# A Bibliometric Analysis of the Research Status of the Technology Enhanced Language Learning

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**Abstract.** The integration of technology into language learning has demonstrated great success and drawn much attention from academia in recent years. Using publications retrieved from Web of Science, this study reveals the research status and development trend of the field from a bibliometric and systematic perspective. The analysis is conducted from publication statistical characteristics, geographical distribution, and collaboration relations. Analysis techniques include a bibliometric method, a geographic visualization method, and a social network analysis method. This analysis of the technology enhanced language learning field presents a global view on the research evolution over time, current research interests, and potential opportunities and challenges.

**Keywords:** Technology · Language learning · Bibliometric analysis

## 1 Introduction

The rapidly developed and well-established technologies have enabled a fast growth of learning resources such as online learning communities, open course videos, and other learning materials available for language learning. Therefore, instructors are encouraged to alter their teaching strategies or adjust their teaching activities to effectively utilize such resources [1]. Technological innovations in language learning can benefit learners in increasing interests, enhancing motivations, encouraging interactions, developing writing/thinking connections, facilitating cross-cultural awareness, etc. Moreover, it provides instructors with efficient means to organize course content and interact with multiple students.

Consequently, technology enhanced language learning research field has attracted more and more interests from academia given the continuing growth of publications. Some representative works are as follows. Based on learner location, learning time, individual English vocabulary abilities and leisure time, Chen and Li [2] presented a personalized context-aware ubiquitous learning system for English vocabulary learning. Hsu et al. [3] focused on personalized recommendation-based mobile language learning. Aiming at engaging students in self-initiated use of technology for language learning, Lai and Gu [4] investigated the usage of technology to self-regulate language learning outside the classroom for students from the University of Hong Kong. Hu et al. [5] applied a deep neural network trained acoustic model and transfer learning based logistic regression classifiers for mispronunciation detection. Their experiment demonstrated a significant improvement in detection performance of the proposed method. Liu et al. [6] applied an electroencephalogram technique to investigate the potential of inhibition advantage in modulating different language switches, regardless of the time spent on second language learning.

Bibliometrics has been considered as an effective statistical method for evaluating scientific publications, and has been widely applied in various fields such as natural language processing [7], diabetes [8], and cardiovascular magnetic resonance [9]. Especially, it has also been applied in interdisciplinary research fields, e.g., natural language processing in medical research [10], natural language processing empowered mobile computing [11], and corporate social responsibility in supply chain management [12]. The results from bibliometric analysis can help researchers better choose their potential research fields, recognize future academic collaborators, and identify appropriate affiliations for conducting joint research [13].

Therefore, this study focuses on the bibliometric analysis of the technology enhanced language learning filed, to analyze the current research status by summarizing existing research publications. Firstly, a statistical descriptive method is used to investigate the latest research status and trend, including publications and citations, dominant subjects and journals, prolific authors and affiliations. Secondly, geographic visualization analysis is applied to investigate geographical distributions of the publications. Finally, scientific collaborations are measured using collaboration degrees and are further visualized using social network analysis.

## 2   The Statistical Approach

Web of Science was used as the data source for retrieving research publications. A list of relevant search words were determined by a domain expert. 807 publications in "Article" type during the period 2008–2017 were obtained. Citations counted to April 30th, 2018 were considered for each publication. The key elements, e.g., title, journal, subject category, author keywords, abstract, and author address of the publications were extracted. 805 publications were identified to be relevant to the research field through manual verification. Author address information was further processed to identify corresponding affiliations and countries/regions. Key terms were extracted from author keywords, keywords-plus, title and abstract.

In addition to basic statistical analysis, methods used in this paper include: geographic visualization, collaboration degree analysis, and social network analysis.

Geographic visualization is a set of techniques such as image processing and virtual reality for the analysis of geospatial data. As Tobler's First Law of Geography shows, everything is related to everything else, and near things are more related than distant things. Through geographic visualization with location as the key index variable, we are able to get related information which is previously unfound. Geographic visualization can be used throughout the process of problem-solving in geographical analysis, from the development of initial hypotheses to knowledge discovery, analysis, presentation and evaluation. In this study, geographic visualization analysis is applied to investigate geographical distributions of publications.

The collaboration degree is used for measuring scientific research's connective relations to the level of authors, affiliations, and countries with Eq. (1) [14].

$$C_{Ai} = \frac{\sum_{j=1}^{N} \alpha_j}{N}, C_{Ii} = \frac{\sum_{j=1}^{N} \beta_j}{N}, C_{Ci} = \frac{\sum_{j=1}^{N} \gamma_j}{N} \tag{1}$$

$C_{Ai}$, $C_{Ii}$, and $C_{Ci}$ are the author, affiliation and country's collaboration degrees of the $i$ year. $\alpha_j$, $\beta_j$, and $\gamma_j$ represent the number of authors, affiliations and countries for each publication. $N$ indicates the annual number of publications in the research field.

This paper uses the social network analysis method to investigate the collaboration relations among countries/regions, affiliations, and authors. Social network analysis is a process of exploring social structures using networks and graph theory to quantify the relations among actors in the social network [15]. In the network, each country, affiliation or author is presented as a node with node size representing publications and node color denoting the continent/country that it belongs to. The line thickness indicates collaboration strength between two countries, affiliations or authors. By accessing to the dynamic networks, users can explore collaboration relations for specific countries/regions, affiliations, or authors by simply clicking the nodes.

## 3    Results and Discussions

### 3.1    Publications and Citations

The statistics result of total publications, total citations, and average citations from 2008 to 2017 is presented as Fig. 1. The publication exhibits an overall upward trend in fluctuation (from 46 publications in 2008 to 100 publications in 2017). The research sees a sudden increase in number in year 2016 with 143 publications compared with 99 publications in the previous year. The highest total citation count is 1477 and average citations per publication is 21 in 2009. However, the highest average citation count is 188 in 2016. Among the total publications, papers by Flöel et al. [16] and Yang [17] have the highest citations as 203 and 167, respectively.

0.50% of the publications have more than 100 citations, and 2.36% have more than 50 citations. 12.92% and 25.84% of the publications have more than 20 and 10 citations, respectively. About half of publications, i.e. 44.35%, have more than 5 citations. Of the total publications, 20.37% have no citations at all, most of which come from 2017.
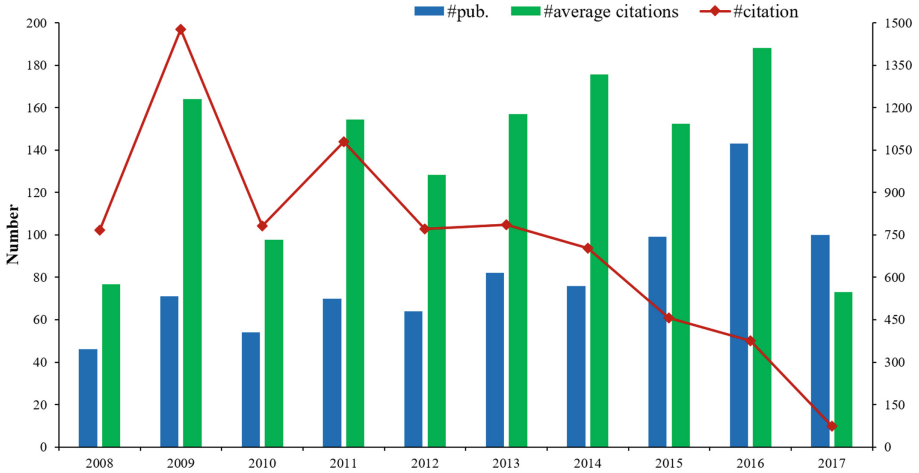
**Fig. 1.** Total publications, total citations, and average citations of the publications

## 3.2 Journals and Subjects

The technology enhanced language learning field is not limited to *Education* or *Linguistics*, but covers over 67 Web of Science categories. This indicates wide applications of technologies in language learning fields. Figure 2 shows the top 10 subjects ranked by the quantities of publication and citation, respectively. *Education & Educational Research* is the largest category with nearly one-third of the total publications and citations. The followings are *Linguistics* and *Language & Linguistics*, each with a sharing of 25.30% and 13.80% publications, as well as 25.94% and 14.71% citations, respectively. This reflects a high influence and quality of the publications in the three subjects. In addition to *Education* and *Linguistics* related categories, the publications are also found to be widely appeared in *Computer Science*, *Acoustics*, *Psychology*, and *Audiology* related categories.
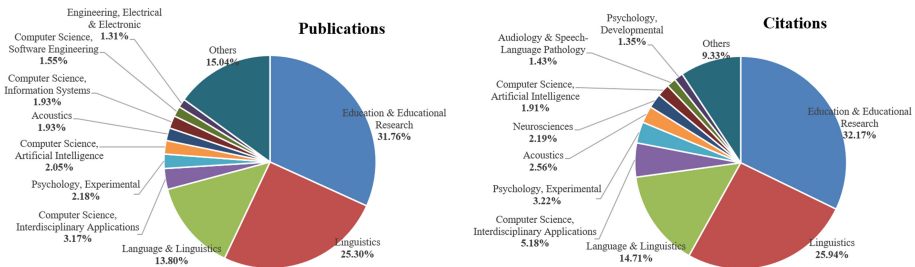


**Fig. 2.** Top subjects ranked by publication and citation quantities

242 SCIE/SSCI-indexed journals have published relevant research work. Among them, *Computer Assisted Language Learning* is the largest one with 93 publications and the highest h-index, followed by *Language Learning & Technology* (83 publications) and *ReCALL* (42 publications). Table 1 lists the top 11 publication outlets in the field. These top journals account for nearly half (46.21% for publications and 57.78% for citations) of the total investigated publications, implying their dominant positions and wide influences in the field. It is worth noting that *Computers & Education* has the highest average citations per publication although with only 15 publications.

**Table 1.** Top 11 contributing journals in the research field

| Rank | Journals | TP | %P | TC | ACP | H | ≥ 10 |
|---|---|---|---|---|---|---|---|
| 1 | *Computer Assisted Language Learning* | 93 | 11.55% | 987 | 10.61 | 17 | 30 |
| 2 | *Language Learning & Technology* | 83 | 10.31% | 764 | 9.20 | 16 | 22 |
| 3 | *ReCALL* | 42 | 5.22% | 619 | 14.74 | 15 | 19 |
| 4 | *Educational Technology & Society* | 28 | 3.48% | 391 | 13.96 | 9 | 9 |
| 5 | *System* | 26 | 3.23% | 92 | 3.54 | 5 | 2 |
| 6 | *Speech Communication* | 23 | 2.86% | 335 | 14.57 | 11 | 11 |
| 7 | *Modern Language Journal* | 19 | 2.36% | 349 | 18.37 | 11 | 12 |
| 8 | *Computers & Education* | 15 | 1.86% | 381 | 25.40 | 11 | 12 |
| 9 | *Foreign Language Annals* | 15 | 1.86% | 119 | 7.93 | 7 | 3 |
| 10 | *Computers in Human Behavior* | 14 | 1.74% | 62 | 4.43 | 4 | 3 |
| 11 | *Interactive Learning Environments* | 14 | 1.74% | 101 | 7.21 | 4 | 1 |

Note: TP: total publications; %P: percentage of publications; TC: total citations; ACP: average citations per publication, calculated as TC/TP; H: h-index; ≥ 10: publication number with citations ≥ 10.
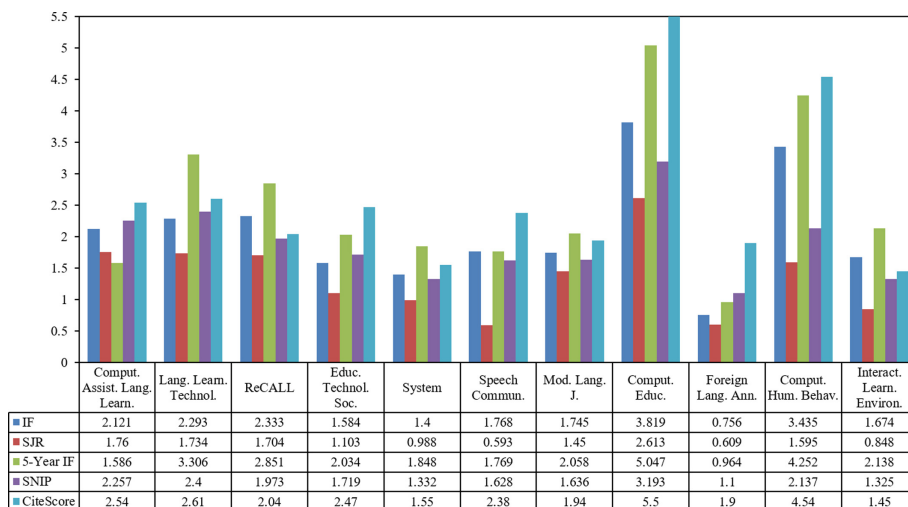


| | Comput. Assist. Lang. Learn. | Lang. Learn. Technol. | ReCALL | Educ. Technol. Soc. | System | Speech Commun. | Mod. Lang. J. | Comput. Educ. | Foreign Lang. Ann. | Comput. Hum. Behav. | Interact. Learn. Environ. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IF | 2.121 | 2.293 | 2.333 | 1.584 | 1.4 | 1.768 | 1.745 | 3.819 | 0.756 | 3.435 | 1.674 |
| SJR | 1.76 | 1.734 | 1.704 | 1.103 | 0.988 | 0.593 | 1.45 | 2.613 | 0.609 | 1.595 | 0.848 |
| 5-Year IF | 1.586 | 3.306 | 2.851 | 2.034 | 1.848 | 1.769 | 2.058 | 5.047 | 0.964 | 4.252 | 2.138 |
| SNIP | 2.257 | 2.4 | 1.973 | 1.719 | 1.332 | 1.628 | 1.636 | 3.193 | 1.1 | 2.137 | 1.325 |
| CiteScore | 2.54 | 2.61 | 2.04 | 2.47 | 1.55 | 2.38 | 1.94 | 5.5 | 1.9 | 4.54 | 1.45 |

**Fig. 3.** Comparisons of the top 11 productive journals on five metrics for the year 2016

The competency of the top productive journals are further compared using 5 assessment indicators, for the year 2016. As shown in Fig. 3, *Computers & Education* and *Computers in Human Behavior* have the relative high IF, 5-Year IF, and CiteScore. The SJR scores of *Computers & Education* and *Computer Assisted Language Learning* are higher than others, while *Computers & Education* and *Language Learning & Technology* have higher SNIP. It is clear that as for all the 5 indicators, *Computers & Education* has the highest values.

### 3.3    Geographical Distribution

Through the analysis of geographical distributions of the publications, the USA dominates in the field, accounting for 26.96% of the total publications, followed by Taiwan with 116 publications. Other productive countries/regions include China, UK, Turkey, Japan, Spain, Australia, Canada, and Germany. The 10 countries/regions have contributed mainly on *Education & Educational Research* and *Linguistics* subjects. They serve as first authors in more than 70% of their publications except Germany.

Figure 4 shows the annual publication numbers of top 4 productive countries/regions. The USA ranks at the top 1 for the period 2008–2017. A sudden increase takes place in 2016. Taiwan ranks at the top 2 since 2009, but falls behind China in 2017. The publication numbers for Taiwan and China are on the whole presenting upward trends in fluctuation, and they both experience sharp increases in 2011. As for UK, the publication number increases slightly with years.
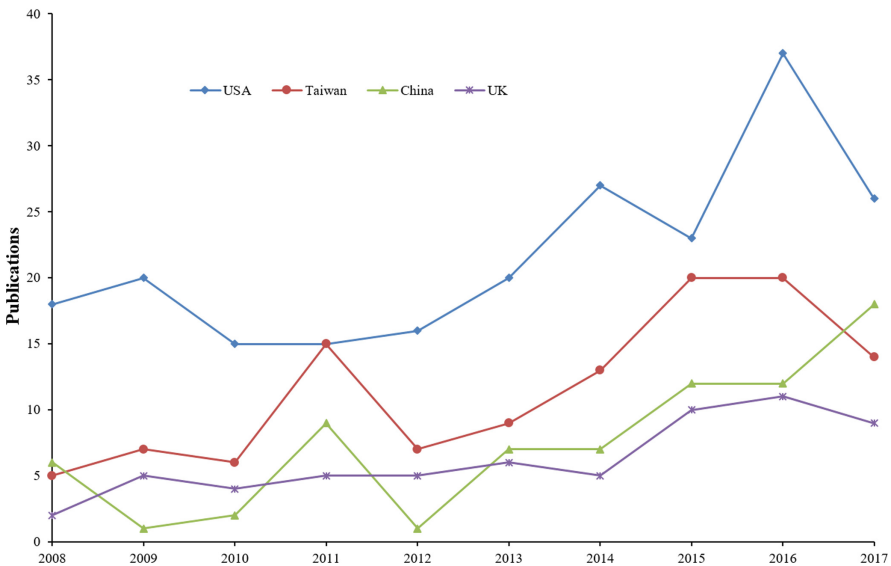


**Fig. 4.** Annual publication distribution for the top 4 countries/regions

### 3.4   Affiliations and Authors

741 affiliations perform technology enhanced language learning research, where 242 affiliations participate in more than one publications. *Nanyang Technological University* from Singapore and *National Taiwan Normal University* from Taiwan lead with 17 publications each, followed by *The University of Hong Kong* from Hong Kong with 14 publications. Table 2 lists the details of the top 14 most prolific affiliations. Among them, 5 organizations locate in Taiwan, confirming that Taiwan is active in technology enhanced language learning research. The 14 affiliations publish studies centering most on subjects *Education & Educational Research* and *Linguistics*. It is worth noting that *Iowa State University* has the highest citations although with only 10 publications, thus it receives the highest average citations per publication as 20.4. This indicates the high influence and quality of its publications.

**Table 2.**  The most prolific affiliations in the research field

| R | Name | C/R | TP | TC | ACP | H | FP(%) | CP(%) |
|---|------|-----|----|----|-----|---|-------|-------|
| 1 | *Nanyang Technological University* | SG | 17 | 141 | 8.29 | 7 | 41.18 | 76.47 |
| 2 | *National Taiwan Normal University* | TW | 17 | 144 | 8.47 | 7 | 41.18 | 70.59 |
| 3 | *The University of Hong Kong* | HK | 14 | 124 | 8.86 | 6 | 42.86 | 100.00 |
| 4 | *National Central University* | TW | 12 | 68 | 5.67 | 5 | 41.67 | 66.67 |
| 5 | *National Cheng Kung University* | TW | 12 | 118 | 9.83 | 7 | 58.33 | 66.67 |
| 6 | *The Open University* | UK | 11 | 162 | 14.73 | 6 | 54.55 | 72.73 |
| 7 | *Iowa State University* | USA | 10 | 204 | 20.40 | 6 | 60.00 | 60.00 |
| 8 | *Michigan State University* | USA | 10 | 71 | 7.10 | 4 | 40.00 | 30.00 |
| 9 | *Radboud Universiteit Nijmegen* | NL | 9 | 93 | 10.33 | 4 | 44.44 | 100.00 |
| 10 | *Arizona State University* | USA | 8 | 103 | 12.88 | 5 | 62.50 | 62.50 |
| 11 | *Islamic Azad University* | IR | 8 | 37 | 4.63 | 4 | 50.00 | 100.00 |
| 12 | *Macquarie University* | AU | 8 | 65 | 8.13 | 3 | 37.50 | 87.50 |
| 13 | *National Taiwan University of Science and Technology* | TW | 8 | 110 | 13.75 | 3 | 37.50 | 37.50 |
| 14 | *National Tsing Hua University* | TW | 8 | 69 | 8.63 | 4 | 50.00 | 87.50 |

Note: C/R: Country/Region; TP: total publications; TC: total citations; ACP: average citations per publication; H: h-index; FP(%): publication percentage as first affiliation; CP(%): collaboration percentage.

In total, 1,707 authors are acknowledged for their contributions although 11.19% of these authors contribute only one publication. Table 3 lists the top 14 most productive authors including their respective publication numbers and h-indexes. The most prolific author is *Lai, Chun* from Hong Kong with 8 publications, followed by *Cucchiarini, Catia* and *Strik, Helmer* from Netherlands (each with 7 publications). In case of Taiwan and the USA, *Wu, Wen-Chi Vivian* and *Chapelle, Carol A.* are the most productive authors. From the perspective of h-index, *Wong, Lung-Hsiang* form Singapore has the highest h-index as 6. It is worth noting that *Chapelle, Carol A.* has the highest citations although with only 6 publications, thus he receives the highest average citations per

**Table 3.** The most prolific authors in the technology enhanced language learning research field

| R | Name | C | TP | TC | ACP | H | FP(%) | LP(%) | CP(%) |
|---|------|---|----|----|-----|---|-------|-------|-------|
| 1 | Lai, Chun | HK | 8 | 105 | 13.13 | 5 | 100.00 | 25.00 | 75.00 |
| 2 | Cucchiarini, Catia | NL | 7 | 65 | 9.29 | 4 | 0.00 | 14.29 | 100.00 |
| 3 | Strik, Helmer | NL | 7 | 65 | 9.29 | 4 | 14.29 | 28.57 | 100.00 |
| 4 | Wong, Lung-Hsiang | SG | 7 | 73 | 10.43 | 6 | 85.71 | 28.57 | 71.43 |
| 5 | Chapelle, Carol A. | USA | 6 | 134 | 22.33 | 4 | 66.67 | 66.67 | 50.00 |
| 6 | Wu, Wen-Chi Vivian | TW | 6 | 15 | 2.50 | 3 | 33.33 | 66.67 | 100.00 |
| 7 | Blake, Robert J. | USA | 5 | 83 | 16.60 | 3 | 80.00 | 100.00 | 20.00 |
| 8 | Chen, Chih-Ming | TW | 5 | 99 | 19.80 | 3 | 100.00 | 0.00 | 100.00 |
| 9 | Huang, Yueh-Min | TW | 5 | 37 | 7.40 | 4 | 0.00 | 40.00 | 100.00 |
| 10 | Lee, Gary Geunbae | KR | 5 | 32 | 6.40 | 3 | 0.00 | 80.00 | 100.00 |
| 11 | Lee, Kyusong | KR | 5 | 32 | 6.40 | 3 | 20.00 | 0.00 | 100.00 |
| 12 | Meurers, Detmar | DE | 5 | 45 | 9.00 | 3 | 0.00 | 60.00 | 100.00 |
| 13 | Noh, Hyungjong | KR | 5 | 32 | 6.40 | 3 | 20.00 | 0.00 | 100.00 |
| 14 | Warschauer, Mark | USA | 5 | 66 | 13.20 | 3 | 20.00 | 80.00 | 80.00 |

Note: LP(%): publication percentage as last author; other abbreviations are the same to Table 2.

publication as 22.33, demonstrating the high influence and quality of his publications. The 14 authors publish studies centering most on subjects *Education & Educational Research*, *Linguistics*, *Language & Linguistics*, *Computer Science*, *Information Systems*, *Computer Science*, and *Software Engineering*.

## 3.5    Collaboration Relationship

The collaboration degrees at the country, affiliation and author levels in the research field are shown in Fig. 5. The collaboration in the three levels are experiencing slow growth. Compared with the collaborations between countries and affiliations, the auctorial collaboration degree is much higher. This finding suggests that the authors tend to collaborate more with those within the same affiliation or country. The three average degrees are 2.49, 1.59 and 1.19, respectively. That is to say, 2.49 authors, 1.59 affiliations and 1.19 countries participate in one publication averagely.

Furthermore, the collaborations among countries, affiliations, and authors are visualized using network analysis. 37 of the 47 affiliations with publications $\geq 5$ and 40 of 61 authors with publications $\geq 3$ involve in publication collaborations. The collaboration among affiliations is as Fig. 6.
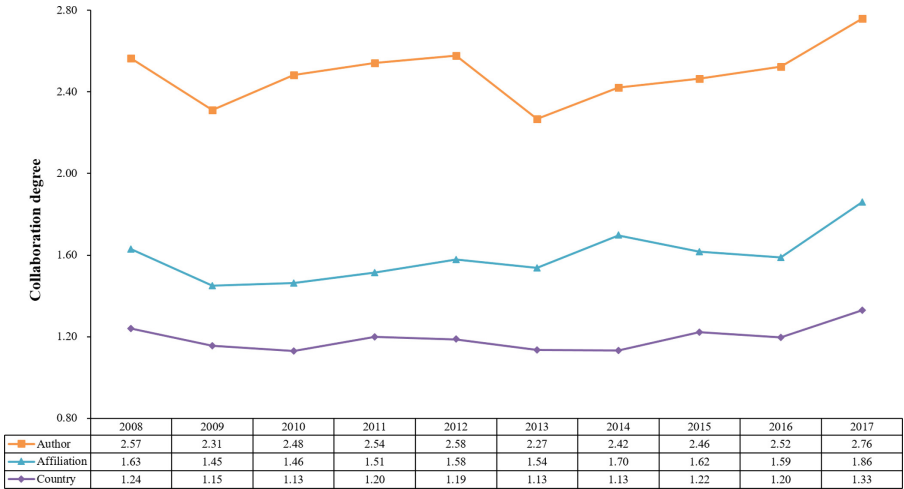
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|
| Author | 2.57 | 2.31 | 2.48 | 2.54 | 2.58 | 2.27 | 2.42 | 2.46 | 2.52 | 2.76 |
| Affiliation | 1.63 | 1.45 | 1.46 | 1.51 | 1.58 | 1.54 | 1.70 | 1.62 | 1.59 | 1.86 |
| Country | 1.24 | 1.15 | 1.13 | 1.20 | 1.19 | 1.13 | 1.13 | 1.22 | 1.20 | 1.33 |

**Fig. 5.** Collaboration degrees in the field
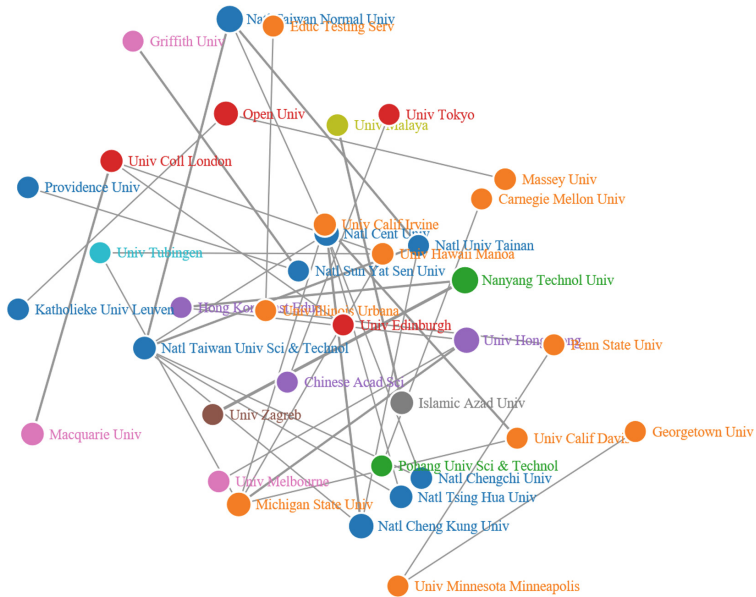


**Fig. 6.** Collaboration network of 37 affiliations with publications ≥ 5, accessed via http://www.zhukun.org/haoty/resources.asp?id=UMLL2018_affiliation

## 4    Conclusion

This study presents a comprehensive overview and an intellectual structure of the technology enhanced language learning research field from the period 2008–2017 through bibliometric analysis. The literature characteristics are revealed through statistics description and geographical visualization. The findings can potentially assist researchers especially newcomers in systematically comprehending the status and development of the field.

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