

Exploring the Effectiveness of Web-Based Concept and Mind Mapping Tools for Enhancing Teaching and Learning ESP

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Abstract: *This study is a descriptive literature review which consolidates findings on the effective use of Web-based concept and mind mapping tools in the realm of teaching and learning ESP at the higher education level. It encompasses related empirical research, published in international scholarly journals and conference proceedings within the period spanning from 2019 to 2024, considering the challenges brought by the COVID-19 pandemic. Concept and mind maps, whether created traditionally with paper and pencil or through Web-based applications, are widely recognized as powerful tools for organizing information logically. Although concept and mind maps follow separate conceptual approaches, many researchers commonly refer to the software related to them simply as mind mapping software. In the seminal Typology of Free Web-based Learning Technologies (Bower and Torrington 2020), both concept and mind mapping tools are categorized as mind mapping tools. These are described as educational resources that support the creation of visual representations of interconnected concepts, forming a visual knowledge network that can be easily shared via URL. Web-based concept and mind mapping techniques prove effective for expanding ESP students' vocabulary by creating a structured knowledge framework that links ESP terms with related words and concepts. They are also helpful in enhancing ESP learners' and writing reading skills, as they help them visualize text, extract key details from ESP materials, identify connections between information, and discern sequences and cause-and-effect relationships. Moreover, they may contribute to boosting ESP learners' motivation.*

Keywords: *English for Specific Purposes; Web-based learning technologies; concept mapping technologies; mind mapping technologies, higher education; descriptive literature review;*

Understanding the Distinction Between Concept Maps and Mind Maps

In recent years (especially in the wake of the COVID-19 pandemic), the field of English for Specific Purposes (henceforth, ESP) in higher education has witnessed a growing interest in innovative educational resources that can enhance the teaching and learning experience. Among these resources, Web-based concept and mind mapping tools have emerged as valuable instruments for transforming the way ESP is taught and learned. Concept and mind maps, whether created traditionally with paper and pencil or through Web-based platforms, are widely recognized as powerful communication tools for

visualizing and organizing information logically. These types of maps, also known as *thinking maps*, *knowledge maps*, *visualization maps*, *semantic maps* or *cognitive maps*, are often considered to be interchangeable terms denoting the same fundamental concept. However, while they share common features, variations exist in their structures, theoretical background and applications, which may require further exploration.

The notion of **concept mapping** originated in the 1970s as part of a research project conducted by American educator and scientist Joseph Novak and his team on human learning and knowledge development. Novak suggested that *concepts* constitute the fundamental elements of our knowledge, while the *propositions* represent the relations between these concepts. Therefore, a *concept map* may be defined as

<...> a graphical two-dimensional display of concepts (usually represented within boxes or circles), connected by directed arcs encoding brief relationships (linking phrases) between pairs of concepts forming propositions. (Cañas et al. 2)

The simplest concept map, according to Cañas et al. (2004) typically comprises two nodes linked by an arc, depicting some simple and straightforward statement, for example, “*grass is green*”; yet they can also become significantly more complex. The Novakian concept maps are associated with David Ausubel’s ideas of cognitive psychology and *Assimilation Theory*, which posits that people learn when they assimilate new concepts and new propositions into their existing frameworks of understanding. This knowledge structure, unique to each learner, is also known as their cognitive structure (Novak, Cañas 2006). In other words, this theory emphasizes *meaningful learning* over rote memorization, where learners associate new, symbolically expressed ideas and information with existing knowledge in a nonverbatim manner. In this framework, knowledge is organized in a hierarchical manner and resembles a pyramid, with broad, general ideas situated at its top, gradually becoming more specific toward its base. Similarly, as explained by Novak and Cañas (2006), the concepts in a concept map are organized hierarchically, with the broadest and most general concepts positioned at the top, and the more detailed and more specific concepts arranged beneath them.

The term **mind mapping**, which also emerged in the 1970s, was introduced and popularized by English author and educational consultant Tony Buzan. Buzan tried to understand the design, architecture and function of the human brain (or *amazing brain*, in his words), as well as the reasons behind challenges experienced by a lot of people in such areas as cognition, memory, focus, motivation, structuring of ideas, decision-making or planning. He

came up with a theory of *Radiant Thinking*, which suggests that each bit of information entering the human brain,

<...> every sensation, memory or thought (incorporating every word, number, code, food, fragrance, line, colour, image, beat, note and texture) can be represented as a central sphere from which radiate tens, hundreds, thousands, millions of hooks. (Buzan, Buzan 53)

Each hook, further explained by the author, symbolizes an association, with each association having countless links and connections. The number of associations used by an individual could be compared to their memory, their database or library, functioning similarly to the most advanced computer in the world. This gives rise to the concept of *radiant thinking*. A *mind map*, as a manifestation of radiant thinking, is defined as a diagram used to visually represent words, ideas, images, or other elements linked to and structured around a central keyword or concept. To be more exact,

<...> a mind map always radiates from a central image. Every word and image becomes in itself a subcentre of association, the whole proceeding in a potentially infinite chain of branching patterns away from or towards the common centre. (Buzan, Buzan 57)

As we can see, concept maps and mind maps slightly differ in their structures, underlying principles and theoretical backgrounds; however, they both share similarities in their recognition as powerful tools for visualizing information and enhancing understanding. Therefore, researchers unanimously highlight the utility of concept and mind mapping techniques for teaching and learning in all education domains and levels. These techniques are versatile in various activities such as idea generation and organization, note-taking, summarizing, memorizing, understanding complex matters or even preparing to write a paper (Kruse et al. 2023; Bower and Torrington 2020; Bhattacharya and Mohalik 2020; Novak and Cañas 2006).

Navigating Concept Mapping and Mind Mapping Software

Concept and mind maps can be created by hand, however in this digital age, numerous software options are available for users. It is important to note that although concept mapping and mind mapping should be treated as distinct concepts (as was discussed in the previous section), many researchers commonly refer to the software related to them under the umbrella term *mind mapping* software. To illustrate, in the seminal Typology of Free Web-based Learning Technologies (Bower and Torrington 2020), both concept and mind mapping technologies are attributed to the category of *mind mapping tools*,

which are defined as Web-based technologies that “support the development of images to represent interrelated concepts in the form of a visual knowledge network that can be shared via URL” (Bower, Torrington 5). A comprehensive list of such tools, alphabetically arranged by the author of this present literature review and based on the aforementioned typology created by Bower and Torrington (2020), as well as the references provided by Mihaylova (2023), Bhattacharya and Mohalik (2020), and Bystrova and Larionova (2015), includes more than 40 examples labeled as mind mapping software:

Ayoo, Bubbl.us, Cacao, Coggle, Comapping, ConceptDraw, Creately, Dabbleboard, DebateGraph, Docear, DrakonHub, Edraw, FreeMind, Freeplane, GitMind, Invision, Lucidchart, MAPMyself, MindGenius, Mindomo, Mindly, MindManager, MindMapper, MindMeister, MindMup, MindNode, Mind42, Miro, Mural, Novamind, Padlet, Popplet, SimpleMind, Slatebox, SmartDraw, SpiderScribe, TheBrain, Vennage, Visio, WiseMapping, Xmind.

It is important to acknowledge here, that this list is not definitive and remains subject to debate, as the characteristics of these enumerated tools in some cases seem to overlap with those of other knowledge visualization tools. For example, according to Bower and Torrington’s Typology of Free Web-based Learning Technologies (2020), *Cacao, Creately* and *Lucidchart* should be categorized as diagramming tools, rather than mind mapping tools, despite falling under the same broader category of Image-Based Tools. *Padlet*, on the other hand, should be classified as a digital pinboard within the category of Multimodal Production Tools.

Moreover, it would perhaps be fairer and more logical to refer to this list as encompassing *both* concept and mind mapping tools, supporting the researchers who challenge the idea of unified mind mapping software. Among such researchers are Kruse et al. (2023), who agree that while mind and concept maps share some fundamental ideas and can be created using the same application, they still represent two conceptually and technologically separate approaches. The main difference, according to the authors, is that concept maps form complex structures by connecting ideas with specific relationships, resulting in a network of interconnected concepts. Mind maps, on the other hand, organize elements hierarchically without specifying detailed relationships, focusing more on representing different levels of abstraction within sets and subsets. Among their list of 16 types of concept and mind mapping software, Kruse et al. (2023) highlight *CmapTools*, as the dominant concept mapping freeware. It is worth noting that this concept mapping tool does not seem to be appear in any typologies or similar lists for unknown reasons. However, it unquestionably deserves a place in all of them, including the previously mentioned compilation of more than forty concept

and mind mapping tools, especially given that *CmapTools* is an exceptionally versatile tool. As stated by Ng (2015),

In particular *CmapTools* is used in schools, universities, government organizations, corporations and small companies and other organizations both individually and in groups, for education, training, knowledge management, brainstorming and information organization. (Ng 115)

Alongside with *CmapTools* the list arranged by Kruse et al. (2023) includes previously mentioned *Coggle*, *Inspiration* and *Scapple*, which in the opinion of the authors, also fall under the category of concept mapping technologies. Moreover, they notice that certain tools such as *Cacoo*, *Ludichart*, *MindManager* or *yEd graph editor*, labeled as mind mapping (or even diagramming) tools by other authors, possess characteristics of both concept and mind mapping software. Additionally, *Freeplane* or *Bubbl.us* could be categorized as mind maps with limited cross-linking capabilities. The answer, why fewer applications for concept mapping are available could perhaps be found in their literature analysis, which suggests that concept maps may sometimes cause greater challenges for learners, “as they have relatively strict formal rules that have to be followed” (Kruse et al. 67). This is primarily due to the time-consuming nature of identifying concepts and relationships, potential inadequacy of a top-down structure for representing sequential content. Moreover, the learners might find it difficult to efficiently represent a great number of items within the traditional boxes-and-arrow format.

Still, both concept and mind mapping tools are being favored by ESP teachers and students, demonstrating their adaptability in this specialized domain of language teaching and learning. To illustrate, Orlova (2017), Abdul-Majeed Omar (2015), Balula et al. (2014), Dias (2011) have all reported on their effectiveness in enhancing ESP students’ reading skills. Juita and Putra (2018) examined their effectiveness in an ESP course focused on reading as well as vocabulary and grammar. Nazri et al. (2018) found them beneficial for improving ESP learners’ writing skills, while Rudzinska et al. (2015) observed their suitability for fostering ESP students’ creativity. The next section of this article will delve deeper into related literature, reviewing the practical applications and effectiveness of these tools within the period spanning from 2019 to 2024, considering the challenges brought by the COVID-19 pandemic. It is important to note that the conceptual framework proposed by Kruse et al. (2023), which distinguishes concept and mind maps as two separate approaches with their own unique characteristics and applications, will serve as the foundation for this exploration.

Exploring the Effectiveness of Concept and Mind Mapping Tools in the Field of ESP

Review articles, as suggested by Paré et al. (2015), provide readers with fresh insights into the research topic, help identify research gaps and highlight potential research directions across diverse fields like medicine, nursing, engineering or information systems. If conducted properly, they serve as powerful information sources for both researchers and practitioners providing them with existing evidence to guide their decision-making processes and professional practices.

In line with this perspective, this present descriptive literature review aims to consolidate findings on the effective use of Web-based concept and mind mapping tools in the field of teaching and learning English for Specific Purposes (ESP) at the higher education level. It encompasses related empirical research published in international scholarly journals and conference proceedings within the period spanning from 2019 to 2024. This period coincides with the beginning, progression (and hopefully, the end) of the COVID-19 pandemic, which resulted in the inevitable use of digital teaching and learning technologies, including Web-based concept and mind mapping tools. In accordance with the guidelines outlined by Whitehead and Maude (2016) for conducting literature searches and reviews, this current descriptive literature review followed an approach consisting of six steps: formulating a review question, conducting a thorough literature search, evaluating relevant studies for inclusion in the review, critically appraising the selected studies, summarizing the findings and finally, reporting on the results and suggesting directions for future research. The first step involved formulating the following three research questions to guide the whole review process:

- What Web-based concept and mind mapping tools have been employed in the field of teaching and learning ESP in formal higher education settings within 2019–2024?
- What language skills and other knowledge domains of ESP have been emphasized through the application of Web-based concept and mind mapping tools?
- What theoretical frameworks underpinned the previous research focusing on the use of Web-based concept and mind mapping tools?

To address these research questions, several criteria for inclusion and exclusion were established. First, to be considered for inclusion into this descriptive literature review, publications were required to exclusively target the field of English for Specific Purposes at formal higher education level to get insights into how Web-based concept and mind mapping tools are used in specialized language learning environments. Second, they had to be empirical research articles with experimental, correlational, qualitative or mixed-

method research designs. It was decided to include conference papers too, as they often provide unique perspectives or preliminary findings that may add to the insights gathered from research articles. Meta-analyses or systematic literature reviews, as well as papers targeting spheres other than ESP and education levels other than higher education, however, were excluded from the investigation. The publications relevant to the review were identified by searching several online data bases including *ERIC (via EBSCOhost)*, *Science Direct*, *Web of Science* as well as *Taylor & Francis Online* using key words *concept mapping tools*, *mind mapping tools*, *concept mapping software*, *mind mapping software*, *web-based concept mapping*, *Web-based mind mapping*, *digital concept mapping*, *digital mind mapping*, *English for Specific Purposes*, *ESP*, *higher education*. This search strategy yielded 12 publications, which were evaluated and screened to apply the previously mentioned exclusion criteria. Ultimately, 9 relevant papers witnessing the effective application of concept and mind mapping tools for teaching and learning ESP at higher education level were incorporated in the study.

The first research question of this current literature review was set to answer which of the previously discussed *types of Web-based concept and mind mapping tools have been investigated and proven to be effective when teaching and learning ESP within formal higher education institutions during the period of 2019–2024*. Evaluative evidence regarding their effective utilization in ESP studies within higher education was obtained through subsequent questions.

The analysis of 9 full-text articles revealed that researchers in the field addressed 8 types of Web-based mind mapping tools and 2 types of concept mapping tools, considered appropriate for teaching and learning ESP. Among the mind mapping tools were *MindMeister*, *MindMup*, *EdrawMind*, *FreeMind*, *XMind*, *GitMind*, *SimpleMind* and *Ayoa*, whereas the concept mapping tools comprised *Coogle* and *CmapTools*. It is important to note that two of the investigated studies mentioned multiple mind mapping tools. The main characteristics of each tool are briefly described below.

The effective practical implementation of *MindMeister* was reported by three of the studies (Amansyah et al. 2023; Marunovich et al. 2021; Tverezovska et al. 2020). It is one of the most widely used Web-based mind mapping platforms with various features, including compatibility with standard Web browsers, real-time collaboration for an unlimited number of users, native apps available for iOS and Android devices, a presentation mode, which allows converting mind maps into presentations as well as options to publish maps on websites or blogs. Two studies (Amansyah et al. 2023; Alba 2021) incorporated into this review addressed the effective use of *MindMup* in the context of teaching and learning ESP. *MindMup* is presented on its official site as an online tool designed for creating mind maps, featuring efficient

keyboard shortcuts to accelerate users' workflow. It offers the ability to convert maps to various formats such as PDF or PowerPoint, as well as effortless publishing and sharing online. Integration with Google Drive allows for easy saving and management using Google Apps. One study (Al-Jarf 2021) examined the employment of *FreeMind*. On its official site *FreeMind* is defined as a productivity program which assists its users in capturing ideas visually. It is ideal for planning a project, writing long-form content or ideating a campaign. In addition, one study conducted by Amansyah et al. (2023) mentioned the use of several mind mapping tools, such as previously discussed *MindMeister* and *MindMup* as well as *EdrawMind*, *XMind* and *Simple Mind*. Similarly, multiple mind mapping tools suitable in ESP teaching contexts were identified in a conference paper authorized by Mihaylova (2023), which included *EdrawMind*, *GitMind* and *Ayoo*. All of them are popular cross-platform mind-mapping applications designed to facilitate their users' thought processes and organize ideas. With intuitive interfaces they enable users to boost their creativity and easily generate various mind maps, visually representing concepts, words, tasks and information.

The review identified only two publications that specifically focused on the utilization of concept mapping tools. Khatib and Zaidoune (2024) reported on the effective use of *Coggle*, while Balula et al. (2020) employed *CmapTools* combined with the assessment tool *Socrative* in their research. *CmapTools* is defined by its creators as “a client-server software tool to facilitate the construction and sharing of concept maps.” (Novak, Cañas, 180). *Coggle* is another user-friendly application designed for the effortless creation of both concept and mind maps directly in the browser without the need for downloads or installations. Both *Coggle* and *CmapTools* are suitable for various activities, such as note-taking, brainstorming or organizing plans; moreover, they support collaborative activities by allowing easy sharing of created maps among multiple users.

It should be noted, however, that in one publication (Wannas et al. 2022), incorporated into this review, the exact type of a Web-based concept mapping or mind mapping software utilized for teaching or learning ESP was not specified by their authors and was referred to as *electronic mind maps* or *mind mapping websites*.

The second research question of this descriptive literature review aimed to investigate *which of the ESP language skills and other knowledge areas had been focused on through the use of Web-based concept and mind mapping tools*. It was established that both types of technologies have been effectively employed in diverse ESP areas to enhance learners' proficiency in productive and receptive language skills, as well to boost their motivation. Most studies

targeting the use of mind mapping tools emphasized their efficacy in developing ESP students' *receptive vocabulary*.

For instance, Alba's (2021) quasi-experimental study, conducted at a university in Iran serves as an illustrative example of how this type of software can help to enhance ESP students' vocabulary acquisition, particularly in the domain of translation studies. Participants in the experimental group of this research received vocabulary instruction supported by *MindMup*, while those in the control group were taught using traditional methods. Post-treatment assessments revealed that learners utilizing this mind mapping software performed significantly better than the control group, indicating the beneficial and effective nature of *MindMup* in facilitating ESP students' vocabulary acquisition.

The impact of digital mind mapping technology on ESP learners' vocabulary acquisition at a university in Russia was further examined by Marunovich et al. (2021). The authors noticed that detailed mind maps created with the assistance of *MindMeister* proved very effective in expanding their students' vocabulary in transport-related topics. Moreover, they were beneficial for teaching ESP vocabulary concerning various modes of transport, their components, materials, electronic equipment or machinery used for energy conversion.

The purpose of the conference paper published by Mihaylova (2023) was to explore how Web-based mind mapping software can be used for teaching Business English vocabulary. It should be noted that this paper not only provided a list of the most popular mind mapping software, but also suggested several examples of how different mind mapping tools, including *EdrawMind*, *GitMind* and *Ayoo* can be employed for teaching business English terms, their derivatives and building a semantic field.

A quasi-experimental study conducted at a college in Egypt by Wannas et al. (2022) aimed to investigate the effects of implementing a Web-based mind mapping strategy on learning engineering vocabulary. The experimental group participants underwent training in online mind mapping (the particular software used was not specified by the authors), while their counterparts in the control group were instructed using traditional methods. Pre- and post-testing was conducted to evaluate the effectiveness of the online mind mapping strategy. The study's results showed a significant difference in mean scores between the pre-test and post-test outcomes within the experimental group only. No statistically significant difference in post-test mean scores between the experimental and control groups was observed, indicating that both online mind mapping and traditional teaching methods produced similar impact on students' ESP vocabulary acquisition. Despite the absence of specific details on the efficiency of mind mapping tools the practical insights provided by this study offer guidance for educators seeking

to integrate Web-based mind mapping strategies into vocabulary instruction (in this case into semi-technical vocabulary) and making the process of acquiring it enjoyable and simple.

The study conducted by Amansyah et al. (2023) examined the efficacy of utilizing various mind mapping tools (including *MindMeister*, *MindMup*, *EdrawMind*, *XMind* and *SimpleMind*) to enhance ESP students' **writing** skills when developing a business plan concept. The research comprised three main stages: pre-task, during-task and post-task activities. All participants were enrolled in a Business English course at a university in Indonesia and were responsible for selecting their preferred mind mapping technologies. Qualitative data, such as their business plan diagrams, actual business plans and reflection sheets were collected and analyzed. The findings indicated that ESP students responded positively to their experience with online mind mapping, as the task encouraged their active participation, exploration, autonomy and engagement throughout the writing process.

Al-Jarf (2021) conducted a study illustrating how ESP instructors can effectively employ the Web-based mind mapping tool *FreeMind* to enhance their students' **reading skills** in understanding of the organizational structure within ESP texts. The study focused on ESP students at a college in Saudi Arabia, who were enrolled in various translation courses spanning disciplines such as medicine, Islamic studies, military field, law, computer science, media, and the oil industry. The utilization of *FreeMind* facilitated these students in identifying connections between analyzed topics and subtopics, grasping main ideas, extracting details, and discerning the text structure.

The three-stage quasi-experimental study conducted by Tverezovska et al. (2020) documented the successful practical integration of *MindMeister*-based mind mapping techniques into an ESP training course focused on computer sciences and cybernetics at a university in Ukraine. The study involved university entrants, junior and graduate students, all with different levels of language proficiency. The research objective was to intensify their learning process and enhance their **language skills** and **motivation**. Research findings, obtained through observation, questioning, testing, output data calculation and data checking, demonstrated improvement in ESP proficiency. Additionally, participants in the experimental research groups found Web-based mind mapping activities to be interesting, engaging and motivating.

The two research studies that utilized concept mapping tools reported on their effectiveness in enhancing ESP students' **receptive vocabulary** and improving their **critical reading** skills. To illustrate, Balula et al. (2020) explored the combination of two Web-based technologies: the assessment tool *Socratic* and the concept mapping tool *CmapTools* to enhance vocabulary acquisition and use among their ESP students at a university in Portugal. To be more exact, they focused on promoting the learning of

Business English acronyms, abbreviations and terms as well as fostering their use in written texts. The teaching and learning strategy employed by the authors incorporated several individual and group activities and integrated the aforementioned Web-based tools. It was established that this strategy added to learners' success as far as the identification and the use of Business English acronyms and abbreviations was concerned, however, it did not have a positive impact on their language competence to use Business English terms in written texts.

The quasi-experimental research conducted by Khatib and Zaidoune (2024) investigated how summarizing texts through the use of Web-based concept mapping tool *Coggle* impacts the critical reading and thinking skills of engineering students at two colleges in Morocco. Half of the participants received training on creating mind maps and were instructed to summarize a text using *Coggle*, while the other half did not receive any training and were asked to summarize the same text conventionally by writing a paragraph. Both groups underwent a post-test on the same text, which included answering multiple-choice questions, providing comments on a key statement from the text, as well as critiquing the author's thesis. The findings indicate that ESP students who received training on *Coggle* performed better on the post-test compared to the control group, suggesting that using *Coggle* mind maps for text summarization can enhance the critical reading and thinking abilities of ESP students in the field of engineering.

The third research question of this descriptive literature review aimed at determining *what theoretical frameworks underpinned the previous research that focused on the use of Web-based concept and mind mapping tools in the field of ESP within the period of 2019–2024*. This question was actually raised to investigate whether the researchers predominantly relied on concepts, theories or approaches traditionally associated with concept mapping techniques, such as *Assimilation Theory* and the concept of *meaningful learning*, or on those related to mind mapping, such as the theory of *Radiant Thinking*, among others. It was identified that only several studies (Mihaylova 2023; Wannas et al. 2022; Marunovich et al. 2021; Tverezovska et al. 2020) explicitly or implicitly mentioned being grounded on Buzan's Radiant Thinking Theory. The remaining part of the studies, however, were not aligned with clearly identifiable theoretical framework.

Discussion and implications for future research. This descriptive literature review consolidates findings on the effective use of Web-based concept and mind mapping tools in the field of teaching and learning ESP at the higher education level. It encompasses related empirical research, published in international scholarly journals and conference proceedings within the period spanning from 2019 to 2024, considering the challenges brought by the

COVID-19 pandemic. The reviewing process was guided by three research questions, which aimed to examine the use of specific types of Web-based concept and mind mapping tools in teaching and learning ESP within formal higher education settings during this challenging period, the language skills and other knowledge domains of ESP emphasized through the application of these tools, and the theoretical frameworks underpinning previous research focused on their use. Researchers tend to commonly refer to concept and mind mapping software as mind mapping software. However, this study was based on the conceptual framework proposed by Kruse et al. (2023), which distinguishes concept and mind maps as two separate approaches with their own unique characteristics and applications. It suggests that the main difference between the two is that concept maps form complex structures by connecting ideas with specific relationships, resulting in a network of interconnected concepts, while mind maps organize elements hierarchically without specifying detailed relationships, focusing more on representing different levels of abstraction within sets and subsets.

The findings of this literature review indicate that researchers in the field addressed 8 types of Web-based mind mapping tools and 2 types of concept mapping tools, considered appropriate for teaching and learning ESP. Among the mind mapping tools were *MindMeister*, *MindMup*, *EdrawMind*, *FreeMind*, *XMind*, *GitMind*, *SimpleMind* and *Ayoo*, while the concept mapping tools comprised *Coogole* and *CmapTools*.

They also suggest that Web-based mind mapping software can assist in improving ESP students' vocabulary acquisition and in fostering their writing and reading skills in a variety of spheres of ESP, including business, transport, engineering or translation. They can also be used to boost students' motivation, having in mind that learning ESP vocabulary or analyzing specific texts can appear a very challenging task. The research studies that utilized concept mapping tools, however, reported on their effectiveness in enhancing ESP students' business English vocabulary and improving their reading skills in the field of engineering. Perhaps further research in other domains of ESP, for example, medicine, law or hospitality could offer valuable insights into the applicability and adaptability of these tools across a wider range of professional contexts.

Only several studies incorporated into this review aligned with a clearly identifiable theoretical framework, i.e., they directly or indirectly mentioned being grounded on Buzan's Radiant Thinking Theory. The remaining part of the studies, however, did not indicate their theoretical background, which suggest that related future research could delve deeper into the theoretical underpinnings of the utilization of these tools to develop more informed and effective pedagogical strategies.

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