An Author Co-citation Analysis: Examining the Intellectual Structure of e-Learning from 1981 to 2014

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ABSTRACT

Despite the emergence of e-learning trends, the author co-citation analysis (ACA) method has not yet been used to analyze e-learning extensively. This study applies ACA to analyze the collected literature on e-learning from 1981-2015, with the goal of identifying the top intellectual areas in three time periods – 1981-1991, 1992-2002, and 2003-2014 - to provide a reference framework for future researchers. Therefore, the objective of this paper is to construct an intellectual framework in the field of e-learning.

Keywords  
E-learning, Author co-citation analysis

INTRODUCTION

In 1996, the American Society of Training and Development (ASTD) made their first Internet training course debut by endorsing the phrase “e-learning”. E-learning challenges the traditional method of teaching and learning experience by providing more freedom to learners to control their learning pace and content (Clark & Mayer, 2007; Chen, Kinshuk, Wei, & Chen, 2008).

In exploring the advantages of e-learning, scholars have applied various methods to investigate learning development and its major dimensions. Khan (2001) suggested a framework for e-learning that intended to build a significant worldwide learning environment with eight dimensions. Shih, Feng, and Tsai (2008) conducted a cognitive content analysis of e-learning and discovered seven categories of e-learning, each with a number of subcategories. Chen et al. (2008) applied concept mapping to consolidate core knowledge sources within the field to help learners see the general structure of the discipline and recognize key articles.

Chen and Lien (2011) were the first who used ACA to analyze e-learning development from the perspective of information systems. Hung (2011) conducted a study to explore the longitudinal trends of e-learning research using text-mining techniques. Tai, Lee, and Lee (2013) applied citation analysis to identify research trends in terms of e-learning quality.

Overall, the authors listed above have offered interesting ways of analyzing existing research on e-learning, and each of their techniques may have significant limitations because of their focus on specific aspects. In view of the increasingly complex and multidisciplinary nature of the field, this study will analyze the domain as a whole in terms of authors’ reputation and research themes.

METHODOLOGY

The study was designed to examine the intellectual structure of e-learning in three time periods – 1981-1991, 1992-2002, and 2003-2014 - using the Web of Science citation data. To determine the intellectual structure, we mapped the field through the creation of an author co-citation network based on topical clusters. The method of analysis used to determine the clusters was Author Co-citation Analysis (ACA). Our methodological approach was modeled off of Chen and Lien’s (2011) co-citation analysis of e-learning articles from 1996 to 2009. The process of identifying the clusters was comprised of five main steps, which included the development of a co-citation matrix in Microsoft Access, a dendrogram to create the clusters, identifying research interests of each scholar using Google Scholar, and a multidimensional scaling (MDS) map to visualize the clustered areas.

IMPLEMENTATION AND RESULTS

Citation records were downloaded from the Web of Science database, by searching for the keyword “e-learning” from 1981 to 2014. There were a total of 13,287 articles from which the citations were extracted, with a total of 230,727 references. Before using the citation records, the authors’ names in the citation records had to be cleaned. Using Microsoft Access, a co-citation network was created to look at the authors that had been co-cited together in articles.
The second and third steps in the process were both completed using SPSS – hierarchical clustering to identify the homogenous groups of co-cited authors. Researchers chose a statistic that quantifies how far apart the authors are. Then, researchers determined the amount of clusters that were needed to represent the data. This method was done by looking at how similar clusters are when researchers created additional clusters or collapsed existing ones. Once the clusters were formed, researchers conducted an investigation on each author’s research interests on Google Scholar before drawing the onto MDS map. The clusters’ topic were finalized based on the most popular research interest among authors.

Our co-citation network was to include at most the 50 most cited authors from each time period. In order to obtain the top 50 cited authors, the top 75 authors were selected and cleaned to account for possible duplicates since there were instances when authors’ names had been cited differently. Regarding the cited authors, if an author appeared multiple times in an article, each citation was recorded as a separate citation. It’s important to note that the current paper is a small-scale research as it was limited to no more than 50 authors per time period. Based on the cleaned data, for the period 1981-1991 there were 47 authors, for 1992-2002 there were 50 authors, and for 2003-2014 there were 49 authors. A co-citation matrix was created and recorded paired authors who had been cited together in articles. The co-citation matrix did not take into account the number of times that the paired authors might be cited within one work.

To determine the intellectual structure of e-learning based on author co-citations, a multidimensional scaling map and dendrogram were created using SPSS for each time period. For 1981-1991, there were six clusters: learning strategies (45 authors), theory of planned behavior and evaluation of customer satisfaction (2 authors), experiential learning theory (1 author), learning and teaching styles (1 author), user acceptance of information technology (1 author), and situated learning theory and communities of practice (1 author). For 1992-2002, there were three clusters: teaching methods and new technology use (48 authors), technology adoption and e-services (1 author), and social computing and learning technologies (1 author). For 2003-2014, there were four clusters: learning strategies (47 authors), technology enhanced simulations (1 author), adaptive technology education (1 author), and educational data mining (1 author). The MDS map put the authors together based on their proximity in the author co-citation network.

Each data point on the map represents one author. Clusters were then drawn on to the map to display the distance of the authors from each other within each cluster and the distance of the individual clusters.

**DISCUSSION**

The main purpose of the study was to examine the intellectual structure of e-learning overtime, from 1981 to 2014, using author co-citation analysis. The analysis has
identified the major research trends for three time periods in e-learning.

Based on the results of the clustering analysis, a clear trend emerges across the three time periods. The early period, 1981-1991, the cited articles focus primarily on learning theories and the behavior of learners. Davis, however, in the cluster C5 (user acceptance of technology) shows that there was a developing trend in examining the use of technology in learning. Davis developed Technology Acceptance Model (TAM). TAM proposes that usefulness and perceived ease of use are the primary indicators for technology acceptance (Roca, Chiu, & Martinez, 2006).

In the period of 1992-2002, fewer cited authors are situated in the realm of learning strategies, but rather the cited authors centered on the use of technology in an educational setting. All of the clusters, as opposed to the earlier period, reference technology use. We found that technology adoption continued to be of focus. For example, Venkatesh collaborated with Davis during this period by advancing the theoretical basis of TAM (Roca et al., 2006). Research studies devoted to TAM made the model more widely accepted by providing theoretically proved criteria for measuring the success of any technology product among its users (Roca et al., 2006). Additionally, we start to see a focus on actual learning technologies development. For example, Brusilovsky focused on adaptive hypermedia systems (AH). AH systems build a model of the individual user and apply it for adaptation to that user (Brusilovsky, 1996).

In the last period, 2003-2014, we found a shift back to the early period with a focus on learning strategies (C1); a continuation of the middle period by focusing on Brusilovsky’s adaptive technology education (C3); and the development of two new intellectual avenues in technology enhanced simulations (C2) and educational data mining (C4). The work of Cook has focused on simulating medical education through the use of technology enhanced simulations (Cook et al., 2011). While Romero has examined the impact of data mining on the learning environment, particularly in examining the data available in course management systems (Romero, Ventura, & Garcia, 2008).

REFERENCES

SIGNIFICANCE AND CONTRIBUTION
In this study, we intended to find important knowledge trends among all the fields, and provide empirical results on the significant patterns of knowledge dissemination. The used knowledge matrix was effective in organizing themes of knowledge. It provided additional insights into interdisciplinary studies based on the popularity of the topics and authors. These indicators were also valuable in forecasting trends for e-learning because ACA can be easily adopted in other related studies by other scholars.