

A Bibliometric Review on Latent Topics and Trends of Language Learning Strategy (1990-2022)

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Abstract

Despite the fact that language learning strategy (LLS) has been playing an important role in language learning and teaching over the past few decades, scant research has systematically tracked and synthesized the development of LLS. This study, therefore, aims to conduct a comprehensive review of LLS within a time span of 1990 to 2022. A total of 927 articles related to LLS were analyzed via bibliometric analysis and structural topic modeling. Performance analysis and science mapping, which included the annual production, the most influential journals, countries, institutions, authors and their collaborative networks, were figured out by bibliometric analysis. 24 important topics were identified by structural topic modeling, which showed that six topics were related to skill-based strategies, three topics were concerned with the subjects of LLS, three topics were about multilingualism issues and the rest concerned different types of LLS and the factors to influence LLS effect. This study provides a panoramic review of LLS in applied linguistics, pointing out potential future directions in this field.

Keywords: language learning strategy, bibliometric analysis, structural topic modeling

1. Introduction

Language learning strategy (LLS) has been taking a pivotal role in language learning and teaching. LLS-related studies have developed into an active period and more and more researchers have been taking great interest in this field. Since the 1970s, scholars have investigated the strategic behaviors of language learners (Hosenfeld, 1976). Afterward, Rubin (1981) and Cohen (2011) conducted a taxonomy of learning strategies, which can be roughly classified into language-learning and language-using strategies, skill-based strategies and function-based strategies, such as metacognitive, cognitive, affective and social strategies. Since then, substantial studies on LLS saw the light of day.

In terms of the definition of LLS, different scholars might have different opinions (Dmitrenko, 2017). For instance, according to Gao (2010), LLS is operationalized as a strategic language learning capacity, which is considered an individual difference factor for second language acquisition. Moreover, Rose (2012) argued that LLS is chiefly reconceptualized as the construct of self-regulated learning capacity. However, Oxford's definition is favored in that the definition emphasizes the active aspect of language learning strategies and also integrates the former definitions. Oxford (2017) defined LLS as specific actions or behaviors consciously selected by the learner and employed in specific contexts to make language learning more successful, easier, faster, enjoyable and self-directed. It can be seen that the definition of LLS might vary across different scholars. Thus, one motivation of this study is to conduct a panoramic review to understand what has been investigated during the past few decades, which can shed light on the definition of LLS.

Aside from the motivation above, this study is conducted for the following reasons. To begin with, a comprehensive review of the LLS field can help us better grasp the development trends in LLS topics and shed light on future directions, which can provide insights and implications for LLS researchers. Moreover, looking through the previous reviews related to LLS (e.g. Zhang et al., 2019), most of them caught a limited scope and merely synthesized a set of articles published in a certain journal. Therefore, to have a systematic and comprehensive review of LLS, bibliometric analysis is a good option. Bibliometric analysis is increasingly popular among different research fields, which is an effective technique to assess academic scientific production (Moed et al., 1995). Meanwhile, it is usually employed to investigate the development trajectory of a specific

field from the past to the future (Morris et al., 2002). In addition, structural topic modeling (STM) (Roberts et al., 2019), is one of the effective machine learning methods to detect latent topics and to synthesize what has been researched in LLS.

However, to date, there is no systematic review of LLS using the aforementioned methods. To that end, the purpose of this study is to fill in these gaps by analyzing the articles related to LLS with the *bibliometrix* R-package tool and STM. This study aims to provide a performance analysis (Cobo et al., 2011) of the LLS field by exploring its annual scientific production of countries, institutions, and authors. It also seeks to conduct science mapping (Cobo et al., 2011), which can examine collaborations among countries, institutions and authors. Meanwhile, the study will also further investigate the trajectory development of LLS topics and illustrate the topic trends for future directions. The research questions are as follows:

- (1) What is the annual production of LLS?
- (2) Which journals, countries, institutions, references and authors are the most influential in the LLS field?
- (3) What are the collaborative relations among those most influential countries, institutions and authors?
- (4) What are the latent topics of the LLS field and how do they evolve?

2. Methodology

2.1 Data Retrieval and Screening

For data retrieval, Scopus, Web of Science and Google Scholar are databases most commonly used in the academic field. But concerning the feasibility and validity, both Web of Science and Google Scholar have some limitations. For one thing, the coverage of pre-1996 publications and citations in Web of Science is not as comprehensive as in Scopus. For another, the limitation of Google Scholar lies in the poor quality of controlling the retrieval process (Harzing & Alakangas, 2015). Thus, due to these reasons, Scopus, one of the largest curated abstract and citation databases (Baas et al., 2020), was finally chosen as our retrieval database. All the data were retrieved on 9th March 2023 and the retrieval process was shown in Figure 1. By setting the time span from 1990 to 2022, we conducted the literature search by using the only search term *learning strategy*. All the publications with *learning strategy* in the title, keywords and abstract were downloaded.

With a further restriction to the articles, reviews and book chapters, we confined the search scope to all the selected LLS-related SSCI applied linguistics journals and a total of 1052 publications were collected. In addition, data cleaning included removing spelling errors and repeated articles. Furthermore, to ensure a close relevance of the analyzed articles to LLS, we carried out manual screening to exclude irrelevant articles based on the following criteria displayed in Table 1. The inclusion criteria were based on Oxford's definition of LLS, which emphasized a plan, step or conscious action toward the achievement of an objective (Oxford, 1990). In addition, since group differences and individual differences exist in learner strategy use (Macaro, 2006), the articles concerning the factors to influence LLS were also included in the inclusion criteria. The exclusion criteria were also provided, which mainly concerned the data structure. To ensure that the final data were valid, articles without authors and abstracts and irrelevant articles were also excluded. At last, 927 publications were collected as the final data.

Table 1. Inclusion and exclusion criteria for data screening

| Criteria | Descriptions |
|--------------------|--|
| Inclusion criteria | <ol style="list-style-type: none"> 1. Analysis of different language learning strategies used in listening, speaking, reading, writing, translating and so forth. 2. Analysis of language learning strategy behaviors in different learning environments and different regions. 3. Analysis of factors to influence the effect of language learning strategy. |
| Exclusion criteria | <ol style="list-style-type: none"> 1. Conference paper, erratum, notes 2. Publications without complete authors and abstract 3. Title and abstract irrelevant to language learning strategy |

2.2 Performance Analysis and Science Mapping

To answer RQ1, RQ2 and RQ3, the *bibliometrix* R-package tool was performed. To accomplish a performance analysis, namely, the analyses of the annual production of LLS research, the most influential journals, the most cited authors, articles and the most productive countries, we identified the indexes of h-index, average citations and total citations. To conduct science mapping analysis of the collaborative relationships among countries, institutions and authors, the relevant collaborative data were downloaded from *bibliometrix* and the collaborative networks were analyzed via Gephi 0.9, which is used to visualize the cooperations among different parameters in this study.

2.3 Structural Topic Modeling

To answer RQ4, the *stm* package and the *stm insights* package were adopted, which can allow researchers to discover topics and estimate their relationship to document metadata (Roberts et al., 2019). As the result of the STM using the *stm* package was isolated words, the AntConc was also adopted to reconstruct the meaning of words after we obtained the result by STM. In other words, we brought the isolated words back to the article abstract to interpret their real meanings in the context, which can guarantee the validity of the final topics. In addition, based on the topic relevancy, the final topics were grouped into several clusters for further illustration.

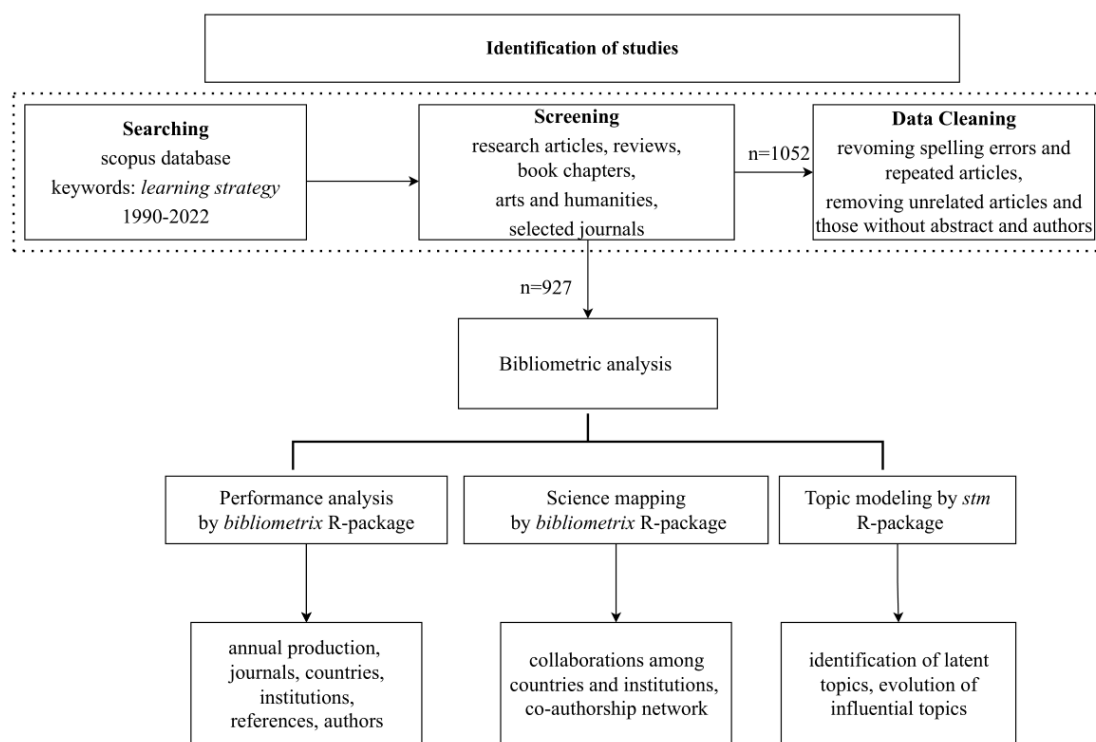


Figure 1. Data collection process and analysis process

3. Result

3.1 Annual Production

As a whole, Figure 2 reveals a marked increase in the number of LLS articles from 1990 to 2022. During the early 1990s and the beginning of 2000, there was a paucity of studies in LLS with only a few, or at most a dozen relevant articles available. Nevertheless, since 2006, a surge of studies sprang up. The number of LLS-related articles remained in the range of 30 to 40. In particular, in the years 2020, 2021, and 2022, over 50 articles were published in three consecutive years. Taken together, the annual production indicates that LLS is an important issue in applied linguistics and it is predicted to get a stably increasing focus after 2022.

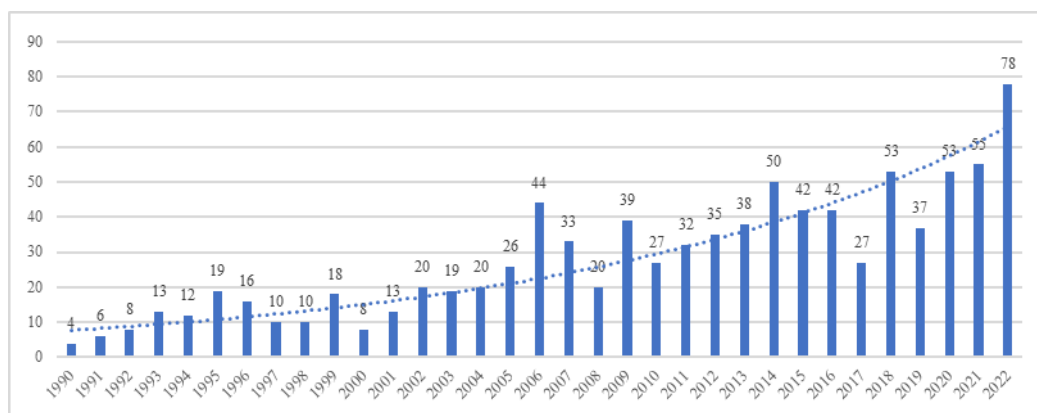


Figure 2. Annual production

3.2 Most Influential Journals

As shown in Table 2, the top 20 prolific journals contributed to the majority of the total publications. The most influential and prolific journal was *System* with 185 articles and the highest h-index value, which covers the applications of educational technology and different types of LLS. The other prolific journals including *Computer Assisted Language Learning* (68 articles), *Language Learning* (43 articles), *Modern Language Journal* (39 articles), and *ELT Journal* (40 articles) also boasted a high value of h-index, which indicated that the aforementioned journals were the kernel academic journals in the LLS field. The result displayed that the above journals not only concerned computer-assisted language learning and teaching methods but also embraced the journals concerning bilingual and multilingual learning techniques. In closing, it is worth noting that LLS is a very important issue in applied linguistics.

Table 2. Most influential Journals

| Journal | h_index | g_index | m_index | TC | NP | PY_start |
|---|---------|---------|---------|------|-----|----------|
| System | 44 | 74 | 1.294 | 6840 | 185 | 1990 |
| Computer Assisted Language Learning | 27 | 45 | 0.931 | 2210 | 68 | 1995 |
| Language Learning | 26 | 43 | 0.765 | 3274 | 43 | 1990 |
| Modern Language Journal | 25 | 39 | 0.893 | 4047 | 39 | 1996 |
| ELT Journal | 22 | 34 | 0.688 | 1213 | 40 | 1992 |
| Language and Education | 19 | 31 | 0.613 | 1063 | 45 | 1993 |
| Language Learning and Technology | 19 | 23 | 0.792 | 1435 | 23 | 2000 |
| Language Teaching Research | 19 | 31 | 1 | 1002 | 50 | 2005 |
| TESOL Quarterly | 19 | 24 | 0.559 | 2125 | 24 | 1990 |
| RELC Journal | 18 | 32 | 0.545 | 1100 | 50 | 1991 |
| Applied Linguistics | 16 | 17 | 0.516 | 1547 | 17 | 1993 |
| English for Specific Purposes | 16 | 25 | 0.485 | 866 | 25 | 1991 |
| Language, Culture and Curriculum | 15 | 31 | 0.517 | 1036 | 31 | 1995 |
| International Journal of Bilingual Education and Bilingualism | 14 | 25 | 0.737 | 691 | 35 | 2005 |
| ReCALL | 14 | 27 | 0.412 | 829 | 46 | 1990 |
| Innovation in Language Learning and Teaching | 13 | 20 | 0.929 | 430 | 27 | 2010 |
| International Journal of Multilingualism | 12 | 22 | 0.667 | 556 | 22 | 2006 |
| Linguistics and Education | 11 | 15 | 0.458 | 252 | 20 | 2000 |
| Studies in Second Language Acquisition | 11 | 13 | 0.333 | 989 | 13 | 1991 |
| Studies in Second Language Learning and Teaching | 10 | 14 | 1.667 | 233 | 20 | 2018 |

3.3 Most Influential Countries and Institutions

The geographic distribution of 927 LLS publications is shown in Figure 3. The area in dark blue presented that more publications have been published in these countries compared with other areas. On the whole, studies in LLS were conducted in 25 countries, but the majority gathered in the USA, the UK, China, Canada, Australia, Spain and Singapore. These countries boasted a large number of publications with copious citations. In terms of the collaboration among countries, it was reflected in the frequency on the map, which was highlighted with red lines. The most frequent collaborative countries included the USA, China, the UK, Australia and Korea.

Afterward, the number of published articles, indexes of betweenness, closeness and PageRank were identified to figure out the most influential institutions, which were shown in Table 3. The most prolific institutions were the University of Hong Kong, the Chinese University of Hong Kong and University of Oxford, which boasted a large number of articles and a high value on PageRank. The following influential institutions included University of Macau, Nanyang Technological University, National Taiwan Normal University, Zhejiang University, University of London, University of Reading, University of Amsterdam and University of Ottawa, whose publications were at least 10 articles.

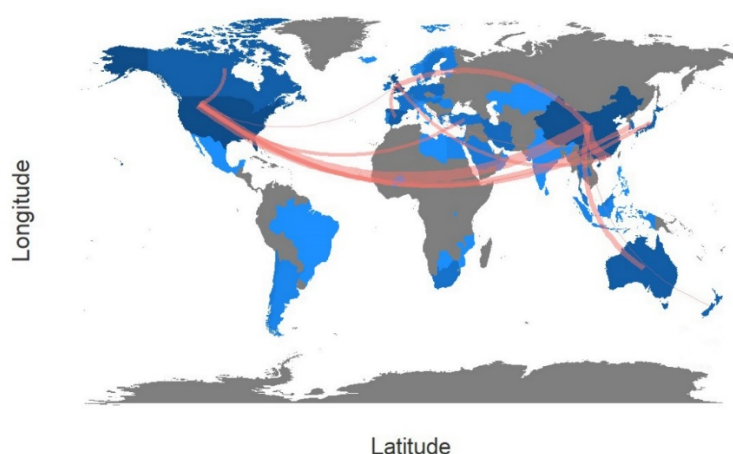


Figure 3. Geographical distribution of LLS publications and collaboration among countries

Table 3. Most influential institutions

| University | Articles | Betweenness | Closeness | PageRank |
|-------------------------------------|----------|-------------|-----------|----------|
| The University of Hong Kong | 19 | 55 | 0.0227 | 0.0617 |
| The Chinese University of Hong Kong | 17 | 74 | 0.024 | 0.0672 |
| University of Oxford | 17 | 0 | 1 | 0.0370 |
| University of Macau | 15 | 86 | 0.0263 | 0.0704 |
| Nanyang Technological University | 15 | 16 | 0.0143 | 0.0398 |
| National Taiwan Normal University | 14 | 31 | 0.0159 | 0.0604 |
| Zhejiang University | 12 | 16 | 0.0182 | 0.0437 |
| University of London | 11 | 0 | 0.5000 | 0.0370 |
| University of Reading | 11 | 0 | 1 | 0.0370 |
| University of Amsterdam | 11 | 0 | 1 | 0.0370 |
| University of Ottawa | 10 | 0 | 0.0116 | 0.0617 |

3.4 Most Influential References

Table 4 shows that the most cited reference was *Learning Strategies in Second Language Acquisition*, which examined the different types of strategies used by learners, the effectiveness of these strategies, and the factors that influence their use. This book laid the foundation for the LLS field and was cited by the majority of LLS studies, such as studies on skill-based learning strategies or research on strategies used in different classroom contexts. Besides, other highly cited references included *The Study of Second Language Acquisition* (17 citations), *Language Learning Strategy Instruction: Current Issues and Research* (15 citations), *Language Learning Strategies: What Every Teacher Should Know* (15 citations) and the rest of the references also boasted at least 10 citations. Taken together, these influential references not only covered the theoretical framework and the strategy model of LLS but also provided some empirical studies related to LLS.

Table 4. Most influential references

| Authors | Cited References | Citations |
|--|---|-----------|
| O'Malley, J.M., Chamot, A.U., (1990) | <i>Learning Strategies in Second Language Acquisition</i> | 28 |
| Ellis, R., (1994) | <i>The Study of Second Language Acquisition</i> | 17 |
| Chamot, A.U.,(2005) | <i>Language Learning Strategy Instruction: Current Issues and Research</i> | 15 |
| Oxford, R.L., (1990) | <i>Language Learning Strategies: What Every Teacher Should Know</i> | 15 |
| Griffiths, C., Oxford, R.L., (2014) | <i>The Twenty-First Century Landscape of Language Learning Strategies: Introduction to This Special Issue</i> | 14 |
| Nation, I.S.P., (2001) | <i>Learning Vocabulary in Another Language</i> | 14 |
| Vandergrift, L., (2003) | <i>Orchestrating Strategy Use: Toward A Model of The Skilled Second Language Listener</i> | 13 |
| Dörnyei, Z., (2005) | <i>The Psychology of The Language Learner: Individual Differences</i> | 12 |
| Ellis, R., (2003) | <i>Task-Based Language Learning and Teaching</i> | 12 |
| Macaro, E., (2006) | <i>Strategies For Language Learning and for Language Use: Revising the Theoretical Framework</i> | 12 |
| Rubin, J., (1975) | <i>What The "Good Language Learner" Can Teach Us</i> | 12 |
| Skehan, P., (1998) | <i>A Cognitive Approach to Language Learning</i> | 11 |
| Cohen, A.D., (1998) | <i>Strategies In Learning and Using A Second Language</i> | 10 |
| Griffiths, C., (2003) | <i>Patterns Of Language Learning Strategy Use</i> | 10 |

3.5 Most Cited Authors

The authors shown in Table 5 were the most influential in the LLS field. In terms of the value of h-index, all the selected authors enjoyed values of 4 h-index. Among a total of 19 authors, Oxford ranked first with the largest h-index, citations and publications, which indicated that Oxford was one of the major contributors to the LLS field. Moreover, it was noted that the majority of the above authors took great interest in LLS since the late 1990s and had very fruitful productions, such as Griffiths (8 articles), Cohen (6 articles), Felix (5 articles) and Gao (6 articles). Moreover, some scholars were newly emerging in the LLS field but they also made great contributions and exerted great influence on later studies, such as Pawlak (128 citations), Teng (249 citations), Bai (96 citations) and Guo (57 citations). Although in recent years, merely several articles were published by these new scholars, they have already gained many citations, which indicated that these emerging scholars were also great contributors to LLS and their articles were impactful to provide insights into the LLS field.

Table 5. Most cited authors

| Authors | h_index | g_index | m_index | TC | NP | PY_start |
|--------------|---------|---------|---------|------|----|----------|
| Oxford R | 13 | 15 | 0.433 | 1301 | 15 | 1994 |
| Griffiths C | 8 | 8 | 0.348 | 436 | 8 | 2001 |
| Pawlak M | 7 | 9 | 0.875 | 128 | 9 | 2016 |
| Gao X | 6 | 6 | 0.333 | 227 | 6 | 2006 |
| Rose H | 6 | 7 | 0.5 | 154 | 7 | 2012 |
| Zhang Lj | 6 | 7 | 0.286 | 396 | 7 | 2003 |
| Cohen Ad | 5 | 6 | 0.152 | 249 | 6 | 1991 |
| Felix U | 5 | 5 | 0.192 | 195 | 5 | 1998 |
| Teng Ls | 5 | 6 | 0.625 | 249 | 6 | 2016 |
| Yang Y-F | 5 | 5 | 0.417 | 66 | 5 | 2012 |
| Bai B | 4 | 8 | 0.8 | 96 | 8 | 2019 |
| Cenoz J | 4 | 5 | 0.182 | 252 | 5 | 2002 |
| Graham S | 4 | 5 | 0.25 | 294 | 5 | 2008 |
| Guo W | 4 | 4 | 0.8 | 57 | 4 | 2019 |
| Henry A | 4 | 4 | 0.174 | 221 | 4 | 2001 |
| Littlewood W | 4 | 4 | 0.143 | 206 | 4 | 1996 |
| Meskill C | 4 | 4 | 0.121 | 93 | 4 | 1991 |
| Sun Y-C | 4 | 4 | 0.235 | 297 | 4 | 2007 |
| Takeuchi O | 4 | 4 | 0.19 | 136 | 4 | 2003 |

3.6 Scientific Collaboration Among Countries and Institutions

The scientific collaborations among countries and institutions were respectively visualized in Figure 4 and Figure 5. The collaborative network among 50 countries was displayed in Figure 4, where we can intuitively find that the USA, the UK and China were the most collaborative countries collaborating with seventeen, seventeen and eleven countries respectively. In addition, the USA and China were the closest collaboratives which were followed by China and Australia, China and the UK, the USA and Korea, along with the USA and Canada.

Furthermore, the collaborative network among institutions is more complex with relatively strong cooperation among many institutions. The network can be roughly grouped into eight clusters represented by different colors. The Chinese University of Hong Kong, University of Macau, National Taiwan Normal University and Nanyang Technological University had the most collaborators, respectively connecting with four, four, three and two institutions. In addition, the closest collaborators were University of Reading and University of Oxford, which was followed by The Chinese University of Hong Kong and Zhejiang University.

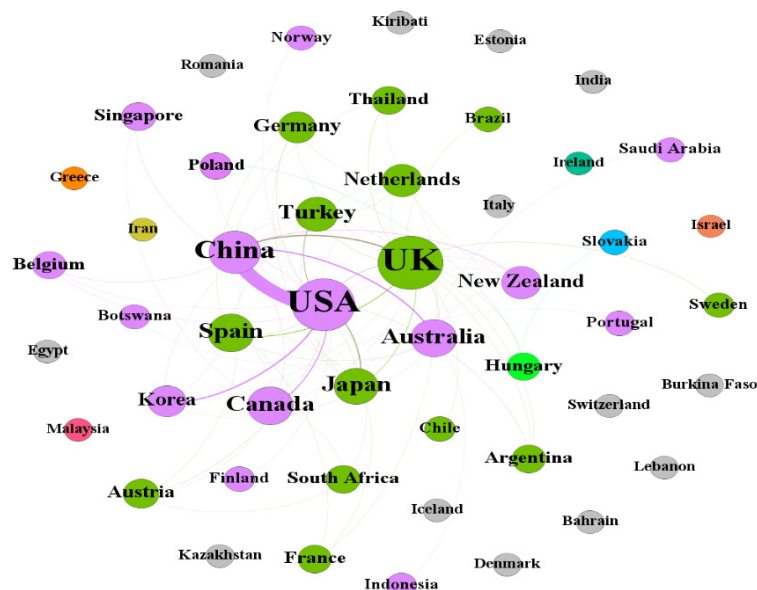


Figure 4. Collaboration network of countries

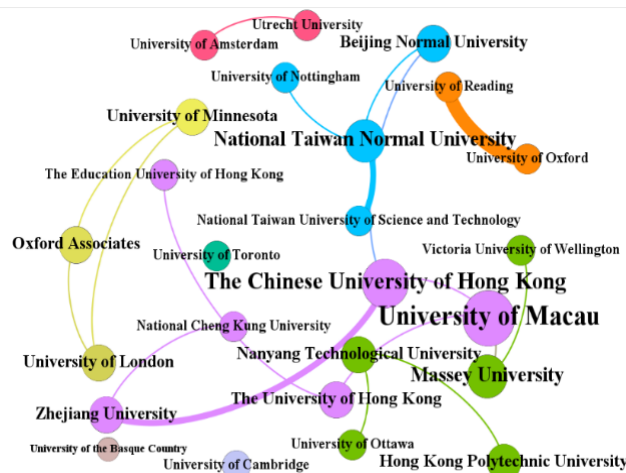


Figure 5. Collaboration network of institutions

3.7 Collaboration Among Authors

In terms of collaboration among authors, Figure 6 plots seven clusters in different colors, but the kernel collaborators are Oxford and Bai. Oxford connected seven collaborators and the closest was Griffith and Ehrman. Moreover, Bai, as the core collaborator, also kept a tight relationship with Guo and Wang. Aside from the above collaborators, Teng and Zhang were close cooperators, together with Pawlak and Csizér.

Concerning the representative works among these authors, The twenty-first century landscape of language learning strategies: Introduction to this special issue by Griffiths and Oxford (2014) summarized the state-of-the-art LLS issues from the perspective of theoretical and empirical studies. In addition, Bai, Guo and Wang highlighted the application of a self-regulated learning strategy. For instance, Bai et al. (2022) examined the relationships between EFL writers' motivation, self-regulated learning and writing competence. Guo et al. (2021) construed the influences of process-based instruction on the effectiveness of self-regulated learning strategy.

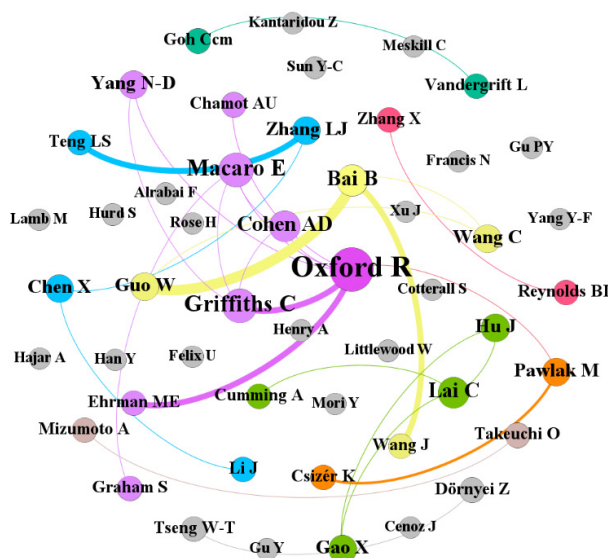


Figure 6. Collaboration network of authors

3.8 Topic Trends

The topic trend is a key factor to pinpoint the development trajectory of the CF field and can shed light on the future direction.

Semantic coherence and exclusivity are usually used to determine the number of topics. Semantic coherence is used to judge the quality of the topic evaluation in an objective way which can confirm whether the result is corresponding to a human's judgment (Lucas et al., 2015). The higher the semantic coherence is, the more relevant the topics are clustered (Zou et al., 2022). Exclusivity is used to indicate the relevancy of a particular topic. If the exclusivity is high, it reveals the terms are more relevant (Kuhn, 2018). Figure 7 presents the semantic coherence and exclusivity scores for 30 topics and the topic number ranges from 1 to 30. Each point indicates that a model is fitted with the number of topics.

Meanwhile, Figure 7 also demonstrates that topics 24 and 27 held a high value of semantic coherence, but the exclusivity value of topic 27 was rather low. To ensure the quality of the final topic number, we compared their results respectively and found 27 topics would mix different topics. In the meanwhile, besides the indexes of semantic coherence and exclusivity, we also considered whether all the terms can be clustered into a topic and whether all the important topics were included. Finally, we selected 24 topics as the final result.

Through the identification of keywords used in LLS and the frequency analysis of these keywords, 24 topics and their corresponding proportions are shown in Appendix A. The most frequently discussed topics included autonomy in LLS (7.1%), motivation in LLS (6.8%), emotions in LLS (5.9%), multilingualism in LLS (5.2%), writing strategy (5.1%) and TBLT for LLS (5%). On the contrary, test-taking strategy (2.3%), language transfer in LLS (2.8%) and processing of LLS (2.9%) accounted for the least proportions.

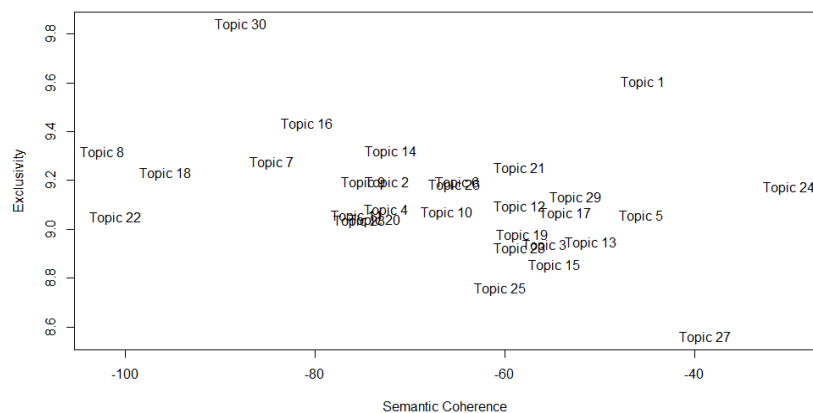


Figure 7. Identification of topic numbers

The evolutions of the 24 topics are shown in Appendix B, which displays that six topics received markedly increasing attention from scholars, including topic 1 self-regulated LLS, topic 3 multilingualism in LLS, topic 7 TBLT for LLS, topic 14 listening strategy, topic 21 motivation in LLS and topic 22 bilingualism in LLS. On the contrary, four topics presented a significantly decreasing tendency, including topic 2 cultural difference in LLS, topic 4 self-assessment in LLS, topic 13 effect of native language and topic 20 computer-assisted LLS. The rest of the topics wholly exhibited some fluctuations, such as topic 5 Chinese learners' LLS, topic 15 beliefs in LLS, topic 16 word-related learning strategy and topic 24 emotions in LLS.

4. Discussion

4.1 Discussion on Performance Analysis

Based on the 927 studies retrieved from Scopus, this study provided an overview of LLS by using bibliometric analysis and STM. The first question of this study examined the annual scientific production of LLS. The result glaringly indicated that LLS research is a promising field, which has been receiving much attention from scholars in applied linguistics. The finding echoes the result of Zhang et al. (2019) that claimed LLS is a potential area with high popularity and that there still exists a rich history of scholarly work to do.

The second question explored which journals, countries, institutions, references and authors were the most influential in the LLS field. One interesting finding was that aside from some traditional journals of second language acquisition, second language learning and teaching, the LLS issues were greatly welcomed by interdisciplinary sources combined with educational technology applications like Computer Assisted Language Learning, Language Learning and Technology. The scopes of these journals are to solve language learning and teaching problems through technology-assisted methods. Therefore, it may infer that LLS needs to keep abreast of technology development in the future.

Regarding the most influential references, Learning Strategies in Second Language Acquisition ranked first place. This book covered the definition and classification of LLS, explored the relationship between learning strategies and language learning achievement, and provided numerous case studies to present learners' use of LLS in different contexts. One possible explanation for its great influence might be due to the comprehensive content of this foundational book, which covers both the theoretical frameworks of LLS and the practical studies in different contexts. Moreover, this book was published in the initial stage of the LLS field, and it was since that period that LLS has been obtaining more and more attention. Therefore, the book was cited by most of the later studies.

Concerning the most impactful author, Oxford ranked first place. She has already received 1301 citations and made great contributions to the development of the LLS field. One plausible explanation for the result might be due to her prolific and important theoretical and practical studies in LLS. For instance, Oxford (1994) introduced the concept and classification of LLS, which provided a theoretical foundation for subsequent research in learning strategies, learning styles, and learning contexts. Meanwhile, her research has helped to deepen our understanding of the role of learners' autonomy and motivation in language learning (see Oxford & Nyikos, 1989; Oxford, 2003). Oxford (1990) also highlighted the influence of cultural and individual differences on the effectiveness of LLS. In addition, Oxford (2017) has played a key role in promoting the integration of LLS instruction into language curricula and she has developed materials and training programs to help teachers incorporate LLS into teaching practices. All of these influential LLS-related studies made her the most impactful researcher in the LLS field.

4.2 Discussion on Science Mapping

One initial objective of the research is to figure out the collaborations among countries, institutions and authors. In terms of collaborations among countries, the finding revealed that the majority of the LLS research was accumulated in English-speaking countries, such as the USA, the UK, Canada and New Zealand. Some possible explanations for this result are as follows. Firstly, most LLS-related theories were put forward by American scholars, such as Metacognitive Theory (Flavell, 1979), and Self-Regulated Learning Theory (Zimmerman, 1986). In addition, English as a global lingua franca is studied by massive users with mature education pedagogy (Seidlhofer, 2004), which provides a basis for LLS studies in those countries. Considering LLS research regions, it can be assumed that more LLS studies should also cover other non-English-speaking countries and regions to generalize the effect of LLS in the future.

Regarding institution collaborations, the representative collaborators include The Chinese University of Hong Kong, University of Macau and Zhejiang University, National Taiwan Normal University and Beijing Normal University, University of Oxford and University of Reading. This phenomenon might be due to the fact that LLS

is an interdisciplinary field concerning linguistics, education and psychology, which needs some support from the technical university and those normal universities with excellent psychology teams. Furthermore, we can also predict that the institutive collaboration is inclined to consider factors of the research scope and the geographical location of a university.

4.3 Discussion on Results of Structural Topic Modeling

Based on the topic relevancy, the 24 topics were classified into five clusters, which concern language-skill-related LLS, subjects of LLS, multilingual issues in LLS, factors influencing LLS and different types of LLS.

4.3.1 Language-skill-related LLS

For language-skill-related LLS, it covers listening strategy, reading strategy, vocabulary learning strategy, writing strategy, test-taking strategy and word-related learning strategy. From the dimension of the classroom context, our finding is consistent with the finding of Chamot (2005) that also summarized the importance of adopting different strategies to cope with listening, reading, vocabulary and writing skills. For listening comprehension strategy, plenty of empirical studies (e.g. Carrier, 2003; Vandergrift, 2003) have been conducted to examine that students tend to single out different strategies to cope with different tasks. Reading strategies concerned a set of explicitly instructed strategies used in class, including making inferences, using selective attention and summarizing. When coping with writing tasks, students preferred to take metacognitive strategies and the quality of their essays was related to their translation ability (Cohen & Brooks-Carson, 2001). Previous research examined that deep processing strategies used in reciting vocabulary were more effective than rote repetition strategies (e.g. Cohen & Apeh, 1981; Schmitt, 2000). In addition, mastering knowledge of high-frequency words was helpful to do reading comprehension and the strategy of word-meaning inference can improve learners' comprehension ability (Hamada, 2009). Test-taking strategies mean the specific methods used to tackle various examinations, including College English Test Band Four and Band Six and so on. Research showed that adopting effective test-taking strategies had a positive effect on students' test performance (Amer, 1993), and meanwhile, students preferred to employ meta-cognitive strategies (Song & Cheng, 2006).

On the whole, substantial learning strategies have been explored to assist classroom teaching and learning. However, combined with previous research, some moderators, like the learner's language proficiency, task difficulty and the learner's metacognitive level, should be taken into consideration before employing these strategies.

4.3.2 Subjects of LLS

For subjects of LLS, they include Chinese learners' LLS, pupils' LLS and children's LLS. From the dimension of cultural and educational perspectives, Rao (2006) explored that Chinese learners chose LLS with consideration of their cultural beliefs and values, traditional Chinese education pattern and English as a Foreign Language (EFL) setting. In addition, the sociocultural theory was favored by scholars to investigate Chinese learners' learning experience and LLS in a specific context (e.g. Gao, 2006; Gao, 2007).

Regarding research on pupils and children, their topic proportions enjoy the same percentage of 4%. Previous studies mainly focused on LLS context (e.g. Le Pichon et al., 2010), LLS applications in immersion classrooms (Uhl Chamot & El-Dinary, 1999) as well as Content and Language Integrated Learning (CLIL) and EFL settings (García et al., 2015). What's more, Purdie and Oliver (1999) investigated whether bilingual children with regional or cultural backgrounds would influence their LLS choice. Judging from the topic trend, the research on pupils and children arrived at a minor fluctuation, but it generally remained stable. Till now, there was a paucity of studies concerning the factors of age, proficiency and gender. Hence, the studies related to the aforementioned factors might be predicted as future directions.

4.3.3 Multilingual Issues in LLS

For the multilingual issues in LLS, they involve bilingualism in LLS, multilingualism in LLS and translanguaging in LLS. Previous research, like Nayak et al. (1990) demonstrated that learners with bilingual or multilingual language backgrounds would take different language learning strategies. They can perform better than monolingual learners, particularly in syntactic processing (Parmegiani, 2022). Meanwhile, the result also concerned different ages and gender. For instance, adults' perception of multilingualism (Dmitrenko, 2017), children's immigrant background to benefit vocabulary learning (Illman & Pietilä, 2018) and gender differences in the frequency of adopting language strategies (Mitits & Gavriilidou, 2016) were presented. Therefore, when conducting the LLS research on multilingual issues, we should also consider these moderators, namely, age and gender. With regard to translanguaging in LLS, it can be used as a medium in a classroom context to help both

teachers and students improve targeted language teaching and learning (Perfecto, 2022). Moreover, translanguaging strategies can also navigate foreign language learning anxiety and can act as scaffolds for emergent multilingual learners' emotional well-being (Back et al., 2020).

Viewing from topic proportions and topic trends, all these issues took relatively large accounts and they overall displayed an increasing tendency. It can be predicted that more research is worthwhile in probing the plurilingual issues in the LLS field.

In closing, it can be concluded that bilingual or multilingual cultural or knowledge background exerts a positive influence on language learners' study process, and translanguaging techniques are often employed to negotiate different learning strategies directly or indirectly.

4.3.4 Factors Influencing LLS

For factors influencing LLS, they include cultural differences in LLS, self-assessment in LLS, TBLT for LLS, processing of LLS, autonomy in LLS, the effect of native language, beliefs in LLS, language transfer in LLS, motivation in LLS and emotions in LLS. Furthermore, they can be roughly classified into external and internal factors. External factors include cultural differences, the effect of native language, and TBLT teaching methodology, while internal factors consist of learners' self-assessment, autonomy, language transfer ability and language processing ability, along with their beliefs, motivations and emotions in LLS. These factors are not separated or independent to impact the effect of LLS, which means external and internal factors would combine and pose effects on LLS simultaneously. For instance, both cultural differences and learners' emotions would cause Korean families to negotiate their strategies of linguistic investment and especially altering multilingual learning strategies (Bae, 2013). In addition, cultural background and multilingual capacity, a kind of language processing ability can be important factors to influence learners' choices of learning strategy (Grainger, 2012). Cultural differences can also influence learners' autonomy and urge teachers to alter techniques (Lamb & Wedell, 2014).

In terms of the effect of native language, Hayakawa et al. (2021) investigated that the similarity between a foreign language and a native language can influence the ease of language acquisition and the process would also be influenced by cognitive strategies and affective states. Besides the effect of native language, the role of transfer is essential to learners' language processing (Heilenman & McDonald, 1993). As to the topic trend, it shows a decreasing tendency. One alternative explanation might be that the effect of the native language is dynamic and would be influenced by individual differences (Rubin, 1975), such as learners' language aptitude and proficiency. In the future, the research on this topic should further consider learners' internal factors, like learners' beliefs, motivations and emotional factors.

In terms of TBLT teaching methodology, an important educational framework for teaching second and foreign languages, has been broadly and effectively used in class. Previous studies have found that the TBLT method can be adopted in class to develop students' metacognitive strategies for listening comprehension Chou (2017), to improve reading strategies (Carrell & Carson, 1997), as well as writing strategies (Byrnes & Manchón, 2014). As to its topic proportion and topic trend, it indicates that the TBLT approach has garnered much attention in the LLS field and it has become very popular since 2010. In the future, when conducting the TBLT approach, different contexts, such as multilingual class context and different learners' language proficiency should be taken into consideration.

Overall, it is indicated that language learning is a dynamic and interactive process, which might be influenced by many factors. Moreover, the aforementioned external and internal factors are interconnected and critical to influence the development of LLS, especially learners' autonomy, motivation and emotions in LLS that take large proportions. Therefore, in the future LLS researchers and language educators should be fully aware of these factors and take advantage of these factors to facilitate LLS development.

4.3.5 Different Types of LLS

For different types of LLS, they comprise self-regulated LLS and computer-assisted LLS. As pointed out by Oxford (2017), self-regulated LLS was pivotal for language acquisition. Its effect was influenced by learners' motivation and there existed glaring variation between low and high achievers (Guo & Bai, 2022). Meanwhile, self-regulated strategies were usually taken in writing tasks to track their relationships with learners' writing performance and writing proficiency, see (Shen & Bai, 2022; Sun & Wang, 2020). Computer-assisted LLS focused on computer-related devices to guide language teaching and learning (Levy, 1997), which has experienced a long history since the 1960s (Warschauer & Healey, 1998). Moreover, most previous studies on computer-assisted LLS were related to listening comprehension (Hoeflaak, 2004), vocabulary learning (Zhang et

al., 2022), as well as language assessment for improving language-testing strategies (Myers, 2002). It can be predicted that the wide usage of computer-assisted strategies has been proliferating and garnered much attention. Furthermore, sometimes the above two types of LLS can be achieved and employed simultaneously, that is, self-regulated LLS can be conducted under a computer-assisted context, such as a web-based environment (Chang, 2005) to achieve a better effect.

In terms of topic proportions and topic trends, self-regulated LLS (4.5%) has maintained a glaringly increasing tendency since 2010, which indicates self-regulated LLS is an extremely essential issue in the LLS field. Computer-assisted LLS (4.1%) prevailed in the initial stage of the 2000s but dropped after 2010. One possible reason might be that research on computer-assisted technology used in language learning sprung up in the late 1990s and the early 2000s, like increasing students' motivation and writing skills (Warschauer & Healey, 1998). However, due to the new demands in language education, some thorny issues of computer-assisted LLS were also found, such as grammar instruction issues and acceptance of online learning (Garrett, 2009). Therefore, in the future, researchers should garner more attention on how to maximize the effectiveness and minimize the drawbacks of computer-assisted LLS. In addition, this classification of LLS is from a general way. To be more specific, the classic six types of LLS also include Oxford's Strategy Inventory for Language Learning (SILL) to guide teachers' adoption of different strategies (Oxford, 1990). The six strategies that Oxford made in her SILL inventory include memory, cognitive, metacognitive, social, compensation and affective strategies. In the future, more studies can also focus on the specific usage and the assessment of these LLS.

To summarize, LLS is a complex and dynamic concept, which is closely associated with individual cognitive and affective factors (Milla & Gutierrez-Mangado, 2019). For instance, such factors as learners' motivation, beliefs, learning styles, previous language experience, and age will make an impact on the alteration of LLS. What's more, contextual factors like cultural differences, and learning environment can also become moderators to influence LLS. In the future, studies on the relationship between LLS and learners' learning styles should give due attention to these mediators.

5. Conclusion

LLS, as an important issue in applied linguistics, has been receiving great attention since 1990 and different learning strategies have been employed by language learners. To detect the annual development, the latent research topics and topic trends in LLS, this study conducted 927 publications over the last 23 years using bibliometric analysis and STM. The contributions and implications of this study lie in offering new lenses (e.g. multilingualism background as an important factor to the effect of LLS) for the advancement of the LLS field and providing a trajectory development of LLS for researchers in applied linguistics and language educators, which helps them to better understand future research hotspots. Meanwhile, the study can help researchers recognize crucial knowledge gaps to situate future research directions in LLS. Moreover, figuring out what has been done in this field over the past decades can also cast light on the definition of LLS. That is, based on this study, LLS refers to language learners' series of intentional and unintentional actions to develop their language proficiency, which will be influenced by learners' subjective and objective factors, such as learning motivation, perception, emotion, as well as multilingual background. Pedagogically speaking, the current study can guide language educators to make reasonable decisions when employing different learning strategies to guide students, in that the study can inspire teachers to duly realize the importance of such factors as learners' multilingual cultural background, learners' autonomy, language proficiency, language transfer abilities, learners' perception of LLS, and so on.

6. Limitation

There is not without limitation in this study. To begin with, the time span of the data is from 1990 to 2022 and the latest publications in 2023 were excluded. The reason is that the data of publications in 2023 is intact and the number might be unlikely to influence the final result. In addition, we only used the term *learning strategy* as the keywords in the process of data retrieval, which might lead to a narrow retrieval scope. In the future, some similar concepts like learning technique, learning method, learning approach, learning tactic and learning device can also be considered.

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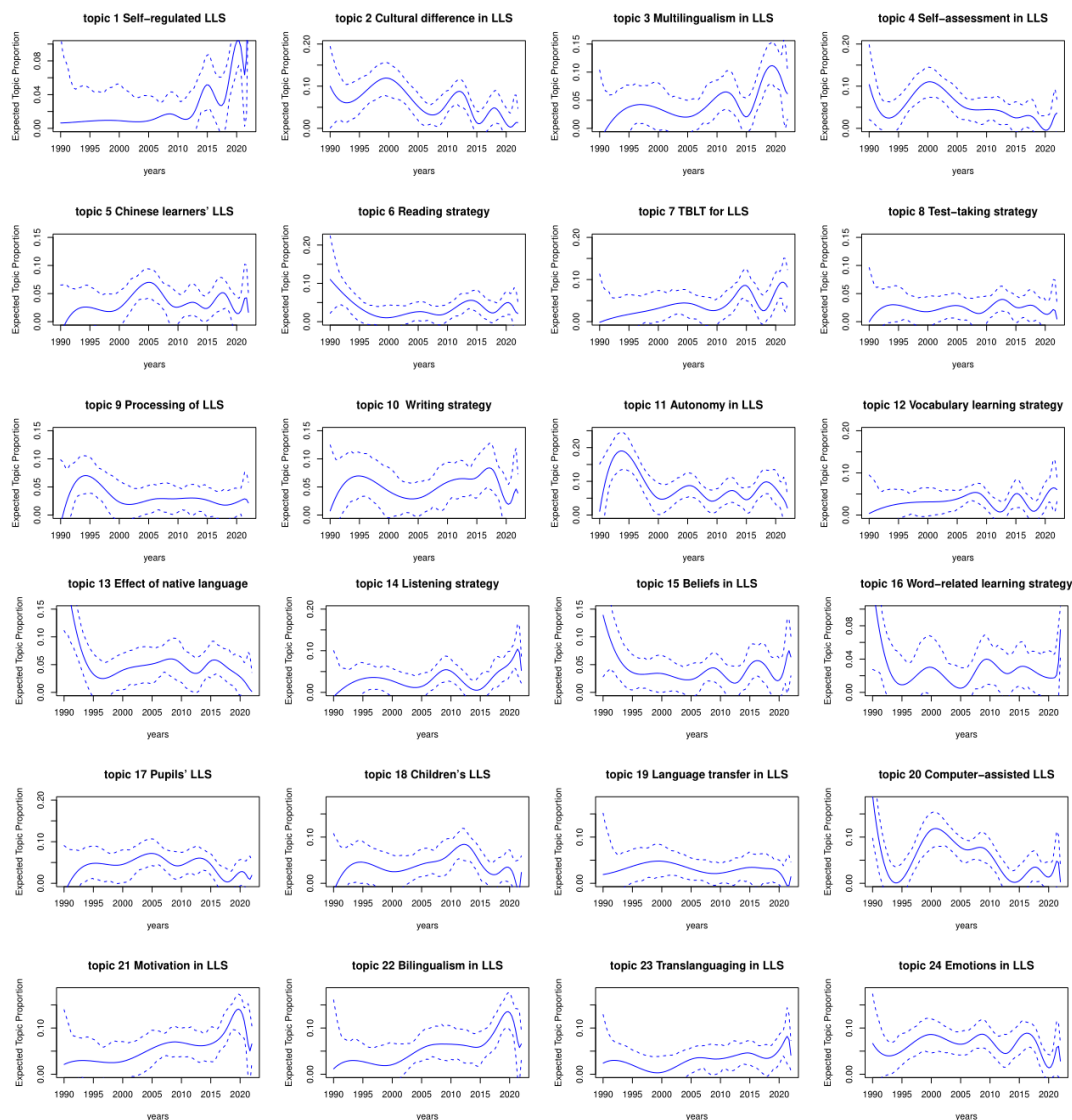
Appendix A

Identification of Latent Topics and Topic Proportions

| Topic No. | 1 | 2 | 3 | 4 | 5 | 6 |
|----------------------|----------------------------------|-----------------------------------|-------------------------------|---------------------------------------|-------------------------------|-------------------------------------|
| Topic and proportion | Self-regulated LLS (4.5%) | Cultural difference in LLS (4.7%) | Multilingualism in LLS (5.2%) | Self-assessment in LLS (4%) | Chinese learners' LLS (3.3%) | Reading strategy (3.4%) |
| Topic No. | 7 | 8 | 9 | 10 | 11 | 12 |
| Topic and proportion | TBLT for LLS (5%) | Test-taking strategy (2.3%) | Processing of LLS (2.9%) | Writing strategy (5.1%) | Autonomy in LLS (7.1%) | Vocabulary learning strategy (3.6%) |
| Topic No. | 13 | 14 | 15 | 16 | 17 | 18 |
| Topic and proportion | Effect of native language (4.2%) | Listening strategy (3.7%) | Beliefs in LLS (3.9%) | Word-related learning strategy (2.8%) | Pupils' LLS (4%) | Children's LLS (4%) |
| Topic No. | 19 | 20 | 21 | 22 | 23 | 24 |
| Topic and proportion | Language transfer in LLS (2.8%) | Computer-assisted LLS (4.1%) | Motivation in LLS (6.8%) | Bilingualism in LLS (3%) | Translanguaging in LLS (3.8%) | Emotions in LLS (5.9%) |

Appendix B

Topic Trends



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