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A Bibliometric Analysis of ASEE Conference Papers Published by Members of the Engineering Libraries Division

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Abstract

The Engineering Libraries Division (ELD) of ASEE has been in existence since 1967, and since then, members of this division have been active participants in the programs of the ASEE annual conference. In this survey, we will present a descriptive analysis of articles published in the Proceedings of ASEE. Data was collected from the ELD webpage, the ASEE Proceedings webpage, and from Ei Compendex for the last 40 years (1976-2016). This study is based on bibliometric analysis and includes the use of visualization techniques with Sci2 Tool software. Although it is recognized that publishing policies for the Proceedings by the ELD Division and ASEE have changed throughout the years, this study aims to present an analysis of the papers published during this period.

Introduction

The inception of engineering librarianship was determined by the evolution of the engineering education field, the expansion of technical information resources and the increased demand for specialized information.[1] Engineering librarians have progressed from mere clerks to experts in the use of specialized information resources and collaborators in the education of technical information consumers.[2] The profession continues to evolve with the shift towards digital scholarship, adding new skills and services.

Engineering librarians have actively participated from the beginning in the engineering education professional organization American Society for Engineering Education (ASEE). As the number of librarians and their visibility increased, their status within the organization was elevated by the granting of Committee status in 1942 and, later the Division status in 1967.[1] Since then, the Engineering Libraries Division (ELD) has continued to be active within the ASEE organization by contributing publications and organizing programs at all the annual conferences.

In 2017, ELD celebrates fifty years as an ASEE division. To mark this anniversary, the authors employed a bibliometric analysis of the ELD publications within ASEE proceedings to produce an overview of the scholarly output published by ELD members. Bibliometric network analysis techniques were used to investigate collaboration patterns between authors and institutions, determine topics of interest and their evolution through time, and identify the most common research topics. The analysis was carried out using a specialized network analysis software, Sci2 Tool, and the results were graphically represented using visualization principles in order to facilitate the discovery of trends and patterns otherwise difficult to observe.

The analysis, conducted despite known inconsistencies and gaps in the collected data, produced partial results characteristic to ELD community and helped identify issues with ELD publications and Ei Compendex database indexing. While results indicate that education is the focus of the ELD publications, they fail to identify topics from other areas of librarianship. In light of these findings, the authors propose solutions for the identified issues that would be beneficial to the

ELD community. This study extends the time analyzed in a previously published bibliometric study of the ASEE-ELD publications.[3]

Literature review

Price's revolutionary idea of applying network theory to studying scientific papers[4] initiated the development of bibliometrics and the analysis of science using networks. The bibliometric network has a basic structure consisting of nodes and connecting links, in which nodes represent documents and links represent the relationship between them. In a bibliometric network, the linkages could consist of direct citations between papers or co-occurrence of specific bibliographic elements such as authors, keywords, classifications, or citations.[5] In order to provide a better understanding, bibliometric networks are graphically represented utilizing visualization theory concepts that have the capacity to uncover trends, patterns, or relationships not noticed otherwise.[6]

Depending on the type of co-occurrence investigated, the analysis could offer multiple insights into the structure of the network. For example, similarity between documents can be determined based on the communality of their references (bibliographic coupling)[7] or based on how many times the papers are cited together (co-citation).[8] Variations of the co-citation analysis are used to determine the intellectual structure of a field,[9] the development of a scientific field,[10] or interdisciplinarity.[11] Analyses of co-occurrence between keywords, classifications, or words within a text corpus are used to determine the cognitive structure of a field, [12] while co-occurrence analysis applied to authors results in co-authorship networks that are used to determine scientific collaborations.[13]

A common practice in studying a scientific field is the analysis of its scholarly output.[14] Lisée[15] argued that the study of conference proceedings could offer sufficient information to create a comprehensive representation of the overall scholarly discourse. Combining Lisée's argument with Butler's idea[16] that bibliometric investigation of proceedings has the potential to create a more complete and detailed picture of a discipline, the authors concluded that ELD publications presented at the ASEE annual conferences could offer insights into the engineering librarians' scholarly contribution to the engineering education field.

However, as the authors discovered, the ELD publications found in Ei Compendex did not include citations and many documents lacked basic bibliographic data. Acknowledging that data availability and quality could be major obstacles in conducting a comprehensive bibliometric analysis,[17] the authors conducted the investigation without performing citation analysis and proceeded with co-occurrence network analyses in order to determine ELD members' collaborations and topics of interest.

Methodology

The original data was collected from three different sources, because there is no direct option to retrieve ELD contributions from one source. These sources were the ASEE-ELD page, Conference information, ELD Conference Program for the years from 1995 to 2016; the ELD Newsletter Archive provided the conference programs from 1987 to 1994; and for the period

1976 to 1986, the programs were obtained from the ELD Archives at the George C. Gordon Library of Worcester Polytechnic Institute, Worcester, MA. The only ASEE-ELD conference program not located was for 1982; this ASEE conference took place at the University of Texas, Austin. Also collected from the conference programs were other sections in the ELD programs such as unconferences, workshops, open forums, tours, and panel sessions.

Once the ELD conference programs were located, every entry corresponding to Papers Sessions and Poster Sessions was searched in the Ei Compendex database, one of the major engineering bibliographic databases. Ei Compendex was selected for this project because it has a good coverage of engineering education field and because it is one of the few databases that indexes articles of the proceedings of the American Society for Engineering Education (ASEE). We decided to use the descriptive metadata assigned to the documents found in this index. The following descriptive metadata elements were collected when available: Controlled terms; Uncontrolled terms; and Classification Codes. We have used this procedure in order to have a consistent terminology to analyze.

The publications were collected into a spreadsheet and prepared for analysis. Thus, authors and institutions' name were consolidated to avoid duplication; uncontrolled vocabulary was also checked and consolidated into one form, eliminating the use of singular and plural forms of same words. The spreadsheet was then converted to .csv format and examined using Sci2 Tool,[18] a network analysis software that can be also utilized for bibliometric analyses. Co-occurrence networks were extracted based on authors, Controlled and Uncontrolled vocabulary, as well as Classification Codes columns. All bibliometric networks were then visualized using Gephi tool included in the Sci2 Tool.

Results and Discussions

The ELD programs at the ASEE conference take diverse forms and discuss a large variety of topics. Besides the regular business meetings, the ELD has organized twenty-six workshops open to all ASEE members, co-sponsored three Distinguished Lecture Series, three Town hall Meetings, two Round Table Discussions, and numerous Open Forums, see Fig. 1. Some of the most common ELD co-sponsors are the Information Systems Division, Women in Engineering Division, Computers in Education Division, Materials Division, Aerospace Engineering Division, and Education Research and Methods Division. A very popular session format is Lightning Talks that allow for two minutes presentations for each speaker. ELD also experimented with organizing two Unconferences in 2015 and 2016 respectively.

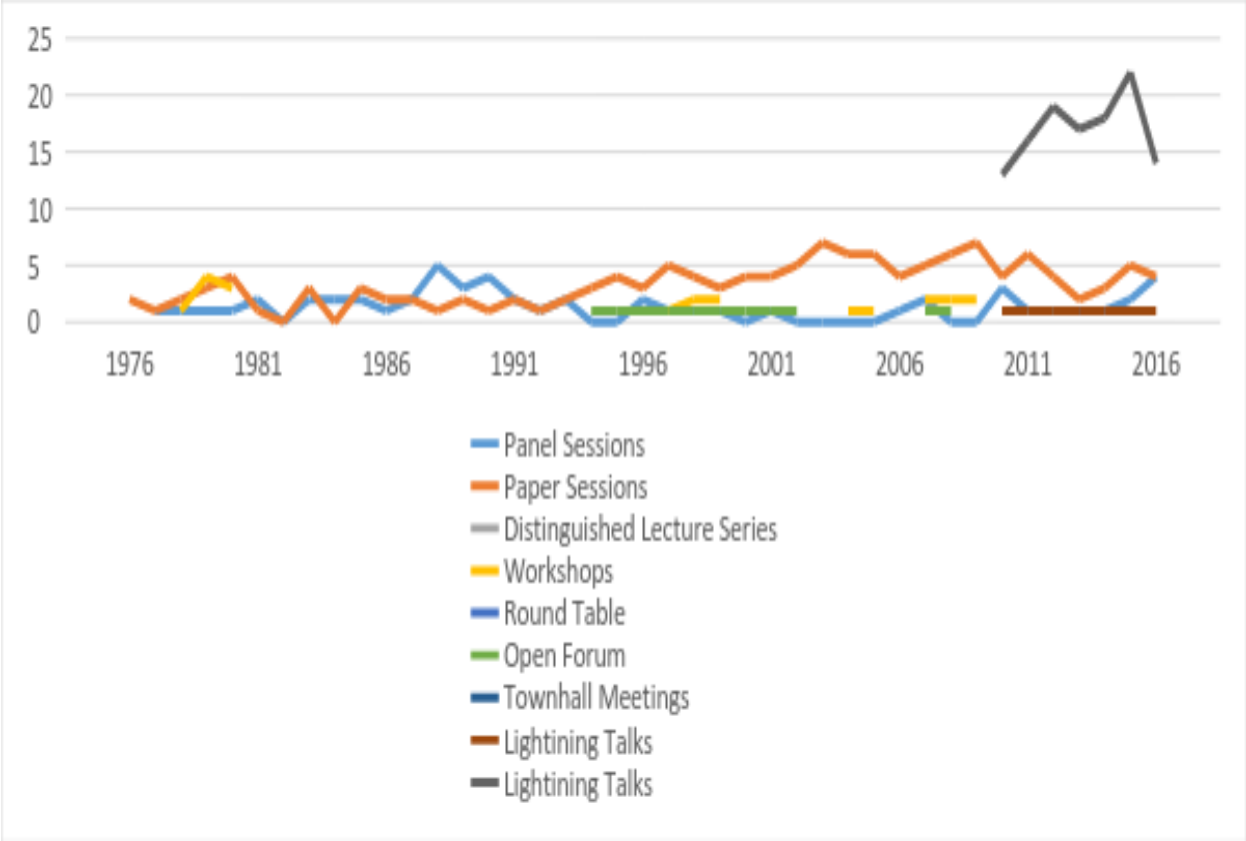

Fig. 1. ELD-ASEE programs types

We identified 594 documents published during the period included in the study, from which 428 were presentations and 128 were posters. For the purpose of this study, due to the overall small number of presentations and posters, the two categories were combined and the term publications was used instead. The number of publications widely varied by years, and although there is an overall upward trend observed in terms of number of publications, the total number of publications for the period of time examined is relatively small considering the number of the ELD members and the number of years covered by this study, see Fig. 2.

We identified 552 individual authors. Publications with single author represent the majority (73%), followed by two authors (15%), three authors (5.8%), and the rest is distributed between four or more authors. In terms of institutions, collaborations were mostly between authors from same organizations (70.8%), followed by collaborations between two institutions (9.4%) and the rest is distributed between three or more organizations.

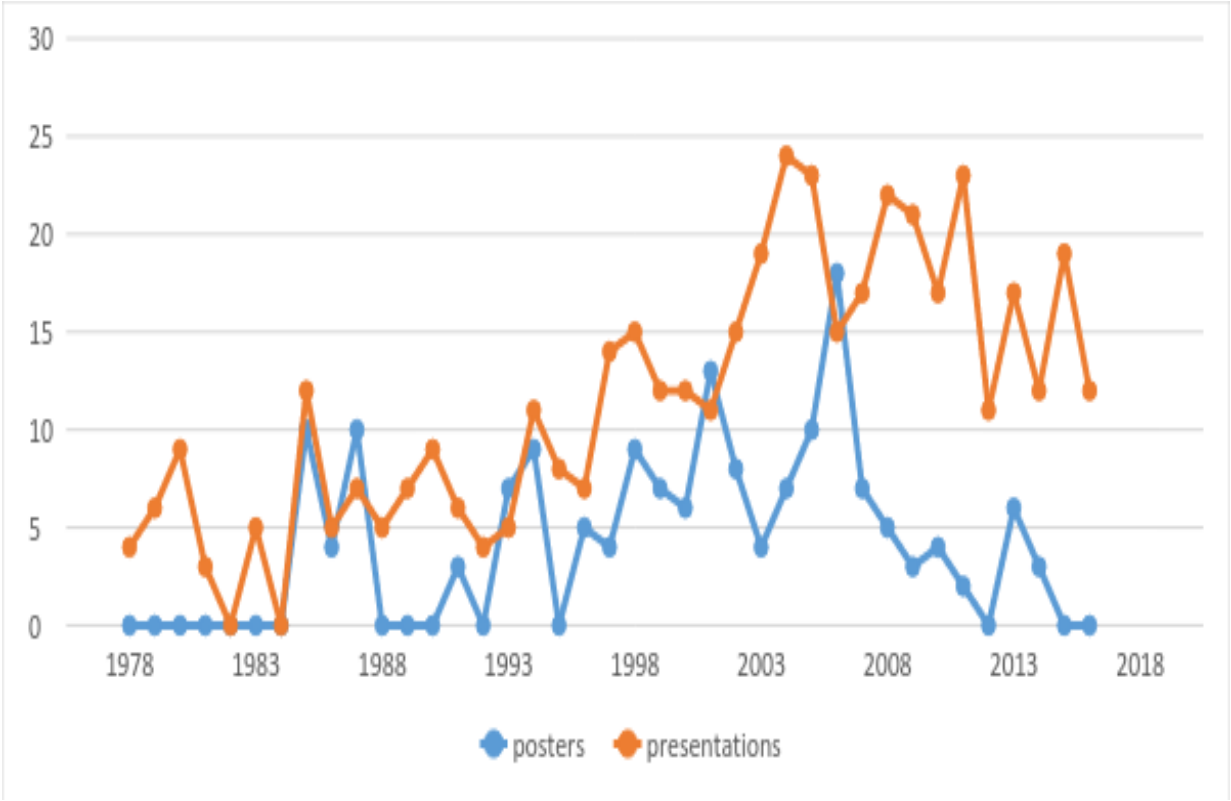

Fig. 2. Number of publications during the 1976-2016 period

From the total number of publications, twenty-one were missing the title (3.5%), two did not include information on the authors (0.3%) and 110 (18.5%) had no mention of the author's' institutional affiliation. Moreover, 502 (84.5%) publications lacked controlled vocabulary, 485 (81.6%) did not include uncontrolled vocabulary, and 489 (82.2%) missed classification codes. Additionally, none of the publications has incorporated citations. Acknowledging that these numbers greatly influence the accuracy of the planned analyses, the authors accepted the fact that no citation analysis was possible and decided to carry on the authorship and affiliation analyses as initially planned, but continue with the other planned investigations as a proof of concept only.

First, the collaborations between the ELD members were investigated by developing the co-authorship network based on the co-occurrence of author's names, Fig. 3. In the network, each node represents an author. The size of the nodes and color represent the number of publications by one author, while the width and color of the links between nodes represent number of collaborations between two authors. The map brings into attention that ELD members do not collaborate too much and identifies groups that have published together. Another observation is that there is little or no collaboration between USA and Canadian authors, or other participant countries.

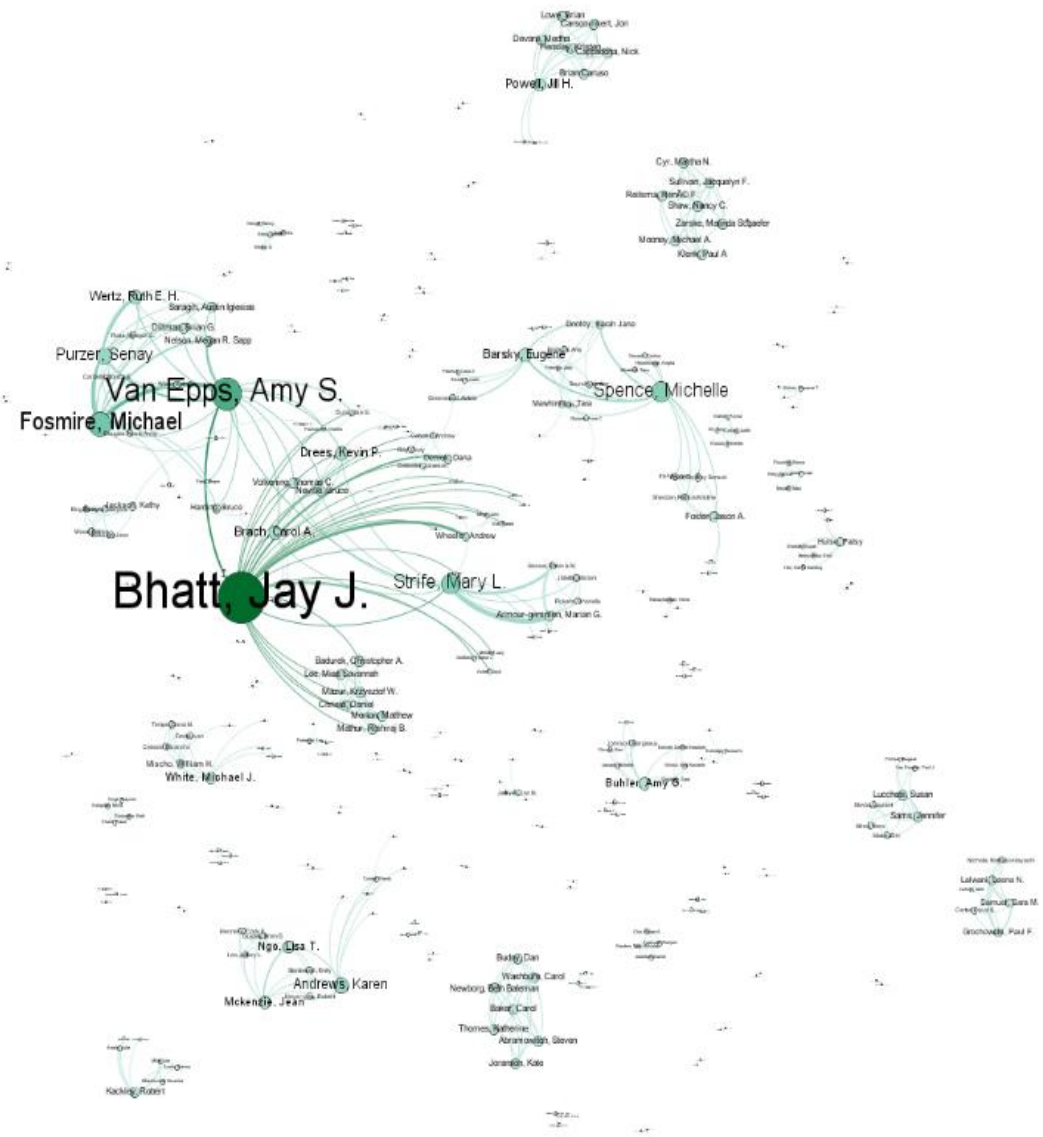

Fig. 3. Authorship network

Co-occurrence analysis based on the author's institutional affiliation was used to identify the most active institutions within ELD, Fig. 4. Nodes in the networks represent institutions. The size of the nodes and color represent the number of publications from same institution, while the width and color of the links between nodes represent number of collaborations between different institutions. The authors represented 172 individual institutions, mostly academic, but other categories were also present such as publishers, library related companies, research institutions and other commercial companies, see Fig. 5. The academic institutions represented countries such as USA, Canada, Australia, India, and United Arab Emirates. As seen in Fig. 6, the number of collaborations with institutions outside academia has decreased over time.

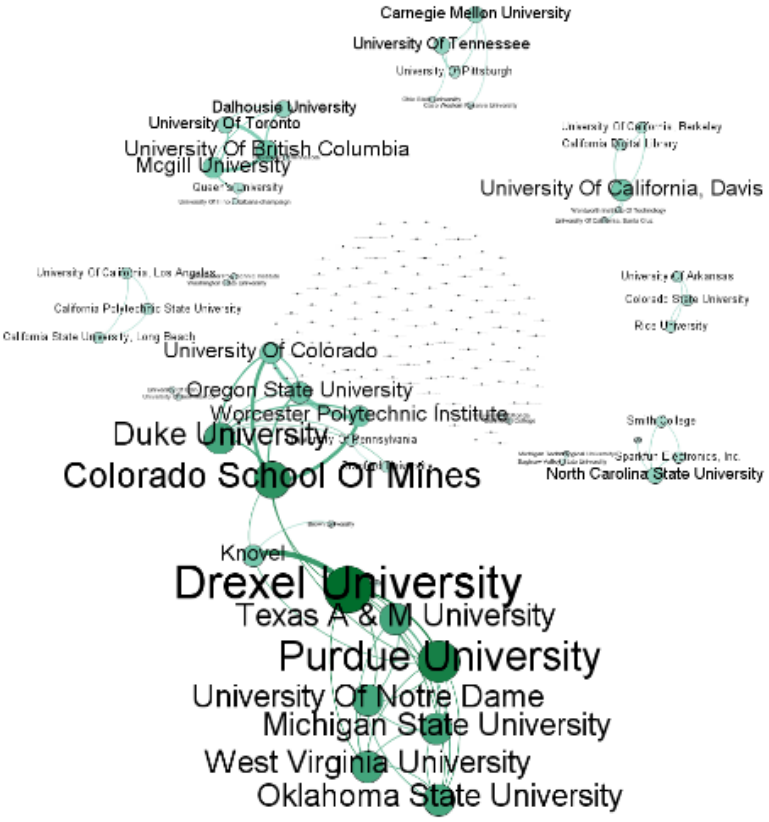

Fig. 4. Co-occurrence of institutional affiliation

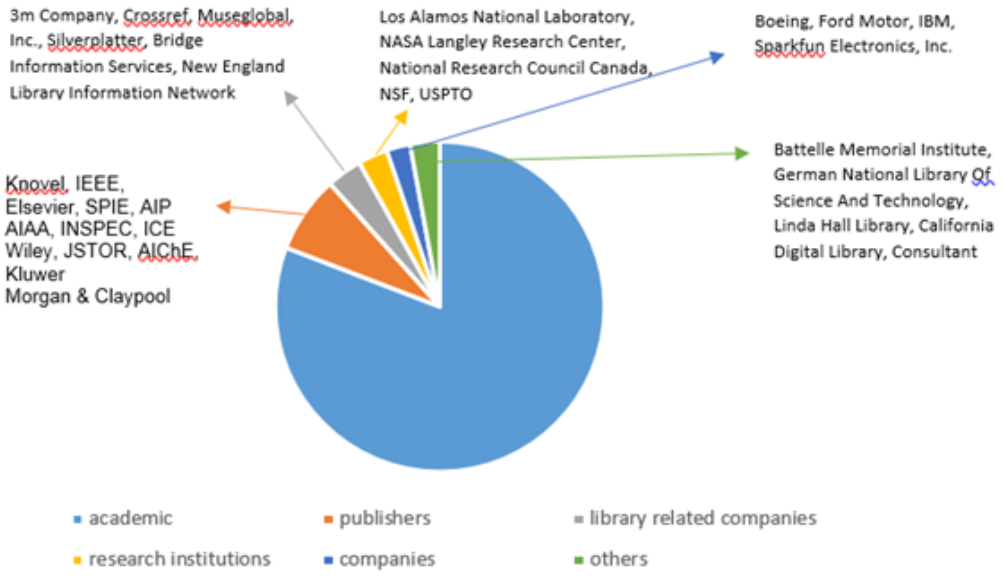

Fig. 5. Categories of Institutions

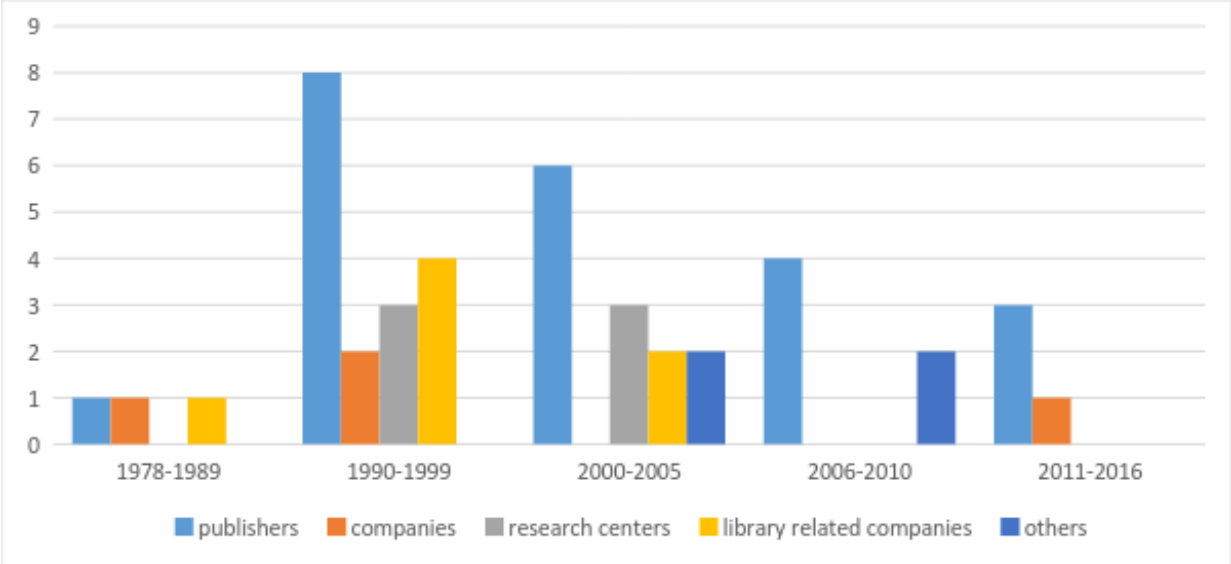

Fig. 6. Trends of collaborations with non-academic institutions

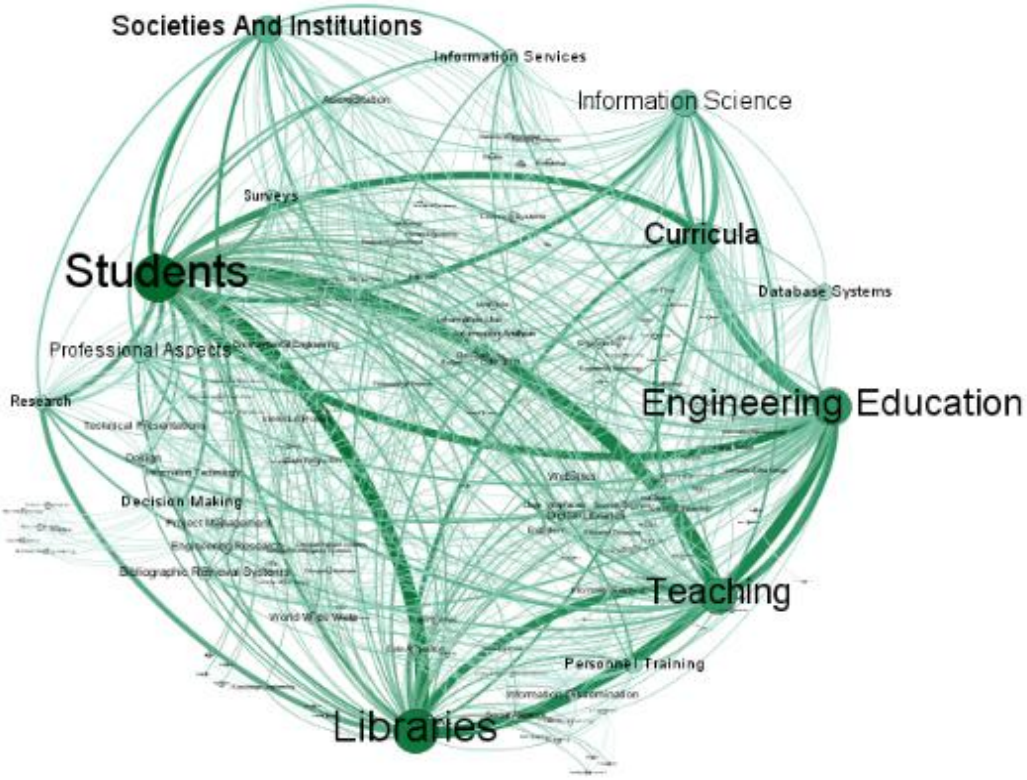

Fig. 7. Controlled vocabulary co-occurrence network

Although with no statistical significance due to the limited availability, we continued with the co-occurrence network analyses of the controlled, uncontrolled vocabulary and classification codes to determine the intellectual composition of the ELD publications, see Fig. 7, Fig 8, and Fig. 9 respectively. The analyses identified a strong focus on information literacy, teaching/education, and students but provided little insights into topics specific to information science such as collections development or library services. Our analysis pinpoints to the structure of Controlled vocabulary and Classification Codes

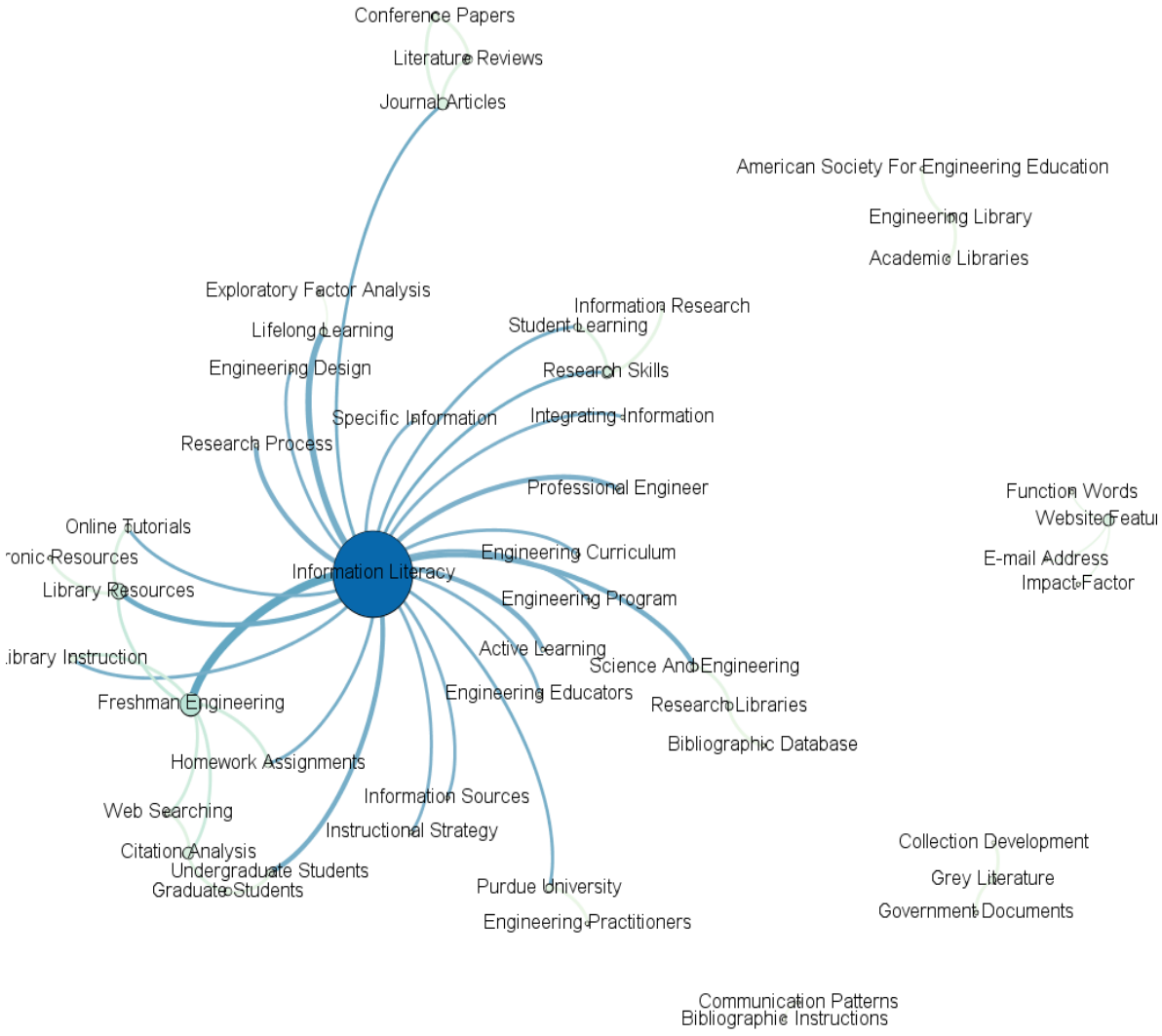

Fig. 8. Top 50 uncontrolled vocabulary co-occurrence network

that were developed to respond to engineering professional needs but are not representative for the information science. Despite the small number of publications to include Uncontrolled

vocabulary, there is a very large number of keywords with most being used only once. Therefore, we limited the co-occurrence analysis to the top fifty most often used together words, Fig. 8. However, even these keywords provided very little insights into the topics in the publications due to the selection of very generic keywords that are not representative of the topics included in the publications

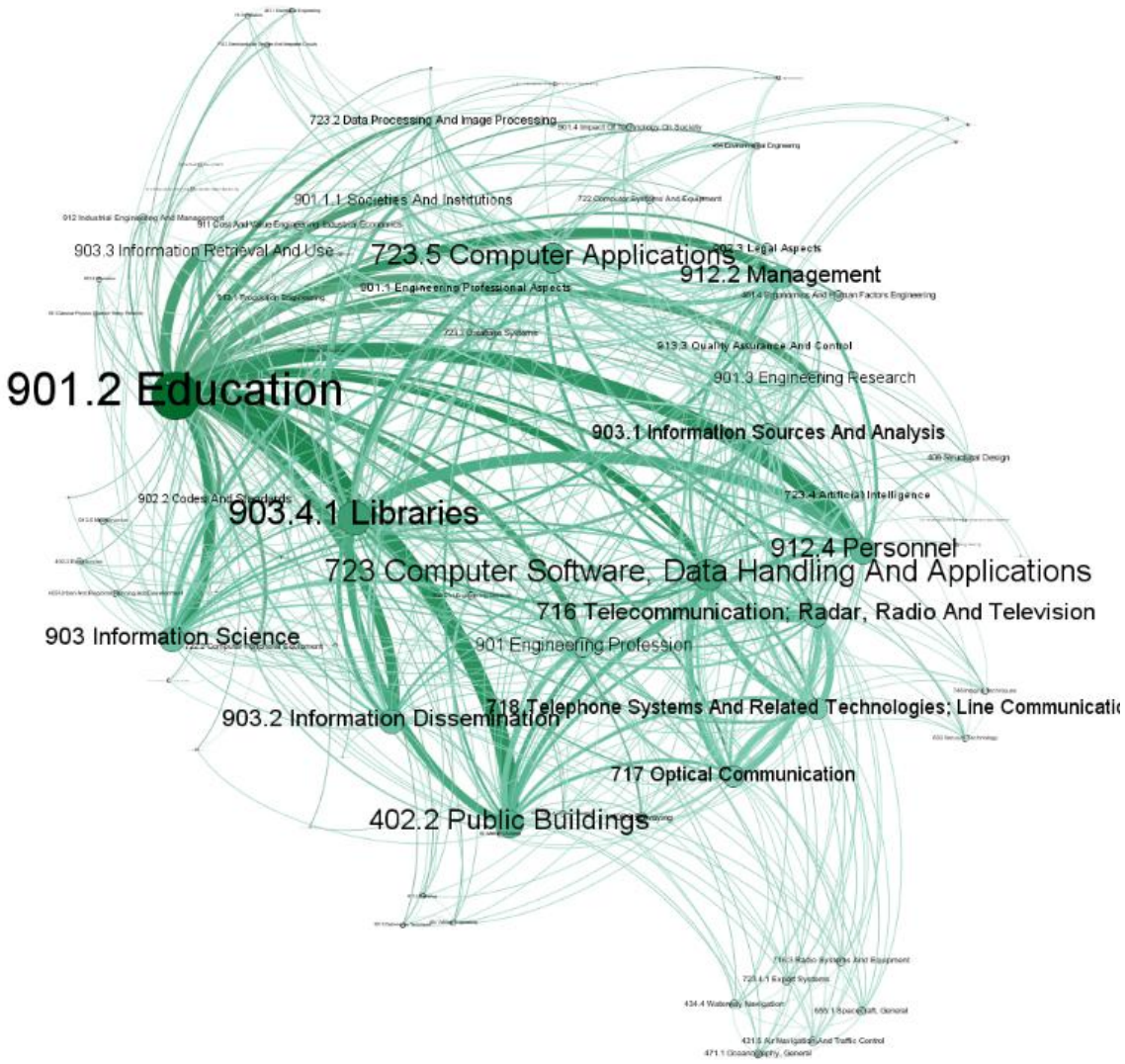

Fig. 9. Classification codes co-occurrence network

As the analyses of the Controlled vocabulary and Classification Codes were too nonspecific to library science and offered no real perception of the topics specific to ELD community, we consider that further investigation into Uncontrolled vocabulary and publication titles may have the potential to create a clearer image of the topics of interest to ELD members. Being personally aware of different themes prevalence over time, we considered that the evolution in time could be determined by adding the time component to the Uncontrolled vocabulary co-occurrence network

analysis.

The temporal analysis was done using a time partition function available in Gephi and the network was visually enhanced by adding various colors to mark correspondences between the uncontrolled vocabulary and the time element. In Fig.10, the applied criterion for time partition was the year of the keyword's first mention and each year was identified with a different color.

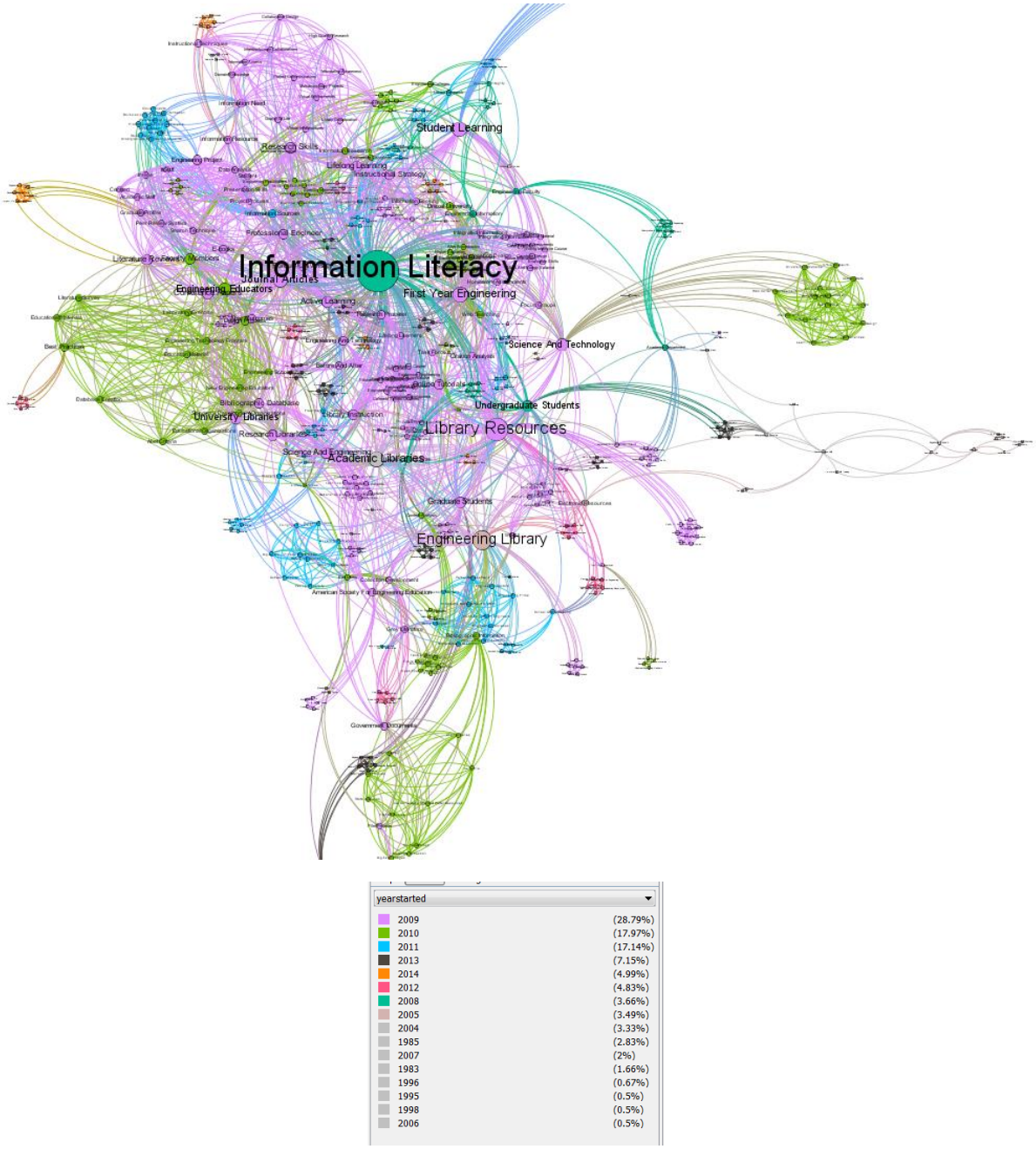

Fig. 10. Preferred topics by years

Through an elimination process, the tool allows visualization of specific years only, which in turn helps one discover the topics predominant during the year visualized. Fig.11 presents the comparison between Uncontrolled Vocabulary listed for the three years during the nineties (1995, 1996, and 1998) and the 2009 year.

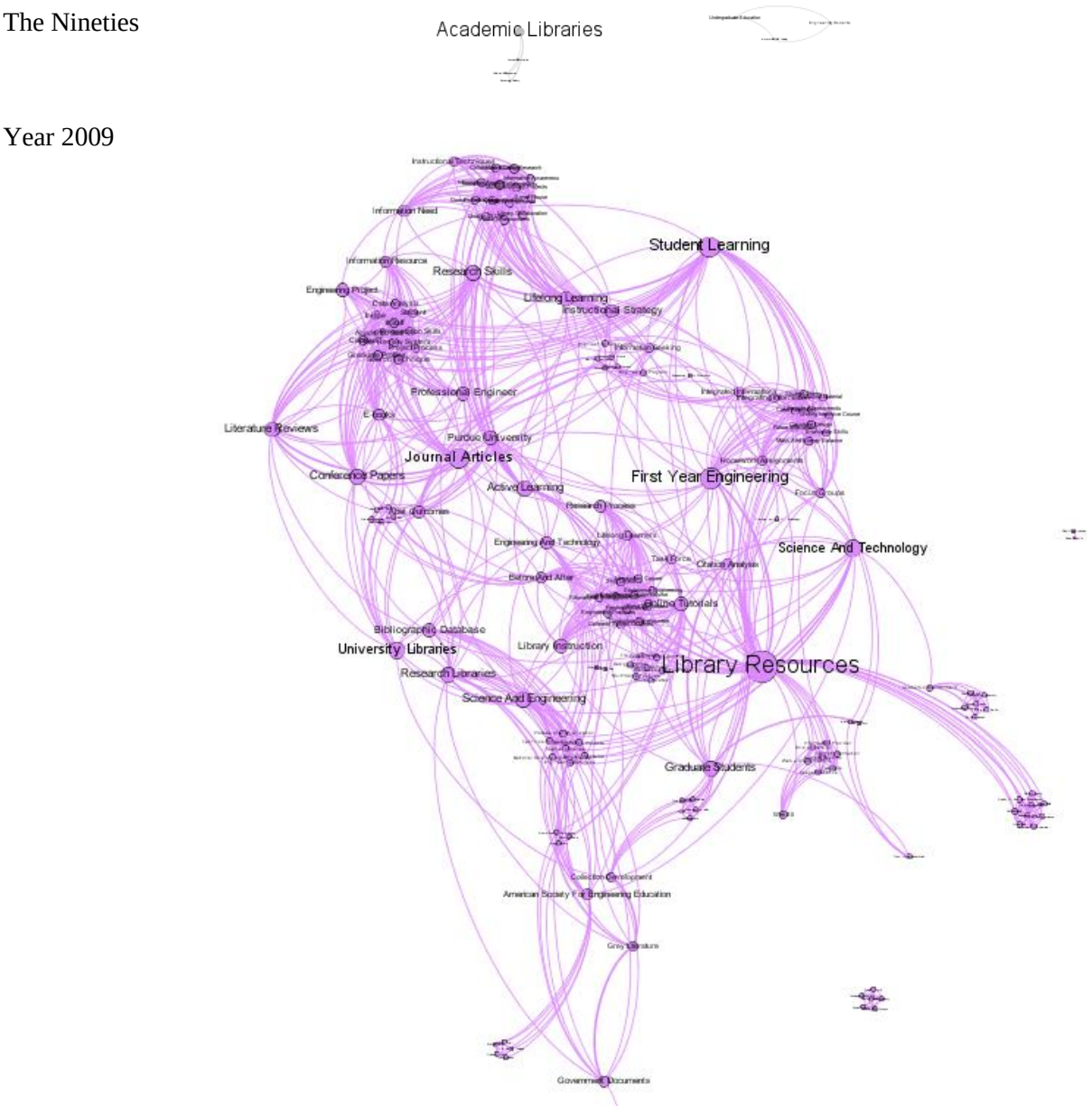

Fig. 11. Comparison of the preferred topics during the nineties and the year 2009

Although the results are limited by the unavailability of uncontrolled vocabulary for a large number of publications, the temporal analysis was able to create a more granular image of the popular topics and identify their evolution over time. For example, based on the available data, in 2009 there was a clear interest in instructional design and active learning, as well as lifelong

learning. The topics listed for 2009 demonstrate a clear impact of the adoption of the ABET's Engineering Criteria 2000 and their mapping to the ACRL Information Literacy Competency Standards for Higher Education.

Conclusions

According to the collected data, the average number of publications per year is nearly fifteen. In this study, we have only analyzed peer-reviewed publications that were included in the proceedings, disregarding research presented during panels or other sessions that had no enforced publication requirements. As the ELD division has maintained a membership of around 200 through many years, a simple review of these figures led us to conclude that there continues to be a low rate of participation of division members publishing in the ASEE proceedings. This is similar to the findings in Hubbard's paper. We speculate that the low participation rate is caused by the fact that not all engineering librarians have tenure status or promotion process that require peer review publications. Further, it is anecdotal information that ELD members also belong to other professional organization where they made additional contributions. Case in point, one of the authors of this paper is an active member of several organizations.

From our review of ELD publications in the ASEE proceedings, we observed limited co-authorship, decreased collaboration with professionals outside librarianship, and a lack of international collaborations between ELD members. It is obvious that ELD is having fewer opportunities to participate in conference programs with other ASEE divisions and perpetuation of this state has been extensively discussed in recent ELD meetings. We suggest that the ELD leadership develop a strategic approach to increased collaboration with other divisions, particularly those that provide support to engineering education such as Computing & Information Technology, Continuing Professional Development, Educational Research & Methods, and Women in Engineering.

In relation to subject coverage, our study indicates a major focus on information literacy. Due to gaps and limitations in the Ei Compendex data, however, we cannot yet discern other major issues of interest that have been covered. We discovered that records of the ASEE Annual Conference are incomplete and the extensive gaps in Ei Compendex are surprising. The best coverage of ELD papers and posters occurred from 2009 to 2014, although there were some items with minimum information or even missing records. Records for 2015 and 2016 include minimum bibliographic information like title, authors, and source but lack any Controlled and Uncontrolled vocabulary as well as the Classification Codes. From 2008 to 1976, the coverage of ELD papers and posters in Ei Compendex is insignificant as we only found some isolated items with minimum of full records.

In addition to coverage limitations, we discovered that Ei Compendex lacks Thesaurus terminology and Classification Codes appropriate for describing the research and practical applications of librarianship to engineering education. This had greatly affected our subject-based analysis. We also observed that the keywords assigned by the authors, and listed as Uncontrolled Terms in Ei Compendex, contain many terms that are not appropriate for describing the authors' own papers. We recommend that the ELD Division takes steps to provide guidance on titles, abstracts and keywords selection so that relevant librarianship and education fields terminology

are used properly. These steps will increase ELD publications retrievability and overall visibility. To improve the utility of Classification Codes and Controlled terms, we also suggest that the division explore collaborating with Ei Compendex to create appropriate codes and terms.

Further research and analysis is needed to get a more complete picture of how ELD members contribute to the engineering education field. The authors plan to perform semantic textual analysis of article titles and abstracts.

Acknowledgments

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