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Biblometrix and Systematic Review of Blended Learning for Critical Thinking from Scopus

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ABSTRACT
Critical thinking is an essential ability for 21st century talents. Blended learning is an emerging learning environment to support learners' cultivation of their critical thinking. Even though there are numerous researches about blended learning on critical thinking, there is lack of a clear summary about above study to provide teachers who are interested in critical thinking cultivation a broad understanding of this area. Thus the purpose of this study is to give lecturers a general guidance by bibliometrix about the trend of blended learning on critical thinking, the most influential journals, themes and nations in this field and a in-depth summary by systematic review about technology, pedagogy and subjects have been studied by scholars to facilitate the instructors to conduct their daily classroom teaching and to have some ideas about future research in the field.

Keywords: bilbilometrix analysis; blended learning; critical thinking; future trend; systematic review.

INTRODUCTION

Critical thinkers, according to [1], can improve academic achievement, engage in social issues thoughtfully and passionately, and find jobs more easily. As a result, each country required the following competency framework for the twenty-first century talents cultivation: A essential skill for lifelong learners is thinking critically, according to [2]. Foreign language majors at Chinese universities are urged to hone their critical thinking abilities by [3]. It is evident from the policies listed above that developing critical thinking skills is now a top priority for talent development at all levels—educational, social, national, and even international. The following studies have also supported the aforementioned ideas. Critical thinking skills are thought to be necessary for both the development of responsible citizens and the assessment of the huge amount of information currently available [4]. Employers consider critical thinking and problem solving to be the most crucial abilities to have when preparing for a job, according to[5]. As a result, higher education now places a strong emphasis on critical thinking [6] . [7] argues that blended learning is an effective teaching strategy. Positive student attitudes towards this method of education inspire them to put more effort into their studies. While enhancing students' cognitive abilities, such as self-control and critical thinking, it can connect learning and action.

But the study of critical thinking has a long history that goes back to ancient Greece, and as psychology, cognition, and educational studies have advanced, it has become increasingly difficult. The tremendous growth in the number of scholarly publications makes it increasingly challenging to keep track of everything that has been published[8]. The R-package bibliometrix, which can address the issue by examining a huge number of publications, offers an open-source platform and ecosystem for analysing published academic papers [9]. Because it is more objective and reliable than other literature review techniques, bibliometrics is frequently used in library and information science research [10]. A network analysis of academic institutions, countries, and keywords based on quotations and frequency analysis methods are all included in bibliometrics, according to [11]. These methods facilitate the creation of research groups, highlight trends for new topics within a domain, and facilitate the recognition of research subgroups. However, the results from bibliometrix are still too abstract to be useful for teachers to use as a guide for their day-to-day work in the classroom.

Systematic techniques for conducting reviews have been created in the medical area to reduce biases and omissions, improve the quality, and encourage transparency of literature reviews [12]. According to [13], systematic reviews are acknowledged as an essential research activity in both the social sciences and the sciences. When combined with a bilbiometrix study, it gives teachers a thorough comprehension of academic research and a clear picture of how to implement their usual teaching techniques to enhance students' critical thinking in a blended learning environment. Additionally, in this systematic review, subjects, pedagogy, and technology will all be studied in order to determine the roles they have played in various studies and how they have affected the use of blended learning and the growth of critical thinking. This was done in an effort to understand how modern technology contributes to the development of critical thinking in blended learning. Furthermore, it can help instructors better comprehend the blended learning paradigm and the development of critical thinking from a pedagogical, technological, and material standpoint. Thus, the following in-depth research questions are generated in order to address the objective of the current study.

RQ1: How are the blended learning studies on critical thinking developing in term of publication year?

RQ2: How are the blended learning studies on critical thinking developing in terms of nation?

RQ3: How are the blended learning studies on critical thinking developing in terms of research topic?

RQ4: How are the blended learning studies on critical thinking developing in terms of technology?

RQ5: How are the blended learning studies on critical thinking developing in terms of pedagogy?

RQ6: How are the blended learning studies on critical thinking developing in terms of subject?

1) METHODS

(a) Bibliometrix

In an effort to solve the aforementioned problems with the research, the study adopts procedure by [11] for bilbiometrix analysis. First, bibliometric citation analysis and network analysis, with the aim of identifying publication patterns, the most influential journals, countries, as well as publishing trends. Second, by using a cluster analysis to pinpoint the sub-cluster system. Finally, the conclusion presents a summary of the research and offers following directions. The options were limited to "journal," "article," "final," and "English," with the keywords "critical thinking" and "blended learning" being used.

The investigation was built on data from Scopus, one of the most well-known academic databases. In order to locate relevant bibliographic material, a keyword search was carried out in the Scopus database on July 23, 2023. The words "critical thinking" and "blended learning" were used in the search. The data findings are divided into four categories: "journal," "article," "final," and "English." Finally, 124 papers are picked to be examined. The extracted bibliographical data includes the title, author, document type, abstract, keywords, source, cited references, and times cited for each unique article. The inclusion and exclusion criteria should be clearly specified in order to guarantee that the studies that have been obtained are pertinent to the primary study objective [14], thus examples of the inclusion and exclusion criteria for this review study are shown in **Table 1.**

Table 1: inclusion and exclusion criteria by [14]

Inclusion criteria	Exclusion criteria
a. Must relate to blended learning	a. Dissertation and thesis are not included
b. Should relevant to critical thinking	b. Conference proceedings are not included
c. Must in the final publication position	c. Book chapters are excluded
	d. Non-English studies are removed

(b) Systematic review

Based on the 124 Scopus papers that were chosen for bilbiometrix analysis, two steps are used to choose publications for systematic review. First, a 2018–2023 time frame constraint was put in place for the selection due to the quick development of educational technology and the aim of our study, which is to offer relevant, useful teaching guidelines for instructors' everyday teaching practices. Even while several works from before 2008 provide insightful theoretical guidance on blended learning today, they are still not taken into account. As a result, 87 papers are removed. Second, read the complete paper. Since their entire articles had nothing to do with critical thinking, twelve items were eliminated. The current review adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) standards during the phases of search and selection[15]. In **Figure. 1**, the PRISMA flow diagram of the article selection procedure is displayed.

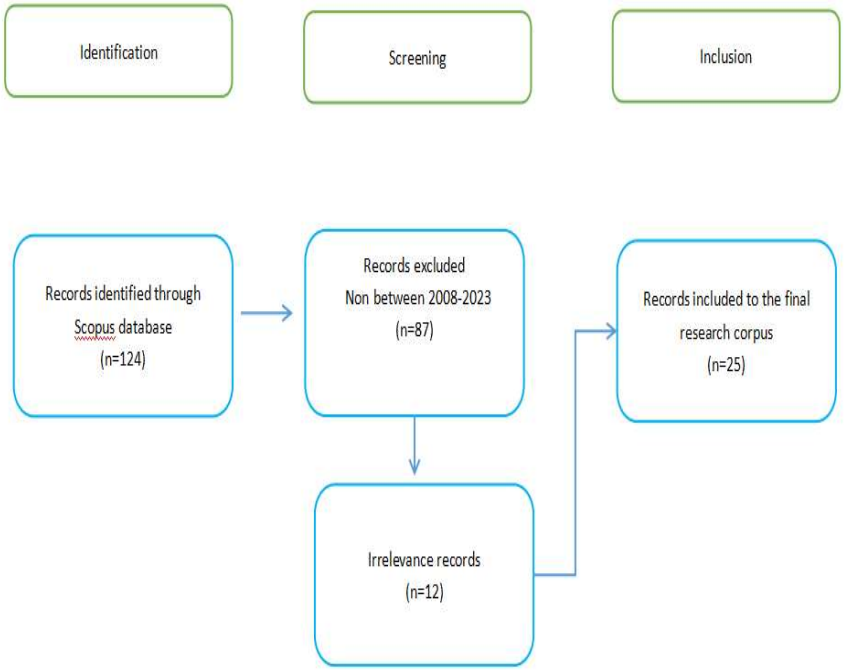

Figure 1. Prism flow diagram by[16]

Basis on the list of 25 papers chosen for the systematic review, a general understanding of research from 2018 to 2023 can be derived. In terms of research methodology, 22 of the studies are quantitative. The remaining three studies are mixed-method research[17], [18], [19].The three papers can be consulted by educators who are interested in mixed methodologies. In terms of sampling, 18 researches focus on higher education, 3 are in high school [20], [21], [22]. 3 are in junior high school [23], [24], [25]and one research project includes both junior high and senior high school students [26]. The aforementioned seven articles can be used by teachers who are interested in learning more about blended learning for critical thinking in junior and senior high schools. In terms of findings, all studies with the exception of two [26], [22]discuss how blended learning enhances students' critical thinking. These two publications can be beneficial to lecturers who want to learn more about the detrimental impacts of this field. As a result, blended learning for critical thinking is well established in quantitative research but underdeveloped in qualitative study. The majority of recent studies have ignored primary and intermediate schools in favour of focusing on higher education. More thorough results and conclusions will be described in the section that follows.

2) RESULTS

(a) Development of studies in term of publication year

Based on **Figure 2**, research question 1 can be answered. There were two papers about blended learning on critical thinking published in Scopus starting in 2010. Since then, from 2 papers in 2010 to 8 in 2018, the number of publications per year has increased consistently. The number of papers published in 2019 has suddenly increased from 8 in 2018 to 15, or nearly twice as many papers. This occurrence supports a prior study that found that the COVID-19 outbreak in 2019 swiftly increased the number of blended learning courses, which led to a linear rise in the quantity of pertinent research[27]. After 2019, the publishing keeps growing, reaching 22 papers in 2023, which is in line with study findings by [28], who predicted that blended learning research would continue to grow over the following two years. Teachers can now focus more on the critical thinking research in blended learning, which is expected to be popular in the years to come.

Figure 3 illustrates the journals that publish articles on blended learning on critical thinking. The International Journal of Emerging Technologies in Learning ranks first with 4 papers, followed by Jurnal Pendidikan IPA Indonesia with 3 papers and the rest journals have 2 papers published within 5 years. Teachers want to know more about the trend of blended learning on critical thinking can focus on this two journals.

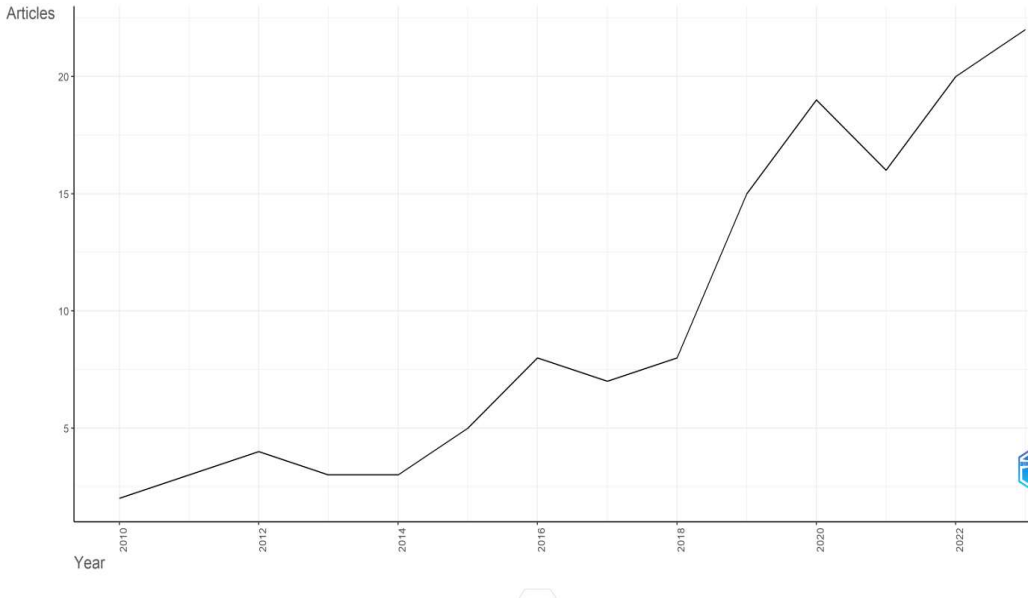

Figure 2. Annual scientific production

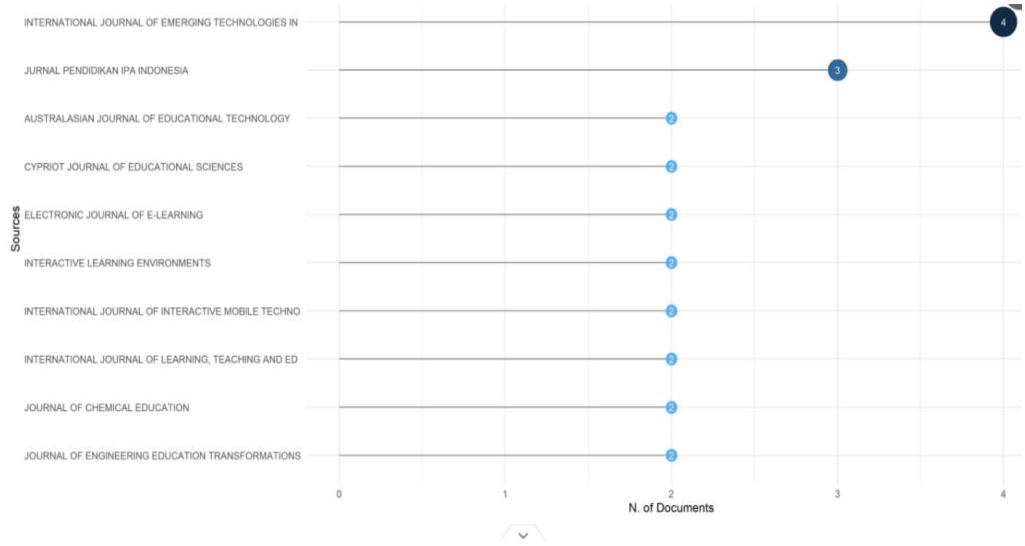

Figure 3. Most relevant sources

(b) Development of studies in term of nation

Figure 4 can answer research question 2. With 39 publications in five years, Indonesia clearly has the most publications. With 33 papers, the USA comes in second. China has 18 papers, which places it third. Malaysia ends up in fourth place with 15 papers. India and Saudi Arabia, each with 11 papers, are ranked fifth.

With 217 papers referenced, it is clear from **Figure 5** that China is the nation that receives the most citations. USA has 169 papers, placing it second. With 141, the United Kingdom comes in third. With 122 papers, Australia moves up to fourth place. With 66 papers, Saudi Arabia ranks fifth, and Indonesia, with 63 papers, is in sixth place.

It is clear from the two figures that within five years, developing nations, particularly those in Asia like Indonesia, China, India, Malaysia, and Saudi Arabia, have come to appreciate the value of critical thinking for the development of talents and society as a whole, as well as the significant contribution that blended learning has made to this development. Their countries published the majority of papers after 2018 because they concentrated on the application of blended learning. But because studies on critical thinking, blending learning, and information technology all began in major economies like the USA and Canada, they account for half of the citations from the top six countries. For instructors, this means that authors from the US, Canada, UK and Spain are your best choices if you're interested in the theory and roots of blended learning and critical thinking. For instance, according to [29] The Handbook of Blended Learning: Global Perspectives, Local Design by [30] and Evaluation of Evidence-Based Practices in Online Learning: A Meta -Analysis and review of Online Learning Studies by [31] have led and supported the critical path to the academic achievement research on blended learning; [32] proposed an instructional model of blended learning based on the

development of a teaching-learning system; [33] investigated the blended learning in higher education from students' perspective. Basis on [34], [35] revealed blended learning is more effective in human anatomy class; [36] reported students' perceptions about collaborative learning in blended learning environment.

Teachers can also focus on authors from China, Indonesia, Malaysia, Saudi Arabia, and India if you're interested in the present implementation of blended learning. For example, among Chinese scholars, [37] is mainly engaged in digital learning design and application in higher education,[38] focuses on mobile learning and ubiquitous education and [39] researches in basic theory of educational technology.

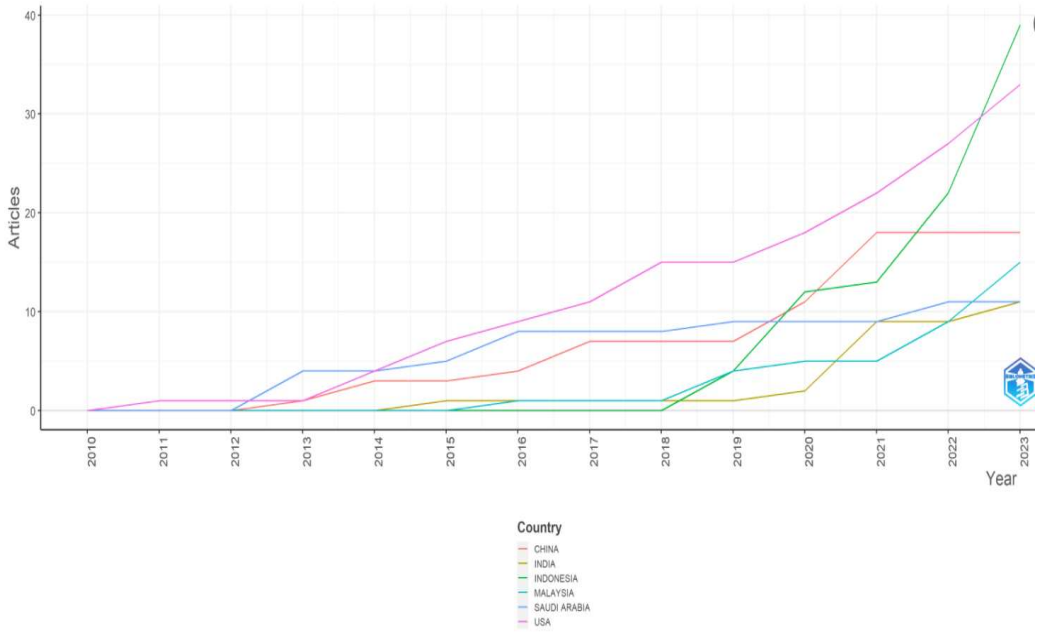

Figure 4. Country production over time

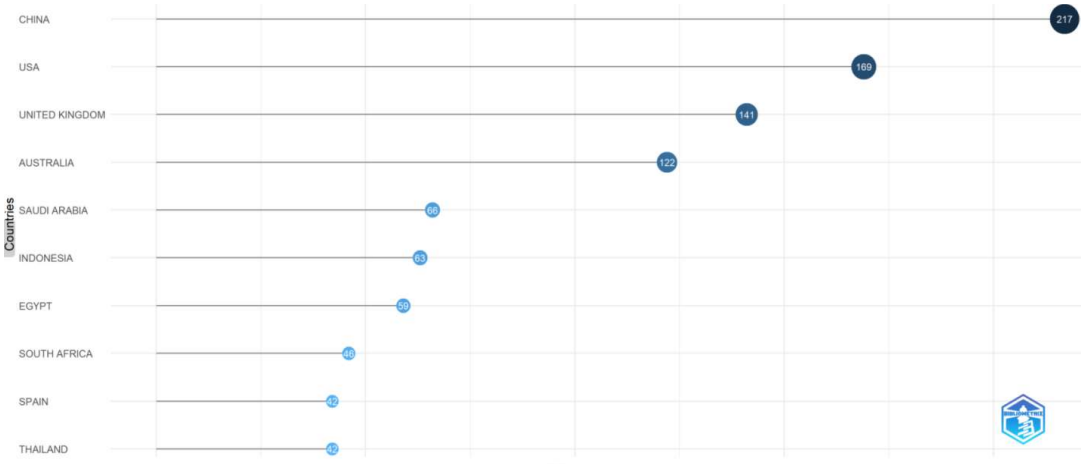

Figure 5. Most cited countries

(c) Development of studies in term of research topic

Research question 3 can be answered by **Figure 6**. From top to bottom and right to left in Figure 6, there are four different types of themes: The motor themes in quadrant 1 (top right) are the crucial and well-developed theme in blended learning for critical thinking. From the centre to the corner, the groups whose importance are decreasing are: the first group, which includes medical education, medical students, and multiple-choice tests; the second group, which involves medical feedback and feedback systems; the third group, which comprises instructional methodology and models; the fourth group, which contains clinical articles, skills, and students; and the last group, which consists of human education learning. The niche themes in quadrant 2 (top left) are well developed but unimportant to the current field. They are isolated and well developed. The first category is systematic review and decision-making, and the second group is curricula and educational computing, arranged from centre to corner. Quadrant 3 (lower left): developing ideas

that are still in the early stages of development and may soon fade. Computer-assisted instruction and blended learning environments make up the first group, followed by learning systems, educational technology, teaching techniques, and surveys in that order from centre to corner. Quadrant IV (lower right): fundamental ideas that are significant to the field but aren't fully explored. Blended learning is in the first group, followed by critical thinking, students, and motivation.

According to **Figure 7**, psychology and perception are the keywords of 2018. The hot topics of 2019 are education, learning, and women. The key terms for 2020 are critical competence, article, and human. Critical thinking, controlled study, and online learning are the themes for 2021. The most popular term for 2022 is "learning system."Based on the two figures, it can be concluded that although clinical and medical studies on blended learning's impact on critical thinking are highly established, they are currently not at the forefront of blended learning research. systematic review of blended learning, students' motivation, and student critical thinking are significant topics in this area that are under-examined. The emphasis of the new blended learning trend on critical thinking is on the learning system and blended learning environment. In the upcoming years, the two issues may move towards the centre and reach the mainstream and fashion. Teachers who are interested in conducting study in this area can therefore concentrate on the aforementioned two topics.

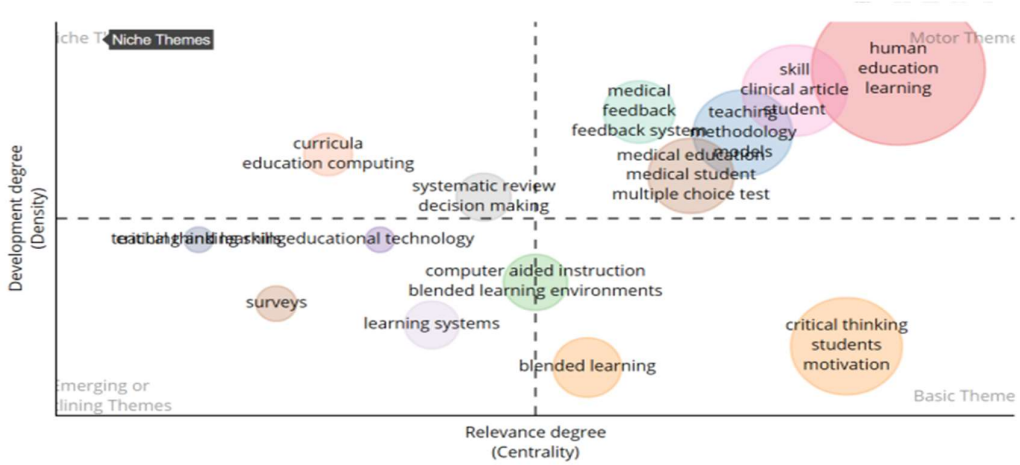

Figure 6. Theme development

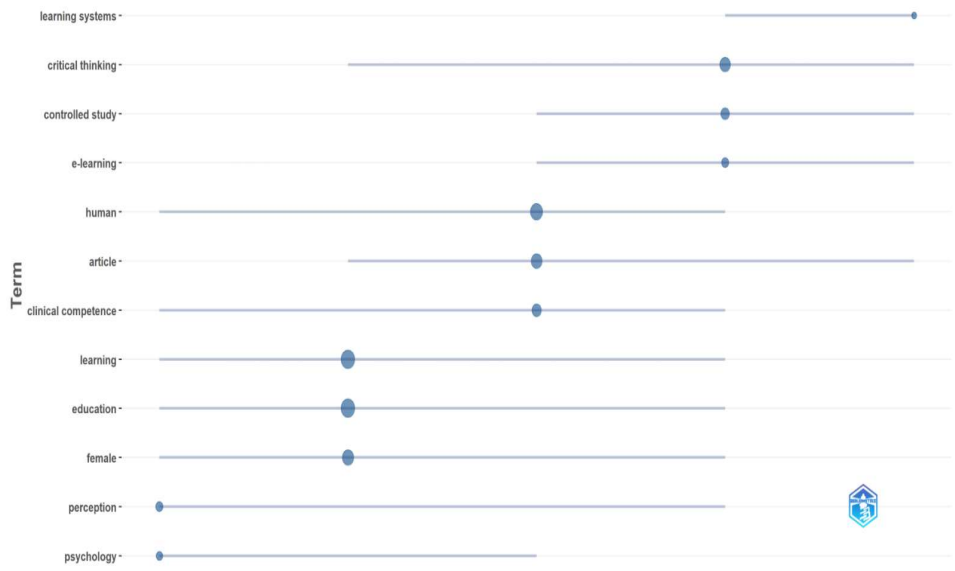

Figure 7. Trend topics

(d) Development of studies in term of technology

Figure 8 can answer research question which displays the research technological developments. The figure illustrates how little attention has been paid by researchers to the significance of technology. Out of 25 publications, 8 studies failed to mention the technology they utilised in the blended learning environment, creating problems for teachers who

want to apply research models to their classrooms and hindering the dissemination of their research findings. As mentioned by [40], there are additional difficulties that technology presents that make it difficult to clearly integrate it into practical training due to its inherent characteristics. Six studies used learning management systems such as Google Classroom[32], Schoology[31] , Emodo[36] , Moodle [41], and Clinic e-Learning[42], which supports the finding from the theme development that learning systems will be popular in the coming years. Two papers employ social media such as facebook[43]. The rest researches utilize MOOC[44], Chatgpt[45], and GeoGebra Assisted Mathematics Learning[37]. To help students develop their critical thinking skills, teachers might use the effective research models mentioned above to adopt specific learning systems or digital technology and use them in their regular classroom settings.

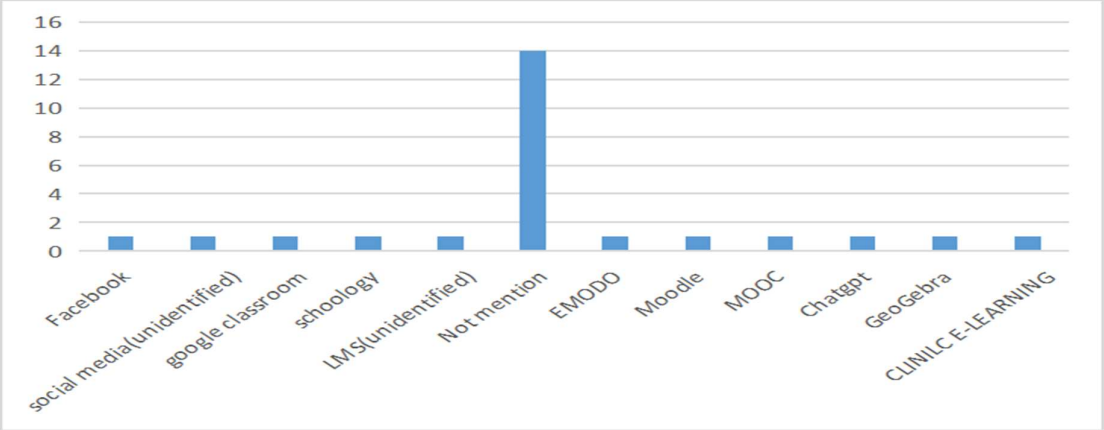

Figure 8. Technology employed in the research

(e) Development of studies in term of pedagogy

Figure 9 can be used to resolve research question which shows how research pedagogy is implemented. Eight studies have not indicated the pedagogy they utilized. The use of problem-based learning[46], [33], [41] in three publications comes first. In two studies that rank second, the approaches to STEM education[31], [35] and clinical research[42], [47] are used. The well-established approach of problem-based learning is one that teachers might use as they begin their blended learning on critical thinking. Teachers who take STEM or medical courses will find that clinical research or stem education methods are appropriate for their regular teaching practices.

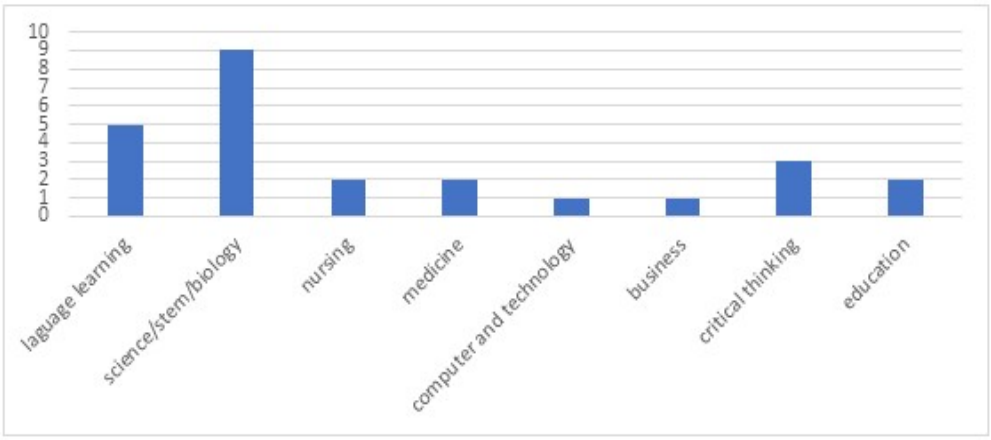

Figure 9. Pedagogy employed in the research

(f) Development of studies in term of subject

Figure 10 can be used to respond to research question which displays the subjects of the study. STEM takes the top spot with 10 studies. With five papers, language learning [48], [28], [49], [50], [51] comes in second. With three papers, critical thinking[32], [41], [52] comes in third. The fourth comes from nursing[44], [53], medicine[47], [42], and education[34], [54], each with two papers. Because these topics are well-researched, teachers can benefit from the findings of previous studies done in the domains of STEM, language acquisition, nursing, and medicine. Whereas the other areas are awaiting the inquiry and exploration of instructors and academics.

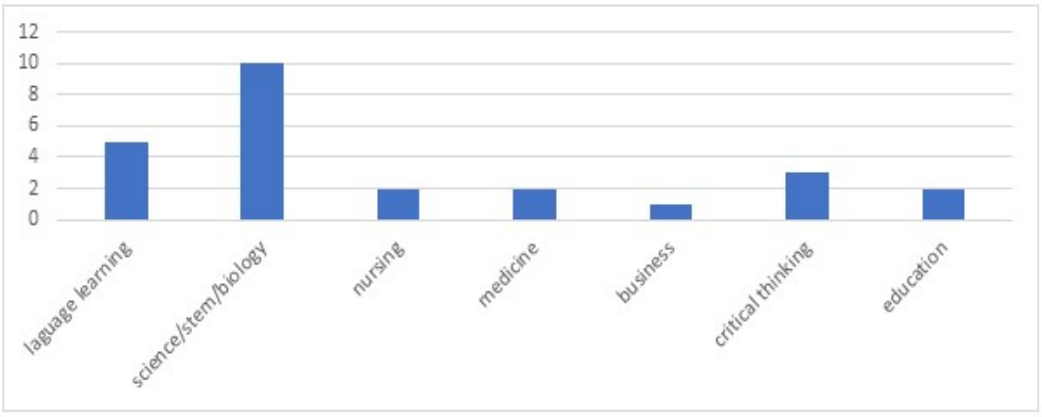

Figure 10. Subjects studied in the research

3) CONCLUSION

According to biliometrix and a systematic evaluation of articles on blended learning for critical thinking, more papers are being published, especially after 2019. The International Journal of Emerging Technologies in Learning is the most important journal in this field. China receives the most citations, yet Indonesia is the most prolific nation. Research on blended learning environments and learning management systems are two topics that are becoming more popular in this area. The learning management system is the most widely used technology in this field. Problem-based learning is the most popular methodology, and STEM, language learning, nursing, and medicine are the fields that have received the most research. However, Some topics, such as how particular technologies operate in blended learning environments and the efficacy of blended learning in primary school, still need further study.

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State the source of financing

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8) DATA AVAILABILITY:

The data that support the findings of this study are available from the corresponding author.

9) CONFLICT OF INTEREST:

The authors declare that there is no conflict of interest.

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