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Production Analysis and Scientific Mapping on Flipped Classroom Research During Covid-19

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ABSTRACT

This research aimed to analyze the production and scientific mapping of Flipped Classroom (FC) research during Covid-19. The bibliometric method was applied using the Scopus database source, and data were analyzed using the VOSviewer. The results of the study are: (1) The trend of FC publication during Covid-19 continues to increase; (2) English is the primary language used in the FC research; (3) Top publication sources are articles published in journals; (4) The top most prolific writers are Lewin, D, R. and authorship patterns resulted in 22 strongly connected authors; (5) The top countries and institutions in conducting FC research during Covid-19 are the United States and the University of Pennsylvania; (6) The author's most used keywords in the top five are FC, Covid-19, students, e-learning, and teaching; (7) The most citations occurred in articles published in 2020 with a total of 405 citations written by Chick et al. in the field of educational technology studies; and (8) The network and overlay visualization of the FC research consist of four clusters representing four themes regarding the FC during Covid-19. The FC approach can be described as a popular educational model among researchers.

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INTRODUCTION

Education has been developing with the rising use of information and communication technology. Learning models that use technology to impart knowledge have become increasingly popular due to the advancement of technology in educational operations (Chick et al., 2020; Divjak et al., 2022; Huynh et al., 2020). The FC, as a technology-infused educational product, has become an integral aspect of educational practice in a variety of subjects, including science, language, physics, mathematics, medical education, music, etc. (Afrilyasanti et al., 2017; C. K. Chen et al., 2019; Durfee et al., 2020; Putri & Purwaningsih, 2021). The FC is an educational idea in which traditional teaching and coursework are replaced with new ones (Singla et al., 2016). Students view educational materials outside the classroom and talk about them with their classmates or substitute new material for what has already been presented in the opposite class (Hew et al., 2020; Li et al., 2021; Ożadowicz, 2020).

The first fundamental thing we must never forget as educators is to produce meaningful learning, meaning that students must be actively involved. Learning occurs when students are involved in attitude, affectively, socially, and cognitively (C. H. Chen & Mullen, 2020; Suprapto et al., 2021). It means that all activities in the classroom should be able to accommodate (students) students to increase their engagement or involvement. As a result, the view that teachers are the only source of information is no longer relevant for millennials.

Communication is easily accessible in seconds (Fitriana et al., 2020; Martín et al., 2021). Of course, anyone can quickly find the desired data/facts/info. Then what is our role as teachers/lecturers? Our role is no longer a knowledge transmitter but rather a role in facilitating learning by stimulating students to sort and process existing information.

Another important aspect related to the FC is the role of technology in learning. We cannot deny that technology offers many conveniences in education to make learning more flexible and not limited by space and time (Camargo et al., 2020; Dickinson & Gronseth, 2020; Lin, 2021). However, it should be underlined that technology is only a tool. The most important thing is to remain a pedagogue or how a teacher/lecturer carries out learning. Bringing technology into learning certainly does not automatically improve the quality of knowing. Learning technology will distract from achieving learning objectives without the proper pedagogy.

Some researchers have conducted recent studies on the FC, including the following. Nja et al. (2022) demonstrate how FC learning can boost student success and attitudes. Furthermore, students feel satisfied after studying in the FC (Yeh, 2022), and their thinking skills can develop (Nugraheni et al., 2022). The FC paradigm is significant because it increases student performance outside of the classroom (Abdullah et al., 2019; Akçayır & Akçayır, 2018; Saira et al., 2021). This model has recently gained popularity in fields such as physics (Hadriani, 2021; Pattiserlihun & Setiadi, 2020; Putri & Purwaningsih, 2021), mathematics (Fung et al., 2021), natural sciences (C. K. Chen et al., 2019; Turan, 2021), languages (Afrilyasanti et al., 2017), medicine (C. H. Chen & Mullen, 2020; Oudbier et al., 2022; Youhasan et al., 2021), and technology education (Ali Ghufron & Nurdianingsih, 2021).

There has not been a genuinely thorough FC bibliometric study on scientific production and mapping during Covid-19, particularly for bibliometric analyses that use Scopus as their principal database. Bibliometric studies, according to researchers, are critical for bibliographic mapping data from specific domains (Fernandez-Batanero et al., 2020; Hidaayatullaah et al., 2021a; Suprapto, Prahani et al., 2021a). Therefore, the article aims to round out other crucial parts of the reverse class research map to create a more detailed map. Unlike earlier research, this study focuses on analyzing FC research's production and scientific mapping during Covid-19.

This study focuses on analyzing the production and scientific mapping of FC research during Covid-19 with eight specific objectives, (1) The distribution of documents by year in the FC research during Covid-19; (2) Languages used by researchers in the FC research during Covid-19; (3) Sources for publishing documents in the FC research during Covid-19; (4) Author's collaboration in the FC research during Covid-19; (5) Distribution of the top countries and institutions in the FC during research Covid-19; (6) Author keyword trends in the FC research during Covid-19; (7) Top citations of documents in the FC research during Covid-19; and (8) Network visualizations and research overlays in the FC research during Covid-19.

RESEARCH METHOD

Database

This study adopted a bibliometric method (Suprapto et al., 2021; Suprapto, Prahani et al., 2021b; Yang et al., 2017). Bibliometric analysis is a quantitative method for assessing bibliographic data from articles and journals using systematic and explicit mapping (Liu & Zhang, 2021; Suprapto et al., 2021; Yanuarti & Suprapto, 2021). Bibliometrics aims to track the evolution of scholarly articles and contributions. The research was conducted by searching the Scopus database. The Scopus database is used because it is one of the most extensive single indexing and abstract databases globally and is considered more relevant by the scientific community regarding its robustness and periodicity (Hidaayatullaah et al., 2021b; Zakhiyah et al., 2021).

Research Process and Metadata Collection

The research began by conducting an online search in May 2022. The complete steps are illustrated in Figure 1. Based on the record's title for this research, the author concentrates on all

FC-related documents during Covid-19. Intrinsically, the Keywords used were "TITLE-ABS-KEY (flipped AND classroom AND covid 19)". A total of 249 documents were obtained based on the search results.

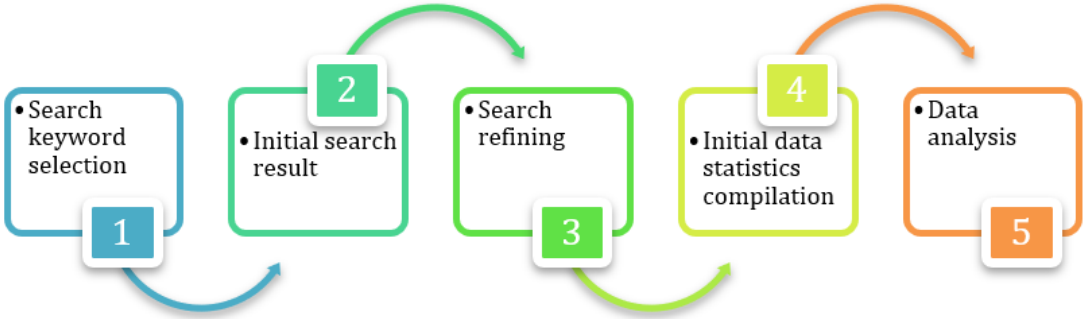


Figure 1. Steps in bibliometric studies (Khoir et al., 2022; Kushairi & Ahmi, 2021; Suprapto, Prahani, et al., 2021a)

Data Analysis

The following eight criteria served as the basis for the bibliometric analysis: (1) publication trends regarding FCs during Covid-19, (2) Language sources, (3) Document publishing sources, (4) Author collaboration, (5) State statistics and institutional collaboration, (6) Trends in the author's most used keywords in the FC (7) Top citations, and (8) Network and overlay visualization of research in the FC during Covid-19.

The VOSviewer application is used to carry out bibliometric analysis and display the outcomes of the bibliometric study (Hidaayatullaah et al., 2021b; Hu & Guo, 2021; Kushairi & Ahmi, 2021; Suprapto et al., 2021). VOSviewer works efficiently with large amounts of data and offers various visuals, analysis, and observations (Al-Shabibi & Al-Ayasra, 2019; Julia et al., 2020; Meral & Teke, 2021). In addition, VOSviewer can create publication, author, or journal maps based on co-citation platforms or keyword maps centred on distributed channels (Hudha et al., 2020). The types of files entered into the VOSviewer program for analysis are data documented in the form (.ris) dan (.csv).

RESULTS AND DISCUSSION

The distribution of documents by year in the FC research during Covid-19

There are 249 documents obtained based on Scopus database search results related to the FC during Covid-19. Publications devoted to converted classroom research during the Covid-19 Pandemic from 2020 to May 2022 are shown in Figure 2. The search focused on documents related to the FC during Covid-19, including articles, conference papers, books, notes, editorials, and letters.

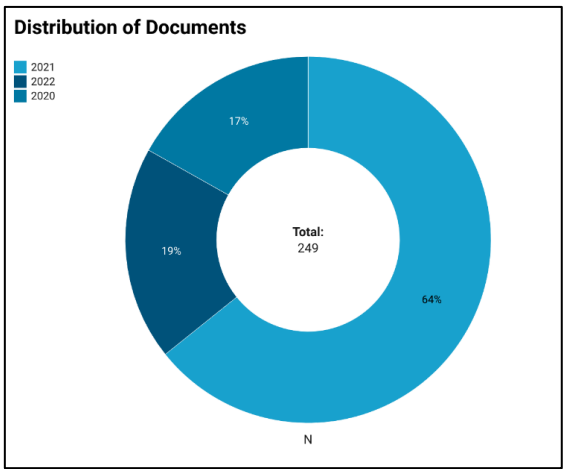


Figure 2. The distribution of documents by year in the FC research

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Figure 2 shows that the trend of research regarding FCs during Covid-19 in 2020 to 2021 increased significantly, with 281%. The high increase in research trends regarding FCs is due to the Covid-19 Pandemic, where FCs are a strategy or learning method that can be done outside the room or mixed face-to-face and online learning. Meanwhile, from 2021 to May 2022, the FC trend reached only 47 documents. It can be predicted that the number of articles regarding FCs will increase drastically in 2022 and the following year. After the pandemic, the FC is a rotating face-to-face learning solution (Kusnandar, 2021). In addition, there are demands for the industrial revolution 4.0 and the social revolution 5.0, which are marked by the necessity of achieving competence by educators, namely digital competence and computational thinking (Mann et al., 2021; Yuan et al., 2021).

The language used in the FC research during Covid-19

In terms of language in the article, most of them use English as the language of writing, which is 93.63% of the total documents. Other documents use Spanish 3.59%, German 1.59%, and Portuguese 1.20%, as shown in Figure 3. English in article writing is the primary international language researchers use in writing and publishing articles.

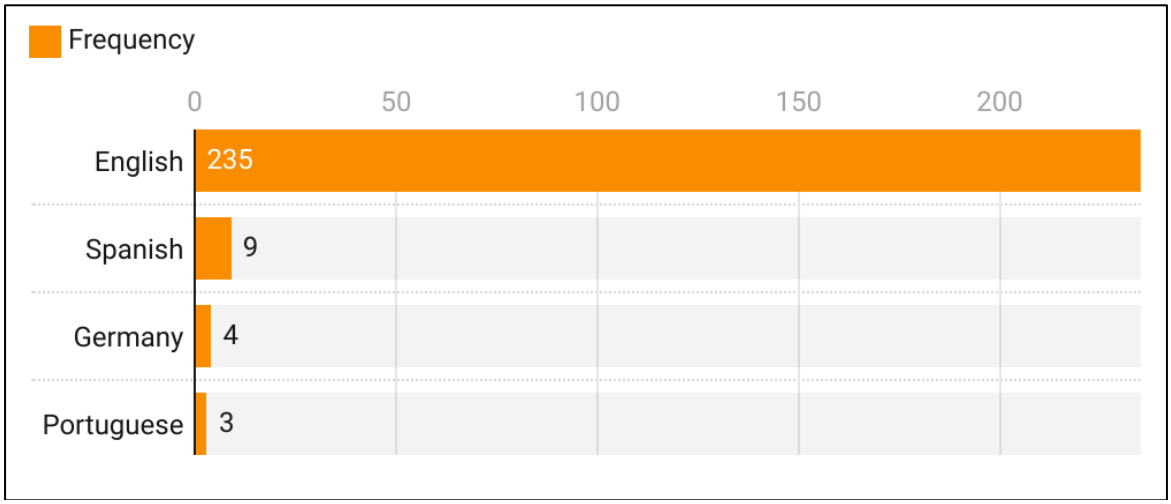


Figure 3. Top 4 most used publication languages in studies on the FC

The sources publishing documents of FC research during Covid-19

Researchers found nine documents related to the FC during Covid-19 in a search through the Scopus database. Two hundred forty-nine documents include articles, conference papers, book chapter reviews, conference reviews, notes, and letters. Table 1 shows that reports accounted for 63.45% of all publications, with conference papers accounting for 24.90%. Other documents accounted for 11.65% of the total records, including book chapter reviews, conference reviews, notes, editors, and letters.

Table 1. Type of FC documents

Type of Documents	∑ docs	Percentage
Article	158	63.45%
Conference Paper	62	24.90%
Book Chapter	8	3.21%
Review	7	2.81%
Conference Review	5	2.01%
Note	4	1.61%
Editorial	2	0.80%
Letter	2	0.80%
Erratum	1	0.40%
Total	249	100.00%

Table 2. Trends of subject area in FC research

Top Subject Area	FC	
	∑ docs	*Percentage (%)
Social Sciences	145	38.77%
Computer Science	76	20.32%
Medicine	57	15.24%
Engineering	43	11.50%
Health Professions	15	4.01%
Psychology	15	4.01%
Decision Sciences	12	3.21%
Business, Management and Accounting	11	2.94%
Total	374	100.00%

*Note: *An article can belong to more than one subject area*

Table 2 shows most of the studies on FC during Covid-19. Based on all the documents collected from the Scopus database, the FC covers almost all fields of study, which shows excellent diversity related to the research topic of the FC during Covid-19. Most of the studies on FCs were in social sciences, which represented 38.77%, followed by computer science (20.32%), Medicine (15.24%), and Engineering (11.50%). Other fields of study in the FC during Covid-19 are shown in Table 3. Meanwhile, Table 3 describes the journals or proceedings contributing to converted classroom research during Covid-19. The ACM International Conference Proceeding Series occupy the top ranking with a complete publication of 8 articles. The second place is the ASEE Annual Conference and Exposition Conference Proceedings, with seven articles. Education Sciences occupy third place with seven articles. The following journal from the fourth order down is published with less than seven articles.

Table 3. Prolific sources of FC research

Journal / Proceeding	∑ Docs
ACM Int. Conf. Proc. Ser.	8
ASEE Annual Conf. & Exposition Conf. Proc.	7
Education Sciences	7
Sustainability Switzerland	6
BMC Medical Education	5
Medical Science Educator	5
Academic Radiology	4
Proc. Frontiers in Education Conference Fie	4
ACS Symposium Series	3
Education & Information Technologies	3
Interactive Technology & Smart Education	3
International Journal of Emerging Technologies in Learning	3
Journal of Higher Education Theory and Practice	3
Journal of Physics Conference Series	3
Proc. 2021 16th Latin American Conf. on Learn. Tech.	3
Proc. 2020 IEEE Int. Conf. Teach. Assess. & Learn for Eng.	3

The author's collaboration in the FC research during Covid-19

The most prolific authors conducting research on FCs during Covid-19 are shown in Table 4. The top authors are Lewis, D.R., who contributed three documents regarding the FC during Covid-19. Meanwhile, the other writers gave an average of 2 papers.

Table 4. Top authors of FC research

No.	Authors	∑ docs	No	Authors	∑ docs
1.	Lewin, D.R.	3	16.	Jia, C.	2
2.	Annamalai, N.	2	17.	Joos, S.	2
3.	Bai, S.	2	18.	Latorre-Cosculluela, C.	2
4.	Barzel, A.	2	19.	Ledig, T.	2
5.	Bischoff, M.	2	20.	Mansbridge, C.	2
6.	Bosack, A.	2	21.	Maun, A.	2
7.	Cruickshank, V.	2	22.	Pill, S.	2
8.	Durrani, U.	2	23.	Quiroga, S.	2
9.	Eismann-Schweimler, J.	2	24.	Quispe, C.	2
10.	Fuchs, M.	2	25.	Schelble, S.M.	2
11.	Förster, C.	2	26.	Schwill, S.	2
12.	González-Gómez, D.	2	27.	Stengel, S.	2
13.	Han, J.	2	28.	Suárez, C.	2
14.	Hew, K.F.	2	29.	Szecsenyi, J.	2
15.	Jeong, J.S.	2	30.	Viana, W.	2

Twenty-two authors with strong connections were identified by the author's cooperation analysis utilizing VOSviewer and the number of times each author's study on the FC appeared in at least one document. Each author has 21 links and one record. The author's collaboration is only formed into one cluster (red) consisting of 22 items. Network visualization of co-authorship through searches in the Scopus database is depicted in Figure 4.

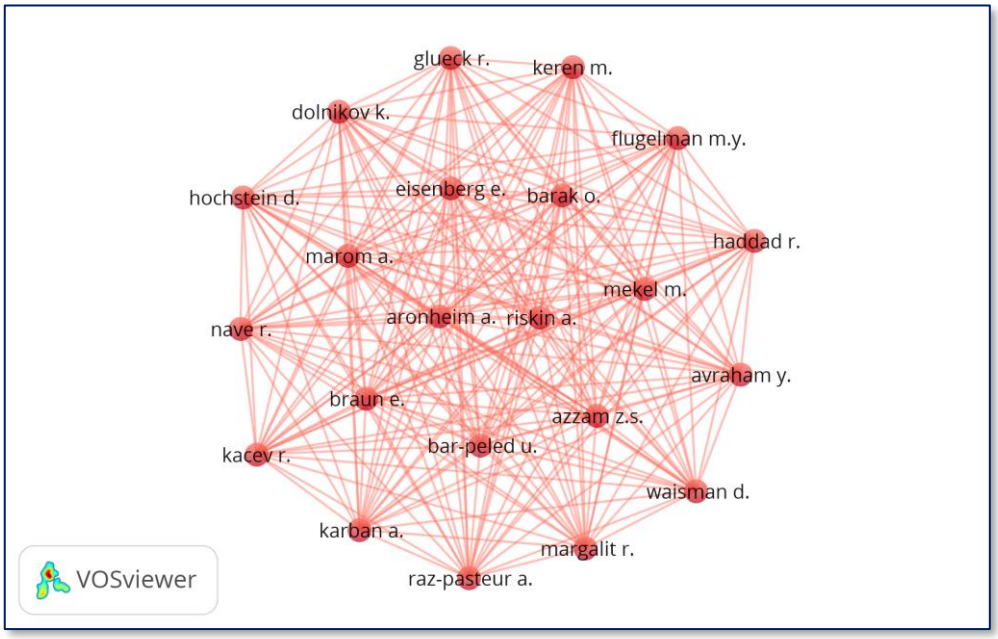


Figure 4. Network visualization of co-authorship of the FC research

Top countries and institutions of the FC research during Covid-19

Countries and institutions that have contributed a lot to research the FC during Covid-19 are presented in Table 5. Based on the number of cross-border documents, it is clear that the United States dominated the converted classroom research from 2020 to May 2022 with 64 papers. They were followed by China, Spain, Indonesia, and the United Kingdom with 23, 18, 12, 11, and 10 documents. Meanwhile, countries with less than ten documents are India, Australia, Brazil, and Hong Kong. The University of Pennsylvania and the Technion - Institute of Technology is the top institution with four documents. Institutions with an average contribution of 3 papers.

Table 5. Top countries and institutions

Country	∑ docs	Institution	∑ docs
United States	64	University of Pennsylvania	4
China	23	Technion - Institute of Technology	4
Spain	18	Harvard Medical School	3
Germany	12	University of Pennsylvania Perelman School of Medicine	3
Indonesia	11	The University of Hong Kong	3
United Kingdom	10	University of Florida	3
India	8	Universidad de Zaragoza	3
Australia	7	Universidad de Extremadura	3
Brazil	7	Universidad Politécnica de Madrid	3
Hong Kong	7		

The author keyword trends in the FC research during Covid-19

The terms dominate the visualization of the top keywords FC, Covid-19, student, education, and others presented in Figure 5. The results of the visualization of the author's keyword mapping network in the FC during the Covid-19 research consist of 4 main clusters indicated by red, yellow, green, and blue. Keywords of the same colour are often grouped. As a result, keywords such as FC, blended learning, online learning, curriculum, and learning strategy have the same colour (red) in this study, indicating that these terms have a close relationship and co-occur. The five main keywords used based on the number of occurrences are FC, Covid-19, students, e-learning, and teaching. Table 6 shows the top 10 keywords with the number and percentage of circumstances regarding converted classroom research during Covid-19.

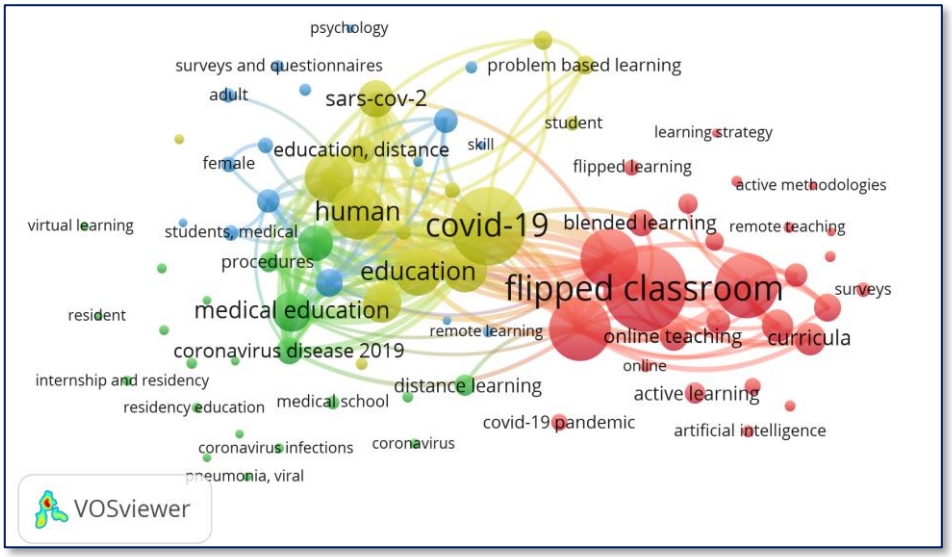


Figure 5. Visualization of the co-occurrence's keywords of FC research

Table 6. The ten most active author keywords

Author keywords	∑	Percentage
FC	101	16.34%
COVID-19	83	13.43%
Students	70	11.33%
E-learning	69	11.17%
Teaching	62	10.03%
Human	56	9.06%
Humans	50	8.09%
Education	46	7.44%
Pandemic	44	7.12%
Medical Education	37	5.99%

Top citations of documents in the FC research during Covid-19

The top ten articles cited in the FC are listed in Table 7. Authors by the name of Chick et al. (2020) about Using Technology to Continue Residents' Education During the Covid-19 Pandemic from the Journal of Surgical Education received the highest number of citations in the Scopus database with a total of 405. This was followed by the article During the Covid-19 Pandemic, emergency remote instruction and Students' academic achievement in higher education: a case study by Iglesian-Pradas et al. (2021) from Computers in Human Behavior received 97 citations, placed second. Meanwhile, the third rank by Tang et al. (2020) was about an FC's efficiency using online instruction in accordance with Covid-19 from Interactive Learning Environments with 61 citations. In contrast, the VOSviewer visualisation display, which shows the top authors and co-authorships and the most influential authors on FC research, is shown in Figure 6.

Table 7. Top 10 cited articles in the FC during Covid-19

No.	Author(s)	Year of Publication	∑ citations	Journal Name
1.	Chick, R.C., Clifton, G.T., Peace, K.M., (...), Almeida, A.A., Vreeland, T.J.	2020	405	Journal of Surgical Education
2.	Iglesias-Pradas, S., Hernández-García, Á., Chaparro-Peláez, J., Prieto, J.L.	2021	97	Computers in Human Behavior
3.	Tang, T., Abuhmaid, A.M., Olaimat, M., (...), Aldhaeebi, M., Bamanger, E.	2020	61	Interactive Learning Environments
4.	Ożadowicz, A.	2020	36	Education Sciences
5.	Camargo, C.P., Tempski, P.Z., Busnardo, F.F., Martins, M.A., Gemperli, R	2020	36	Clinics (Sao Paulo, Brazil)
6.	Durfee, S.M., Goldenson, R.P., Gill, R.R., (...), Flower, E., Avery, L.L.	2020	35	Academic Radiology
7.	Martín, C.T., Acal, C., Honrani, M.E., Estrada, Á.C.M.	2021	27	Sustainability (Switzerland)
8.	Hew, K.F., Jia, C., Gonda, D.E., Bai, S.	2020	26	International Journal of Educational Technology in Higher Education
9.	Chen, C.H., Mullen, A.J.	2020	20	JMIR Medical Education
10.	Dickinson, K.J., Gronseth, S.L.	2020	19	Journal of Surgical Education

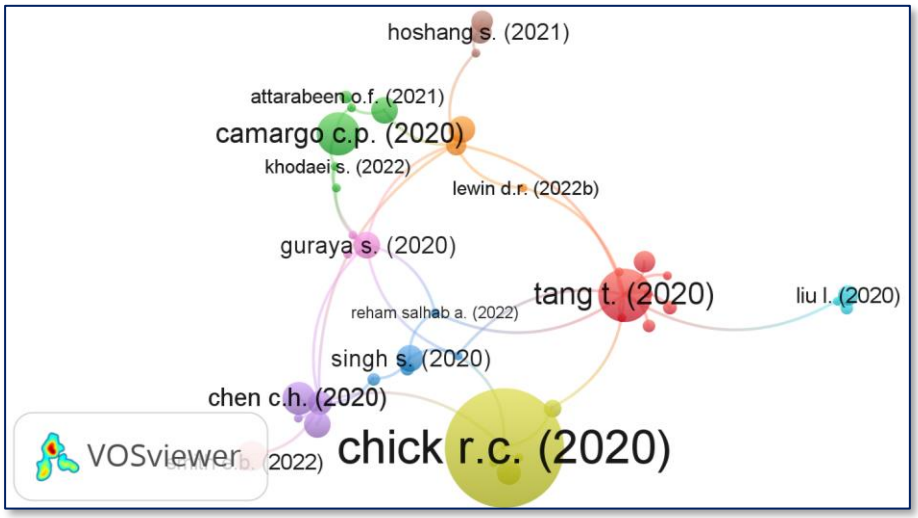


Figure 6. Top authors and co-authorships and the most influenced authors on FC research

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Network and overlay visualization of research in the FC during Covid-19

From a total of 249 documents, the visualization results of the VOSviewer network related to the FC are shown in Figure 7. The distance between the nodes in this visualization network, which stands for similar terms or concepts, reveals the relationship every time (Hidaayatullaah et al., 2021b; Suprapto, Prahani, et al., 2021b). Each colour in the image represents a cluster. Four clusters (red, green, blue, and yellow) illustrate the four themes in this VOSviewer network visualization map. Clusters are grouped as online learning groups (red clusters) as theme one, teaching or training model groups (green) as theme two, class methods and concepts group (blue) as these three, and assessment techniques group (yellow) as theme four.

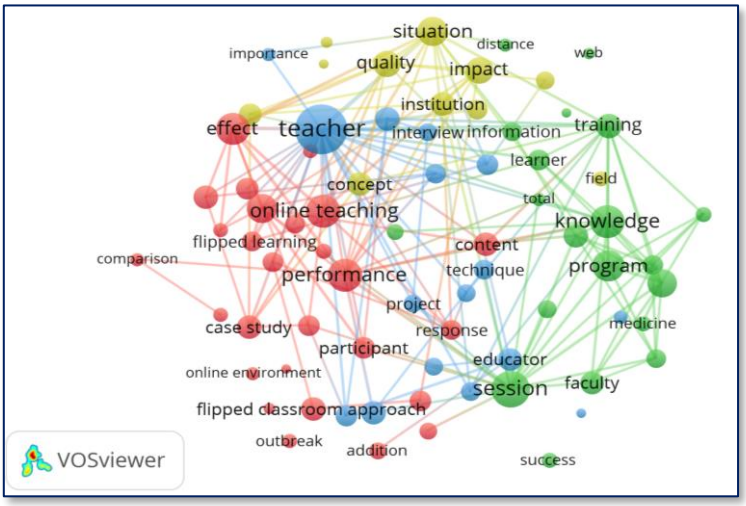


Figure 7. Network visualization of the whole picture of the FC research during Covid-19

Additionally, data is displayed in overlay and density visualization on the VOSviewer display (see Figure 8). The overlay visualization can show historical traces in the FC research during Covid-19, and the density visualization shows the emphasis of the FC research group from 2020 to May 2022. The picture on the left is the dominant topic regarding converted classroom research from August 2020 to February 2021. Each colour in the phrase symbolizes the previous two years; the dark blue represents older research, while the yellow shows the current trend in research. It can be seen that the topic trends carried out by researchers regarding the FC are approaches and strategies regarding flipped learning and online learning. The bright yellow in the picture on the right shows the research topic many researchers have done. At the same time, the faded yellow colour indicates research topics that are still few to be researched so that the results of the VOSviewer display can be used as a reference to find research gaps and novelty by researchers who will conduct research (Hidaayatullaah et al., 2021b; Kushairi & Ahmi, 2021; Meral & Teke, 2021).

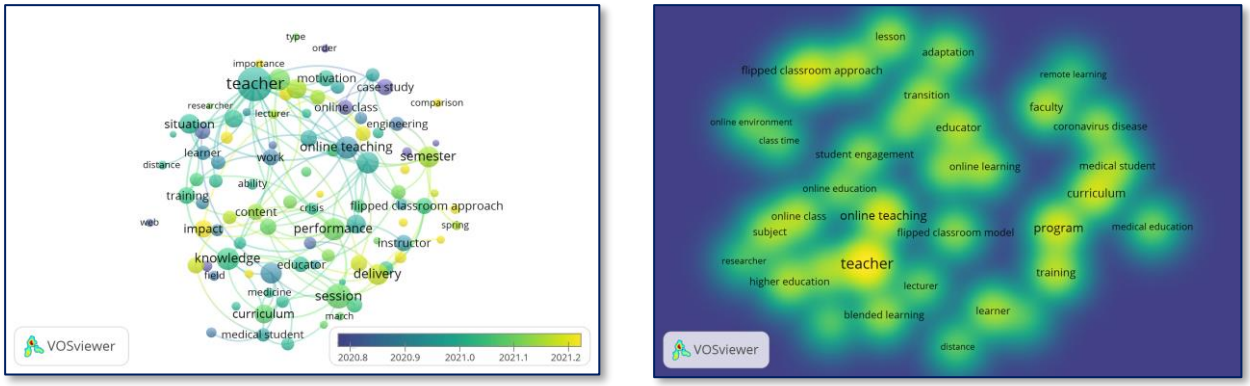


Figure 8. The network and density visualization map of the FC research during Covid-19

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The results of the overlay visualization of the dominant terms regarding the FC are shown in Figure 9. The FC is connected and has close relationships with teachers, students, curriculum, blended learning, online learning, etc. We find several findings if we detail specific relationships between terms to capture trends from the novelty of FC research. Figure 10a emphasizes the role of the teacher in the FC, where the teacher is related to online teaching, online education, educator, instructor, training and learner. Meanwhile, the FC approach is closely related to online teaching, lesson, online class, online environment, and educators (see Figure 10b). Figure 11 displays the word cloud generator of the FC during Covid-19. The FC is closely related to Covid-19, flipped learning, blended learning, teaching, education, online, and technology. In earlier research on the FC, blended learning mixes synchronous learning with asynchronous independent learning through in-person and virtual/online interactions. (Al-Far et al., 2021; Divjak et al., 2022; Puspitasari & Dewi, 2021; Zulhamdi et al., 2022).

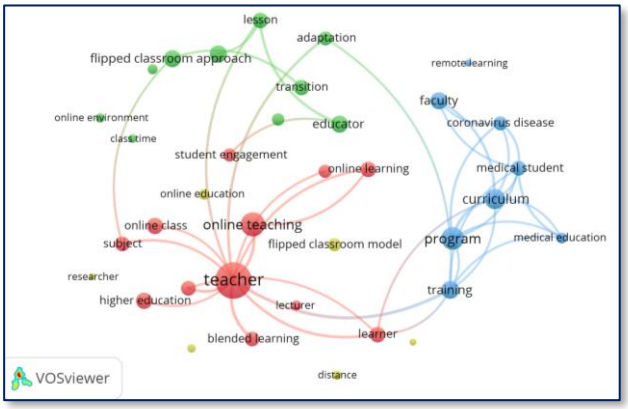
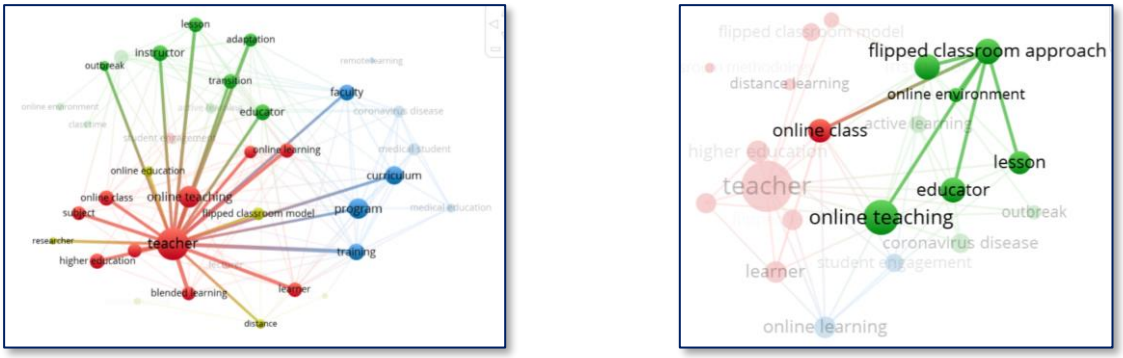


Figure 9. An overlay visualization of dominant terms regarding FC research



(a) (b)

Figure 10. (a) The role of a teacher in FC during Covid-19; (b) The variable connection of FC approach during Covid-19

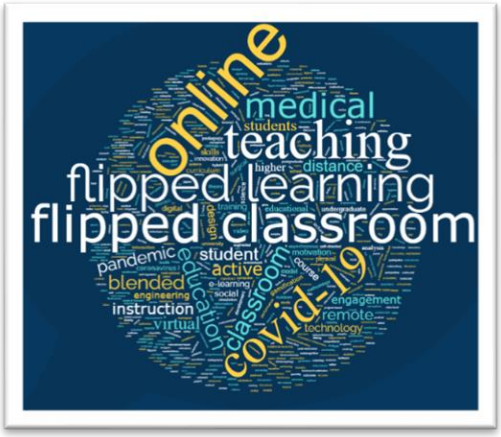


Figure 11. Word cloud generator of the FC research during Covid-19

CONCLUSION

In conclusion, eight problems are posed at the beginning of the study, which can be answered as follows. First, publications on FCs on the Scopus database increased during Covid-19 (2020 to May 2022). Second, the language used by researchers in the FC during Covid-19 documents, namely the majority, uses English as the primary language. Third, publication sources from 249 records regarding the FC during Covid-19, namely articles, conference papers, book chapter reviews, conference reviews, notes, and letters, and research subject areas almost cover all fields of study, such as social and computer science, science, and medicine. Fourth, the top prolific writers are Lewin, D.R., and authorship patterns, which resulted in 22 strongly connected authors. Fifth, the United States and the University of Pennsylvania are the top countries and institutions conducting FC research during Covid-19. Sixth, the author's most used keywords in the top five are FC, Covid-19, students, e-learning, and teaching. Seventh, the most citations occurred in articles published in 2020, with 405 citations written by Chick et al. in educational technology studies. Eighth, the network and overlay visualization results of the FC research consist of four clusters representing four themes in the VOSviewer visualization map. Clusters are grouped as the online learning group (red) as theme one, the teaching model group (green) as theme two, the class methods and concepts group (blue) as these three, and the assessment technique group (yellow) as theme four.

This research provides important implications for understanding flipped classrooms, identifying research gaps that need further investigation, determining future research directions, developing models and frameworks, promoting collaboration and networking, evaluating the quality of existing research, making a significant contribution to the development and implementation of a flipped classroom in the educational context.

REFERENCES

Abdullah, M. Y., Hussin, S., & Ismail, K. (2019). Implementation of FC model and its effectiveness on English speaking performance. *International Journal of Emerging Technologies in Learning*, *14*(9), 1–18. https://doi.org/10.3991/IJET.V14I09.10348

Afrilyasanti, R., Cahyono, B. Y., & Astuti, U. P. (2017). Indonesian efl students' perceptions on the implementation of FC model. *Journal of Language Teaching and Research*, *8*(3), 476–484. https://doi.org/10.17507/jltr.0803.05

Akçayır, G., & Akçayır, M. (2018). The FC: A review of its advantages and challenges. *Computers and Education*, *126*, 334–345. https://doi.org/10.1016/j.compedu.2018.07.021

Al-Far, I., Shahin, Y., & Allam, A. (2021). The effectiveness of FC for developing Achievement Motivation in third preparatory grade students. *International Journal of Instructional Technology and Educational Studies*, *2*(3), 6–9. https://doi.org/10.21608/ihites.2021.29007.1010

Al-Shabibi, T. S., & Al-Ayasra, M. A. K. (2019). Effectiveness of the FC strategy in learning outcomes (bibliometric study). *International Journal of Learning, Teaching and Educational Research*, *18*(3), 96–127. https://doi.org/10.26803/ijlter.18.3.6

Ali Ghufron, M., & Nurdianingsih, F. (2021). FC method with computer-assisted language learning (CALL) in EFL writing class. *International Journal of Learning, Teaching and Educational Research*, *20*(1). https://doi.org/10.26803/ijlter.20.1.7

Camargo, C. P., Tempski, P. Z., Busnardo, F. F., Martins, M. de A., & Gemperli, R. (2020). Online learning and COVID-19: a meta-synthesis analysis. *Clinics (Sao Paulo, Brazil)*, *75*(e2286), 1–4. https://doi.org/10.6061/clinics/2020/e2286

Chen, C. H., & Mullen, A. J. (2020). COVID-19 can catalyze the modernization of medical education. In *JMIR Medical Education* (Vol. 6, Issue 1). https://doi.org/10.2196/19725

Chen, C. K., Huang, N. T. N., & Hwang, G. J. (2019). Findings and implications of flipped science learning research: A review of journal publications. In *Interactive Learning Environments*. https://doi.org/10.1080/10494820.2019.1690528

Chick, R. C., Clifton, G. T., Peace, K. M., Propper, B. W., Hale, D. F., Alseidi, A. A., & Vreeland,

T. J. (2020). Using Technology to Maintain the Education of Residents During the COVID-19 Pandemic. *Journal of Surgical Education*, *77*(4), 729–732. https://doi.org/10.1016/j.jsurg.2020.03.018

Dickinson, K. J., & Gronseth, S. L. (2020). Application of Universal Design for Learning (UDL) Principles to Surgical Education During the COVID-19 Pandemic. *Journal of Surgical Education*, *77*(5). https://doi.org/10.1016/j.jsurg.2020.06.005

Divjak, B., Rienties, B., Iniesto, F., Vondra, P., & Žižak, M. (2022). FCs in higher education during the COVID-19 pandemic: findings and future research recommendations. In *International Journal of Educational Technology in Higher Education* (Vol. 19, Issue 1, pp. 1–24). https://doi.org/10.1186/s41239-021-00316-4

Durfee, S. M., Goldenson, R. P., Gill, R. R., Rincon, S. P., Flower, E., & Avery, L. L. (2020). Medical Student Education Roadblock Due to COVID-19: Virtual Radiology Core Clerkship to the Rescue. *Academic Radiology*, *27*(10), 1461–1466. https://doi.org/10.1016/j.acra.2020.07.020

Fernandez-Batanero, J. M., Montenegro-Rueda, M., Fernandez-Cerero, J., & Garcia-Martinez, I. (2020). Impact of the information and communication technologies on the education of students with down syndrome: A bibliometric study (2008-2018). *European Journal of Educational Research*, *9*(1), 79–89. https://doi.org/10.12973/eu-jer.9.1.79

Fitriana, M., Rasyid, Y., & Dewanti, R. (2020). The flipped english classroom in EFL context: A study of education 4.0. *International Journal of Advanced Science and Technology*, *29*(5), 1503–1508.

Fung, C. H., Besser, M., & Poon, K. K. (2021). Systematic Literature Review of FC in Mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(6), 1–17. https://doi.org/10.29333/ejmste/10900

Hadriani, N. (2021). Implementation FC Based Video for Improving Interest Learning of Physics. *Sang Pencerah: Jurnal Ilmiah Universitas Muhammadiyah Buton*, *7*(1), 33–39. https://doi.org/10.35326/pencerah.v7i1.771

Hew, K. F., Jia, C., Gonda, D. E., & Bai, S. (2020). Transitioning to the "new normal" of learning in unpredictable times: pedagogical practices and learning performance in fully online FCs. *International Journal of Educational Technology in Higher Education*, *17*(1). https://doi.org/10.1186/s41239-020-00234-x

Hidaayatullaah, H. N., Suprapto, N., Hariyono, E., Prahani, B. K., & Wulandari, D. (2021a). Research trends on ethnoscience based learning through bibliometric analysis: Contributed to physics learning. *Journal of Physics: Conference Series*, *2110*(012026), 1–8. https://doi.org/10.1088/1742-6596/2110/1/012026

Hidaayatullaah, H. N., Suprapto, N., Hariyono, E., Prahani, B. K., & Wulandari, D. (2021b). Research Trends on Ethnoscience based Learning through Bibliometric Analysis: Contributed to Physics Learning. *Journal of Physics: Conference Series*, *2110*(012026), 1–8. https://doi.org/10.1088/1742-6596/2110/1/012026

Hu, Z., & Guo, H. (2021). Topics and their evolution in the research field of Teaching Chinese as A Foreign Language : A bibliometrics analysis based on VOSviewer. *Proceedings - 2021 2nd International Conference on Artificial Intelligence and Education, ICAIE 2021*, 646–649. https://doi.org/10.1109/ICAIE53562.2021.00142

Hudha, M. N., Hamidah, I., Permanasari, A., Abdullah, A. G., Rachman, I., & Matsumoto, T. (2020). Low carbon education: A review and bibliometric analysis. In *European Journal of Educational Research* (Vol. 9, Issue 1, pp. 319–329). https://doi.org/10.12973/eu-jer.9.1.319

Huynh, V. D. B., Nguyen, P. T., Nguyen, Q. L. H. T. T., & Vu, N. B. (2020). E-learning evolution and development from the perspectives of technology, education, and economy. *Research in World Economy*, *11*(1), 11–19. https://doi.org/10.5430/rwe.v11n1p11

Iglesias-Pradas, S., Hernández-García, Á., Chaparro-Peláez, J., & Prieto, J. L. (2021). Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. *Computers in Human Behavior*, *119*(106713).

https://doi.org/10.1016/j.chb.2021.106713

Julia, J., Dolifah, D., Afrianti, N., Isrokatun, I., Soomro, K. A., Erhamwilda, E., Supriyadi, T., & Ningrum, D. (2020). FC educational model (2010-2019): A bibliometric study. *European Journal of Educational Research*, *9*(4), 1377–1392. https://doi.org/10.12973/eu-jer.9.4.1377

Khoir, E. F., Suprapto, N., Setyarsih, W., & Deta, U. A. (2022). Literature review student's metacognitive ability: Bibliometric analysis. *Journal of Teaching and Learning Physics*, *7*(1), 10–21. https://doi.org/10.15575/jotalp.v7i1.13698

Kushairi, N., & Ahmi, A. (2021). FC in the second decade of the Millenia: a Bibliometrics analysis with Lotka's law. *Education and Information Technologies*, *26*(4), 4401–4431. https://doi.org/10.1007/s10639-021-10457-8

Kusnandar. (2021, June 24). FC sebagai Solusi Pembelajaran Tatap Muka Bergilir Pasca Pandemi. *Https://Pusdatin.Kemdikbud.Go.Id/*. https://pusdatin.kemdikbud.go.id/flipped-classroom-sebagai-solusi-pembelajaran-tatap-muka-bergilir-pasca-pandemi/

Li, Q., Li, Z., & Han, J. (2021). A hybrid learning pedagogy for surmounting the challenges of the COVID-19 pandemic in the performing arts education. *Education and Information Technologies*, *26*(6), 7635–7655. https://doi.org/10.1007/s10639-021-10612-1

Lin, J. (2021). Design and research of inverted classroom teaching of information technology integrating into the major of finance and economics. *ACM International Conference Proceeding Series*, 892–895. https://doi.org/10.1145/3452446.3452660

Liu, S., & Zhang, S. (2021). A Bibliometric Analysis of Computer-assisted English Learning from 2001 to 2020. *International Journal of Emerging Technologies in Learning*, *16*(4), 53–67. https://doi.org/10.3991/ijet.v16i14.24151

Mann, L., Chang, R., Chandrasekaran, S., Coddington, A., Daniel, S., Cook, E., Crossin, E., Cosson, B., Turner, J., Mazzurco, A., Dohaney, J., O'Hanlon, T., Pickering, J., Walker, S., Maclean, F., & Smith, T. D. (2021). From problem-based learning to practice-based education: a framework for shaping future engineers. *European Journal of Engineering Education*, *46*(1), 27–47. https://doi.org/10.1080/03043797.2019.1708867

Martín, C. T., Acal, C., Honrani, M. El, & Estrada, Á. C. M. (2021). Impact on the virtual learning environment due to covid-19. *Sustainability (Switzerland)*, *13*(2), 1–16. https://doi.org/10.3390/su13020582

Meral, E., & Teke, D. (2021). General trends of studies on FC model : Bibliometric mapping and content analysis general trends of studies on FC model : Bibliometric mapping and content analysis. *International Online Journal of Education and Teaching (IOJET)*, *8*(2), 564–587.

Nja, C. O., Orim, R. E., Neji, H. A., Ukwetang, J. O., Uwe, U. E., & Ideba, M. A. (2022). Students' attitude and academic achievement in a FC. *Heliyon*, *8*(1), 1–14. https://doi.org/10.1016/j.heliyon.2022.e08792

Nugraheni, B. I., Surjono, H. D., & Aji, G. P. (2022). How can FC develop critical thinking skills? A literature review. *International Journal of Information and Education Technology*, *12*(1), 1–9. https://doi.org/10.18178/ijiet.2022.12.1.1590

Oudbier, J., Spaai, G., Timmermans, K., & Boerboom, T. (2022). Enhancing the effectiveness of FC in health science education: a state-of-the-art review. *BMC Medical Education*, *22*(1), 1–15. https://doi.org/10.1186/s12909-021-03052-5

Ożadowicz, A. (2020). Modified blended learning in engineering higher education during the COVID-19 lockdown-building automation courses case study. *Education Sciences*, *10*(10), 1–20. https://doi.org/10.3390/educsci10100292

Pattiserlihun, A., & Setiadi, S. J. J. (2020). Blended-FC learning for physics students with the topic of the photoelectric effect. *Jurnal Inovasi Pendidikan IPA*, *6*(1). https://doi.org/10.21831/jipi.v6i1.28109

Puspitasari, Y. D., & Dewi, I. S. (2021). Student Learning Independence through Blended Learning FC type during the Covid-19 Pandemic. *International Journal of Educational Research & Social Sciences*, *2*(6), 1553–1560.

Putri, E. F. N., & Purwaningsih, E. (2021). Students' view of FC in physics' class. *Revista*

Mexicana de Fisica E, *18*(1), 131–135. https://doi.org/10.31349/REVMEXFISE.18.131

Saira, Ajmal, F., & Hafeez, M. (2021). Critical review on FC model versus traditional lecture method. *International Journal of Education and Practice*, *9*(1), 1–13. https://doi.org/10.18488/journal.61.2021.91.128.140

Singla, N., Saini, P., & Kaur, J. (2016). Evaluating the flipped Vs traditional teaching method on student nurse's performance. *International Journal of Community Health & Medical Research*, *2*(4), 30–37.

Suprapto, N., Prahani, B., & Deta, U. (2021a). Top 100 Cited Publications in Physics Education in The last Thirty Years: A Bibliometric Analysis. *Library Philosophy and Practice (e-Journal)*. https://digitalcommons.unl.edu/libphilprac/5928

Suprapto, N., Prahani, B., & Deta, U. A. (2021b). Research trend on ethnoscience through bibliometric analysis (2011-2020) and the contribution of Indonesia. *Library Philosophy and Practice (e-Journal)*, *5599*, 1–17. https://digitalcommons.unl.edu/libphilprac/5599

Suprapto, N., Sukarmin, S., Puspitawati, R. P., Erman, E., Savitri, D., Ku, C. H., & Mubarok, H. (2021). Research trend on TPACK through bibliometric analysis (2015-2019). *International Journal of Evaluation and Research in Education*, *10*(4), 1375–1385. https://doi.org/10.11591/IJERE.V10I4.22062

Suprapto, N., Sunarti, T., Alif, S., & Husni, S. A. (2021). Learning from Technopark : Exploring of Physics Concept Through Advanced Technology. *International Joint Conference on Science and Engineering 2021*, *209*, 642–648.

Tang, T., Abuhmaid, A. M., Olaimat, M., Oudat, D. M., Aldhaeebi, M., & Bamanger, E. (2020). Efficiency of FC with online-based teaching under COVID-19. *Interactive Learning Environments*. https://doi.org/10.1080/10494820.2020.1817761

Turan, Z. (2021). Evaluating Whether FCs Improve Student Learning in Science Education: A Systematic Review and Meta-Analysis. *Scandinavian Journal of Educational Research*. https://doi.org/10.1080/00313831.2021.1983868

Yang, L., Sun, T., & Liu, Y. (2017). A bibliometric investigation of FC research during 2000-2015. *International Journal of Emerging Technologies in Learning*, *12*(6), 178–186. https://doi.org/10.3991/ijet.v12i06.7095

Yanuarti, E. A., & Suprapto, N. (2021). Ten Years of Research on History of Science (Physics): A Bibliometric Analysis. *Studies in Philosophy of Science and Education*, *2*(1), 7–16. https://doi.org/10.46627/SIPOSE.V2I1.66

Yeh, Y. C. (2022). Student Satisfaction with Audio-Visual FC Learning: A Mixed-Methods Study. *International Journal of Environmental Research and Public Health*, *19*(3), 1–14. https://doi.org/10.3390/ijerph19031053

Youhasan, P., Chen, Y., Lyndon, M., & Henning, M. A. (2021). Exploring the pedagogical design features of the FC in undergraduate nursing education: a systematic review. *BMC Nursing*, *20*(1), 1–13. https://doi.org/10.1186/s12912-021-00555-w

Yuan, Y. H., Liu, C. H., & Kuang, S. S. (2021). Innovative interactive teaching model for cultivating digital literacy talent in decision making, sustainability, and computational thinking. *Sustainability (Switzerland)*, *13*(9), 1–13. https://doi.org/10.3390/su13095117

Zakhiyah, I., Suprapto, N., & Setyarsih, W. (2021). Prezi mind mapping media in physics learning: A bibliometric analysis. *Journal of Physics: Conference Series*, *2110*(012015). https://doi.org/10.1088/1742-6596/2110/1/012015

Zulhamdi, Z., Rahmatan, H., Artika, W., Pada, A. U. T., & Huda, I. (2022). The Effect of Applying Blended Learning Strategies FC Model on Students' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 86–93. https://doi.org/10.29303/jppipa.v8i1.1186

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