International Journal of Instruction *October 2022 ● Vol.15, No.4*
e-ISSN: 1308-1470 ● www.e-iji.net *p-ISSN: 1694-609X*
pp. 935-954

Article submission code: 20211113145727
Received: 13/11/2021 Revision: 03/06/2022
Accepted: 26/06/2022 OnlineFirst: 11/09/2022

Understanding Research Trends in HyFlex (hybrid flexible) Instruction Model: A Scientometric Approach

Nina B. Eduljee
Prof., corresponding author, Department of Psychology, Saint Joseph's College of Maine, Standish, ME 04084, *neduljee@sjcme.edu*

Rupak Chakravarty
Prof., Department of Library & Information Science, Panjab University, Chandigarh, 160014, India, *rupak2811@gmail.com*

Karen Croteau
Prof. Department of Sport and Exercise Science, Saint Joseph's College of Maine, Standish, ME 04084, *kcroteau@sjcme.edu*

Laurie Murphy
Assoc. Prof., Department of Business, Saint Joseph's College of Maine, Standish, ME 04084, *lmurphy@sjcme.edu*

The onset of the Covid-19 pandemic necessitated that higher education institutions go online and utilize a HyFlex instruction model. The current study used a scientometric approach to evaluate the current status of HyFlex, as well as a visual analysis of the topic. Published research from 1989-2021 was retrieved from Web of Science (WoS) and the search generated 1453 results, which were analysed by title, year of publication, authors, country, journal, and research area. The data was processed using VOSviewer and Bibliometrix R software to visualize trends for HyFlex. The research identified document types, author collaborations, annual scientific production, most relevant journals, collaboration network between authors, institutions, country, cluster coupling of authors, documents and sources, thematic evolution, and co-occurrence of all keywords. The results indicated the topic gained interest in 2008, with the highest number of articles published in 2019-2020. The top collaborator and country with the highest volume of citations and published articles was the United States. Word clusters indicated the most repetitive words were students, education, performance, and knowledge. The visualization of data offers information on trends on the body of research as well as providing researchers an understanding of the topic.

Keywords: hyflex, hybrid-flexible, sociometric analysis, bibliometrix-r package, vosviewer, co-occurrence

Citation: Eduljee, N. B., Chakravarty, R., Croteau, K., & Murphy, L. (2022). Understanding research trends in hyflex (hybrid flexible) instruction model: A scientometric approach. *International Journal of Instruction*, *15*(4), 935-954. https://doi.org/10.29333/iji.2022.15450a

INTRODUCTION

The Covid-19 pandemic required higher education institutions to pivot quickly from face-to-face to virtual instruction in March 2020 to complete the existing academic term (Ensmann et al., 2020; Fischer & Cossey, 2021; Mortazavi et al., 2021). The ongoing nature of the pandemic caused higher education institutions to creatively shift how to provide educational experiences to incoming students for the next academic term (Dhawan, 2020; Miller et al., 2021; Murphy, et al., 2020). Since institutions were required to follow state or national social distancing mandates, classroom capacity was reduced and the need to provide a safe learning environment to students required that many courses be offered in a HyFlex modality (Griesemer, 2021).

HyFlex refers to a course format where some students attend a course face-to-face while others attend remotely via a meeting technology in a synchronous or asynchronous manner (Parra & Abdelmalak, 2016; Langston, 2021). It also represents a course delivery option that includes both online and face-to-face options for student's choice (Musgrove & Bryan, 2014). In this model, students can decide the manner they wish to participate, however, with social distancing rules, institutions might have found it necessary to assign students to a modality, i.e., face-to-face, virtual, or some combination of both, thus limiting the flexibility feature of HyFlex (Beatty, 2019). All students in a HyFlex course are expected to undergo the same combination of in-person and online activities (Lohmann et al., 2021). In contrast, the "flexible" aspect of HyFlex occurs when students are given a choice in how they participate in the course and engage with material in the mode that works best for them over the course and from session to session (Naffi et al., 2020). In addition to its flexibility, one aspect of HyFlex learning is its hybrid nature. Hybrid learning refers to learning that integrates complementary face-to-face (synchronous) and online learning (asynchronous) experiences. "Research has shown that hybrid learning venues provide a plethora of academic benefits including enhancement of computer, writing, and time management skills" (Crawford et al., 2014, p. 239).

Scientometrics, a sub-field of bibliometrics, is the quantitative methods of studying, measuring and analysing science, technology and innovation, impact of research papers and academic journals, the understanding of scientific citations, and the use of such measurements in policy and management contexts (Suresh & Thanuskodi, 2019). It is a science of all applications of mathematical and statistical methods which quantifies, measures, and encompasses evaluation and assessment of scholarly content (Aria & Cuccurullo, 2017; Mingers & Leydesdorff, 2015). Methods of research include qualitative, quantitative, and computational approaches (Gupta & Chakravarty, 2021; Rusydiana, et al., 2021). The data generated includes information about the type of research being published, the most prominent journals publishing articles in the field, the researchers, trends, and ideas for future research are also generated. In addition, the data generates visualization which can assist with better interpretation of the data (Szomsor, et al., 2021).

Studies using scientometrics/bibliometrics to examine the research are plentiful. They have been used in various contexts like smart learning (Agbo et al., 2021), sharing social

media (Abbas et al., 2022), ecopreneurship (Guleria & Kaur, 2021), health-related and infection-related literature (Sweileh, 2020), management and organization (Zupic & Čater, 2015), Seaweed biorefinery (Zhang & Thomsen, 2020), effects of technology on education (Vázquez-Cano et al., 2022), tracking research trends (Kalantari et al., 2017), Parkinson's disease (Liu et al., 2020), research data management (Gupta, Arora, & Chakravarty, 2021), pain research (Chuang & Ho, 2014), and publications on COVID-19 (Boonroungrut et al., 2022; Yu et al., 2020). Given the recent dramatic increase in the use of bibliometrics and the increase in use of HyFlex as a teaching modality, the purpose of this study was to examine the research conducted on the use of HyFlex in the classroom. While a bibliometric analysis on emergency remote teaching was recently conducted (Bond et al., 2021), bibliometric analysis on the topic of HyFlex itself has not yet been examined.

Objectives of the Study

This study uses a scientometric approach and is aimed at reviewing the literature on HyFlex. The present study had two main objectives:

1. To examine and analyze document contents, citation patterns, authorship patterns, and trends in co-occurrence models in the body of research as related to HyFlex, and
2. To discover thematic trends as well as clustering by source coupling as they relate to HyFlex.

METHOD

Data Collection Strategy

In the present study, a bibliometric analysis was conducted. Every journal and book covered by Web of Science (WoS) core collection is assigned to at least one Web of Science category (WC). Every record in the WoS core collection contains the subject (SU) category of its source publication in the WoS Categories field. Research Areas (SU) constitute a subject categorization scheme that is shared by all WoS product databases, thus facilitating the identification, retrieval, and analysis of documents, originating from multiple databases that pertain to the same subject. Journals and books covered by "*Web of Science Core Collection*" (WoSCC/WSCC) are assigned to at least one web of science category (WC). Each WC is mapped to one Research Area (SU) and Subject Category (WC) is classified into five broad categories: Arts & Humanities, Life Sciences and Biomedicine, Physical Sciences, Social Sciences and Technology. In WoS, the topic is represented by TS. When executed, it searches for topic terms in the fields including Title, Abstract, Author Keywords, and Keywords Plus®. Based on this study, HyFlex research is the combination of two terms "hybrid" and "flexible."

Data Analysis Technique

In the present study, a TS=(HyFlex OR Hybrid) search was executed using the WoS Advanced Search query builder with a combination of TS, SU and WC. The TS was separated with SU and WC using the Boolean operator "AND". Boolean operator "OR" was used between SU and WC. The query above yielded n=1453 results, which were exported as a plain text file (.txt) for further analysis and data visualizations (Table 1).

Table 1
Data collection strategy

Topic	Research Areas (Categories/Classification)	Category
TS	SU	WC
(HyFlex OR Hybrid)	(Education & Educational Research)	(Psychology, Educational OR Education & Educational Research OR Education, Scientific Disciplines OR Education, Special)
Query Structure = TS AND (SU OR WC)		
The Search Strategy construct terms were: TS=(HyFlex OR Hybrid) AND (SU=(Education & Educational Research) OR WC=(Psychology, Educational OR Education & Educational Research OR Education, Scientific Disciplines OR Education, Special))		

FINDINGS AND DISCUSSION

The results of this study are presented to indicate the following: (a) trends in the field of HyFlex research by presenting document contents, citation patterns, authorship patterns, hot topics, trends in co-occurrence models, and (b) thematic trends and clustering by source coupling as related to HyFlex.

Objective # 1: Document contents, citation patterns, authorship patterns, and trends in co-occurrence models

Table 2 indicates that out of the 1453 results obtained, 304 were journals, books, and other sources. The average number of citations per document was 15.12 and the average number of years since publication was 6.85. In addition, the average number of number of citations obtained per document per year was 1.833. Furthermore, the data revealed that 1250 (86.02%) of the documents were articles, 82 (5.64%) were review articles; early access, and 46 (3.16%) were reviews.

Table 2
Time Span and document types

Timespan	1989-2021
Total number of documents	1453
Sources (Journals, book, other sources)	304
Average years from publication	6.85
Average citations per document	15.12
Average citations per year per document	1.833
Document Types	n (%)
Article	1250 (86.02)
Article; book chapter	2 (0.13)
Article; early access	82 (5.64)
Article; proceedings paper	16 (1.10)
Bibliographic item	1 (0.06)
Book review	5 (0.34)
Correction	7 (0.48)
Editorial material; early access	28 (1.91)
Letter	9 (0.61)
News item	2 (0.13)
Note	1 (0.06)
Review	46 (3.16)
Review; early access	4 (0.27)

Document Contents

Table 3 indicates patterns of authorship in the field of study. An impressive total of 3734 authors produced work on the theme, with 4002 author appearances, including 373 single-authored documents, and 3361 multi-authored documents. In addition, 385 documents had single authors, resulting in an average of 0.389 documents per author, 2.57 authors per document, and 2.75 co-authors per document. Over a 32-year period, the Collaboration Index for HyFlex was found to be 3.15.

Table 3
Document contents and author collaborations

Document Contents	n	Authors Collaborations	n
Keywords Plus (ID)	2011	Single-authored documents	385
Author's Keywords (DE)	4089	Documents per Author	0.389
Authors	3734	Authors per Document	2.57
Author Appearances	4002	Co-Authors per Documents	2.75
Authors (single-authored documents)	373	Collaboration Index	3.15
Authors (multi-authored documents)	3361		

Annual Scientific Production

Figure 1 below indicates that while the topic has been investigated since 1989, it gained greater interest starting in 2008, with interest peaking in 2012 and 2017. The highest number of articles on HyFlex were published in 2020, when the Covid-19 pandemic occurred.

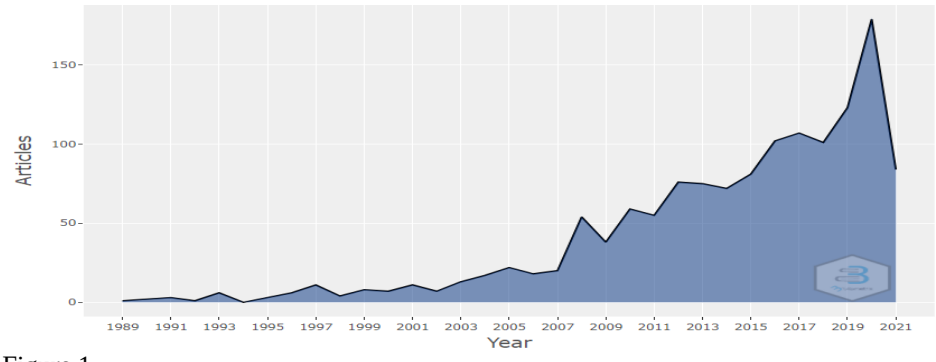


Figure 1
Annual scientific production of documents published since 1989

The data indicates the average citations per year which peaked in 1996, 2003, and 2010. There was a decline in 2019 and a peak in 2020, which coincided with the Covid-19 pandemic. The data also indicated an annual growth rate of 15.36% (Figure 2).

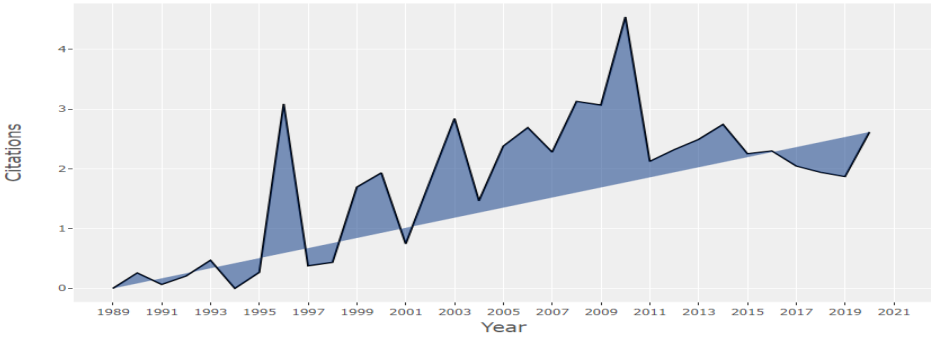


Figure 2
Average citations per year

Three Factor Analyses (Keyword, Organization, Country)

Figure 3 indicates that some of the top universities (by author affiliations) were Pennsylvania State University, Purdue University, Columbia University, University of Wisconsin, and University of Minnesota. The USA was the most productive country regarding articles related to HyFlex. Work on HyFlex came from different continents and included North America (USA and Canada), Asia (China, India, and Turkey), Europe (UK, Netherlands, Germany, Turkey, France, Belgium, Spain, and Portugal), South America (Brazil), and Australia.

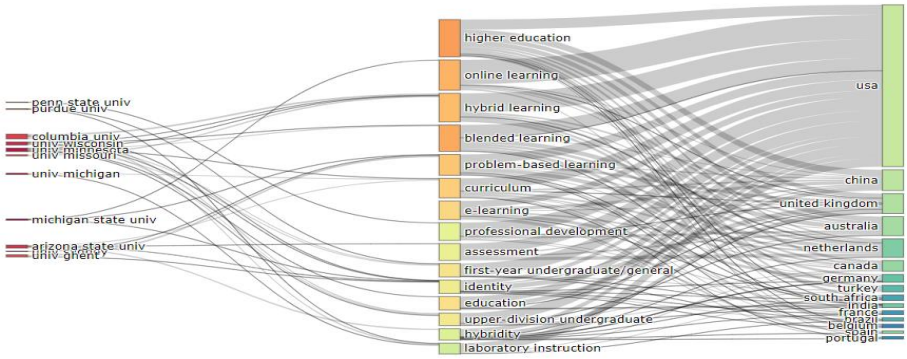
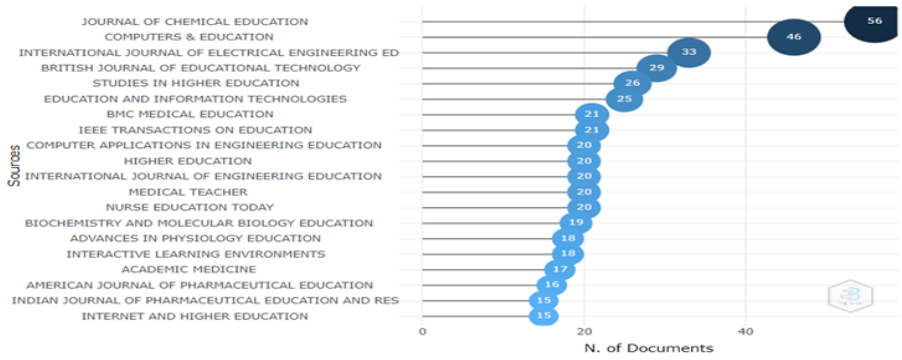


Figure 3
Three-field plot of active institutions and countries publishing articles related to HyFlex

Most Relevant Journals

The top twenty journals that have published actively in the topic of "HyFlex" are shown in Figure 4. The darker blue colour represents greater quantity and relevance of the research theme. The Journal of Chemical Education (n = 56), and Computers and Education (n = 46), International Journal of Electrical Engineering Education (n = 33), British Journal of Educational Technology (n = 29), and Studies in Higher Education (n = 26) ranked as the top five most relevant sources.



Most relevant journal sources

Author Production Over Time

Figure 5 depicts the top 20 author's work throughout time, not only in journals, but also the output of some of the top authors from 2004 to 2020, as represented by a red line that runs from the beginning of the author's publication to the last year the author published their paper. The circle in the red line indicates the number of papers published in each year. While some have been researching HyFlex-themed papers for a long time, others have only done so lately. Researcher Billett S has the earliest publication starting in 2004 with the latest publication in 2020, while Graham CR began publishing in the 2012 with last publication in 2016 and highest number of papers published in the field.

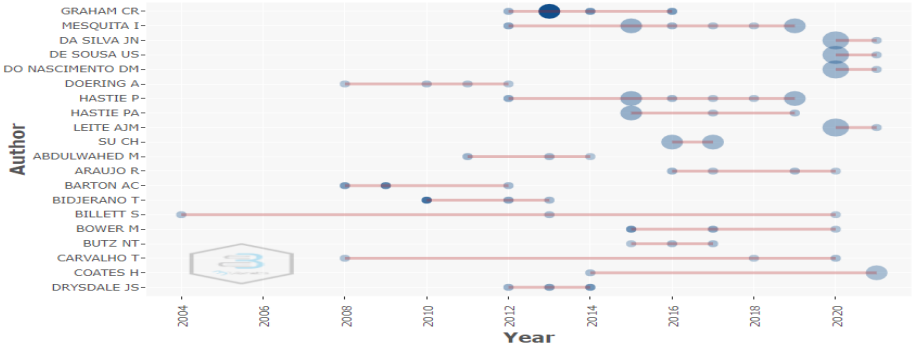


Figure 5
Author Production over Time

Most Relevant Affiliations

The data in Figure 6 indicate the highest number of articles produced by top 20 universities to which the authors are affiliated. The top three universities with highest articles published are Michigan State University (24 articles), the University of Sydney (19 articles), and University of Minnesota (17 articles). The darker blue colour represents articles that are more relevant to the theme.

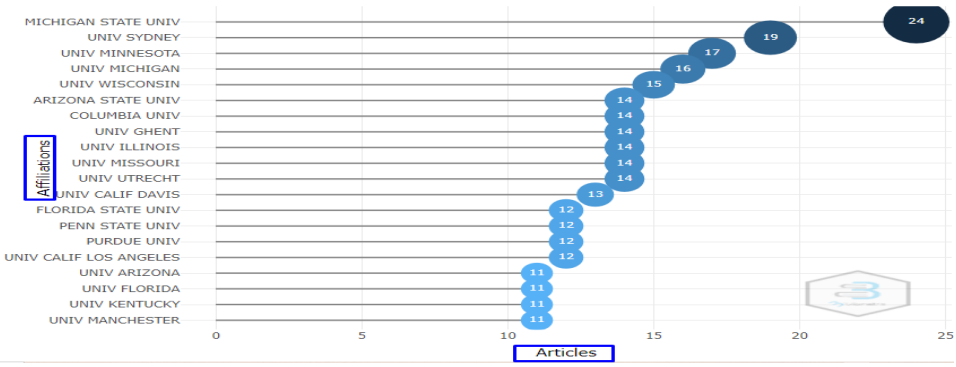


Figure 6
Most relevant affiliations

Country Scientific Production

Figure 7 represents the most prolific countries that publish scientific work in HyFlex with highest citations received. The United States had the highest number of citations (10683), followed by UK (2372), Australia (1427), China (1319), Canada (452), Spain (452), Turkey (436), Georgia (397), and Germany (332).

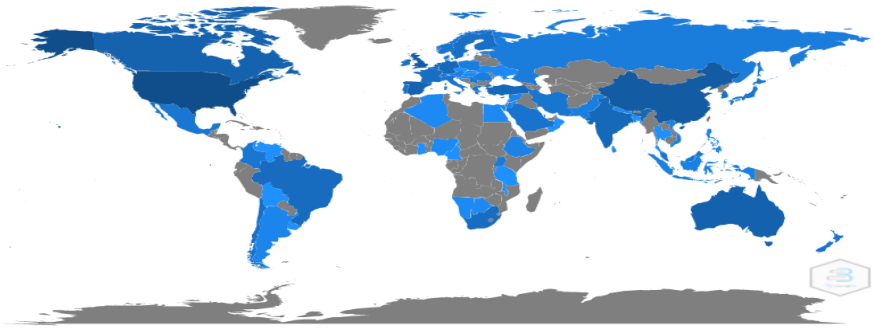


Figure 7
Most cited countries

Trend Topics (Author Keywords)

Thematic trends provide an overview of thematic changes by year (Figure 8). It also indicates topics that have been studied for a long time and the topics have been used recently. The topics appearance also adapts to the frequency of the word count in the HyFlex study. The data indicates that "laboratory instruction" was the most trending topic in HyFlex and that began trending in 2018, while words like "hybrid learning" and "blended learning" began trending in 2012.

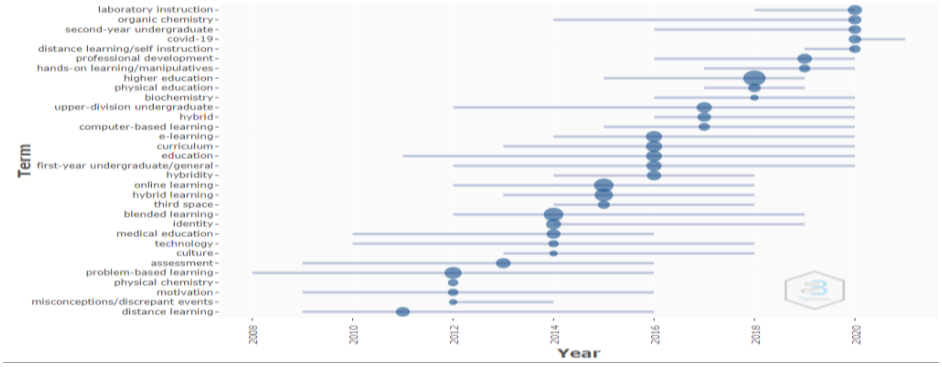


Figure 8
Trending topics based on author keywords

Clustering by Source Coupling

In Figure 9, the X-axis measures cluster centrality (via Callon's centrality index), while the Y-axis measures cluster impact via average normalized local citation score (MNLCS). The normalized local citation score (NLCS) for a document is calculated by dividing the actual count of local citation items by the expected citation rate of the publication in the same year (CouplingMap: Coupling Analysis in Bibliometrix: Comprehensive Science Mapping Analysis, n.d). To perform the analysis, the unit of analysis taken was Sources, where coupling was measured by titles and impact measure is Global Citation Score.

As indicated in Figure 9, three clusters are formed by source coupling. Cluster 1 is made up of high-impact sources based on a Global Citation Score. The cluster falling in the upper left quadrant can be observed with high impact, but the low center indicates progressive development. The groups three main sources are Reading Research Quarterly, Child Development and Physical Education and Sport Pedagogy. Cluster 2 includes sources of moderate impact but highly concentrated, highlighting their importance and resources that fall into this category are Interactive Learning Environments, Critical Studies in Education, Internet, and Higher Education. Cluster 3 indicates the sources that have low impact and have moderate centrality, and these include American Educational Research Journal, Energy Education Science and Technology Part B-Social and Educational Studies, and Assessment & Evaluation in Higher Education.

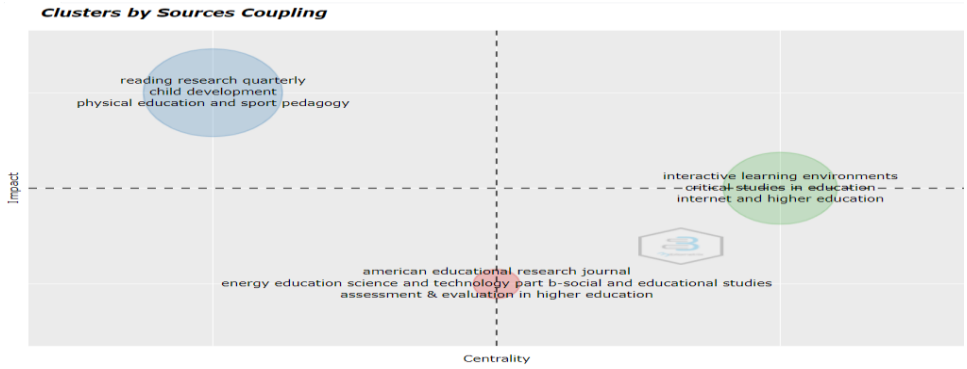


Figure 9
Cluster by source coupling

Clustering by Documents Coupling

Figure 10 represents the clusters formed by the coupling of documents based on the global citation score. The X-axis of the graph represents the centrality, while Y-axis represents the impact of the documents. Based on the data, four clusters were observed.

Cluster 1 is in the top right quadrant with high centrality and impact factor highlighting the importance and demand of the documents. It includes blended learning, hybrid learning, and e-Learning. Cluster 2 was observed in the top left quadrant with good impact but low centrality indicating the documents that have rare themes and are progressing towards development. In the bottom left quadrant (cluster 3) with low impact and centrality, indicates the down trend of the documents. The bottom right quadrant consists of cluster 4 with high centrality but low impact. The documents in this cluster are more of a general theme that have low impact but are important to consider.

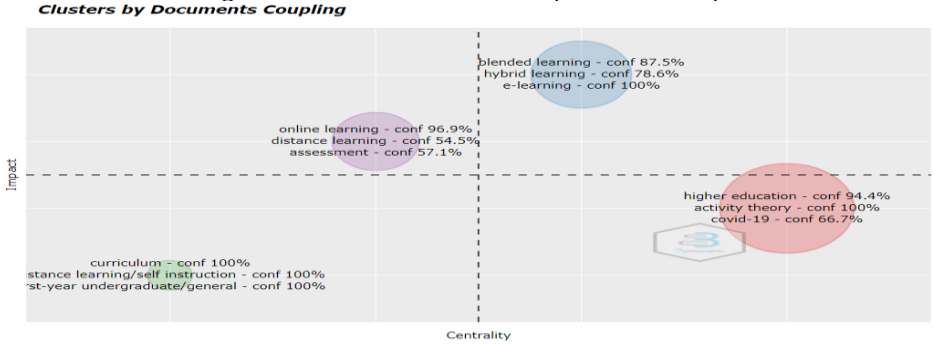


Figure 10
Clusters by documents coupling

Clustering by Author Coupling

Figure 11 represents the clusters by author coupling. The X-axis represents centrality, while the Y-axis represents the impact of documents. The top right quadrant indicates good impact but low centrality. In this quadrant, two clusters form, where Cluster 1 has

the least centrality but the greatest impact, while Cluster 2 has more centrality than Cluster 1. The clusters with the greatest impact and centrality are represented in the top left quadrant having two clusters. One cluster has low impact, and the centrality is in the bottom left quadrant, indicating that the documents are on the decline. Finally, the bottom right quadrant is dominated by a single cluster with high centrality but low impact. The documents in this cluster are more general in nature and have little impact, but they are necessary for consideration.

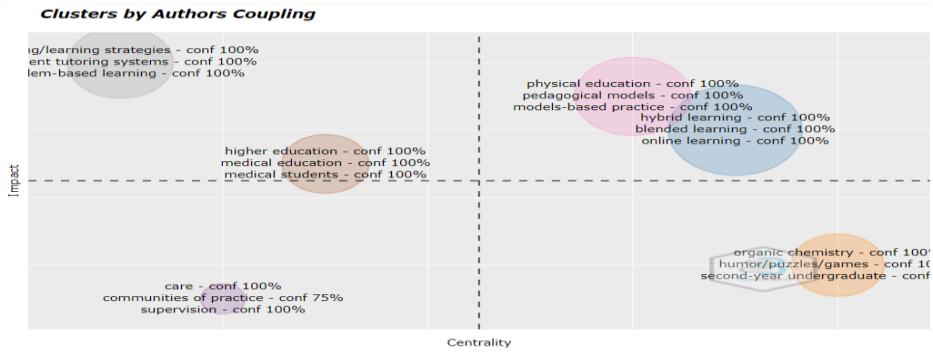


Figure 11
Cluster by author coupling

Word Clusters

Word clustering is a description of the words that frequently appear in a data collection of papers in the form of a network that connects words. Clustering also shows the words in colored clusters to help determine grouping by looking at the relationship between the words (Figure 12). Four Clusters of words were obtained.

Cluster 1: Red. The most frequent keywords include education, students, curriculum, teachers, and outcomes.

Cluster 2: Purple. The most frequent keywords include knowledge, performance, instruction, and impact.

Cluster 3: Blue. The most frequent keywords include technology, classroom, online, perceptions, and engagement.

Cluster 4: Green. The most frequent keywords include motivation, school, achievement, and work.

An examination of the clusters indicates that students, education, performance, and knowledge are often repetitive words used in documents by various authors.

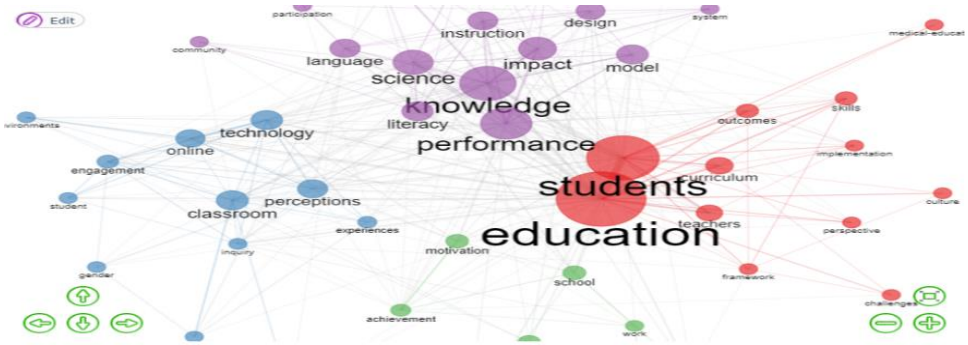


Figure 12
Word clusters

Authors Collaboration Network

The collaboration network shows 8 clusters (23 authors) who collaborate with each other in the research. A large cluster represents the proximity between authors in terms of collaboration. Isolated authors belonging to the same cluster indicate a lower degree of cooperation and intimacy (Figure 13).

Figure 13
Authors collaboration network

Institutional Collaboration Network

Figure 14 depicts the institutions that have collaborated with each other for research studies. Bigger clusters represent proximity between the institutions in terms of collaboration. Three clusters were obtained. Cluster 1 comprises 4 universities (University of Minnesota, University of Texas at Austin, Arizona, State University, and University of Wisconsin). Clusters 2 and 3 comprise of two universities each.

Figure 14
Institutional collaboration network

Country Collaboration Map

The data in Figure 15 shows the world's cooperative pathways. The blue on the map indicates the presence of research networks with other countries. The red lines indicate the connection between the two countries. It is interesting to note that countries with political disturbances are also assisting each other to share information and find scientifically relevant results related to the HyFlex Model. The United States of America emerged as the top collaborator with China (16 articles each), United Kingdom, Spain, Australia, Portugal, and includes a total of 41 countries. The United Kingdom collaborated with 27 countries, and Australia with 14 countries. Countries including China, United Kingdom, Brazil, France, and Australia depicted significant research collaboration with the researchers of other countries for HyFlex with relatively higher network strength.

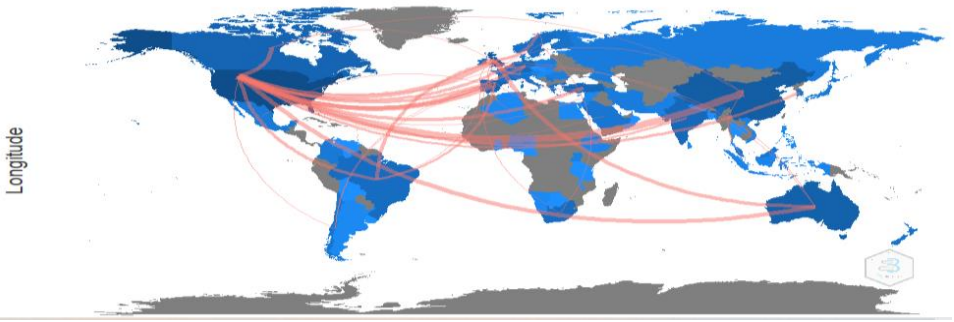


Figure 15
Country collaboration map

Objective # 2: Thematic Trends

Thematic Evolution

With advancing time, the themes of the papers around the research objectives have been changing and continue to change. Figure 16 depicts this thematic evolution (TE) over the time since 1989. For deeper analysis, the thematic evolution was compared between three time slices i.e., 1989-2013, 2014-2018 and 2019-2021. Although the central theme of this study is “HyFlex”, the figure depicts further sub-themes that revolve around and are inter-related with the central theme.

The left side indicates the themes that were studied during 1989-2013. Eight themes are listed with different sizes based on usage of the theme. Themes include e-learning, problem based-learning, education, higher education pedagogy, globalization, and communities of practice. The middle section highlights the themes that were studied during 2014-2018. Some of the themes that have emerged during this period are a progression from the themes used in the past and have a connection in their content like hybrid courses, distance education, teacher professional development and physical education have emerged from the theme. The third section gives the recent themes in the field i.e., from 2019-2021. Ten themes are listed here, which have evolved from the previous themes.

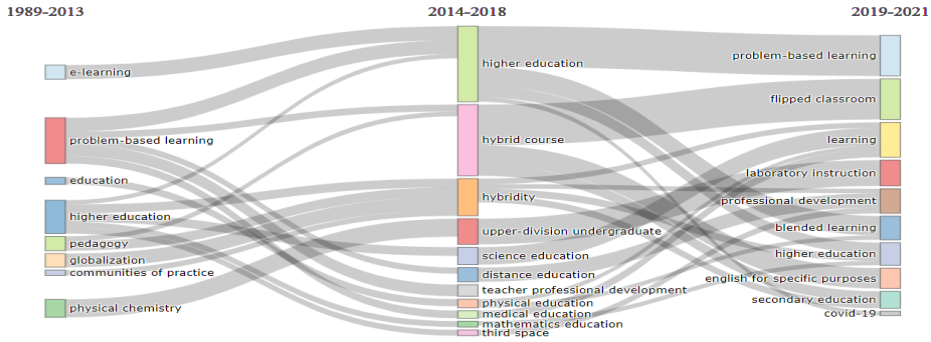


Figure 16
Thematic evolution

In the present study, an analysis of thematic maps was carried out based on density and centrality, divided into four theme quadrants. This result is obtained from a semi-automatic algorithm by reviewing the titles of all references to the research object with the addition of author's keywords so that the results can capture deeper variations. For further detailed analysis, the collection was sliced in three based on time.

Time Slice 1: Figure 17a gives the TE from 1989 to 2013. In the figure, since the upper right quadrant is a driving theme characterized by high density and centrality, which is important to consider in future studies. In this quadrant, the major themes caught are problem-based learning and globalization. The left quadrant shows certain rare themes, but the development is progressing as shown by high density but low centrality. The themes in this quadrant are conceptual development, conceptual learning, adaptation, and laboratory education. In the left lower quadrant, themes are experiencing a downtrend characterized by long usage and low centrality. earthquake engineering and middle school science are the fields facing a downward trend. In the lower right quadrant are basic themes characterized by high centrality but low density. These themes are important in the research because they are general topics that are commonly used. As depicted in the figure, physical chemistry, teaching/learning strategies pedagogy, education. communities of practice, higher education, adventure learning and e-Learning are the common terms to be studied while studying HyFlex.

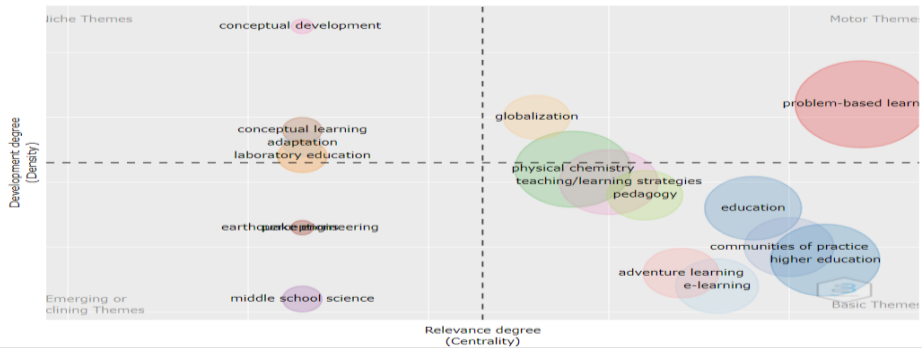


Figure 17a
Time slice 1

Time Slice 2: Figure 17b gives the TE from the year 2014 to 2018. It is clear from the that distance education, upper division under graduation and medical education were the driving themes during the years 2014-2018 with high density and centrality. System, third space and teacher professional development are the rare themes with high density but low centrality that need to be studied in the field as the development of the topics is progressing depicted by high density, whereas decoding, artificial neural networks and team-based learning were the themes with long run time, followed by the down trend. Lastly, mathematics education, hybrid course, physical education, higher education, hybridity and autonomy were the basic themes to be studied (Figure 17b).

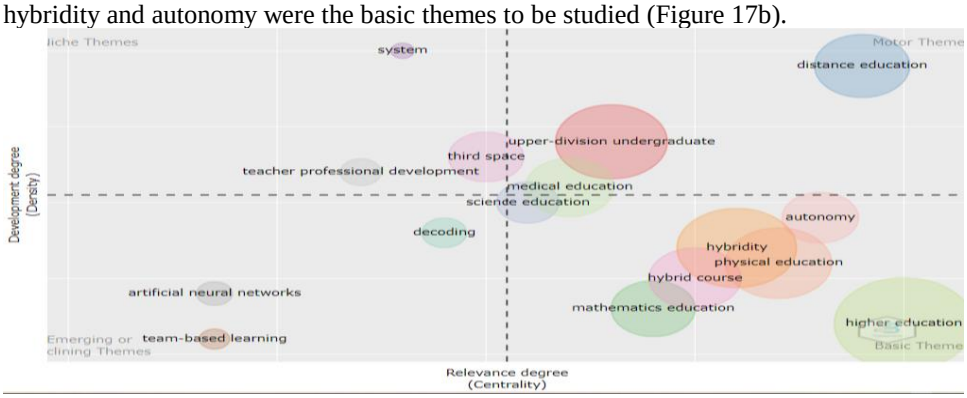


Figure 17b
Time slice 2

Time Slice 3: Figure 17c gives the current TE in "HyFlex" from 2019 to 2021. It was observed that professional development, higher education, Covid, and blended learning are the centralized themes. Based on current studies on 'HyFlex' experimental learning, English for specific purposes and docking are the rare themes with low centrality and high density indicating the progress in the topics. Flipped classroom, problem based learning and self-regulated learning have experienced a downward trend marked by low centrality. Educational technology, qualitative research learning, laboratory instructions and secondary education are the basic themes to be studied.

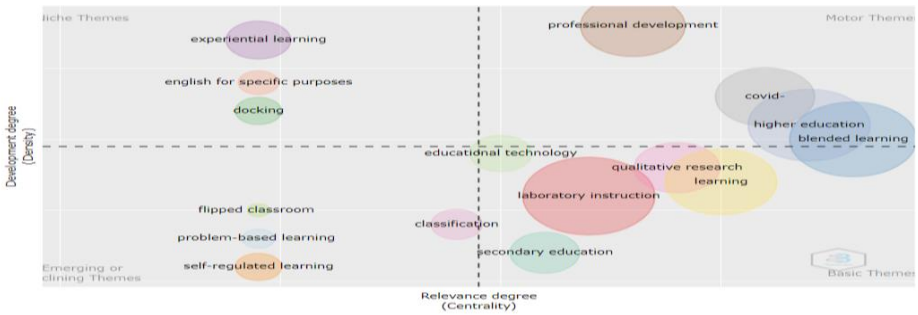


Figure 17c
Time slice 3

Co-Occurrence of all Keywords

Co-occurrence refers to the frequency and proximity of common occurrences of similar keywords in multiple documents. Co-occurrences contain keywords that are like each other and are based on the same subject, but not completely identical. To explore hot topics and potential future topics, we performed co-occurrence analysis on keywords using VOSViewer. Here, it is observed that education, knowledge, curriculum, blended learning, online learning, hybrid, and system are the central nodes. By conducting co-occurrence analysis, a network consisting of clusters namely education, knowledge, blended learning, curriculum, higher education, and language. Cluster "education" mainly focuses on problem-based learning and medical education. Cluster "blended learning" is about online learning and hybrid courses, their system and design. Cluster "curriculum" focuses on hybridization for student-centered learning for first year and upper-division undergraduate. The clusters education, knowledge, blended learning, higher education, and language are closely interconnected while curriculum has close connections but with few loose ends (Figure 18).

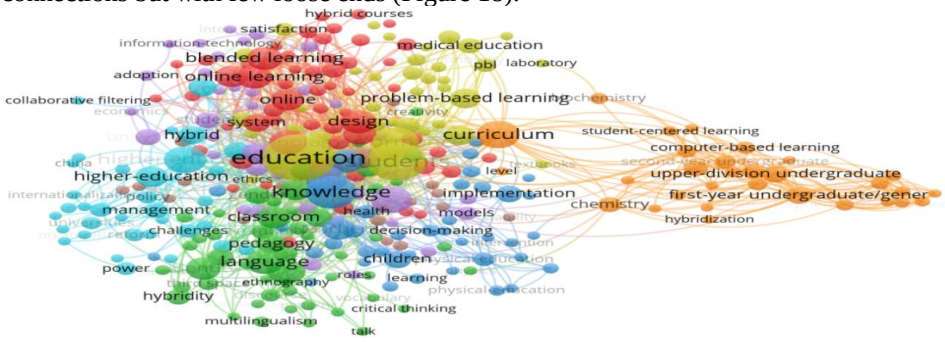


Figure 18
Co-occurrence of keywords

CONCLUSIONS

The present study presents a scientometric analysis and mapping of the trends and themes related to HyFlex. The study examined themes related to HyFlex and the

analysis indicated document types and contents, author collaborations, scientific production, keywords, trend topics, clustering by document types, co-occurrence networks, country collaboration maps, and thematic evolution.

A total of 1453 articles were obtained, 304 were from journals, books, and other sources, 1250 were articles, and 385 were single-authored documents. While the topic was being examined since 1989, it gained greater interest in 2020, when the COVID-19 pandemic occurred.

The United States was the most productive country with the highest number of citations as well as the top collaborator. Research on HyFlex was generated from North America, Asia, Europe, South America, and Australia and the United States had the highest number of citations followed by the UK. The Journal of Chemical Education published the most research on the topic and "laboratory instruction" was the trending topic in 2018.

While the topic has been investigated for a long time, Billet had the earliest publication in 2004 and the latest in 2020. Billet opined for "work integrated learning" for providing students with experiences in practice settings to assist them to move more effectively into their selected educational practice. Graham who began publishing in 2003 (with the last publication in 2016) had the highest number of papers published in the field.

Thematic analysis show that words like blended learning, hybrid learning, and e-Learning are highly connected to HyFlex as indicated by high importance and demand. Words like online learning, distance learning, and assessment are progressing towards development. Words like curriculum, distance learning/self-instruction, and first-year undergraduate/general indicate a downward trend in the documents. Lastly, words like higher education, activity theory, and Covid-19 indicate words that are important to consider.

Word clusters indicated that students, education, performance, and knowledge were the most repetitive words used by most authors. Thematic evolution on the topic indicates that themes such as "problem-based learning," "e-learning," "education," "higher education," "globalization," "communities of practice and physical chemistry" were connected to HyFlex. Interestingly, the theme "problem-based learning" generated terms such as "hybrid courses," "distance education," "teacher professional development," and "physical education' which merit further investigation.

LIMITATIONS

The present study only considered scholarly articles relating to the HyFlex (hybrid flexible) research, as reflected in Web of Science (WoS). Hence, the study findings are to be viewed in-context with the scope and coverage of the dataset. The current study is based on quantitative measures and does not explore qualitative evaluations. Thus, the results should be interpreted with caution, especially considering how the post-Covid scenario is shaping in higher education and learning as well as the appropriateness and application of HyFlex in a larger context. The articulations of the study could be supplemented and enhanced with qualitative investigation and as the research corpus grows over time, the study may be replicated alongside other emerging instructional design techniques.

In conclusion, the present study provides useful information on HyFlex through scientometrics, mapping techniques, emerging topics, and thematic evolutions. It provides an overview that will assist researchers who want to further their knowledge in the area of HyFlex.

REFERENCES

Abbas, A. F., Jusoh, A., Mas'od, A., Aisharif, A. H., & Ali, J. (2022) Bibliometrix analysis of information sharing in social media. *Cogent Business & Management*, *9*(1). https://doi.org/10.1080/23311975.2021.2016556

Agbo, F. J., Oyelere, S. S., Suhonen, J., & Tukiainen, M. (2021). Scientific production and breakthroughs in smart learning environments: a bibliometric study. *Smart Learning Environments*, *8*(1), 1-25. https://doi.org/10.1186/s40561-020-00145-4

Aria, M. & Cuccurullo, C. (2017). *bibliometrix*: An R-tool for comprehensive science mapping analysis, *Journal of Informetrics*, *11*(4), 959-975. https://doi.org/10.1016/j.joi.2017.08.007

Beatty, B. J. (2019). Teaching a Hybrid-Flexible Course: The Faculty Experience. In B. J. Beatty, Hybrid-Flexible Course Design: Implementing student-directed hybrid classes. EdTech Books. Retrieved from https://edtechbooks.org/hyflex/teaching_hyflex

Bond, M., Bedenlier, S., Marin, V. I., & Handel, M. (2021). Emergency remote teaching in higher education: mapping the first global online semester. *International Journal of Educational Technology in Higher Education*, *18*, 50. https://doi.org/10.1186/s41239-021-00282-x

Boonroungrut, C., Thamdee, N., & Saroinsong, W. P. (2022). Research on students in COVID-19 pandemic outbreaks: A bibliometric network analysis. *International Journal of Instruction*, *15*(1), 457-472. https://doi.org/10.29333/iji.2022.15126a

Chuang, K-Y., & Ho, Y. (2014). A bibliometric analysis on top-cited articles in pain research. *Pain Med*, *15*(5), 732-744. https://doi.org/10.1111/pme.12308

couplingMap: Coupling Analysis, n. d. Retrieved from https://rdrr.io/github/massimoaria/bibliometrix/man/couplingMap.html

Crawford, C., Barker, J., & Seyam, A. (2014). The promising role of hybrid learning in community colleges: Looking towards the future. *Contemporary Issues in Education Research*, *7*(3), 237-242. https://files.eric.ed.gov/fulltext/EJ1073254.pdf

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, *49*(1), 5-22. https://doi.org/10.1177/0047239520934018

Fischer, H., & Cossey, K. M. (2021). Navigating the storm: Community colleges' decision to pivot to virtual international education in response to the COVID-19 pandemic. *Community College Journal of Research and Practice*, *46*(1-2), 122-123. https://doi,org/10.1080/10668926.2021.1972360

Guleria, D., & Kaur, G. (2021). Bibliometric analysis of ecopreneurship using VOSViewer and RStudio Bubliometrix, 1989-2019. *Library Hi Tech*, *39(*4), 1001-1024. https://doi.org/10.1108/LHT-09-2020-0218

Gupta, N., Arora, S., & Chakravarty, R. (2021). Science mapping and visualization of research data management (RDM): Bibliometric and scientometric study. *Library Philosophy and Practice (e-journal)*, 6096. https://digitalcommons.unl.edu/libphilprac/6096

Gupta, N., & Chakravarty, R. (2021). Trends in loT research: A bibliometric and science mapping analysis of Internet of Things. *Library Philosophy and Practice* (e-journal), 5269. https://digitalcommons.unl.edu/libphilprac/5269/

Griesemer, P. R. (2021, March), *Delivering a Hyflex Statics Course in a Flipped Classroom Model* Paper presented at ASEE 2021 Gulf-Southwest Annual Conference, Waco, Texas. https://peer.asee.org/36367

Kalantari, A., Kamsin, A., Kamaruddin, H. S., Ebrahim, N. A., Gani, A., Ebrahimi, A., & Shamshirband, S. (2017). A bibliometric approach to tracking big data research trends. *Journal of Big Data*, *4*(30), 1-18. https://doi.org/10.1186/s40537-017-0088-1

Langston, K. J. (2021). Meeting challenges in virtual learning environments with the

Community of Inquiry Framework. In S. Swartz, B. Barbosa, I. Crawford, & S. Luck (Eds.), *Developments in Virtual Learning Environments and the Global Workplace* (pp. 43-62). IGI Global. http://doi:10.4018/978-1-7998-7331-0.ch003

Lohmann, M. J., Randolph, K. M., & Oh, J. H. (2021). Classroom management strategies for HyFlex instruction: Setting students up for success in the Hybrid Environment. *Early childhood Education Journal*, *49*, 807-814. https://doi.org/10.1007/s10643-021-01201-5

Liu, C., Liu, Z., Zhang, Z. li, Y., Fang, R., Li, F., & Zhang, J. (2020). A scientometric analysis of research on Parkinson's disease associated with pesticide exposure. *Front. Public Health*, *8*, 91. https://doi.org/10.3389/fpubh.2020.00091

Miller, A. N., Sellnow, D. D., & Strawser, M. G. (2021). Pandemic pedagogy challenges and opportunities: instruction communication in remote, *HyFlex*, and *Blendflex* courses. *Communication Education*, *70*(2), 202-204. https://doi.org/10.1080/03634523.2020.1857418

Mingers, J., & Leydesdorff, L. (2015). A review of theory and practice in scientometrics. *European Journal of Operational Research*, *246*(1), 1–19. https://doi.org/10.1016/j.ejor.2015.04.002

Mortazavi, F., Salehabadi, R., Sharifzadeh, M., & Ghardashi, F. (2021). Students' perspectives on the virtual teaching challenges in the COVID-19 pandemic: A qualitative study. *Journal of Education and Health Promotion*, *10*, 59. https://doi.org/10.4103/jehp.jehp_861_20

Murphy, L., Eduljee, N. B., & Croteau, K. (2020). College student transition to synchronous virtual classes during the COVID-19 pandemic in Northeastern United States. *Pedagogical Research*, *5*(4), em0078. https://doi.org/10.29333/pr/8485

Musgrove, A., & Bryan, V. C. (2014). Theory and application: Construction of multimodal eLearning. In V. Wang (Ed.), *Handbook of Research on Education and Technology in a Changing Society* (pp. 1068-1083). IGI Global. http://doi:10.4018/978-1-4666-6046-5.ch079

Naffi, N., Davidson, A-L., Patino, A., Beatty, B., Gbetoglo, E., & Duponsel, N. (2020). Online learning during COVID-19: 8 ways universities can improve equity and access. https://sfpirg.ca/wp-content/uploads/2021/02/Equity-and-Online-Educ.pdf

Parra, J. L., & Abdelmalak, M. (2016). Expanding learning opportunities for graduate

students with HyFlex course design. *International Journal of Online Pedagogy*

and Course Design (IJOPCD), 6(4), 19–37. DOI:10.4018/IJOPCD.2016100102

Rusydiana, A. S., As-Salafiyah, A; Sanrego, Y. D., & Marlina, L. (2021). Fiqh on Finance: A Scientometric Analysis using Bibliometrix. *Library Philosophy and Practic*e (e-journal). 5436. https://digitalcommons.unl.edu/libphilprac/5436/

Sweileh, W. M. (2020). Bibliometric analysis of peer-reviewed literature on climate change and human health with an emphasis on infectious diseases. *Globalization and Health*, *16*, Article number 44. https://doi.org/10.1186/s12992-020-00576-1

Szomsor, M., Adams, J., Fry, R., Gebert, C., Pendlebury, D. A., Potter, R. W. K., and Rogers, G. (20210) Interpreting bibliometric data. *Front. Res. Metr. Anal.*, *5*, 628703. https://doi.org/10.3389/frma.2020.628703

Suresh, N., & Thanuskodi, S. (2019). Seed Technology Research Output: A Scientometric Analysis on SCOPUS Database. *Library Philosophy and Practice* (e-journal). 2245. https://digitalcommons.unl.edu/libphilprac/2245

Vázquez-Cano, E., Parra-Gonzalez, M.ª E., Sugura-Robles, A., & López-Meneses, E. (2022). The negative effects of technology on education: a bibliometric and topic modeling mapping analysis (2008-2019). *International Journal of Instruction*, *15*(2), 37-60. https://www.e-iji.net/dosyalar/iji_2022_2_3.pdf

Yu, Y., Zhang, Z., Gu, Z., Zhong, H., Zha, Q., Yang, L., Zhu, C., & Chen, E. (2020). A bibliometric analysis using VOSviewer of publications on COVID-19. *Annals of Translational Medicine*, *8*(13), 1-11. http://dx.doi.org/10.21037/atm-20-4235

Zhang, X., & Thomsen, M. (2020). Bibliographic data and bibliometric analysis of the literature about "seaweed biorefinery" from WoS. Mendeley Data, VI. DOI:10.17632/3yjsm857fv.1

Zupic, I., & Čater. T. (2015). Bibliometric methods in management and organization. Organization Research Methods, 18(3), 429-472. https://doi.org/10.1177/1094428114562629