there were still limitations that were known and those that emerged as the research study progressed.

Period of Investigation

The data collection process consisted of multiple phases of collection. When the proposal for this research was presented, it was logical to include the 2017 Higher Education *Horizon Report* because it was published at the beginning of the year. Logically the findings in the report would correspond to 2016 events and therefore could be compared as such. The K-12 *Horizon Report* was published too late in the year to include in this study which made for an inconsistent *Horizon Report* dataset. Although the intention was to attempt as thorough data collection as possible, the inclusion of the 2017 report simple made for an outlier in the data analysis and presentation. Publishing delay is a known reality for academic research and one that is difficult to control for. Because this phenomenon was not accounted for in the other publications attempts to account for publishing delay in one of the twelve publications did not prove to be helpful in better analyzing the data. Future research should examine consistent time periods throughout all portions of the data set. The decision to proceed with the existing data set was made after determining that the possibility of the 2017 report influencing the resulting 25 extracted topics was minimal, if not non-existent.

Data Selection

Abstracts and paragraphs were used to represent the two types of publications in this study. Abstracts used as a representative of the full article is a common practice when performing content analysis on a corpus consisting of academic articles and journals. Although not an exact equivalent, report paragraphs provided comparisons that were close in word count and annual contribution to those of the journal abstracts. The decision to proceed with these forms of data was made because the potential contribution to the field, even without perfect equivalents, was worth pursuing.

Even with the generally accepted practice of using article abstracts as representatives of the articles themselves, there were limitations in data collection with the article abstracts. Some articles simply did not have an authored abstract. This was especially true for *TechTrends* and *Educational Technology Magazine*. The use of database authored abstracts was made with the rationale that these sources were publicly available should others be interested in further research or a replication study. However, as Crawford (2010) points out, those writing abstracts for articles written by others may simply be using keywords or have other motivations for how an abstract should be written (e.g. marketing purposes) rather than the care and focus an author has when writing his own. Missing abstracts was not a widespread issue for a majority of the journals, however, *Educational Technology Magazine* did not being using abstracts on a consistent basis until 2007 and it was not until 2010 for *TechTrends.* Many of the abstracts used for these publications were primarily retrieved using university library database resources, especially in the earlier years of the period of investigation.

Implications

This study was intended to address the challenge of synthesizing the vast amounts of information pertaining to educational technology available for the purpose of decision making and practical application. Those benefitting would be the educators, education researchers, policy makers, research funders, and practitioners by providing the ability of “seeing the forest” (Miller et al., 2016), or having a more holistic view, of the interplay between research *and* practice. Depending on the role, implications for this study may have different meaning. For this reason, implications are addressed by each role one may play in the field of educational technology.

Educators

Those with the responsibility of teaching have the job of determining which instructional strategies are most useful in their learning spaces. Based on the symmetric plot provided in Figure 5, the academic journals continue to be a valuable source for pedagogical concerns. The selection of a journal for guidance may depend on the particular interest the educator has. For example, if the broad interest is on instructional strategies (F25.13), the educator may reference *Instructional Sciences* because of the high contribution this journal made to the topic (see Appendix I). However, if the educator is interested in the topic of learner support (F25.23), the *British Journal of Educational Technology* or the *Journal of Educational*

Technology & Society (see Appendix I) may be more suitable places to begin. Referring to these particular findings related to any of the 25 topics may serve an educator in this way.

One aspect of the *Horizon Reports* that may be particularly useful to educators is their practice of providing examples of how topics and technologies are being used in the field. The specific examples could be a useful supplement to the pedagogical concerns with a particular topic. In following the learner support (F25.23) example, educators could refer to the *Horizon Reports*, particularly in the years following 2011 when the interest in this topic began to increase (see Figure 6) for more relevant topic examples.

Education Researchers

Education researchers have the concern of deciding where and how to focus efforts with their research agendas. The breakdown of contributions made by the ten academic journals could serve as a useful resource in determining which journals are most aligned with their own research interests. For example, researchers interested in the topic of social media (F25.9) may focus efforts toward the *Journal of the Learning Sciences* first. The contributions of each of the journals to this topic were relatively modest, however the *Journal of the Learning Sciences* had a slightly higher contribution that, without an analysis such as this, may have been lost to researchers otherwise.

The time plots may offer some insight into how education researchers plan their efforts, Take the topic of mobility and mobile devices (F25.3) as an example. The *Horizon Reports* had high interest in this topic between the years 2006 through 2012 whereas the academic journals simply maintained a conservative, but increasing interest. Perhaps this reveals an emerging stream of research where researchers may use the examples provided in the *Horizon Reports* where interest was highest as starting places for research planning. Social media (F25.9) and digital literacy (F25.19) are other examples where the *Horizon Report* examples may supplement research planning in under researched areas.

Policy Makers

Policy makers have the charge of advocating and implementing sound policies for the greater good of the field. Of the 25 topics, new models and policies in education (F25.14) may serve as the topic of greatest interest to policy makers in the field. This topic had 1,663 contributions with representation from every publication in the study. The *K-12 Horizon Report* had significantly more to contribute to this topic than any other publication (see Appendix I) however, other top contributors were the *Journal of Research on Technology in Education*, the *Journal of the Learning Sciences*, and the *Journal of Educational Computing Research*. The *Horizon Reports* show two distinct years where interest in this topic increased, 2008 and 2012. Policy makers may look to these reports for more insight into the discussion.

Research Funders

Research funders have the job of deciding where resources should be devoted with regard to research initiatives. The topic of innovation in education (F25.8) may be the most useful for research funders in deciding the potential areas of greatest impact. Perhaps the times series plots would be the most helpful in this efforts. Although the Higher Education *Horizon*

Report was the highest individual contributor to this topic, of the 25 topics, *TechTrends* also contributed to this topic more than any of the other 24 topics (see Appendix I).

The time series plots may also serve research funders in similar ways that they serve researchers. Topics with sustained, but increasing interest may be useful in determining where to devote research resources particularly in areas that show low or moderate interest but are trending up on the part of the academic journals.

Practitioners

Practitioners rely on sound research-based practices to perform well in their jobs. The 25 topics presented in this study provide a basis for practitioners to review the “conversations” that are occurring around a particular topic to better inform personal or organizational practice. Using instructional design as an example, an applied science, the ability of practitioners to identify appropriate insights from academic research is important in solving instructional problems. For example, instructional designers may focus efforts on the topic of instructional design (F25.4) by making a practice of referring to *Educational Technology Research and Development* and *Educational Technology Magazine,* as they were the highest contributors to this topic, or *TechTrends*, a publication most interested in this topic. In the case of instructional strategies (F25.13), referring to *Instructional Sciences* or the *Journal of Educational Computing Research* as reasonable publications to follow. Although the *Horizon Reports* had low contributions to the topic of Instructional Design (F25.4), the reports still serve a practical purpose through the examples of practice in the field. Turning to the topics of interest would be the most effective use of the reports for this purpose.

In similar fashion to the researcher group, practitioners may also find that specific topic interests will inform their practice. Although instructional design is traditionally initiated from the pedagogical perspective, outside motivations or pressures could promote particular technologies in instruction. The technology-oriented topics may provide a basis for culling out research-based practices in the literature to support practical decisions. For example, games and learning (F25.6) had a moderate contribution from all of the publications, one that was identified as being less than expected based on the chi-square test results (see Table 14). However, the *Horizon Reports* contributed more than expected to this topic, suggesting this may be a rational place to begin when examining the use of games in learning, especially in 2006-2007 and again in 2012 when this topic greatly increased in interest (see Figure 11). *Computers and Education* and *Educational Technology Research and Development* were also amongst the higher contributors to this topic. These academic journals could serve the purpose of closing the gap between research and practice if used in conjunction with the scenarios presented in the *Horizon Reports*.

The Field

The last implication to discuss is one that impacts the educational technology field as a whole. Based on the symmetric plot (see Figure 5), *Educational Technology Magazine* was the one publication well-balanced between the two dimensions, teaching-learning and technology-pedagogy. Being that the editor/owner, Larry Lipsitz, passed away in 2016, and a successor has not been named, the magazine is in danger of ending (J. M. Spector, personal communication, April 30, 2017). Recognizing the impact this publication has made on the field of educational technology, the discontinuation of this magazine would be a great loss to the field in providing balance to research and practice, literally. A finding noted by West (2011) in the journal review series (see Table 4) was the technology-centric focus of most journals. Research found "very few journals focused instead on instructional design and instructional/learning theory" (p. 44). The loss of *Educational Technology Magazine* would further exacerbate this gap by losing an important voice in the educational technology community. In addition, it has been announced that *Educational Technology & Society* is ending in the near future, which is an additional loss of an important online, open-access venue (see http://ifets.info/Announcements/1481271385.pdf)

Recommendations for Future Research

The aims of this study were to better understand the interplay between industry reporting and academic journals, a broad, yet rich endeavor. The findings presented in this study offer a foundation for a variety of opportunities for future research. In addition to the opportunities for potential research exploration already mentioned in the previous section, further research could be performed by also focusing on a more detailed analysis using the current findings, expanding the corpus, and altering the methodology.

Detailed Analysis with the Current Findings

The findings in this study helped to identify high and low interest topics during the period of investigation. An investigation into any one of the 25 topics would provide a deeper understanding of how the topic changed over the period of investigation. Relationships between the topics may also become more apparent with this kind of detailed examination. For example, several of the time series plots showed a pattern where the *Horizon Reports* seem to follow the interests of the academic journals (see Figure 6). A deeper investigation into these patterns would be warranted in a future study. A deeper investigation could also take place by shifting the focus from topics to individual publications to examine publishing tendencies for any one of the publications in this study. As for West's (2011) finding about the technology-centricity of the academic journals in the field of educational technology, future research could investigate this claim. There were differences between the two *Horizon Reports* that may even warrant a deeper investigation between these two publications. Comparisons could also be made between various publication outlets to determine similarities and differences between them.

A closer examination of subsets of specific documents included in this study may also provide an opportunity for future research. As described in Table 11, document contributions to the various topics ranged from zero to nine times. A specific examination of the documents that made no contribution to any of the 25 extracted topics could highlight areas of emerging research, emerging technologies, or underserved research interests. Likewise, an examination of the articles with contributions to multiple topics may illuminate more of the overlap between topics and technologies. A closer investigation of these high-contributing documents, in particular, relative to time may also offer insights into trends in educational technology.

In this study, comparisons between the journals and the publications were made using time series plots. Each of the plots offered in this study could benefit from further investigation. Differences and similarities in points in time as well as patterns over time were recognized as part of each time series plot but a deeper investigation throughout the period of investigation may uncover reasons for the shifts in interest. For example, three categories of time series plots were used in this study to provide a means for discussing the vast amount of findings. Other categories or trends may be revealed with a closer examination of each time series plot. Likewise, although chi-square tests were performed in this study to compare the publication types, further analysis could be performed to expand the contingency table to a 25-by-31, topic-by-source/year combination category table to examine how the topics and publications move through time.

The various anomalies that arose throughout data analysis may serve as points in which to expand this research. All 12 publications showed some level of contribution to each of the 25 topics with the exception of *Instructional Science* and the topic of mobility and mobile devices (F25.3). This and other topics where publications contributed minimally could serve as special interest to researchers in the field to investigate the reasons for almost absent representation with regard to those topics. Additionally, there were several outliers that appeared on the symmetric plot and can be observed in Figure 6. The K-12 *Horizon Reports*, the *Journal of Research on Technology in Education*, teacher preparation and professional development (F25.2), and (F25.14) stood out from the rest of the publications and topics.

The Gartner Group's hype cycle has been used to evaluate trends in educational technology over periods of time (Gartner, 2017). The findings in this study are no different in the sense that the hype cycle could be compared against timelines for each of the extracted topics. It is possible that predictions could be made about topics and technologies based on where they seem to fall in the hype cycle. Comparisons could be made with how the topics and technologies are reported in this study with other studies about the same topics and technologies that also involve the hype cycle. The topics in which the *Horizon Reports* showed the greatest vacillation may be a rational placed to begin an analysis using the hype cycle.

Finally, as with any study, and perhaps even more so with studies such as this that used large amounts of data, a replication study would benefit the field by helping to confirm or deny the findings offered in this study. There were enough points in the data analysis that required subjective interpretation that other research perspectives would provide valuable insight to either strengthen or find weaknesses in this research.

Expanding the Corpus

The ten journals and the *Horizon Reports* were the selected publications for this study. However, as mentioned earlier there are other possibilities, 270 academic journals according to Perkins and Lowenthal (2016), when assembling the sources for the corpus. There are also a variety of sources that may serve as representatives to broaden the industry reporting perspective. As identified earlier, *THE Journal*, the *Chronicle of Higher Education*, and the *EDUCause Review* are reputable sources to name just a few. The NMC also has a variety of special issue topics that could be included in an expansion of the *Horizon Report* corpus. Conference proceedings may also be a source to help identify new areas of research or emerging technologies. And with the variety of venues in which researchers are publishing, less traditional forms of publication may be incorporated into the corpus. For example, webinar transcripts, established educational technology blogs, and even the articles that were specifically removed from the corpus in this research. Editorials, commentaries, and regular columns serve as other voices in the overall educational technology conversation.

Another area of continued research is to expand the investigation period for the study. With each year of newly published articles and industry reports, the data set naturally expands for further research. In this study, the academic journals contributed an average of 570 articles per year. The *Horizon Reports* contributed an average of 210 paragraphs per year. Broadening the time period for investigation is an approach that provides a continuing examination of the conversations happening in the field of educational technology without end.

Altering the Methodology

The methodology used in this study is one of many approaches that could have been used to perform content analysis. Although manual forms of content analysis would not be recommended for the size corpus used in this study, other software packages equipped to handle large data sets use different algorithms to analyze groups or trends in the data. For example, Rapid Miner Studio 7.0 (Rapid Miner, 2017) is an open source predictive analytics platform that performs cluster analysis using a k-mean algorithm, a widely-used process in content analysis (Arthur & Vassilvitskii, 2007; Berkhin, 2006). This cluster analysis uses hard clustering so that each item in the dataset is assigned to a cluster. Using a hard clustering approach against a soft clustering approach as in this research may provide some insights into content analysis research, especially with large datasets.

According to Wang, Yang, and Ju (2015), “different clustering algorithms lead to different results based on different considerations” (p. 62). In the case of this study, 1,450 documents were left without a topic association. However, with a different algorithm these documents would have been forced to make an association. Other topics of interest may be identified with the use of such an approach.

Broadening the Research Questions

The study performed by Natividad (2016) included research questions pertaining to the article bibliometrics to determine who has published research papers and to what extent both from the author and journal perspective. Not only could these research questions be extended to the corpus offered in this study, a review of the expert panel that is responsible for the final *Horizon Reports* could be examined. Because a portion of the expert panel changes with each year, patterns may emerge that reveal who the voices belong to on the industry side of the conversation around educational technology.

Focusing on What Was Not Identified

The *Horizon Reports*, as a regular practice, identify the top six technologies of interest for each annual report. Although many of the technologies identified were also represented as one of the 25 extracted topics in this study, many of the *Horizon Report* technologies were not represented. For example, makers spaces, artificial intelligence, and adaptive learning were technologies identified in several of the more recent *Horizon Reports* (see Appendices C and D) however, these technologies were not specifically identified as one of the extracted topics. An investigation of how the documents in the corpus loaded to the topics would provide more specific insight as to how these emerging areas fit into the educational technology research at large.

Similarly, as mentioned earlier, the National Education Technology Plan provided by the U.S. Department of Educational Technology (2017) highlight student-centered learning as an important development in higher education. Future research could investigate the evolution of this paradigm shift as well as other developments that have been highlighted by the U.S. Department of Educational Technology and the relationships to those topics and technologies in the academic journals and industry reports.

Lastly, one particular phenomenon that was not specifically identified in this study but has garnered interest in both academic research and popular media has been the massive open online course (MOOC). Being that the *New York Times* named 2012 the "Year of the MOOC" (Pappano, 2012), this phenomenon is likely embedded in one of the extracted topics. This suggests that other emerging technologies that may have been likely topic candidates could instead be embedded in a more broadly representative topic. This supports the argument for the importance of a deeper investigation into each of the 25 extracted topics presented in this study.

Scholarly Significance

The body of knowledge in educational technology continues to grow because of the number of academic journals available to researchers, the affordances of the internet for distribution, and the alternative forms of publishing available to authors. Synthesizing the information for the purpose of sound decision making, practical application, defining suitable research agendas, or allocating resources is a massive undertaking for anyone invested in the field. Additionally, while rigorous research is important to advancing the field, practical application is the cornerstone for learning. In an effort to bridge research and practice, this study broadened the body of knowledge by examining the industry reporting contributions alongside the publications of academic researchers. However, the contribution to the field of educational technology was in extracting the topics and technologies relevant to both researchers and practitioners and in providing an examination of the interplay between the two voices to help anyone with a role in educational technology with efficient and informed decision making.

APPENDIX A

IRB

IRB Number	IRB 17-306
Title of Study	Educational Technology: A Comparison of Academic Journals and the NMC Horizon Reports for the Period of 2004-2016
Supervising Investigator	Dr. Lin Lin
Supervising Investigator email	lin.lin@unt.edu
Student Investigator	Gwendolyn Morel
Student Investigator email	gwendolynmorel@my.unt.edu

July 10, 2017

Hello Dr. Lin,

The UNT Institutional Review Board has jurisdiction to review proposed "research" with "human subjects" as those terms are defined in the federal IRB regulations. The regulations define research as "a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge." The phrase "human subjects" is defined as "a living individual *about* whom an investigator (whether professional or student) conducting research obtains (1) data through intervention or interaction with the individual, or (2) identifiable private information.

Based on the description of your proposed study in your IRB Application, your study will not involve "human subject research" therefore review and approval by the UNT IRB is not needed.
We appreciate your efforts, however, to comply with the federal regulations and sincerely thank you for your IRB application submission!

Thank You,

Jillian Byrne-Sweeney, MA
Research Analyst II, Research Integrity and Compliance
Office of Research and Innovation
University of North Texas
Hurley Administration Building, Suite 121
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APPENDIX B

TOP THREE WORD AND PHRASE FREQUENCIES FOR THE 23 JOURNALS INCLUDED IN THE EDUCATIONAL TECHNOLOGY MAGAZINE REVIEW SERIES

Journal	Investigation Period	Top Three Findings for Word and Phrase Frequencies
American Journal of Distance Education	2001-2010	critical thinking, perceptions of, learning environment
Educational Technology Research and Development	2001-2010	problem solving, instructional design, learning environment/s
Journal of the Learning Sciences	2001-2010	Science related topics, Mathematics-related topics, Cognitive-related topics
Distance Education	2000-2011	online learning, learning environments, web based
Journal of Technology and Teacher Education	2001-2010	educational technology, preservice teacher education, teaching methods
Journal of Research on Technology in Education	2001-2010	technology integration, distance education, teacher education
Performance Improvement Quarterly	2001-2010	self-efficacy, needs assessment, human resource development
British Journal of Educational Technology	2001-2010	attitudes, English Language, computers in testing
Internet and Higher Education	2001-2010	communication, social/network/environment, community
Contemporary Issues in Technology & Teacher Education	2001-2010	educational technology, preservice teacher education, teachers
Instructional Science	2002-2011	cognitive load, computer-mediated communication, collaborative learning
International Review of Research in Open and Distance Learning	2002-2011	distance education, online learning, e-learning
Computers and Education	2002-2011	teaching/learning strategies, interactive learning environments, pedagogical issues
Journal of Computer Assisted Learning	2002-2011	communication & communication technology, case study & qualitative methodology, collaboration
Cognition and Instruction	2003-2012	deep level reasoning, think aloud protocols, problem based learning
Australasian Journal of Educational Technology	2003-2012	foreign countries, educational technology, electronic learning
Journal of Distance Education	2003-2012	online learning, distance education, e-learning
Journal of Computing in Higher Education	2003-2012	online learning, distance education, higher education
Journal of Educational Computing Research	2003-2012	educational technology, computer assisted instruction, learning
International Journal of Technology and Design Education	2005-2014	technology education, creativity, design and technology
Journal of Educational Technology & Society	2010-2014	computer assisted instruction, computer and video games, elementary school students
Interactive Learning Environments	2004-2013	interactive learning environment(s), virtual learning environment(s), online learning environment(s)
International Journal of Computer-Supported Collaborative Learning	2006-2014	collaborative learning, knowledge building, computer-supported

Note: Journals in bold are those selected for this research project.

APPENDIX C

HIGHER EDUCATION HORIZON REPORT SUMMARY (2004-2017)

	Significant Challenges	Broad adoption expected within: One year or less	Three-to-Five Years	Four-to-Five Years
2017	Solvable: Improving Digital Literacy; Integrating Formal and Informal Learning Difficult: Achievement Gap; Advancing Digital Equity Wicked: Managing Knowledge Obsolescence; Rethinking the Roles of Educators http://cdn.nmc.org/media/2017-nmc-horizon-report-he-EN.pdf	Adaptive Learning Technologies Mobile Learning	The Internet of Things Next-Generation LMS	Artificial Intelligence Natural User Interfaces
2016	Solvable: Blending Formal and Informal Learning; Improving Digital Literacy Difficult: Competing Models of Education; Personalizing Learning Wicked: Balancing Our Connected and Unconnected Lives; Keeping Education Relevant http://cdn.nmc.org/media/2016-nmc-horizon-report-he-EN.pdf	Bring Your Own Device (BYOD) Learning Analytics and Adaptive Learning	Augmented and Virtual Reality Makerspaces	Affective Computing Robotics
2015	Solvable: Blending Formal and Informal Learning; Improving Digital Literacy Difficult: Personalizing Learning; Teaching Complex Thinking Wicked: Competing Models of Education; Rewarding Teaching http://cdn.nmc.org/media/2015-nmc-horizon-report-HE-EN.pdf	Bring Your Own Device (BYOD) Flipped Classroom	Makerspaces Wearable Technology	Adaptive Learning Technologies The Internet of Things
2014	Solvable: Low Digital Fluency of Faculty; Relative Lack of Rewards for Teaching Difficult: Competition from New Models of Education; Scaling Teaching Innovations Wicked: Expanding Access; Keeping Education Relevant http://cdn.nmc.org/media/2014-nmc-horizon-report-he-EN-SC.pdf	Flipped Classroom Learning Analytics	3D Printing Games and Gamification	Quantified Self Virtual Assistants
2013	Faculty training lacks digital media literacy Sufficient and scalable modes of assessment needed for new scholarly forms of authoring, publishing, and researching Education processes and practices limit the broader uptake of new technologies Current technology and practices are not supporting the demand for personalized learning Unprecedented competition in traditional models of higher education due to new models of education Most academics are not using new technologies for learning, teaching, or research. http://www.nmc.org/pdf/2013-horizon-report-HE.pdf	Massively Open Online Courses Tablet Computing	Games and Gamification Learning Analytics	3D Printing Wearable Technology
2012	New Models of Education Metrics of evaluation for new scholarly forms of authoring, publishing, and researching Digital media literacy Institutional barriers with moving emerging technologies forward New modes of scholarship challenging libraries and universities as curator http://www.nmc.org/pdf/2012-horizon-report-HE.pdf	Mobile Apps Tablet Computing	Game-Based Learning Learning Analytics	Gesture-Based Computing The Internet of Things
2011	Digital media literacy Metrics of evaluation for new scholarly forms of authoring, publishing, and researching New models of education presenting unprecedented competition to traditional models of the university Keeping pace with the rapid proliferation of information, software tools, and devices	Electronic Books Mobiles	Augmented Reality Game-Based Learning	Gesture-Based Computing Learning Analytics

	Significant Challenges	Broad adoption expected within: One year or less	Three-to-Five Years	Four-to-Five Years
	http://www.nmc.org/sites/default/files/pubs/1316814265/2011-Horizon-Report(2).pdf			
2010	The role of the academy in preparing students is changing Metrics of evaluation for new scholarly forms of authoring, publishing, and researching Digital media literacy Shrinking institutional budgets http://www.nmc.org/sites/default/files/pubs/1316815357/2010-Horizon-Report.pdf	Mobile Computing Open Content	Electronic Books Simple Augmented Reality	Gesture-Based Computing Visual Data Analysis
2009	Growing need for formal instruction in information literacy, visual literacy, and technological literacy Educational materials have not progressed for today's students. Shifts in the way that scholarship and research are conducted Scalable forms of formal student assessment Making use of and providing services through mobile devices http://www.nmc.org/sites/default/files/pubs/1316814843/2009-Horizon-Report.pdf	Mobiles Cloud Computing	Geo-Everything The Personal Web	Semantic-Aware Applications Smart Objects
2008	Greater need for innovation and leadership at all levels of the academy Making use of and providing services through mobile devices New forms of interaction and assessment needed Greater need for formal instruction in information, visual, and technological literacy http://www.nmc.org/sites/default/files/pubs/1316816013/2008-Horizon-Report.pdf	Grassroots Video Collaboration Webs	Mobile Broadband Data Mashups	Collective Intelligence Social Operating Systems
2007	Assessment of new forms of work Greater need for innovation and leadership at all levels of the academy Issues with intellectual property and copyright Skills gap between media creation and meaningful content New forms of interaction and assessment needed Making use of and providing services through mobile devices http://www.nmc.org/sites/default/files/pubs/1316813966/2007_Horizon_Report.pdf	User-created Content Social networking	Mobile phones Virtual Worlds	The New Scholarship and Emerging Forms of Publication Massively Multiplayer Educational Gaming
2006	Academic processes (e.g. peer review, promotion and tenure reviews) do not reflect the ways scholarship is actually conducted. Information literacy Intellectual property and the management of digital rights Deployment of new technologies does not include a process to scale up Increasing levels of support needed to support new technologies http://www.nmc.org/sites/default/files/pubs/1316813666/2006_Horizon_Report.pdf	Social Computing Personal Broadcasting	The Phones in their pockets Educational Gaming	Augmented Reality and Enhanced Visualization Context-Aware Environments and Devices
2005	A shift in the locus of ownership to learners with both the process of constructing and sharing knowledge New models for sharing and licensing content and software	Extended Learning	Intelligent Searching	Social Networks and Knowledge Webs

	Significant Challenges	Broad adoption expected within: One year or less	Three-to-Five Years	Four-to-Five Years
	Desktop computers and mobile devices are increasingly more compatible Increased access to the internet Increased use of technology to connect with others easily, informally, and on many levels. Increased consumer concern for content over format http://www.nmc.org/sites/default/files/pubs/1316813462/2005_Horizon_Report.pdf	Ubiquitous Wireless	Educational Gaming	Context-Aware Computing and Augmented Reality
2004	Challenges not specified http://www.nmc.org/sites/default/files/pubs/1316813245/2004_Horizon_Report.pdf	Learning Objects Scalable Vector Graphics	Rapid Prototyping Multimodal Interfaces	Context Aware Computing Knowledge Webs

From "An analysis of educational technology publications: Who, what and where in the last 20 years," by G. O. Natividad, 2016. Adapted with permission.

APPENDIX D

K-12 HORIZON REPORT SUMMARY (2009-2017)

	Significant Challenges	Broad adoption expected within: One year or less	Three-to-Five Years	Four-to-Five Years
2017	Solvable: Authentic Learning Experiences; Improving Digital Literacy Difficult: Rethinking the Roles of Teachers; Teaching Computational Thinking Wicked: The Achievement Gap; Sustaining Innovations through Leadership Changes https://cdn.nmc.org/wp-content/uploads/2017-nmc-cosn-horizon-report-K12-advance.pdf	Makers Spaces Robotics	Analytics Technologies Virtual Reality	Artificial Intelligence The Internet of Things
2016	Solvable: Authentic Learning Experiences; Rethinking the Roles of Teachers Difficult: Advancing Digital Equity; Scaling Teaching Innovations Wicked: Achievement Gap; Personalizing Learning http://cdn.nmc.org/media/2016-nmc-cosn-horizon-report-k12-EN.pdf	Makerspaces Online Learning	Robotics Virtual Reality	Artificial Intelligence Wearable Technology
2015	Solvable: Creating Authentic Learning Opportunities; Integrating Technology in Teacher Education Difficult: Personalizing Learning; Rethinking the Roles of Teachers Wicked: Scaling Teaching Innovations; Teaching Complex Thinking http://cdn.nmc.org/media/2015-nmc-horizon-report-k12-EN.pdf	Bring Your Own Device (BYOD) Makerspaces	3D Printing Adaptive Learning Technologies	Digital Badges Wearable Technology
2014	Solvable: Creating Authentic Learning Opportunities; Integrating Personalized Learning Difficult: Complex Thinking and Communication; Safety of Student Data Wicked: Competition from New Models of Education; Keeping Formal Education Relevant http://cdn.nmc.org/media/2014-nmc-horizon-report-k12-EN.pdf	Bring Your Own Device (BYOD) Cloud Computing	Games and Gamification Learning Analytics	The Internet of Things Wearable Technology
2013	Professional development needs to be valued and integrated Current K-12 education establishment resists changes New models of education creating unprecedented competition Increased blending of formal and informal learning Current technology and practices are not supporting the demand for personalized learning Digital media is not being used for formative assessment http://www.nmc.org/pdf/2013-horizon-report-k12.pdf	Cloud Computing Mobile Learning	Learning Analytics Open Content	3D Printing Virtual and Remote Laboratories
2012	Digital media literacy Increased blending of formal and informal learning Current technology and practices are not supporting the demand for personalized learning Current K-12 education establishment resists changes Learning outside the classroom is not valued or acknowledged Learning outside of the classroom is not incorporated into current learning metrics http://www.nmc.org/pdf/2012-horizon-report-K12.pdf	Mobile Devices and Apps Tablet Computing	Game-Based Learning Personal Learning Environments	Augmented Reality Natural User Interfaces

	Significant Challenges	Broad adoption expected within: One year or less	Three-to-Five Years	Four-to-Five Years
2011	Digital media literacy New models of education creating unprecedented competition Current technology and practices are not supporting the demand for personalized learning Current K-12 education establishment resists changes Learning outside of the classroom is not incorporated into current learning metrics http://www.nmc.org/sites/default/files/pubs/1316810422/2011-Horizon-Report-K12.pdf	Cloud Computing Mobiles	Game-Based Learning Open Content	Learning Analytics Personal Learning Environments
2010	Digital media literacy Educational materials have not progressed for today's students. Despite agreement that deep reform is needed, there is little agreement on how Current K-12 education establishment resists changes Learning outside the classroom is not valued or acknowledged http://www.nmc.org/sites/default/files/pubs/1316814904/2010-Horizon-Report-K12.pdf	Cloud Computing Collaborative Environments	Game-Based Learning Mobiles	Augmented Reality Flexible Displays
2009	Growing need for formal instruction needed for information literacy, visual literacy, and technological literacy. Educational materials have not progressed for today's students. Real life experience is not incorporated or is undervalued in learning Recognition to adopt new technologies is not effectively being done Current K-12 education establishment resists changes http://www.nmc.org/sites/default/files/pubs/1316814579/2009-Horizon_Report-K12.pdf	Collaborative Environments Online Communication Tools	Mobile Cloud Computing	Smart Objects The Personal Web

From "An analysis of educational technology publications: Who, what and where in the last 20 years," by G. O. Natividad, 2016. Adapted with permission.

APPENDIX E

22 EXTRA TERMS ADDED TO THE STANDARD ENGLISH STOP LIST

Extra Terms

abstract
article
author
authors
conference
control group
control groups
edition
education
educational
experimental group
experimental groups
go.nmc.org
horizon
journal
journals
learning
nmc
paper
report
study
technologies
technology

APPENDIX F

HIGH-LOADING TERMS FOR ALL 25 TOPICS

List of High-Loading Terms (Topics 1-6)

F25.1	**F25.2**	**F25.3**	**F25.4**	**F25.5**	**F25.6**
student	teacher	mobile	design	online	game
class	classroom	device	instructional	discussion	game
classroom	preservice	mobile device	instructional design	forum	game
lecture	professional	mobile	designer	online learn	video
university	integration	phone	theory	online discussion	play
science	preservice teacher	tablet	principle	instructor	player
learn	tech	application	research	participation	gaming
discussion	pre-service	apps	instructional designer	online course	game-base
activity		mobile learn	development	asynchronous	serious
				learner	video game
				interaction	educational game
				face-to-face	computer game
				community	

List of High-Loading Terms (Topics 7-13)

F25.7	**F25.8**	**F25.9**	**F25.10**	**F25.11**	**F25.12**	**F25.13**
perceive	university	social	system	year	computer	learner
internet	faculty	media	user	trend	attitude	group
model	program	network	model	discussion	science	effect
factor	institution	social network	e-learning	topic	software	instruction
intention	high	social media	propose	panel	gender	text
attitude	university	community	discussion	five	anxiety	cognitive
research	policy	networking	e-learn	research	difference	instructional
self-efficacy	high education	interaction	adaptive	six	self-efficacy	condition
e-learning	college	feedback	management	next	computer game	participant
acceptance	innovation	presence	evaluation	creative	scale	video
data		feedback		challenge	program	performance
usefulness				emerge	programming	reading
				adoption		comprehension

List of High-Loading Terms (Topics 14-19)

F25.14	**F25.15**	**F25.16**	**F25.17**	**F25.18**	**F25.19**
school	ict	internet	knowledge	virtual	digital
cloud	information	information	tpack	environment	literacy
student	school	web	share	world	skill
learner	communication	object	prior	reality	media
internet	communication technology	video	concept	augment	digital literacy
school	policy	resource	community	simulation	learner
classroom	teaching	tool	science	virtual world	language
system	integration	search	prior	object	tool
system	level	content	domain	user	thinking
policy	pupil	user	pedagogical	ar	critical
teacher		material	technological		
			conceptual		

List of High-Loading Terms (Topics 20-25)

F25.20	**F25.21**	**F25.22**	**F25.23**	**F25.24**	**F25.25**
child	problem	assessment	learn	group	data
internet	solve	feedback	learner	collaborative	analytics
parent	cognitive	peer	style	collaboration	cloud
activity	problem-solve	evaluation	environment	interaction	analyses
program	skill	test	learn style	activity	tool
young	model	formative	approach	project	science
interaction	solution	student	student	environment	learn
young	thinking	performance	propose	collaborative learn	application
child	complex	portfolio	teaching	share	visualization
robot	student	online	mobile	process	concept
reading	mathematical	formative assessment	cognitive	group	research
			analytics	support	computing
				communication	software

APPENDIX G

CONTINGENCY TABLE (CROSS-TABULATION) FOR ALL 25 TOPICS

Contingency Table (Cross-Tabulation) of Document Counts by Journal and Topic (Topics 1-7)

	F25.1	F25.2	F25.3	F25.4	F25.5	F25.6	F25.7
All Publications	2222	1416	1042	1350	1376	757	1657
BJET	242	125	59	137	196	81	224
CE	684	326	120	184	310	185	664
ETMAG	32	62	36	227	70	33	16
ETRD	123	81	12	197	70	42	105
IS	156	76	0	71	38	3	62
JECR	176	119	21	58	103	39	214
JETS	283	144	70	171	162	58	257
JLS	65	40	1	41	11	9	6
JRTE	90	144	9	43	45	12	68
TETR	110	153	44	173	126	26	29
HE	154	13	423	32	162	162	8
K	107	133	247	16	83	107	4

Contingency Table (Cross-Tabulation) of Document Counts by Journal and Topic (Topics 8-14)

	F25.8	F25.9	F25.10	F25.11	F25.12	F25.13	F25.14
All Publications	1888	1159	1384	940	1107	1734	1663
BJET	152	125	163	78	135	180	109
CE	139	227	442	60	345	573	303
ETMAG	91	67	56	20	43	30	56
ETRD	56	42	68	18	38	160	72
IS	9	26	20	25	11	226	29
JECR	34	51	77	19	151	196	106
JETS	125	107	344	49	101	233	111
JLS	4	26	15	9	9	24	44
JRTE	39	18	7	20	61	49	104
TETR	186	85	37	34	64	52	117
HE	773	265	102	373	91	10	30
K	280	120	53	235	58	1	582

Contingency Table (Cross-Tabulation) of Document Counts by Journal and Topic (Topics 15-21)

	F25.15	F25.16	F25.17	F25.18	F25.19	F25.20	F25.21
All Publications	471	1636	1166	1259	1185	633	1247
BJET	101	149	108	133	126	77	102
CE	190	253	310	254	237	192	296
ETMAG	16	66	68	50	63	21	68
ETRD	18	38	74	50	47	20	120
IS	3	16	109	20	18	28	149
JECR	20	52	88	65	63	54	77
JETS	71	189	175	146	128	60	177
JLS	1	7	51	18	11	20	61
JRTE	15	29	48	16	33	25	23
TETR	14	137	38	54	87	43	44

HE	3	447	66	283	203	22	56
K	19	253	31	170	169	71	74

Contingency Table (Cross-Tabulation) of Document Counts by Journal and Topic (Topics 22-25)

	F25.22	**F25.23**	**F25.24**	**F25.25**
All Publications	1114	1923	1618	1431
BJET	173	247	197	140
CE	331	510	469	267
ETMAG	37	73	50	28
ETRD	70	112	110	73
IS	50	89	96	52
JECR	109	114	95	78
JETS	167	382	284	142
JLS	11	36	54	54
JRTE	25	37	28	23
TETR	40	55	45	31
HE	60	147	93	346
K	41	121	97	197

APPENDIX H

COUNT OF DOCUMENTS – TOPIC BY PUBLICATION

Topics	Topic	BJET	CE	ETMAG	ETRD	IS	JECR	JETS	JLS	JRTE	TETR	HE	K
F25.1	Technology-Enhanced Learning Environments	242	684	32	123	156	176	283	65	90	110	154	107
F25.2	Teacher Education and Professional Development	125	326	62	81	76	119	144	40	144	153	13	133
F25.3	Mobility and Mobile Devices	59	120	36	12	0	21	70	1	9	44	423	247
F25.4	Instructional Design	137	184	227	197	71	58	171	41	43	173	32	16
F25.5	Online Learning	196	310	70	70	38	103	162	11	45	126	162	83
F25.6	Games and Learning	81	185	33	42	3	39	58	9	12	26	162	107
F25.7	Learner and Teacher Behaviors	224	664	16	105	62	214	257	6	68	29	8	4
F25.8	Innovation in Education	152	139	91	56	9	34	125	4	39	186	773	280
F25.9	Social Media	125	227	67	42	26	51	107	26	18	85	265	120
F25.10	Learning Systems	163	442	56	68	20	77	344	15	7	37	102	53
F25.11	Trends in Educational Technology	78	60	20	18	25	19	49	9	20	34	373	235
F25.12	Attitudes Toward Computers	135	345	43	38	11	151	101	9	61	64	91	58
F25.13	Instructional Strategies	180	573	30	160	226	196	233	24	49	52	10	1
F25.14	New Models and Policies in Education	109	303	56	72	29	106	111	44	104	117	30	582
F25.15	Information and Communication Technology (ICT)	101	190	16	18	3	20	71	1	15	14	3	19
F25.16	The Internet of Things	149	253	66	38	16	52	189	7	29	137	447	253
F25.17	Knowledge Management	108	310	68	74	109	88	175	51	48	38	66	31
F25.18	Virtual and Augmented Reality	133	254	50	50	20	65	146	18	16	54	283	170
F25.19	Digital Literacy	126	237	63	47	18	63	128	11	33	87	203	169
F25.20	Childhood Education	77	192	21	20	28	54	60	20	25	43	22	71
F25.21	Problem Solving	102	296	68	120	149	77	177	61	23	44	56	74
F25.22	Assessment	173	331	37	70	50	109	167	11	25	40	60	41
F25.23	Learner Support	247	510	73	112	89	114	382	36	37	55	147	121
F25.24	Collaboration	197	469	50	110	96	95	284	54	28	45	93	97
F25.25	Learning Analytics	140	267	28	73	52	78	142	54	23	31	346	197
	TOTAL	**3559**	**7871**	**1379**	**1816**	**1382**	**2179**	**4136**	**628**	**1011**	**1824**	**4324**	**3269**

APPENDIX I

CONTINGENCY TABLE CONVERSION TO PERCENT CONTRIBUTIONS FOR EACH JOURNAL BY TOPIC (ALL TOPICS)

	F25.1	F25.2	F25.3	F25.4	F25.5	F25.6	F25.7	F25.8	F25.9	F25.10	F25.11	F25.12	F25.13
All journals	15%	10%	7%	9%	10%	5%	12%	13%	8%	10%	7%	8%	12%
BJET	17%	9%	4%	10%	14%	6%	16%	11%	9%	12%	6%	10%	13%
CE	**27%**	13%	5%	7%	12%	7%	26%	5%	9%	17%	2%	14%	23%
ETMAG	4%	8%	4%	**28%**	9%	4%	2%	11%	8%	7%	2%	5%	4%
ETRD	19%	13%	2%	**31%**	11%	7%	17%	9%	7%	11%	3%	6%	25%
IS	31%	15%	0%	14%	7%	1%	12%	2%	5%	4%	5%	2%	**45%**
JECR	24%	16%	3%	8%	14%	5%	**29%**	5%	7%	10%	3%	20%	27%
JETS	20%	10%	5%	12%	11%	4%	18%	9%	8%	24%	3%	7%	16%
JLS	**27%**	17%	0%	17%	5%	4%	3%	2%	11%	6%	4%	4%	10%
JRTE	24%	**39%**	2%	12%	12%	3%	18%	11%	5%	2%	5%	16%	13%
TETR	11%	15%	4%	17%	12%	2%	3%	**18%**	8%	4%	3%	6%	5%
HE	5%	0%	14%	1%	5%	5%	0%	**26%**	9%	3%	13%	3%	0%
K	6%	8%	14%	1%	5%	6%	0%	16%	7%	3%	13%	3%	0%

Note: The highest contribution made by each publication is in boldface.

	F25.14	F25.15	F25.16	F25.17	F25.18	F25.19	F25.20	F25.21	F25.22	F25.23	F25.24	F25.25
All journals	12%	3%	11%	8%	9%	8%	4%	9%	8%	13%	11%	10%
BJET	8%	7%	11%	8%	10%	9%	6%	7%	12%	**18%**	14%	10%
CE	12%	8%	10%	12%	10%	9%	8%	12%	13%	20%	19%	11%
ETMAG	7%	2%	8%	8%	6%	8%	3%	8%	5%	9%	6%	3%
ETRD	11%	3%	6%	12%	8%	7%	3%	19%	11%	18%	17%	12%
IS	6%	1%	3%	21%	4%	4%	6%	29%	10%	18%	19%	10%
JECR	14%	3%	7%	12%	9%	9%	7%	10%	15%	15%	13%	11%
JETS	8%	5%	13%	12%	10%	9%	4%	12%	12%	**27%**	20%	10%
JLS	18%	0%	3%	21%	8%	5%	8%	25%	5%	15%	23%	23%
JRTE	28%	4%	8%	13%	4%	9%	7%	6%	7%	10%	8%	6%
TETR	11%	1%	13%	4%	5%	8%	4%	4%	4%	5%	4%	3%
HE	1%	0%	15%	2%	10%	7%	1%	2%	2%	5%	3%	12%
K	**33%**	1%	14%	2%	10%	10%	4%	4%	2%	7%	5%	11%

Note: The highest contribution made by each publication is in boldface.

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