# Reviewing International Researches on Computer-Assisted Language Testing from 2011 to 2021—A Visual Analysis Using CiteSpace

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*Abstract: With the development of information technology, computer is gradually used in language testing. This paper analyses the articles of computer-assisted language testing published in the Social Sciences Citation Index (SSCI) database of Web of Science between 2011 and 2021 using CiteSpace, a visual analysis software. The analysis focused on the number of publications, countries and institutions, authors, keywords and so on. It is found out that the number of publications in this field shows a trend of increasing in a fluctuating manner from 2011 to 2021, and reached a peak in 2020. Countries with the most publications are the USA, China and England, and most of the institutions with relatively more publications are universities. The research hotspot and frontier in this field include students' performance in computer-assisted language testing and so on. Meanwhile, there are some research gaps in this field which include students' or teachers' adaptability of computer-assisted language testing, the washback of computer-assisted language testing on language teaching and so on. It is hoped that this paper can provide reference on the application of computer-assisted language testing in language teaching and the future research in this field.*

*Keywords: Computer-assisted Language Testing, CiteSpace, Visual Analysis*

## 1. Introduction

Since the 21st century, with the rapid development of information technology, computer has become the main carrier and an important way for people to obtain and spread information. Meanwhile, with the development of network and computer technology, testing methods are modernizing. In the field of language testing, computer technology has been widely used. As early as the 1960s, computer technology has made important contributions to language testing (Wang & Chen, 2015). Then, it began to affect the field of language testing on a large scale, and more and more scholars began to pay attention to computer-assisted language testing. In the post-pandemic era, the blended teaching mode, which is the combination of online teaching and classroom teaching, is widely used. In this case, computer-assisted language testing can provide convenience for language teaching. What needs to be clarified here is that in this paper, computer-assisted language testing refers to language tests that are caried out with the help of computers, including computer-based language testing, computerized language testing, internet-based language testing and so on.

With the development of computer-assisted language testing, some scholars have analyzed and summarized the current situation and developing trend of it (Yu & Zhang, 2017; Wang & Chen, 2015; Zhang & Zhang, 2017). However, most of the existing reviews focus on certain regions, and there are few reviews on international computer-assisted language testing. Meanwhile, most of the existing reviews of computer-assisted language testing adopt traditional method of literature review, and the results mainly rely on researchers' subjective judgment.

According to Mayr and Scharnhorst (2015), bibliometric analysis is the quantitative analysis of publications in a given field. A comprehensive bibliometric analysis of a specific topic is helpful for researchers to understand the knowledge of this topic (Shafique, 2013). It can also help analyzing information such as countries, institutions, authors, keywords, references, journals, and even topics for future research.

Therefore, this paper chose the Social Sciences Citation Index (SSCI) database in the Web of Science

core collection for topical retrieval. The query was set as "((Topic = (language testing) OR Topic = (language assessment)) AND Topic = (computer)", and the date range was set as from 2011-01-01 to 2021-12-31. Then, the results were used as the source of literature to make a bibliometric analysis of the development in international computer-assisted language testing in the past 11 years. CiteSpace, a widely used tool for visual exploration of scientific literature, was used in this paper. This paper mainly analyzed the publication, countries, institutions, authors, journals, research hot topics and frontiers in international computer-assisted language testing, hoping to bring inspiration to the application of computer-assisted language testing in language teaching. Meanwhile, it is hoped that this review paper can provide a reference on the follow-up research in this field.

## 2. Materials and Methods

### 2.1. Data Collection

According to Bradford's (1948) law of literature dispersion, most key documents are usually published in a few core journals. Therefore, this review paper used papers published in the Social Sciences Citation Index (SSCI) journals in Web of Science core collection database as data source. Meanwhile, the time span of this review paper is from 2011 to 2021. The reason for choosing this time span is to focus on the authority document in the past 11 years, showing the development trends, researcher hot topics and frontiers in international computer-assisted language testing, so as to provide reference for language testing in the post-pandemic era.

Although there are many combinations of retrieval fields in Web of Science, according to Chen (2015), CiteSpace primarily tracks and analyzes the evolution of a topic, so the targeted topic retrieval results are better. Therefore, this study used the search strategy of "((Topic = (language testing) OR Topic = (language assessment)) AND Topic = (computer)", and the date range is from 2011-01-01 to 2021-12-31 to collect data. Review articles were excluded from the search results. Meanwhile, since the term language testing will also appear in the fields of psychology, special education, rehabilitation and so on, to ensure data accuracy, Web of Science Categories was set as "English Educational Research", "Linguistics", and "Language Linguistics", which are most relevant to language testing, and the language of literature was set as English. This query generated 572 records. Then, these records were manually sifted through reading the titles, keywords and abstracts. Articles that are not highly related to computer-assisted language testing were eliminated. Finally, there are 132 articles as the data source of this paper. Although the amount of data collected in this study is relatively small, it still meets the requirements for CiteSpace analysis (Chen, 2017).

### 2.2. Data analysis

Mapping knowledge domains is a kind of image which takes the knowledge domains as the object and shows the relationship between the development process and structure of scientific knowledge. It has the dual properties and characteristics of graph and spectrum—it is not only a visual knowledge graph, but also a serialized knowledge pedigree, showing many hidden complex relationships among knowledge units or knowledge groups, such as their network, structure, interaction and so on (Chen et al., 2015). In this paper, knowledge mapping was used to visually analyze the collected data.

In this study, Microsoft Office Excel 2019 and CiteSpace 5.8.R3 (64-bit) were used to organize and analyze the collected data. Excel was used to help rank information and make line charts. CiteSpace 5.8.R3 is a bibliometric tool developed by Prof. Chaomei Chen. It is a citation visual analysis software that can help researchers understand the basic knowledge of a discipline, find classical literature in this field, discover hot topics and research frontiers, and clarify the context of research evolution (Chen, 2016).

First, the number of publications among the 11 years is concluded and analyzed. Then, a scientific research collaboration analysis was conducted in this study, including national collaboration, institutional collaboration and author collaboration. In addition, a keywords cluster analysis weas performed. The results are shown in the following part.

## 3. Results

In this part, the results obtained from the analysis of the collected data by CiteSpace are shown.

Meanwhile, some analysis and interpretation of these results are also shown in this part.

### 3.1. Number of Publications

The number of publications for each year is displayed in Figure 1. As can be seen from this figure, the international research on computer-assisted language testing shows a trend of increasing in a fluctuating manner from 2011 to 2021. There were two sharp increases just after 2016 and 2019. The publications of international computer-assisted language testing research reached two peaks in 2017 and 2020 (17 and 22, respectively). In the first jump, which is from 2016 to 2017, the increase in number of publications is mainly in People's Republic of China, which increased from 2 to 8. Meanwhile, in 2017, the research of computer-assisted language testing began to appear in New Zealand and Pakistan. As for keywords, the keywords of researches in 2016 include "computer-assisted language learning", "student", and "learner". The keywords of researches in 2017 include "language", "strategy", "proficiency", "performance", "English", "attitude", "learner" and "skill". Thus, it can be inferred that in 2017, on the basis of paying attention to students, researchers began to focus on students' strategies and performance in computer-assisted language testing, as well as people's attitude towards computer-assisted language testing. The second jump is from 2019 to 2020, and in this year, the research on computer-assisted language testing showed an explosive growth, with an increase of ten articles. This may be due to the outbreak of COVID-19 at the end of 2019. At that time, students were unable to return to school, online teaching is widely used, and the methods of language testing were also changed. So, the research on computer-assisted language testing increased and reached a peak in 2020, and the number of publications were kept steady in 2021. Meanwhile, the number of keywords in computer-assisted language testing has also increased from 2019 to 2020. From "student", "computer", "performance", and "English" in 2019 to "language", "support", "comprehension", "text comprehension", "2nd language", "skill", "automated feedback" and "instruction" in 2020, it can be seen that the research of computer-assisted language testing is becoming diversified.
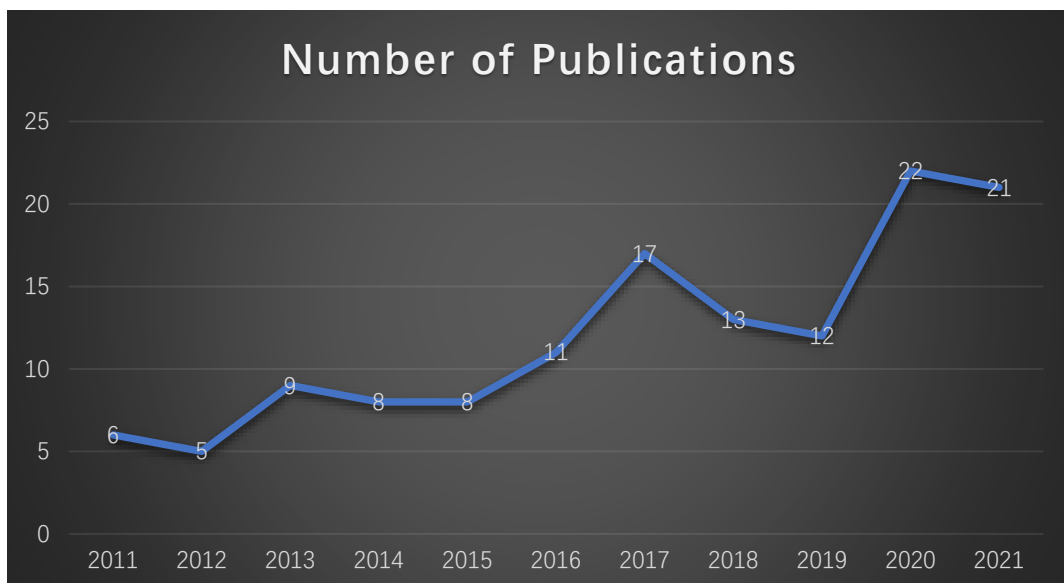


*Figure 1: Number of publications*

### 3.2. Mapping and Analysis on Countries and Institutions

### 3.2.1. Countries or Territories

The sample documents of this study included 37 countries or territories, eight of which have published five or more articles and three of which have published more than ten articles. The map of countries or territories is shown in Figure 2 (only the countries or territories with more than three publications are shown in the figure), and the top eight productive countries or territories are listed in Table 1.

CiteSpace, v. 5.8.R3 (64-bit)
January 6, 2022 12:29:12 PM CST
WoS: E:\WOS_132\data
Timespan: 2011-2021 (Slice Length=1)
Selection Criteria: g-index (k=25), LRF=3.0, L/N=10, LBY=5, e=1.0
Network: N=37, E=25 (Density=0.0375)
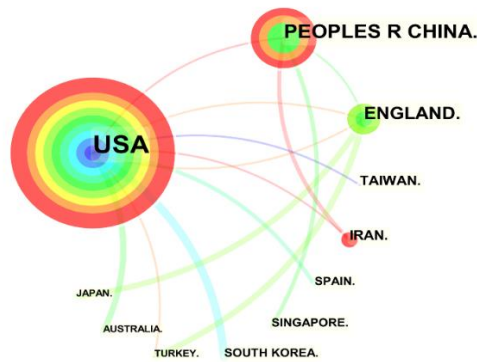Largest CC: 21 (56%)
Nodes Labeled: 1.0%
Pruning: None



*Figure 2: Map of countries or territories*

*Table 1: Top eight productive countries or territories*

| Country/Territory | Publications | Centrality |
|---|---|---|
| USA | 49 | 0.42 |
| People's Republic of China | 18 | 0.18 |
| England | 13 | 0.18 |
| Taiwan | 8 | 0.11 |
| Iran | 7 | 0.06 |
| Spain | 5 | 0.00 |
| Singapore | 5 | 0.00 |
| South Korea | 5 | 0.00 |

It is obvious that USA is the leading country for the research of computer-assisted language testing. Among the total 132 articles, 49 publications are from USA which is more than a third of the sample size. USA also has the highest centrality—0.42. The betweenness centrality of a node in a network is a commonly used structural metric (Chen, 2017), which shows the degree of one node linking with other nodes. It is also shown in figure 2 by the liking lines. The thicker the linking line, the closer and stronger the cooperation. So, with such high centrality, USA has much cooperation with other countries or territories, namely South Korea, Australia, Spain, Iran, Taiwan, England, People's Republic of China, etc.

In Figure 2, each color refers to a certain year in which the articles are published. Grey refers to the year 2011, purple refers to 2012, blue purple 2013, blue 2014, light blue 2015, cyan 2016, green 2017, light green 2018, yellow 2019, orange 2020, and red 2021 (the correspondence between these colors and years is the same in the knowledge maps in the following parts of this paper). Therefore, it is clear that countries that have researches about computer-assisted language testing in the latest years are USA, People's Republic of China and Iran.

### 3.2.2. Institutions

*Table 2: Top seven productive institutions*

| Institutions | Publications |
|---|---|
| Nanyang Technological University | 5 |
| Michigan State University | 4 |
| Education Testing Service | 4 |
| University of Bedfordshire | 4 |
| Capital Normal University | 3 |
| The Chinese University of Hong Kong | 3 |
| Arizona State University | 3 |

A total of 160 institutions are included in the collected data of this study, but there is little cooperation among these institutions. Therefore, the centrality of institutions will not be talked about. The top seven

productive institutions are listed in Table 2, and the map of institutions is shown in Figure 3.
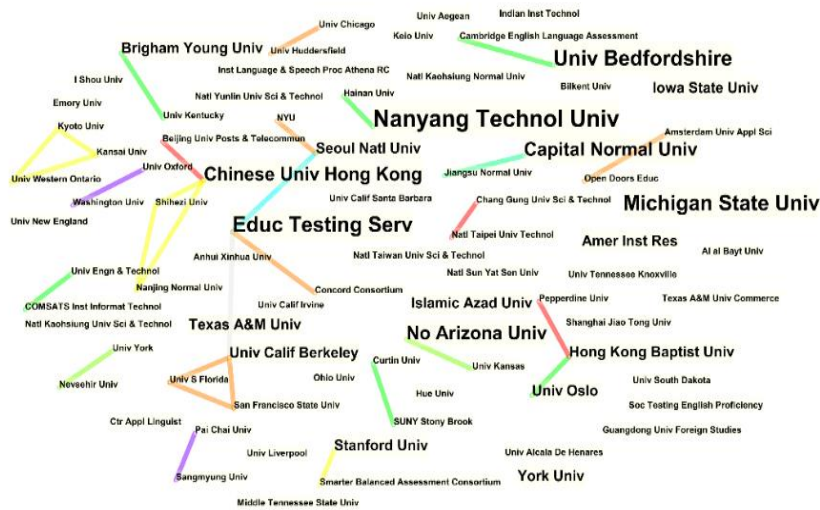


*Figure 3: Map of institutions*

According to Table 2 and Figure 3, Nanyang Technological University is the most productive institution with 5 publications. However, in these top seven productive institutions, three of them—Michigan State University, Education Testing Service and Arizona State University—are in the USA, and two of them—Capital Normal University and The Chinese University of Hong Kong—are in China. So, it is easy to find that this result is in accordance with the analysis of countries which highlight the weight of the USA and China in the field of computer-assisted language testing. As can be seen from Figure 2, most of the institutions are scattered. There are few institutions with cooperative relations, and most of the institutions with cooperative relations belong to the same country, such as University of Bedfordshire and Cambridge English Language Assessment, Capital Normal University and Jiangsu Normal University, The Chinese University of Hong Kong and Shihezi, University Arizona State University and University of Kansas, etc. But there are also a small number of institutions that cooperate with institutions that do not belong to the country in which they are located, such as Nanyang Technological University and Hainan University, Education Testing Service and Seoul National University, etc.

### 3.3. Mapping and Analysis on Author and Cited Authors

The top 10 most productive authors and their research areas are listed in Table 3.

*Table 3: Top 10 most productive authors*

| Author | Publications | Research areas |
|---|---|---|
| Bax, Stephen | 3 | Cognitive validity; eye-tracking |
| Winke, Paula | 3 | Eye-tracking; speaking assessment |
| Engeness, Irina | 2 | Automated feedback; essay writing |
| Chan, Sathena | 2 | Cognitive validity |
| Chai, Ching Sing | 2 | Formative assessment |
| Lee, Hee-Sun | 2 | Item response theory; automated feedback |
| Barkaoui, Khaled | 2 | Keyboarding skills; writing tests |
| Gao, Jianwu | 2 | Automated feedback; corrective feedback |
| Thompson, Gregory L. | 2 | Oral proficiency; test development |
| Aryadoust, Vahid | 2 | Pearson test of English academic reading |

The most influential authors in a field can be found by the analysis of cited authors from references. In this study, cited authors of the collected data were analyzed by CiteSpace, and the result is depicted in Figure 4. Meanwhile, the top 20 cited authors are listed in Table 4.
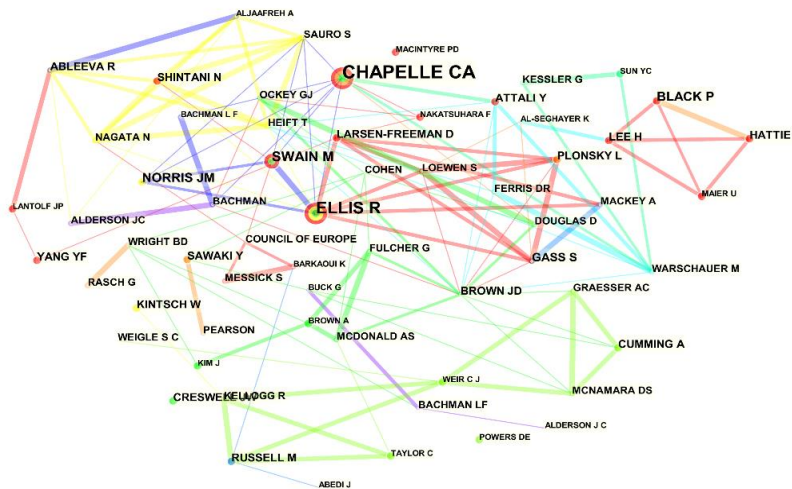
*Figure 4: Map of authors co-citation*

*Table 4: Top 20 cited authors*

| Author | Frequency | Centrality | Author | Frequency | Centrality |
|---|---|---|---|---|---|
| Chapelle C.A. | 17 | 0.16 | Sawaki Y. | 5 | 0.04 |
| Ellis R. | 14 | 0.15 | Brown J.D. | 5 | 0.29 |
| Swain M. | 8 | 0.01 | Hattie J. | 5 | 0.01 |
| Black P | 7 | 0.03 | Larsen-Freeman D. | 5 | 0.02 |
| Norris J. M. | 7 | 0.04 | Lee H. | 5 | 0.04 |
| Gass S. | 6 | 0.07 | Cumming A. | 5 | 0.06 |
| Kintsch W. | 5 | 0.04 | Yang YF | 5 | 0.04 |
| Russell M. | 5 | 0.28 | Ableeva R. | 5 | 0.16 |
| Attali Y. | 5 | 0.01 | Creswell J.W. | 5 | 0.00 |
| Shintani N | 5 | 0.01 | Plonsky L. | 5 | 0.03 |

As shown in Figure 4, the CiteSpace analysis result shows a total of 357 nodes, indicating 357 cited authors, and 1285 lines, indicating that the cooperation rate between these authors is relatively high. Five key authors, who have both high cited frequency and high centrality, are identified as the most influential figures in the field of computer-assisted language testing. They are Chapelle C.A., Ellis R., Russell M., Brown J.D. and Ableeva R.

### 3.4. Mapping and Analysis on Keywords

According to Li and Chen (2016), research hotspot refers to the topic that scholars in a field focus on and pay attention to in a specific time period. The research frontier refers to the emerging theoretical trends or emerging new topics in a field. The analysis of keywords can be used to help learn more about the substance of a research field and to identify the current hot topics in this field. The Burstness function of CiteSpace allows researchers to get the time when a certain keyword emerges, the duration of the research on the keyword, and the time when the keyword disappears. Therefore, the research hotspot in a specific time period and the research frontier of a research field can be found out by this function.

The top 20 keywords (those having a frequency equal to or larger than four) are listed in Table 5. What needs to be known is that to make Table5, we combined some words with same meaning such as "computer-assisted language learning" and "CALL". Among these keywords, "learner" is the most used word in computer-assisted language testing, which reflects the important position of learners in computer-assisted language testing. Apart from "learner", it is also found that researchers are focusing on learners' performance in and the feedback from computer-assisted language testing. Meanwhile, testing and learning are two inseparable parts, therefore, computer-assisted language learning often come

together in research. This echoes the viewpoint of assessment for learning and assessment as learning.

*Table 5: Top 20 keywords*

| Keyword | Frequency |
|---|---|
| Learner | 24 |
| Language | 13 |
| Computer-assisted language learning | 12 |
| Performance | 10 |
| English | 10 |
| Feedback | 10 |
| Acquisition | 8 |
| $2^{nd}$ language | 7 |
| Proficiency | 6 |
| Computer | 5 |
| Computer-mediated communication | 4 |
| Teacher | 4 |
| Foreign language | 4 |
| Formative assessment | 4 |
| Skill | 4 |
| Efficacy | 4 |
| Computer-based testing | 4 |
| Accuracy | 4 |
| Comprehension | 4 |
| Automated feedback | 4 |

Meanwhile, the 20 keywords with the strongest citation bursts are identified by the Burstness function of CiteSpace which enables the discovery of the emergence of hotspots in a field and when the emergence ends. The keyword burst graph is depicted in Figure 5.

**Top 20 Keywords with the Strongest Citation Bursts**

| Keywords | Year | Strength | Begin | End | 2011 – 2021 |
|---|---|---|---|---|---|
| explicit | 2011 | 0.89 | 2011 | 2014 | |
| form | 2011 | 0.89 | 2011 | 2014 | |
| education | 2011 | 0.84 | 2011 | 2013 | |
| english language learner | 2011 | 0.74 | 2011 | 2015 | |
| evaluation methodology | 2011 | 1.04 | 2012 | 2014 | |
| corrective feedback | 2011 | 1.7 | 2013 | 2015 | |
| grammar correction | 2011 | 1.1 | 2013 | 2014 | |
| computer-assisted language learning | 2011 | 2.27 | 2015 | 2016 | |
| design | 2011 | 0.99 | 2015 | 2018 | |
| call | 2011 | 0.92 | 2016 | 2018 | |
| performance | 2011 | 2.73 | 2017 | 2021 | |
| proficiency | 2011 | 1.54 | 2017 | 2018 | |
| cohesion | 2011 | 1.46 | 2017 | 2018 | |
| anxiety | 2011 | 0.76 | 2017 | 2018 | |
| language | 2011 | 0.76 | 2017 | 2018 | |
| student | 2011 | 1.43 | 2018 | 2021 | |
| cognitive validity | 2011 | 1.02 | 2018 | 2019 | |
| cognitive load | 2011 | 0.75 | 2018 | 2021 | |
| attention | 2011 | 0.75 | 2018 | 2021 | |
| computer | 2011 | 1.01 | 2019 | 2021 | |

*Figure 5: Keyword burst graph*

The 20 keywords in Figure 5 are/were hot topics during certain years. From Figure 5, it can be known that the keywords "English language learner" and "performance" have the longest burst time which is five years. But the popularity of "English language learner" ended in 2015. The keywords "explicit", "form" and "design" also lasted for a relatively long time, but they ended in 2014, 2014 and 2018 respectively.

As for the research frontier, it can be known from Figure 5 that "performance", "student", "cognitive load", "attention" and "computer" are the new topics of computer-assisted language testing which emerged in recent years, and their popularity has been lasted till 2021. This indicates that they hold the potential to turn into hot spots in future research. These clues all together point to the fact that research focuses are moving from testing itself to the learner side, including learners' performance, anxiety, cognitive load, etc.

What has not been fully studied are the teacher side, students' and teachers' perceptions of or attitudes towards computer-assisted language testing, and the influence of computer-assisted language testing on students' learning and teachers' teaching, which may be some of the research gaps in computer-assisted language testing.

### 3.5. Mapping and Analysis on Journals

In this study, journal co-citation network analysis is used to help find out the journals which contribute most to the field of computer-assisted language testing. Firstly, the top 15 most cited journals are listed in Table 6. What is more, the map of journal co-citation is shown in Figure 6.

*Table 6: Top 15 most cited journals*

| Journal | Frequency | Centrality |
|---|---|---|
| Modern Language Journal | 55 | 0.01 |
| Language Testing | 54 | 0.13 |
| Language Learning | 47 | 0.16 |
| SYSTEM | 44 | 0.08 |
| Language Learning & Technology | 43 | 0.07 |
| TESOL Quarterly | 43 | 0.03 |
| Computer Assisted Language Learning | 37 | 0.12 |
| CALICO Journal | 30 | 0.08 |
| Applied Linguistics | 30 | 0.16 |
| Computers & Education | 29 | 0.13 |
| Studies in Second Language Acquisition | 29 | 0.05 |
| Foreign Language Annals | 28 | 0.13 |
| Journal of Second Language Writing | 28 | 0.05 |
| Language Teaching Research | 27 | 0.14 |
| Assessing Writing | 23 | 0.09 |
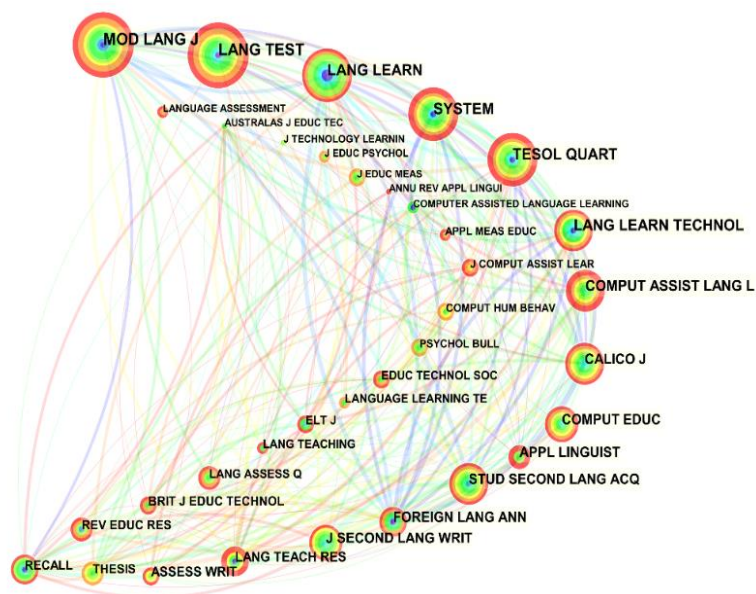


*Figure 6: Map of journal co-citation*

Among the top 15 most cited journals in Table 6, "Language Testing", "Language Learning", "Computer Assisted Language Learning", "Applied Linguistics", "Computer & Education", "Foreign Language Annals" and "Language Teaching Research" are identified by CiteSpace as crucial journals in computer-assisted language testing with both of their high cited frequency and centrality.

## 4. Suggestions for Future Research

In this paper, CiteSpace was used to make a visual analysis of the researches on computer-assisted language testing in the SSCI database of Web of Science. It shows the research hotspots, knowledge maps, etc. in international computer-assisted language testing research in the past 11 years. The main purpose of this part is to discuss the results of the analysis and its implications for the research and development of computer-assisted language testing in the future.

Firstly, through the analysis of the number of publications, it can be known that in the past two years, due to the influence of COVID-19, sometimes students are not allowed to go back to campus for study, so, online teaching is widely used. At the same time, the way of testing is also changing with the change of teaching mode. Schools and teachers have to adapt their tests in ways that would avoid the spread of the covid-19 virus and to keep the validity of the decisions based on these tests (Gary, 2021). Therefore, computer-assisted language testing is still a topic worth studying, and scholars can do researches on this topic in the future, which will provide help for language testing under the blended teaching mode (the combination of online teaching and classroom teaching) in the post-pandemic era.

Secondly, according to the analysis of countries and territories, it can be learned that the countries with relatively more publications in the field of computer-assisted language testing are the USA, China and Iran, and except for the USA, China and England, other countries or territories have little cooperation with other countries in the research of computer-assisted language testing. Therefore, it is suggested that researchers can conduct research in countries or territories in which there is little research on computer-assisted language testing, and they can cooperate with other countries or territories when it is necessary. In terms of institutions, through the analysis results in the previous part, it can be learned that at present, most of the institutions that have published relatively more papers on computer-assisted language testing are universities, while those of other institutions are very few. Meanwhile, there is little cooperation among different institutions. Therefore, in addition to universities, other institutions related to language teaching or testing, such as primary and secondary schools, can also carry out research in the field of computer-assisted language testing, which may provide reference for their teaching and testing. What is more, these institutions can carry out cooperative research and help each other in order to make greater achievements in and shed light on the field of computer assisted language testing.

Thirdly, according to the analysis of authors, cited authors and cited journals, the important scholars and major journals in the field of computer-assisted language testing are concluded. The important scholars include Chapelle C.A., Ellis R., Russell M., Brown J.D. and Ableeva R. In future research, researchers can review the works of these scholars in this field, which may provide theoretical basis or reference for the research. The major journals in this field include "Language Testing", "Language Learning", "Computer Assisted Language Learning", "Applied Linguistics", "Computer & Education", "Foreign Language Annals" and "Language Teaching Research". Researchers can refer to the articles about computer-assisted language testing in these journals in future research, which may bring some help or inspiration for the research.

Last but not least, from the analysis of keywords, the research hotspot and research frontier in the field of computer-assisted language testing can be learned. What is more, the research gap in this field can also be conclude on the basis of the analysis of keywords. The research hotspots in this field include learners' performance in computer-assisted language tests, the feedback provided to students by computer-assisted language tests and so on. The research frontiers, which are also hot topics, in this field include students' performance in computer-assisted language tests, their cognitive load and attention. In future research, scholars can conduct further research on these topics. Meanwhile, through the analysis of the keywords in collected data, it is not hard to find that there are still some deficiencies in the field of computer-assisted language testing, for example, there are few researches on the following topics—teachers' role or their identity cognition in the use of computer-assisted language tests, students' and teachers' attitude towards or their adaptability of computer-assisted language testing, factors that have impact on students' performance in computer-assisted language tests, etc. In particular, there is little research on the washback of computer-assisted language testing on language teaching and learning. According to Liz (1997), washback is one of a set of terms that have been used in general education,

language education and language testing to refer to a set of beliefs about the relationship between testing and teaching and learning. It mainly refers to both positive and negative influences of testing on teaching and learning (Hung, 2012). The purpose of assessment or testing is to help promote teaching and learning, and in this post-pandemic era, the blended teaching mode is widely used and computer-assisted language testing is becoming more and more popular. Thus, the washback of computer-assisted language testing on language teaching and learning holds the potential to become one of the topics worth studying in the near future. Scholars can do research on the washback of computer-assisted language testing in classroom-based assessment, which may help teachers to develop or find out the computer-assisted language tests that are most suitable for their students and are most helpful to their language instruction, so as to make contribution to language teaching and testing in the post-pandemic era.

## 5. Conclusion

This paper applied CiteSpace as a visualized analytical tool to conduct a bibliometric citation analysis of 132 articles in the field of computer-assisted language testing published from 2011 to 2021, combing the international research on computer-assisted language testing from five aspects—number of publications, countries, institutions, authors and cited authors, keywords, and journals, discussing the results and providing some suggestions and research ideas for future research. However, it is inevitable that there are some limitations of this review paper. First of all, in order to ensure the core and authority of the literature, the database selected in this paper is relatively single, resulting in a small number of collected data. Secondly, this paper only reviewed the international research articles on computer-assisted language testing, and only the article written in English were chosen. Inclusion of papers with other languages may help gain more comprehensive results. Therefore, future research may consider include papers with other languages or make comparisons among papers with different languages, such as the comparison between English papers and Chinese papers. Lastly, because of the limitation of time and energy, this paper only analyzed the international research situation of computer-assisted language testing from a relatively macro point of view, and there is little in-depth interpretation of the results.

## Acknowledgment

## References

*[1] Bradford, S. C. (1948). Documentation. London: Crosby Lockwood.*

*[2] Chen, C. (2015). How to use CiteSpace. Victoria, British Columbia, Canada: Leanpub.*

*[3] Chen, C. (2016). CiteSpace: A practical guide for mapping scientific literature. New York: Nova Science Publishers.*

*[4] Chen, C. (2017). Expert Review. Science Mapping: A Systematic Review of the Literature. Journal of Data and Information Science, 2(2), pp. 1-40.*

*[5] Chen Y., Chen C., Liu Z., Hu Z. & Wang X. (2015). The methodology function of CiteSpace mapping knowledge domains. Studies in Science of Science, (2), pp. 242-253.*

*[6] Gary J. Ockey. (2021). An Overview of COVID-19's Impact on English Language University Admissions and Placement Tests. Language Assessment Quarterly, 18(1), pp. 1-5.*

*[7] Hamp-Lyons, L. (1997). Washback, impact and validity: ethnical concerns. Language Testing, 14(3), pp. 295-303.*

*[8] Hung, S. (2012). A washback study on e-portfolio assessment in an English as a Foreign Language teacher preparation program. Computer Assisted Language Learning, 25(1), pp. 21-36.*

*[9] Li J. & Chen C. (2016). CiteSpace: Text Mining and Visualization in Scientific Literature. Beijing: Capital University of Economics and Business Press.*

*[10] Mayr, P. & Scharnhorst, A. (2015). Scientometrics and information retrieval: weak-links revitalized. Scientometrics, 102(3), pp. 2193-2199.*

*[11] Shafique, M. (2013). THINKING INSIDE THE BOX? INTELLECTUAL STRUCTURE OF THE KNOWLEDGE BASE OF INNOVATION RESEARCH (1988—2008). Strategic Management Journal, 34(1), pp. 62-93.*

*[12] Wang J. & Chen Y. (2015). Computer-assisted Language Assessment: Application and Development.*

*Foreign Languages in China, 12(6), pp. 76-81.*

*[13] Yu Guoxing & Zhang Jing. (2017). Computer-Based English Language Testing in China: Present and Future. Language Assessment Quarterly, 14(2), pp. 177-188.*

*[14] Zhang Y. & Zhang J. (2017). A Review of Research on Computer-Assisted Language Testing in China. China Examinations, (5), pp. 47-53.*