Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

Clarivate Research Fronts in the Digital Education: Perspectives from Asean Higher Education System

Nguyen Huu Thanh Chung[1], Tran Ai Cam[2]

Abstract

This study examines impactful research fronts within the digital educational ecosystem, focusing on contributions from ASEAN higher education institutions. Using Clarivate Analytics' bibliometric methodologies, the five hot research research fronts —including Online Learning, Artificial Intelligence, Collaborative Learning, Virtual Reality, and Educational Technology—are explored and analyzed through core indicators such as Citation (Pciting), Productivity (Pcore), and Trajectory (Tciting), alongside the CPT index to measure impact. ASEAN universities, particularly in Malaysia and Indonesia, demonstrate notable productivity in Online Learning and Collaborative Learning. Malaysia ranks 4th globally in Online Learning, while Indonesia follows in 5th place. However, ASEAN contributions in Virtual Reality, Educational Technology, and Artificial Intelligence remain limited, highlighting opportunities for growth. The study underscores the need for ASEAN universities to enhance research capacity, foster regional collaboration, and focus on emerging fields like Virtual Reality and Artificial Intelligence. Targeted efforts will enable ASEAN institutions to strengthen their global impact and address regional educational challenges effectively.

Keywords: *Bibliometric Analysis, Clarivate Research Fronts, Digital Educational Ecosystem, Education Technology, Impactful Research Front.*

Introduction

Research fronts are dynamic, knowledge-driven clusters of scholarly activity that emerge in response to pressing problems, innovative methodologies, or groundbreaking discoveries. These clusters represent interconnected networks of researchers and their work, unified by shared citations or thematic keywords. The concept of research fronts was first articulated by Garfield (1955) in his seminal work on citation indexing, which demonstrated how citation patterns reveal precise and objective connections within the scientific literature. This approach offers a clear representation of research themes, free from subjective interpretation.

Price (1965) further developed the concept by introducing the notion of an "immediacy factor" in scientific communication. He emphasized that research fronts are characterized by tightly interconnected networks of recent publications, with dense citation links marking them as hubs of current scientific exploration and rapid discovery. This framework provides a powerful lens for identifying and understanding emerging trends and transformative shifts in the landscape of scientific knowledge.

The structure of research fronts is defined by two core components: highly cited core papers, which establish the foundational knowledge, and citing papers, which expand and build upon these core ideas (Small & Griffith, 1974). This dual structure facilitates tracking both the established knowledge base and the evolving boundaries of research innovation. Zheng et al. (2016) highlighted the importance of keyword co-occurrence analysis in systematically identifying research fronts, demonstrating the value of bibliometric methods in capturing their evolution. Advanced techniques such as co-citation analysis and co-word analysis are crucial for identifying and analyzing these domains (Li & Chu, 2016). Mazov et al. (2020) further refined the definition, describing research fronts as groups of recently published articles with a shared topical focus, characterized by strong internal citation networks and relatively weak external connections.

[1] VNU University of Social Sciences and Humanities, Hanoi, Vietnam; UPM Innovation Institute, Hanoi, Vietnam, 336 Nguyen Trai, Thanh Xuan Trung, Thanh Xuan, Hanoi, Email: chungnht@vnu.edu.vn.

[2] Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam, 300A, Nguyen Tat Thanh Street, Ward 13, District 4, Ho Chi Minh City, Vietnam, Email: tranaicam75@gmail.com (Corresponding Author)

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

According to Clarivate Analytics (Research Fronts, 2017, 2024), research fronts are not merely reflections of prevailing trends but are also predictive of future developments, providing insights into emerging scientific priorities. This definition emphasizes the structural characteristics that distinguish research fronts from broader research trends. Over the last ten years, the analysis has identified 110 especially active or 'hot' research fronts, as well as 15 emerging fronts, with the latter selected based on notably recent core literature from each year.

The digital educational ecosystem encompasses the interconnected platforms, tools, and stakeholders that support learning, teaching, and educational management in a technology-driven environment. Investigating research fronts within this domain is essential for uncovering cutting-edge advancements, addressing global educational challenges, and driving pedagogical innovation.

The geographical distribution of research in the digital educational ecosystem highlights significant disparities in contributions and access. Developed nations such as the United States, the United Kingdom, and East Asian countries dominate research output, driven by well-established higher education systems and robust funding mechanisms. Meanwhile, developing regions, including parts of ASEAN, are making notable contributions through scalable solutions such as mobile learning and low-resource educational technologies. However, challenges such as the digital divide, limited infrastructure, and insufficient teacher readiness remain pressing issues, particularly in underserved regions.

Ultimately, exploring these research fronts provides critical insights into the development of the digital educational ecosystem and the opportunities it presents. This exploration emphasizes the need for continued investment in innovative technologies, equitable access, and interdisciplinary collaboration. Addressing the specific needs of regions like ASEAN while maintaining a global perspective is key to shaping the future of education effectively.

This study investigates most active and hot research fronts within the digital educational ecosystem by analyzing bibliometric data and relevant studies. Specifically, it addresses the following research questions:

What are the hot research fronts derived from Clarivate's analysis?

What is the geographical distribution of research with respect to nations and higher education systems?

What are the contributions from ASEAN universities and their perspectives?

Methodology

Search Strings

To address the research questions, bibliometric data was collected from Scopus, covering all journal publication types from 2019 to 2023. The search employed 17 high-frequency keywords and their synonyms (as detailed in Table 1) (Tran Ai Cam and Nguyen Huu Thanh Chung, 2024). The search syntax was formulated as follows: TITLE-ABS-KEY ((“synonyms keyword terms”) AND (“higher education” OR “universit*” OR “college*”)). This approach was carefully designed to ensure both the validity and reliability of the data collection process. After a thorough manual review, the results, along with all available bibliometric information, were exported in CSV format for further analysis.

Table 1. Research Fronts and Keywords Using Synonyms in the Search String

No	Research front	Keyword and Synonyms terms
1.	Artificial Intelligence	("Artificial Intelligence" OR "Machine Learning")
2.	Blockchain	"Blockchain"

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

3.	Cloud Computing	("Cloud Computing" OR "Internet-based computing" OR "Network-based computing")
4.	Collaborative Learning	("Collaborative Learning" OR "Cooperative Learning")
5.	Digital Assessment	("Digital Assessment" OR "Online Assessment")
6.	Digital Literacy	("Digital Literacy" OR "Digital Competence" OR "Digital Skill")
7.	Educational technology	("Learning technology" OR "Educational technology")
8.	Gamification	"Gamification"
9.	Hybrid Learning	("Hybrid Learning" OR "Blended Learning" OR "Hyflex learning")
10.	Learning Analytics	("Learning Analytics" OR "Academic Analytics" OR "Learning Data Analysis")
11.	Learning Management Systems	("Learning Management Systems" OR "LMS")
12.	Lifelong Learning	("Lifelong Learning" OR "Lifelong education")
13.	Massive Open Online Courses	("Massive Open Online Courses" OR "MOOC")
14.	Mobile Learning	("Mobile Learning" OR "M-learning")
15.	Online Learning	("Online Learning" OR "E-learning" OR "Distance Education")
16.	Personalized Learning	("Personalized Learning" OR "Individualized Learning")
17.	Virtual Reality	"Virtual Reality"

Clarivate Analytics

As mentioned above, the Clarivate's methodology for identifying and analyzing research fronts combines bibliometric analysis with advanced statistical metrics, emphasizing the evaluation of core papers and citation trends is firstly introduced in the Research Fronts 2014 report. There, refined indicators, such as the number of core papers (P) and the CPT index, are integral to capturing the dynamics of impactful research fronts.

In such study, the CPT indicator, which is defined as the ratio of the average citation impact of a research front to the age/occurrence of its citing papers and is calculated as follows:

$$CPT = \left(\frac{P_{citing}}{P_{core}}\right)/T_{citing} = \frac{P_{citing}}{(P_{core} \times T_{citing})} \quad (1)$$

where:

- P_{citing} represents the number of citing articles, i.e., the total of articles citing the core papers, i.e. the Citation (C);

- P_{core} is the number of foundational core papers, i.e., the highly cited papers, i.e. the Productivity (P);

- T_{citing} indicates the age of citing articles, which is the number of citing years, from the earliest year of a citing paper ((here 2019) to the the average citing year (T_{citing}), i.e. the Trajectory (T).

In this case, CPT is so-called the Citation, Productivity and Trajectory indicator. The higher the CPT number, the hotter or the more impactful the topic.

CPT is the ratio of the average citation (P_{citing}/P_{core}) of a research front to the age/occurrence of its citing papers (T_{citing}), meaning the higher the number avergare citation, the hotter or the more impactful the topic. It measures how extensive and immediate a research front is and can be used to explore the emerging or developing aspects of research fronts and to forecast future possibilities. The degree of citation impact can

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

also be seen from CPT, while it also takes the average publication years of citing papers into account and demonstrates the trend and extent of attention on certain research fronts across years.

Document Analysis

Figure 1 illustrates the search string and analysis process, outlining the various steps involved. The source data consists of Scopus's annual number of published papers. At the first output level (Output 1), the number of publications (S) related to each research front is identified. To determine the number of highly-cited core papers (P_{core}) from this total S number, articles are ordered in descending order of citations, and the Hirsch score (H-index) (Hirsch, 2005) is computed. The H-index represents both the productivity and impact of a scholar or group, and it is used here to identify P_{core}.

At the second output level (Output 2), the step involves determining the total number of citing articles (P_{citing}), i.e., the number of articles citing the published (core) papers.

Additionally, the average citing years (T_{citing}), as shown in Table 2), are calculated are calculated based on the annual citing articles in year y ($P_{citing}(y)$) using the following equation:

$$T_{citing} = \frac{\sum_{y=2019}^{2023} y \times P_{citing}(y)}{\sum_{y=2019}^{2013} P_{citing}(y)} - 2019 \qquad (2)$$

Finally, the analysis process presents the values of the Citation, Productivity and Trajectory (CPT) indicators, along with scientific and geographical mapping.

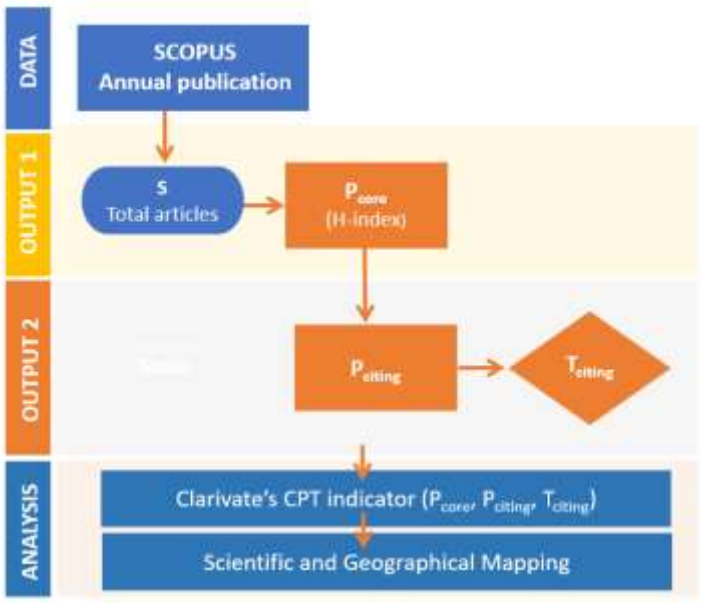

Figure 1. The Search String and Analysis Process

Results

Key Metrics

Table 2 presents the results of data collection for Citation (P_{citing}), Productivity (P_{core}), and Trajectory (T_{citing}), along with the calculated CPT numbers for all 17 high-frequency keywords under investigation. This table highlights key bibliometric indicators for hot research fronts in the digital educational ecosystem. Below are key observations and remarks.

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

Citation

The P_{citing} metric in the table represents the number of citing articles, reflecting the breadth of academic interest and the extent to which research on a given topic has been referenced or cited by other studies. It provides insight into the overall popularity and influence of a research area within the academic community.

Table 2. Data Collection for Citation (P_{citing}), Productivity (P_{core}), And Trajectory (T_{citing}), Along with The Calculated CPT Numbers for All 17 Investigated Research Fronts

Topic Keywords	P_{citing}	P_{core}	$T_{citation}$	CPT
Online Learning	16532	121	3.087	44.26
Artificial Intelligence	13505	107	3.031	41.64
Collaborative Learning	3476	45	2.994	25.80
Virtual Reality	4469	58	2.999	25.69
Educational technology	3447	49	2.970	23.69
Hybrid Learning	3625	54	3.112	21.57
Digital Assessment	1420	22	2.993	21.57
Mobile Learning	3068	54	2.986	19.03
Learning Analytics	2738	49	2.951	18.94
Cloud Computing	1490	31	2.755	17.45
Gamification	1979	41	2.817	17.13
Learning Management Systems	2385	47	3.018	16.81
Digital Literacy	2251	48	2.954	15.88
Massive Open Online Courses	1798	38	3.049	15.52
Lifelong Learning	1136	25	3.090	14.71
Personalized Learning	911	23	3.077	12.87
Blockchain	1129	29	3.056	12.74

In the table, Online Learning exhibits the highest P_{citing} value (16,532), demonstrating its dominance and widespread relevance in the digital educational ecosystem. This indicates that the topic has captured significant attention and is foundational to ongoing research in the field. Artificial Intelligence follows with a P_{citing} value of 13,505, confirming its strong influence and integration within educational research, particularly in areas such as adaptive learning and analytics. Despite its slightly lower P_{citing} compared to Online Learning, its substantial citation count underscores its importance as a transformative technology in education.

Other topics, such as Collaborative Learning (3,476) and Virtual Reality (4,469), have moderate P_{citing} values, reflecting a solid but narrower scope of academic engagement compared to Online Learning and Artificial Intelligence. These values indicate that while these areas are gaining traction, they remain more specialized or emerging in their applications and adoption.

Lower P_{citing} values are observed for topics like Blockchain (1,129), Lifelong Learning (1,136), and Digital Assessment (1,420). These numbers suggest these areas are either in their early stages of research or have a niche focus, appealing to a smaller but dedicated academic audience.

Relation between Citation and Productivity

The general trend in the table shows a positive relationship between P_{citing} and P_{core}, where topics with more core articles tend to attract a higher number of citations. However, the degree of correlation varies across topics. This variation, when analyzed in relation to P_{core}, provides insights into the balance between foundational research and the breadth of academic interest.

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

Online Learning (P_{citing}: 16,532, P_{core}: 121) and Artificial Intelligence (P_{citing}: 13,505, P_{core}: 107) represent fields where both P_{citing} and P_{core} are very high. This combination indicates that these fields have a substantial number of foundational articles and broad academic engagement, showcasing their role as established and impactful research areas. The strong correlation between high Pciting and Pcore suggests that foundational research in these fields drives a large volume of subsequent studies.

Collaborative Learning (P_{citing}: 3,476, P_{core}: 45) and Virtual Reality (P_{citing}: 4,469, P_{core}: 58) exhibit moderate values for both metrics. This balance implies that while these fields have a solid foundation of core articles, their academic influence and citation reach are narrower compared to Online Learning and Artificial Intelligence. These fields may still be growing, with potential for expanding their foundational research and attracting more citations.

Topics like Blockchain (P_{citing}: 1,129, P_{core}: 29) and Lifelong Learning (P_{citing}: 1,136, P_{core}: 25) display both low P_{citing} and low P_{core}. These fields are likely emerging or niche, with a smaller foundational research base and limited academic interest. The low P_{citing} relative to the small number of core articles suggests that these areas are in early development stages, with their potential impact yet to be fully realized.

Digital Assessment (P_{citing}: 1,420, P_{core}: 22) and Mobile Learning (P_{citing}: 3,068, P_{core}: 54) show relatively low P_{citing} despite having a moderate number of core articles. This discrepancy may indicate that while there is a reasonable amount of foundational work, these topics have not yet achieved widespread visibility or broad citation influence. Factors such as niche appeal or slower adoption could contribute to this trend.

This variation highlights the interplay between foundational research and its dissemination. Topics with high P_{citing} and P_{core} are likely central to the digital educational ecosystem, while those with low values in both metrics may represent emerging research fronts with future growth potential.

Trajectory

The T_{citing} values represent the average number of years cited articles have contributed to a research topic, indicating sustained relevance, growth, and impact within the digital educational ecosystem. The observed T_{citing} can be devided to three groups of high T_{citing} ($\geq$3.0), moderate T_{citing} (2.9–3.0) and lower T_{citing} (<2.9).

Online Learning (3.087) has the highest T_{citing} value, showcasing enduring relevance and consistent growth. It reflects the pivotal role of Online Learning in shaping the educational ecosystem, with broad interest across disciplines. Artificial Intelligence (3.031), slightly lower than Online Learning, still indicates robust long-term impact and suggests steady integration into various educational applications. Hybrid Learning (3.112), with the highest T_{citing} among all topics, underscores its importance as a growing approach combining online and offline methods and demonstrates recent yet rapidly increasing attention in research. Massive Open Online Courses (MOOCs) (3.049) align with their transformative potential in democratizing education globally, reflecting ongoing academic interest despite challenges in implementation. Lifelong Learning (3.090) highlights its importance in addressing evolving educational needs across a person's lifespan, suggesting steady momentum for this emerging field. Personalized Learning (3.077) reflects the growing focus on tailored education experiences, a key area for future innovation.

Collaborative Learning (2.994) indicates steady interest and foundational relevance in group-based educational research. Virtual Reality (2.999) represents a rapidly evolving field, particularly in immersive learning applications. Digital Assessment (2.993) reflects moderate growth and continued exploration of innovative evaluation mechanisms. Mobile Learning (2.986) suggests a relatively stable yet less distinct research trajectory, likely due to overlaps with broader Online Learning topics. Digital Literacy (2.954) indicates sustained attention but with potential for greater research standardization and focus. Educational Technology (2.970) highlights the maturity of the field, suggesting slower growth compared to emerging areas.

Cloud Computing (2.755) has one of the lowest Tciting values, suggesting relatively recent adoption in educational applications and the potential for significant growth as its relevance in scalable and flexible

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

learning solutions expands. Gamification (2.817) reflects limited yet growing interest, emphasizing the need for more robust foundational studies. Learning Analytics (2.951), despite its importance in data-driven education, suggests slightly lower Tciting due to methodological challenges and variability in research. Blockchain (3.056), though relatively high, remains an emerging field with limited foundational contributions, as indicated by lower Pcore and Pciting values. Learning Management Systems (3.018), a practical tool in education, shows moderate relevance but limited innovation compared to newer research fronts.

Overally, high T_{citing} values (≥3.0) generally correspond to well-established and impactful research areas, such as Online Learning, Artificial Intelligence, and MOOCs. Moderate T_{citing} values (2.9–3.0) suggest areas with stable yet consistent research focus, such as Collaborative Learning and Virtual Reality. Low T_{citing} values (<2.9) highlight emerging fields like Cloud Computing and Gamification, which are still developing their research base but hold significant potential for future growth.

T_{citing} appears in the denominator of the formula. As T_{citing} increases, the denominator becomes larger, leading to a smaller CPT value if other variables remain constant. A high T_{citing} suggests the research field has a long and sustained impact, with citations spread over many years. While this demonstrates consistent relevance, it also implies that the impact is distributed over time rather than concentrated within a shorter period. CPT rewards concentrated impact because it reflects the efficiency of foundational research (P_{core}) in generating citations (P_{citing}) within a shorter timeframe. If T_{citing} is very high, it may indicate a mature or well-established field where foundational articles accumulate citations gradually over time, diluting the short-term influence captured by CPT. Conversely, fields with lower T_{citing} often represent "hotter" or rapidly developing areas, where core articles quickly generate a large number of citations, resulting in higher CPT values.

CPT Indicator and Hot Research Fronts

The CPT data for all research fronts within the digital educational ecosystem are presented in Figure 2. It highlights both the values and variations, serving as the basis for ranking the 'hotness' of these research fronts.

CPT numbers

The CPT numbers reveal key trends in emerging research fronts within the digital educational ecosystem. Online Learning stands out with the highest CPT (44.26), supported by a robust foundational base of 121 core articles and 16,532 citing articles, along with a high Tciting (3.087), indicating its sustained relevance and rapid growth. Artificial Intelligence follows with a CPT of 41.64, 107 core articles, and 13,505 citations, reflecting strong integration into digital education despite a slightly lower Tciting (3.031), suggesting steady rather than explosive growth.

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

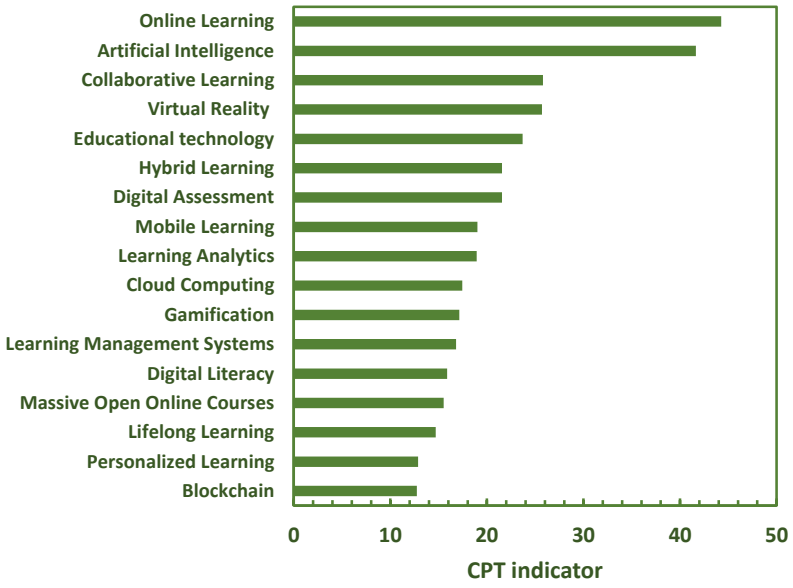

Figure 2. The CPT Data for All Research Fronts Within the Digital Educational Ecosystem.

Moderate CPT values are observed for Collaborative Learning (25.80) and Virtual Reality (25.69), each reflecting growing interest in innovative approaches to group-based and immersive education. Educational Technology (23.69), Hybrid Learning (21.57), and Digital Assessment (21.57) exhibit stable yet moderate CPTs, indicative of ongoing research activity but a need for further foundational breakthroughs.

Lower CPT values, such as Mobile Learning (19.03), Learning Analytics (18.94), and Blockchain (12.74), highlight either niche appeal or early-stage development. While Mobile Learning benefits from 54 core articles, its impact may be diluted by overlaps with Online Learning. Learning Analytics, despite its potential, suffers from inconsistent methodologies, while Blockchain remains in its infancy with only 29 core articles and 1,129 citations.

Top 5 Hot Research Fronts

The top 5 CPT values from the table are:

Online Learning

Artificial Intelligence

Collaborative Learning

Virtual Reality

Educational Technology

These top 5 CPT values highlight fields that are either well-established or rapidly growing within the digital educational ecosystem. As above mentioned description, key reasons for these high CPT rankings are ralated to (i) Impactful foundational research: The high number of core articles in these fields indicates robust foundational research driving further studies; (ii) Broad applicability: Topics like Online Learning and AI are widely applicable across disciplines and educational levels, ensuring continued relevance and citation; (iii) Emerging technologies: Fields such as VR and Collaborative Learning have become critical due to advances in technology and shifts in educational practices; and (iv) Global trends: The shift to digital

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

and hybrid education post-pandemic has amplified interest in these areas, especially Online Learning and Educational Technology.

Geographical Mapping and Contributions From ASEAN

Productivity

Table 3 presents rankings of the published productivity, i.e. the foundational papers for the five hot research fronts in Online Learning, Artificial Intelligence, Collaborative Learning, Virtual Reality, and Educational Technology, highlighting contributions from universities, affiliations, and countries based on publication counts. China and the USA dominate the global research outputs across all research fronts, occupying top positions in terms of publication counts for both countries and affiliated institutions. ASEAN universities, particularly from Malaysia and Indonesia, are significantly represented in several research fronts, demonstrating their emerging prominence in digital education research.

In Online Learning, Malaysia ranks 4th globally with 444 publications. Leading Malaysian universities include Universiti Teknologi MARA (Rank 1) with 62 papers, Universiti Malaya (Rank 3) with 46 papers, and Universiti Kebangsaan Malaysia and Universiti Teknologi Malaysia (Rank 8) with 41 papers each. Indonesia ranks 5th globally with 390 publications, showing its growing research activity in this area.

In Collaborative Learning, Universiti Teknologi Malaysia ranks 4th globally with 11 publications, positioning Malaysia among the top contributors in this category. Malaysia ranks 6th overall with 50 papers, showcasing focused research efforts on group-based educational methods.

In Virtual Reality, ASEAN universities are not featured in the top 10 affiliations. This indicates that the field remains a growth opportunity for institutions in the region.

In Educational Technology, Malaysia ranks 10th globally with 28 publications, reflecting its contributions to advancing educational technology. ASEAN universities, however, do not appear individually in the top 10 affiliations for this category, suggesting scope for strengthening institutional efforts.

Table 3. Top 10 Countries and Institutions Producing Core Papers in the Five Hot Research Fronts

Research Front	Rank	Affiliation	Pub. Papers	Rank	Country	Pub. Papers
Online Learning	1	Universiti Teknologi MARA	62	1	China	990
	2	University of South Africa	59	2	USA	923
	3	King Saud University	47	3	Saudi Arabia	449
	3	King Abdulaziz University	46	4	Malaysia	444
	3	Universiti Malaya	46	5	Indonesia	390
	3	King Faisal University	46	6	Spain	384
	7	The University of Jordan	44	7	UK	352
	8	Universiti Kebangsaan Malaysia	41	8	Australia	346
	8	Universiti Teknologi Malaysia	41	9	India	339
	10	Imam Abdulrahman Bin Faisal University	40	10	Russia	210
Artificial Intelligence	1	Harvard Medical School	87	1	China	1700
	2	Ministry of Education of the People's Republic of China	75	2	USA	1284
	3	Chinese Academy of Medical Sciences, Peking Union Medical College	58	3	UK	369

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

	4	Massachusetts General Hospital	51	4	India	334
	4	Renmin Hospital of Wuhan University	51	5	Germany	266
	6	Chinese Academy of Sciences	49	6	Spain	235
	6	University of California, San Francisco	49	7	South Korea	219
	8	Fudan University	48	8	Saudi Arabia	209
	9	Inserm	45	9	Canada	182
	9	Stanford University	45	10	Australia	180
	9	Sichuan University	45			
	9	Brigham and Women's Hospital	45			
Colaborative Learning	1	Beijing Normal University	15	1	USA	264
	2	University of Toronto	13	2	Spain	154
	3	Zhejiang University	12	3	China	120
	4	Oulun Yliopisto	11	4	UK	65
	4	Universiti Teknologi Malaysia	11	5	Taiwan	54
	4	College of Education, Zhejiang University	11	6	Malaysia	50
	7	Universidad de Granada	10	7	Australia	46
	8	Universidad de Córdoba	9	8	Canada	33
	8	Universidad de Zaragoza	9	9	Finland	30
	8	Universidad Complutense de Madrid	9	10	Netherlands	29
	8	Universidad de Sevilla	9	10	Germany	29
Virtual Reality	1	Tecnológico de Monterrey	15	1	USA	328
	2	University of Illinois Urbana-Champaign	13	2	China	261
	2	University of Florida	13	3	Spain	96
	4	University of Toronto	11	4	UK	87
	5	Universitat de Barcelona	10	5	Australia	70
	5	The University of Hong Kong	10	6	Germany	66
	5	University of Southern California	10	7	Taiwan	64
	8	Chinese University of Hong Kong	9	8	Italy	51
	8	University College Dublin	9	8	Canada	51
	8	Monash University	9	10	South Korea	47
	8	Beijing Normal University	9			
Educational technology	1	Tecnológico de Monterrey	16	1	Spain	155
	1	Universidade de São Paulo	16	2	USA	154
	1	Kazan Federal University	16	3	China	107
	4	Universidad de Granada	15	4	Russian	105
	5	Sechenov First Moscow State Medical University	12	5	UK	58
	6	Universidad de Sevilla	11	6	Australia	53

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

	6	International University of La Rioja	11	7	Brazil	49
	8	Universidad de Murcia	9	8	Saudi Arabia	30
	8	Universidad de Extremadura	9	9	Canada	29
	8	University of Technology Sydney	9	10	Mexico	28
	8	Abai Kazakh National Pedagogical University	9	10	Malaysia	28

Malaysia stands out as a leader among ASEAN countries, consistently ranking within the top 10 globally across multiple research fronts, particularly in Online Learning and Collaborative Learning. Indonesian research output is noteworthy in Online Learning, where it ranks 5th globally, reflecting its growing investment in digital education. Other ASEAN nations, such as Thailand, Vietnam, and the Philippines, do not appear in the top rankings, indicating opportunities to enhance research visibility and collaboration.

ASEAN universities demonstrate strong specialization in Online Learning and Collaborative Learning, areas where they contribute significantly to global research trends. Fields like Virtual Reality and Educational Technology remain underexplored by ASEAN institutions, presenting areas for future focus and interdisciplinary collaboration. The data highlights ASEAN countries' growing contributions to digital educational research, particularly from Malaysian institutions. To further strengthen their global position, ASEAN countries could focus on emerging areas like Virtual Reality and Artificial Intelligence, fostering collaboration and expanding foundational research efforts.

Core paper

Table 4 provides detailed data on core papers across five research fronts: Online Learning, Artificial Intelligence, Collaborative Learning, Virtual Reality, and Educational Technology. The data highlights the rankings of institutions and countries based on their published paper counts, shedding light on the distribution and contribution of research activity globally.

Table 4. Top 5 Countries and Institutions Producing Core Papers in the Five Hot Research Fronts

Research front	Institution				Country		
	Rank	Name	Country	Pub. Paper	Rank	Name	Pub. paper
Online learning	1	King Faisal University	Saudi Arabia	4	1	Saudi Arabia	12
	2	Universiti Teknologi Malaysia	Malaysia	2	2	Malaysia	9
	3	University of Oslo	Norway	2	2	USA	9
	4	University of Economics in Katowice	Poland	2	4	China	8
	5	Qassim University	Saudi Arabia	2	5	Australia	7
Artificial Intelligence	1	German Cancer Research Center	Germany	5	1	USA	22
	2	University Of Sharjah	UEA	3	2	China	14
	3	Sun Yat-sen University	China	2	3	UK	10
	3	Wuhan University	China	2	4	Turkey	9
	3	The Chinese University of Hong Kong	Hong Kong	2	5	Germany	8

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

	3	University of Granada	Spain	2			
	3	National Central University	Taiwan	2			
	3	Northeastern University	USA	2			
	3	Stanford University	USA	2			
Collaborative Learning	1	Zhejiang University	China	2	1	China	9
	1	University of Eastern Finland	Finland	2	2	USA	6
	1	University of Oulu	Finland	2	3	Netherlands	5
					4	Finland	4
					5	Spain	3
Virtual Reality	1	University of Copenhagen	Denmark	3	1	USA	10
	2	Malaysia University of Science and Technology	Malaysia	2	2	China	7
					3	Taiwan	5
					4	UK	4
					5	Denmark	3
					5	Malaysia	3
Educational Technology	1	Tecnologico de Monterrey	Mexico	3	1	Spain	12
	2	Royal Roads University	Canada	2	2	Australia	4
	2	University of Patras	Greece	2	2	Saudi Arabia	4
	2	King Saud University	Saudi Arabia	2	4	Canada	3
	2	University of Almeria	Spain	2	4	China	3
	2	University of Salamanca	Spain	2	4	Germany	3
					4	Mexico	3
					4	UK	3
					4	USA	3

In Online Learning, King Faisal University from Saudi Arabia ranks first with 4 published papers, contributing to Saudi Arabia's leading position globally with 12 papers. Universiti Teknologi Malaysia ranks second with 2 papers, positioning Malaysia as the second-ranked country with a total of 9 papers. The United States shares second place with Malaysia, also contributing 9 papers. Other notable contributors include China, ranked fourth with 8 papers, and Australia, ranked fifth with 7 papers. These results emphasize the prominent role of Saudi Arabia and Malaysia in Online Learning research.

In Artificial Intelligence, the German Cancer Research Center leads with 5 papers, while the University of Sharjah from the United Arab Emirates follows closely with 3 papers. A group of institutions, including Sun Yat-sen University and Wuhan University from China, The Chinese University of Hong Kong, University of Granada, and National Central University, share the third position with 2 papers each. At the country level, the United States dominates with 22 papers, followed by China with 14 papers and the United Kingdom with 10 papers. Turkey and Germany contribute 9 and 8 papers, respectively. This data highlights the significant contributions of both advanced Western institutions and emerging Asian research centers in shaping Artificial Intelligence research.

In Collaborative Learning, Zhejiang University from China and two Finnish institutions—University of Eastern Finland and University of Oulu—share the top rank with 2 papers each. China emerges as the leading country with 9 papers, followed by the United States with 6 papers and the Netherlands with 5 papers. Finland secures the fourth position with 4 papers, while Spain follows with 3 papers. These results

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

indicate China's strong leadership in Collaborative Learning research, alongside significant contributions from European countries such as Finland and the Netherlands.

In Virtual Reality, the University of Copenhagen in Denmark takes the top position with 3 papers. Malaysia University of Science and Technology ranks second with 2 papers, placing Malaysia in a notable global position. At the country level, the United States leads with 10 papers, followed by China with 7 papers and Taiwan with 5 papers. Several countries, including the United Kingdom, Australia, Canada, Denmark, and Malaysia, contribute 3 papers each, reflecting the growing global interest in Virtual Reality research. Malaysia's appearance among the top institutions and countries highlights its emerging role in this innovative field.

In Educational Technology, Tecnologico de Monterrey from Mexico leads with 3 papers, while multiple institutions, including King Saud University from Saudi Arabia, Royal Roads University from Canada, and University of Almeria from Spain, share the second position with 2 papers each. Spain tops the country rankings with 12 papers, followed by Australia and Saudi Arabia with 4 papers each. Several other countries, including Canada, China, Germany, Mexico, the United Kingdom, and the United States, contribute 3 papers each. The data underscores Spain's significant leadership in Educational Technology research, with notable contributions from a diverse range of countries.

Malaysia stands out as the leading ASEAN country with strong contributions in Online Learning and Virtual Reality research. Universiti Teknologi Malaysia ranks second globally in Online Learning, contributing to Malaysia's overall second position with 9 papers. Malaysia University of Science and Technology also achieves recognition in Virtual Reality research, ranking second globally with 2 papers. Malaysia further ties for fifth place at the country level in Virtual Reality, with a total of 3 papers. These results reflect Malaysia's growing prominence in digital education research and its commitment to innovative technologies.

From ASEAN, while Malaysia demonstrates strong performance, other countries such as Indonesia, Thailand, Vietnam, and the Philippines are absent from the rankings. This absence highlights a research gap in the region and presents opportunities for greater participation and contributions to global research. Expanding research efforts and fostering international collaborations could help these nations strengthen their visibility and impact in emerging fields.

Overall, the table highlights Malaysia's leadership within ASEAN in the fields of Online Learning and Virtual Reality. This success reflects a combination of institutional efforts and national priorities focused on digital education and technological innovation. To further enhance their global standing, ASEAN countries, including Malaysia, could invest in emerging research fronts such as Artificial Intelligence, Collaborative Learning, and Educational Technology. Strengthening regional collaboration, increasing research funding, and focusing on interdisciplinary approaches will be key to advancing ASEAN's contributions to the digital educational ecosystem.

Discussion

Contributions of Asean Universities

The above mentinoned data highlights the impressive contributions of ASEAN universities, particularly Malaysia, to foundational research in the five hot research fronts: Online Learning, Artificial Intelligence, Collaborative Learning, Virtual Reality, and Educational Technology. These contributions position Malaysia as a regional leader in digital education research and underscore the potential for ASEAN universities to further strengthen their global influence through targeted strategies and increased collaborations.

In Online Learning, Malaysia ranks 4th globally with 444 publications, showcasing its strong institutional foundation in digital education. Leading Malaysian universities include Universiti Teknologi MARA with 62 papers, Universiti Malaya with 46 papers, and Universiti Kebangsaan Malaysia and Universiti Teknologi Malaysia, each contributing 41 papers. This research output highlights Malaysia's strategic focus on Online

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

Learning, which plays a central role in addressing educational access and quality, particularly in the context of Southeast Asia's diverse and expanding educational demands. Indonesia ranks 5th globally with 390 publications, signaling significant progress and growing investments in this research front. Indonesian universities demonstrate increasing capabilities, providing a strong base for future advancements. These achievements reflect how ASEAN nations are leveraging Online Learning to respond to regional challenges such as expanding educational access, improving learning outcomes, and supporting lifelong learning.

In Collaborative Learning, Malaysia further strengthens its position as a key contributor, with Universiti Teknologi Malaysia ranking 4th globally with 11 core papers. Nationally, Malaysia ranks 6th overall with 50 publications, demonstrating a focused research effort in group-based and collaborative educational methodologies. Collaborative Learning is particularly relevant for ASEAN countries, where social and peer-based learning approaches align well with cultural and pedagogical traditions. With increasing regional and international collaboration opportunities, ASEAN institutions have the potential to expand research in Collaborative Learning to address new educational challenges, such as team-based skills development and multidisciplinary learning environments.

In Virtual Reality, Malaysia University of Science and Technology stands out by ranking 2nd globally with 2 papers, placing Malaysia among the leaders in this innovative field. Malaysia ties for 5th place globally with 3 papers at the country level, underscoring the country's potential to influence Virtual Reality research. Virtual Reality technologies have transformative potential for immersive learning experiences, particularly in STEM education, medical training, and technical skills development, areas highly relevant for ASEAN's workforce needs. However, Virtual Reality remains underexplored by other ASEAN universities, which highlights the need for regional efforts to build capacity in this field. Developing Virtual Reality applications tailored to local educational needs, such as vocational training and simulation-based learning, can help ASEAN countries address skill gaps and enhance digital competency across sectors.

In Educational Technology, Malaysia ranks 10th globally with 28 papers, marking its consistent contributions to advancing technology-driven teaching and learning solutions. Despite this, no ASEAN universities feature individually among the top-ranked institutions, indicating a gap in high-impact research outputs. Educational Technology is a crucial area for ASEAN countries, as it can address issues of scalability, inclusivity, and personalization in education. With rising adoption of technology across the region, Malaysian institutions have the opportunity to take the lead in this research front by developing innovative tools for digital assessments, adaptive learning systems, and technology-enabled classrooms. Other ASEAN countries could follow Malaysia's lead by fostering interdisciplinary collaborations between educators, technologists, and policymakers to drive impactful Educational Technology research.

In Artificial Intelligence, ASEAN universities are notably absent from the top global rankings, signaling a significant research gap in this transformative field. Artificial Intelligence is reshaping the educational landscape worldwide through advancements in learning analytics, intelligent tutoring systems, and personalized learning pathways. For ASEAN nations, investing in Artificial Intelligence research is critical to remain competitive and address challenges such as improving educational quality, providing real-time feedback, and analyzing large-scale student data to inform policy decisions. Malaysia, as the leading ASEAN country, is well-positioned to spearhead initiatives in this area through increased research funding, faculty development programs, and collaborations with global technology partners. Building Artificial Intelligence expertise will allow ASEAN countries to innovate solutions that align with regional educational goals, such as inclusivity and equitable access.

Perspectives for ASEAN Universities

The achievements of Malaysian universities highlight the potential of ASEAN countries to contribute meaningfully to the global digital educational ecosystem. Malaysia's leadership in Online Learning, Collaborative Learning, and Virtual Reality provides a strong foundation for regional progress. However, the absence of other ASEAN nations, such as Thailand, Vietnam, and the Philippines, in top global rankings reflects untapped opportunities for research expansion and collaboration.

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

To build on Malaysia's success and elevate ASEAN's collective research impact, the following perspectives can guide future efforts:

- Strengthening Regional Collaboration: ASEAN universities can benefit from increased partnerships, shared resources, and joint research projects. Establishing regional research networks in fields like Online Learning, Artificial Intelligence, and Virtual Reality will allow institutions to pool expertise, share funding opportunities, and address regional educational priorities collectively.

- Capacity Building in Emerging Fields: Research in Artificial Intelligence and Virtual Reality is particularly underdeveloped among ASEAN countries. Governments and institutions should prioritize investments in faculty training, research infrastructure, and international collaborations to accelerate progress in these transformative areas. Building local expertise will enable ASEAN universities to produce impactful research that meets both regional and global demands.

- Focus on Localized Solutions: ASEAN countries have unique educational challenges, including language diversity, access disparities, and digital divides. Research outputs should emphasize developing localized, context-specific solutions that address these challenges. For example, Virtual Reality applications tailored for vocational training and Artificial Intelligence tools designed to analyze multilingual educational data can have significant regional impact.

- Increasing Research Funding and Support: Governments, industry partners, and policymakers must collaborate to create funding mechanisms that incentivize research in digital education. Targeted grants, scholarships, and research fellowships can enable ASEAN universities to compete globally and drive innovation in Educational Technology and Collaborative Learning.

- Promoting Interdisciplinary Approaches: Research in digital education requires collaboration across disciplines, including computer science, education, psychology, and engineering. ASEAN universities should encourage interdisciplinary research programs to address complex educational challenges and develop innovative technologies for teaching and learning.

Conclusion

This study highlights the most active and hot research fronts in the digital educational ecosystem, identified through Clarivate's analysis of bibliometric data. By examining foundational research, citation impact, and geographical distribution, the study identifies Online Learning, Artificial Intelligence, Collaborative Learning, Virtual Reality, and Educational Technology as the five key research fronts shaping the future of digital education.

ASEAN universities, particularly from Malaysia and Indonesia, demonstrate notable contributions, with Malaysia emerging as a regional leader in Online Learning and Virtual Reality. Malaysian institutions like Universiti Teknologi MARA and Malaysia University of Science and Technology play pivotal roles in advancing these research fronts. However, the underrepresentation of other ASEAN nations, such as Thailand, Vietnam, and the Philippines, underscores opportunities for growth and collaboration.

The study emphasizes the need for targeted strategies to strengthen ASEAN's research capacity. Investments in Artificial Intelligence and Virtual Reality, enhanced regional collaboration, and increased research funding are essential to address existing gaps and unlock the potential for innovation. Moreover, developing localized solutions tailored to ASEAN's unique educational challenges, including digital divides and access disparities, will be critical for inclusive and impactful progress.

Ethics Approval and Consent to Participate: All authors have reviewed the manuscript and provided their consent for its publication

Acknowledgements: Not applicable

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 12630 – 12645
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5975

Conflict of Interest: The authors declare no Conflict of interest

Funding: Not applicable

Generative AI Statement

The authors used ChatGPT 4.0 during the preparation of this work to review and, in some instances, enhance the text's flow. Following this process, the authors thoroughly reviewed and edited the content as necessary. The authors assume full responsibility for the data, methodology, and content of this publication.

ORCID

Nguyen Huu Thanh Chung: https://orcid.org/0009-0007-6293-6129

Tran Ai Cam: https://orcid.org/0009-0006-7411-4280

References

Garfield, E. (1955). Citation indexes for science: A new dimension in documentation through association of ideas. Science, 122(3159), 108-111. https://garfield.library.upenn.edu/papers/science1955.pdf

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. Proceedings of the National academy of Sciences, 102(46), 16569-16572. https://doi.org/10.1073/pnas.0507655102

Li, M., & Chu, Y. (2017). Explore the research front of a specific research theme based on a novel technique of enhanced co-word analysis. Journal of Information Science, 43(6), 725-741. https://doi.org/10.1177/0165551516661914

Mazov, N. A., Gureev, V. N., & Glinskikh, V. N. (2020). The methodological basis of defining research trends and fronts. Scientific and Technical Information Processing, 47, 221-231. https://doi.org/10.3103/S0147688220040036

Price, D. J. D. S. (1965). Networks of scientific papers: The pattern of bibliographic references indicates the nature of the scientific research front. Science, 149(3683), 510-515. https://doi.org/10.1126/science.149.3683.510

Research fronts. (2017, June 30). Institutes of Science and Development, Chinese Academy of Sciences. http://www.casisd.cn/zkcg/zxcg/201706/P020170630548078477885.pdf

Research fronts. (2024, Dec 4). Institutes of Science and Development, Chinese Academy of Sciences. http://english.casisd.cas.cn/research/rp/202412/P020241204460356658847.pdf

Small, H., & Griffith, B. C. (1974). The structure of scientific literatures I: Identifying and graphing specialties. Science studies, 4(1), 17-40. https://doi.org/10.1177/030631277400400102

Tran Ai Cam and Nguyen Huu Thanh Chung. (2024). Exploring Impactful Research Fronts of the Digital Educational Ecosystem: A Bibliometric Analysis, submitted to Journal of Learning for Development.

Zheng Y., Xu X., Liu Z. (2016). Study on the Method of Identifying Research Fronts Based on Keywords Co-occurrence. Library and Information Service, 60(4), 85-92. https://doi.org/10.13266/j.issn.0252-3116.2016.04.012.