

Research Trends in Educational Technology: A Review of Studies Published in Five Social Science Citation Indexed Journals From 2010 to 2019

Yih-Ping Cheng, Ming Chuan University, Taiwan

Chun-Hung Huang, Ming Chuan University, Taiwan*

Lynne Cheng Hsu, Ming Chuan University, Taiwan

ABSTRACT

The researchers of this study selected five journals in the field of education and conducted a series of analyses regarding publications dating from 2010 to 2019 to investigate the research trends and characteristics in the field of educational technology. By using the analytic tool Content Analysis Toolkit for Academic Research (CATAR), the researchers in this study conducted bibliometric analysis and breakdown analyses to summarize major contributing countries, educational institutions, most productive authors, and most cited papers; moreover, they used co-word analysis to reveal the representative items within each cluster. The findings in this study can provide implications and references for educators and researchers in the field of educational technology when selecting variables for their studies and technologies for their students.

KEYWORDS

Bibliometric Analysis, Educational Technology, Research Trends

1. INTRODUCTION

Technology changes daily human life at a rapid pace, and impacts every field of work, including education. From chalk and blackboard in classroom, to slide projector and interactive projector, all these could be considered as forms of technology (Arnold & Sangrà, 2018). When modern technology is applied systematically to an organized educational process, it can be used in three domains, such as tutor, teaching tool, and learning tool (Lazar, 2015). By focusing on the benefits of the chosen tools and applications, teachers and administrators can acknowledge the value of Educational Technology when it is properly integrated into programs or curriculum. Nowadays, educators are more and more familiar with tools that can be used in distance education, educational games, and simulations; many researchers also pay more attention to the effects that technology can bring about (Morrison et al., 2010; Waxman et al., 2013). Many studies suggest the use of technology could inspire positive effects among students, such as improve academic performance, increase students' competitive capabilities, and elevate learning motivation (Clark, Tanner-Smith, & Killingsworth, 2016; Lai & Bower, 2019;

DOI: 10.4018/IJTHL.293191

*Corresponding Author

This article published as an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>) which permits unrestricted use, distribution, and production in any medium, provided the author of the original work and original publication source are properly credited.

Merchant et al., 2014), therefore the growth and trends in the field of Educational Technology deserve attention and discussions.

In addition, the definition of technology itself could lead to numerous ramifications. In some recent studies, educational technology is defined as tools that help learners gain cognitive knowledge, enhance communication skills and develop problem-solving abilities (Lee, Yeung, & Cheung, 2019; Warner, Bell, & Odom, 2018). Based on this definition, the emphasis would fall on computer-related technology (Doyle et al., 2019). However, from the initial collaboration with personal computers in the 1980s, through the explosive development with the Internet in the 1990s, and into the age of multimedia content with portable devices, the advancements in Educational Technology in recent years have been astonishing (Pedro, de Oliveira Barbosa, & das Neves Santos, 2018). In the past, the focus of Educational Technology was on computers; after the popularization of smartphones, other interactive devices are also included in the technologies that support both teaching and learning (Jack & Higgins, 2019).

Not only the instruments of learning are being revolutionized by technological advancements, so are the pedagogies and mindsets of educators. With the ongoing development of technology, both learners and teachers need adjustments and creativity in order to best utilize the benefits that technology can bring.

Academic journals are an essential platform to disseminate and exchange professional thinking and knowledge among scholars. They have become a medium for researchers and practitioners to learn the known and to identify the unknown. As pointed out by Shafique (2013), “Studying the kind and content of the knowledge produced by a field can inform about the justification and contribution of the field as well as its evolution and future prospects.” Thus, examining articles published in academic journals can help determine the influential literature and research trends about Educational Technology, to quickly understand the newly emerging topics in this field. Moreover, such retrospection can reveal the predominant evolutions of the field and provide an overview of the knowledge structure of the domain (Chen et al., 2020; Li, Antonenko, & Wang, 2019).

Bibliometrics offers an objective and data-driven set of methods and measures to investigate the cumulated efforts over years of contributions from scholars within a field (Borgman and Furner, 2002). It relies on statistical analysis and provides visualization of article data by examining the citation patterns and revealing the most common keywords, linking keywords and terms via co-word analysis. Numerical and visual keyword frequency data provides useful insights regarding the trends and issues that have been the focus of empirical studies. Importantly, it can be employed to obtain a better understanding of what has been investigated in the past and further make predictions about what will happen in the future. Bibliometric analysis has been widely applied in scientific research trend analysis, as well as identification of emerging topics within a particular research area (Chen et al., 2020; Chou, Wu, & Tsai, 2019). It is increasingly recognized as an invaluable and effective technique for evaluation of academic outputs within a specific research field (Moed, De Bruin, & Van Leeuwen, 1995); Notably, bibliometric analysis is a popular choice for evaluating the academic outputs of a specific publication source.

This study selected five journals in the field of Educational Technology and conducted a series of analyses regarding publications dating from 2010 to 2019 to investigate the research trends and characteristics. By using an analytic tool called Content Analysis Toolkit for Academic Research (CATAR), the study conducted bibliometric and breakdown analysis to answer the following questions:

1. What is the geographical distribution of these publications and are they concentrated in certain regions?
2. Which educational institutions support studies in Educational Technology and their geographical distribution?
3. Who are the most productive authors and most cited references within the selected journals with respect to Educational Technology?

4. What topics or themes have been studied by researchers within the selected articles related to the area of Educational Technology?
5. What kind of clusters can be formed after using CATAR? Who are the top contributors of these clusters?

2. METHOD

In order to investigate the trends in Educational Technology, the researchers of this study selected five journals in this field and conducted a series of analyses regarding publications dating from 2010 to 2019. The researchers in this study selected five Social Science Citation Index (SSCI) indexed journals, including *Australasian Journal of Educational Technology*, *British Journal of Educational Technology*, *Educational Technology & Society*, *Educational Technology Research and Development*, and *International Journal of Educational Technology in Higher Education*. These journals were selected not only because the phrase “Educational Technology” is directly on the names of these journals, but also because they are included in the SSCI. In addition, they are highly recommended by scholars for their prestige in the field.

The tool used for searching articles is Content Analysis Toolkit for Academic Research (CATAR), which was developed by Dr. Yuen-Hsien Tseng. CATAR can conduct bibliometric analysis and provide breakdown analysis of various factors such as authors, institutions and countries (Tseng & Tsay, 2013; Yuan, Gretzel, & Tseng, 2015). Also, CATAR can track trends and knowledge development; as it allows users to analyze a set of publication records from the Web of Science, CATAR is the preferred tool for this study.

3. RESULTS AND DISCUSSION

The researchers retrieved a total of 3,861 papers of limited duration from January 1, 2010 to December 31, 2019, from the five journals which are Educational Technology-related in the SSCI database. The retrieved data was then processed in spreadsheets for further analysis.

3.1. Major Contributing Countries/Institutions

In order to give an overview of the trends in Educational Technology papers, Figure 1 presents the top ten contributing countries from 2010 to 2019. As shown below, authors from USA contributed the most publications (778), closely followed by Taiwan (666); Australian landed in third place with 485 articles, UK and Spain rank fourth (384) and fifth (204). The top five countries make up 65.19% of the reviewed articles (2,517 out of 3,861 articles).

Table 1 presents the top ten institutions with the most publications on the topics of Educational Technology. Most of the ranking are occupied by universities from Asian countries and six of them are located in Taiwan. The top three institutions, National Taiwan Normal University, National Taiwan University of Science and Technology and National Central University are separated by only slight differences: 130, 129 and 106 articles. Nanyang Technological University of Singapore comes in the fourth place, Open University lands in the ninth place and University of Georgia from USA at the tenth place.

3.2. Most Productive Authors

In Table 2 different views of the the top 15 authors are listed based on number of publications, fractional count or times cited. NC refers to normal count, which means the number of papers returned by Web of Science database in reply to a query. Each author is counted once regardless of how many contributing authors are listed for a particular publication. FC stands for fractional count; as all authors

Figure 1. Top 10 contributing countries in field of Educational Technology from 2010 to 2019

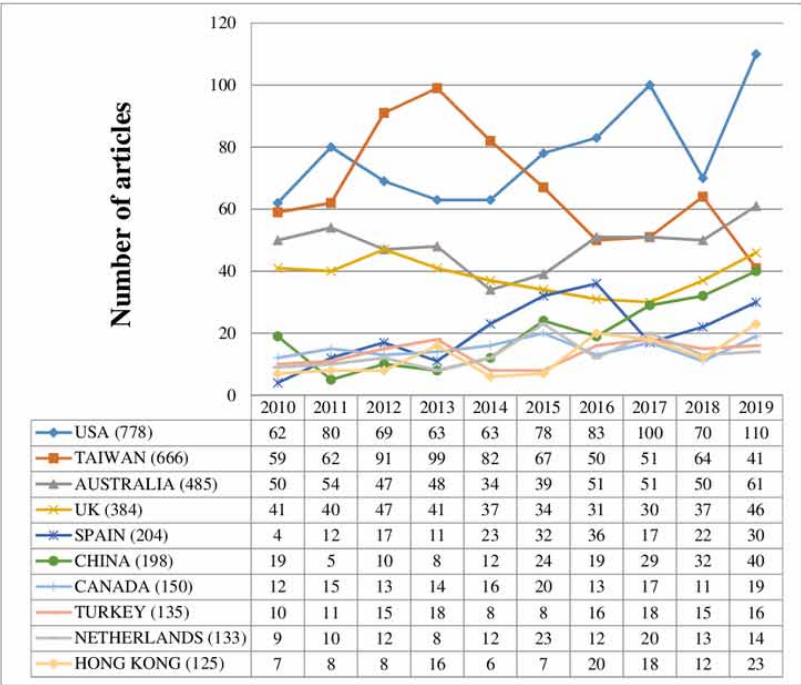


Table 1. Top 10 institutions based on the number of publications in field of Educational Technology from 2010 to 2019

	Natl Taiwan Normal Univ	Natl Taiwan Univ Sci & Technol	Natl Cent Univ	Nanyang Technol Univ	Natl Cheng Kung Univ	Univ Hong Kong	Natl Univ Tainan	Natl Sun Yat Sen Univ	Open Univ	Univ Georgia
2010	12	6	15	17	7	3	4	2	4	5
2011	4	7	13	10	6	4	5	5	6	6
2012	17	19	15	16	9	3	8	9	5	3
2013	17	21	13	10	9	6	9	7	2	1
2014	14	21	15	6	13	3	5	8	6	4
2015	9	13	9	1	11	2	4	5	2	7
2016	11	9	5	3	6	7	5	3	5	7
2017	11	15	9	7	7	11	3	4	4	5
2018	24	11	11	5	5	5	3	3	5	3
2019	11	7	1	5	2	15	1	1	7	6
Total	130	129	106	80	75	59	47	47	46	47

are considered to have equal contribution to the article, each author is counted $1/n$ times if n authors contributed to the same publication. Therefore the combination of FCs for any article would be 1.0.

TC refers to times cited, and similar to NC, it indicates total citation counts of papers, as each author receives one count whenever cited by others. FTC represents fractional times cited, when an article is cited m times, all n authors receive m/n citation counts. CPP stands for citations per paper, the value of which comes from TC/NC , and FCPP stands for fractional citations per paper, which is the value after calculating FTC/FC . Both are used to compare impact of a publication.

Table 2. Top 15 authors in field of Educational Technology from 2010 to 2019 based on normal count (NC), fractional count (FC), and times cited (TC)

Rank	Author	NC	Author	FC	Author	TC
1	Hwang, GJ	75	Cowan, J	40.3	Hwang, GJ	2344
2	Huang, YM	48	Dettori, G	31.5	Tsai, CC	1390
3	Tsai, CC	47	Rushby, N	26.0	Huang, YM	1056
4	Cowan, J	41	Hwang, GJ	24.1	Lee, MJW	808
5	Chen, NS	33	Laborda, JG	20.0	Chai, CS	641
6	Dettori, G	32	Smyth, R	18.0	Kinshuk	605
7	Rushby, N	27	Martin, M	18.0	Chen, NS	598
8	Dalgarno, B	25	Huang, YM	16.6	Yang, SJH	578
9	Henderson, M	24	Thomas, M	15.5	Dalgarno, B	526
10	Hwang, WY	24	Tsai, CC	14.3	Wong, LH	524
11	Bennett, S	24	Teo, T	12.9	Koh, JHL	506
12	Laborda, JG	23	Atkinson, R	10.0	Chu, HC	491
13	Kinshuk	22	Deeson, E	10.0	Liu, M	422
14	Chang, CY	20	Chen, NS	9.4	De Freitas, S	401
15	Teo, T	20	Johnson, M	9.3	Hung, CM	372

Below are brief introductions of top ten most productive authors ranked by NC; profiles from Google Scholar or institutional webpages are listed as sources of reference.

Dr. Gwo-Jen Hwang (NC= 75) is a Chair Professor of Graduate Institute of Digital Learning and Education at National Taiwan University of Science and Technology in Taiwan with publications in fields of mobile learning, ubiquitous learning, digital game-based learning, and artificial intelligence in education. (Data retrieved from: <http://www.idlslab.net/>)

Dr. Yueh-Min Huang (NC=48) is a Chair Professor of Department of Engineering Science, at National Cheng Kung University in Taiwan with publications in the field of e-learning multimedia systems. (Data retrieved from: <https://scholar.google.com/citations?user=HCJfp9AAAAAJ&hl=zh-TW>)

Dr. Chin-Chung Tsai (NC=47) is a Professor and in Program of Learning Sciences at National Taiwan Normal University in Taiwan with publications in fields of science education, computers & education, and Educational Technology. (Data retrieved from: <https://scholar.google.com/citations?user=KiFjo88AAAAJ&hl=zh-TW>)

Dr. John Cowan (NC=41) is an emeritus Professor of Learning Development at UK Open University. Publications in fields of engineering education, innovative teaching. (Data retrieved from: <https://depts.washington.edu/celtweb/pioneers-wp/?p=942>)

Dr. Nian-Shing Chen (NC=33) is a Chair Professor at National Yunlin University of Science and Technology in Taiwan with publications in fields of educational robots, gesture-based learning, game-based learning, and synchronous teaching & learning. (Data retrieved from: <https://scholar.google.com/citations?hl=zh-TW&user=1sym0nAAAAAJ>)

Giuliana Dettori (NC=32) is a senior researcher at the Institute for Educational Technology in Genova, Italy with publications in fields of Educational technology, self-regulated learning, narrative learning, e-Learning and teacher education. ((Data retrieved from: https://scholar.google.it/citation_s?user=jahaxPwAAAAJ&hl=it)

Dr. Nick Rushby (NC=27) is a visiting professor at the Institute of Education and Psychology at Kazan (Volga Region) Federal University with publications in fields of educational & training technology, pedagogy & education, curriculum development, and E-learning. (Data retrieved from: <https://orcid.org/0000-0002-2379-1402>)

Dr. Barney Dalgarno (NC=25) is the Deputy Pro Vice Chancellor, Learning and Teaching at Charles Sturt University in Australia with publications in fields of blended learning, communication technology, learning environment and information technology. (Data retrieved from: <https://researchprofiles.canberra.edu.au/en/persons/barney-dalgarno>)

Dr. Michael Henderson (NC=24) is a professor and Academic Director of Monash Education Innovation at Monash University in Australia with publications in fields of Educational Technology, higher education and computer science. (Data retrieved from: <https://research.monash.edu/en/persons/michael-henderson>)

Dr. Wu-Yuin Hwang (NC=24) is a distinguished professor of Network Learning Technology at National Central University in Taiwan with publications in fields of Innovation education, learning technology and ergonomics. (Data retrieved from: https://scholar.google.com/citations?hl=zh-TW&user=__yyDZUAAAAJ)

3.3. Most Cited Papers

Table 3 presents the top 30 most cited papers. With 448 citations, the first paper, titled “What are the learning affordances of 3-D virtual environments?”, published in British Journal of Educational Technology in 2010, was written by Dalgarno, B and Lee, MJW from Australia. The second paper titled “Personalised and self-regulated learning in the Web 2.0 era: International exemplars of innovative pedagogy using social software” has 302 citations, and was published in Australasian Journal of Educational Technology, written by one of the same authors (Lee, MJW) of the first paper. Thus, it is believed that Lee, MJW could be one of the most important authors with critical impact in the field of educational technology. Dr. Lee, MJW is a professor at Charles Sturt University, and specializes in learning technologies, Educational Technology, online learning, E-learning, and virtual worlds (Data retrieved from: <https://scholar.google.com/citations?user=bIEHFJUAAAAJ&hl=en>). The third most cited paper is titled “Flipping the classroom and instructional technology integration in a college-level information systems spreadsheet course”, with 297 citations, published in Educational Technology Research and Development and authored by Davies, RS; Dean, DL; and Ball, N from the USA. The top 30 most cited studies, to some extent, represent the pioneering work and innovative endeavors in learning and teaching design by using newly emerging technologies at the time of their publication.

In addition, among the authors involved in writing the top 30 papers, viewed from the TC (times cited) perspective, Dr. Mark JW Lee lands in first place, followed by Dr. Chin-Chung Tsai, Dr. Gwo-Jen Hwang, Dr. Barney Dalgarno and Dr Sara de Freitas. Among these 30 works, 13 papers are from British Journal of Educational Technology, 10 from Educational Technology & Society, 5 from ETR&D-Educational Technology Research and Development, and 2 from Australasian Journal

of Educational Technology. None of them are from International Journal of Educational Technology in Higher Education.

Code numbers for source title:

- 1: AUSTRALASIAN JOURNAL OF EDUCATIONAL TECHNOLOGY
- 2: BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY
- 3: EDUCATIONAL TECHNOLOGY & SOCIETY
- 4: ETR&D-EDUCATIONAL TECHNOLOGY RESEARCH AND DEVELOPMENT
- 5: INTERNATIONAL JOURNAL OF EDUCATIONAL TECHNOLOGY IN HIGHER EDUCATION

3.4. Most Productive Institutions

In Table 4, the researchers put together a list of the educational institutions with which the authors of these Educational Technology papers are affiliated, wherein and the institutions are ranked by number of papers published during 2010-2019. According to the data, National Taiwan Normal University and National Taiwan University of Science and Technology both ranked in first place with NC=130. This is followed by National Central University of Taiwan with NC= 106, and Nanyang Technological University of Singapore as the fourth (NC=80).

3.5. Co-Word Analysis

After using CATAR for quantitative analysis, the researchers in this study utilized co-word analysis to classify seven clusters from the published articles. The number of clusters was carefully chosen according to their related size, in order to present them without too much disparity in article numbers.

Figure 2 shows 21 sets of items within the seven clusters; the items represent the categorized results of Bibliographic Coupling in each cluster. In addition, the top contributors to each of these clusters is listed in Table 5.

Cluster one is principally associated with teaching environment design, and includes 2,808 articles, with USA as the top contributing country (513), closely followed by Taiwan (506), then Australia (273). The representative items in this cluster are: online, mobile, collaborative, social media, game, affective learning, digital badge, cyberhunt, and gamification. These diverse items show that Cluster one covers comprehensive issues regarding the topic of Educational Technology.

Cluster two is about digital learning environment and contains 168 articles. Authors in USA contribute the most articles (47), followed by Australia (33) and UK (23). The representative items in this cluster are: eportfolio-based, and digital citizenship with social media.

Cluster three discusses digital assessment and includes 67 articles; the top contributor is Australia (19), followed by Taiwan (16) and UK (9). The representative items are learning analytics, e-assessment, and feedback on students.

Cluster four focuses on digital learning and contains 141 articles, among which Australia contributes 33 publications, followed by Taiwan (26) and USA (22). The representative items are e-books, e-readers, internet-enabled, and interactive.

Cluster five is about the trends in Educational Technology and includes 37 publications. Among them, 14 are from UK, 7 from Australia and 5 from South Africa. The representative items are journal, Educational Technology, trend, decade, and publication.

Cluster six is about edu-sharing and multivocal approach across systems or organizations. It contains 41 articles, with USA contributing 9, followed by Australia (8) and Taiwan (5). The representative items are multivocal approach, praxis, and edu-sharing.

Cluster seven focuses on assurance of education quality and contains 110 publications. USA contributes the most with 20 articles, followed by UK (13) and Spain (11). The representative items are quality assurance, accreditation, and tool-facilitating.

Table 3. List of the top 30 most cited works in the five selected Educational Technology journals from 2010 to 2019

Rank	Article Title	Authors	Code number for Source Title	Publication Year	Times Cited
1	What are the learning affordances of 3-D virtual environments?	Dalgarno, B; Lee, MJW	2	2010	448
2	Personalised and self-regulated learning in the Web 2.0 era: International exemplars of innovative pedagogy using social software	McLoughlin, C; Lee, MJW	1	2010	302
3	Flipping the classroom and instructional technology integration in a college-level information systems spreadsheet course	Davies, RS; Dean, DL; Ball, N	4	2013	297
4	Gamification in Education: A Systematic Mapping Study	Dicheva, D; Dichev, C; Agre, G; Angelova, G	3	2015	294
5	Augmented Reality Trends in Education: A Systematic Review of Research and Applications	Bacca, J; Baldiris, S; Fabregat, R; Graf, S; Kinshuk	3	2014	257
6	Using the Facebook group as a learning management system: An exploratory study	Wang, QY; Woo, HL; Quek, CL; Yang, YQ; Liu, M	2	2012	255
7	Translating Learning into Numbers: A Generic Framework for Learning Analytics	Greller, W; Drachsler, H	3	2012	235
8	Research trends in mobile and ubiquitous learning: a review of publications in selected journals from 2001 to 2010	Hwang, GJ; Tsai, CC	2	2011	224
9	University students' behavioral intention to use mobile learning: Evaluating the technology acceptance model	Park, SY; Nam, MW; Cha, SB	2	2012	214
10	Use of three-dimensional (3-D) immersive virtual worlds in K-12 and higher education settings: A review of the research	Hew, KF; Cheung, WS	2	2010	205
11	Leveraging mobile technology for sustainable seamless learning: a research agenda	Looi, CK; Seow, P; Zhang, BH; So, HJ; Chen, WL; Wong, LH	2	2010	201
12	Factors affecting technology integration in K-12 classrooms: a path model	Inan, FA; Lowther, DL	4	2010	193
13	Mapping learning and game mechanics for serious games analysis	Arnab, S; Lim, T; Carvalho, MB; Bellotti, F; de Freitas, S; Louchart, S; Suttie, N; Berta, R; De Gloria, A	2	2015	187
14	Social Learning Analytics	Shum, SB; Ferguson, R	3	2012	182
15	Facilitating Preservice Teachers' Development of Technological, Pedagogical, and Content Knowledge (TPACK)	Chai, CS; Koh, JHL; Tsai, CC	3	2010	170
16	Defining Mobile Learning in the Higher Education Landscape	El-Hussein, MOM; Cronje, JC	3	2010	167

continued on next page

Table 3. Contineud

Rank	Article Title	Authors	Code number for Source Title	Publication Year	Times Cited
17	A review of online course dropout research: implications for practice and future research	Lee, Y; Choi, J	4	2011	160
18	Learning Analytics and Educational Data Mining in Practice: A Systematic Literature Review of Empirical Evidence	Papamitsiou, Z; Economides, AA	3	2014	158
19	Understanding cognitive presence in an online and blended community of inquiry: Assessing outcomes and processes for deep approaches to learning	Akyol, Z; Garrison, DR	2	2011	151
20	Impact of class lecture webcasting on attendance and learning	Traphagan, T; Kucsera, JV; Kishi, K	4	2010	151
21	Assessor or assessee: How student learning improves by giving and receiving peer feedback	Li, L; Liu, XY; Steckelberg, AL	2	2010	145
22	Students' perceptions of using Facebook as an interactive learning resource at university	Irwin, C; Ball, L; Desbrow, B; Leveritt, M	1	2012	143
23	Tweeting for learning: A critical analysis of research on microblogging in education published in 2008-2011	Gao, F; Luo, T; Zhang, K	2	2012	140
24	Adding Innovation Diffusion Theory to the Technology Acceptance Model: Supporting Employees' Intentions to use E-Learning Systems	Lee, YH; Hsieh, YC; Hsu, CN	3	2011	139
25	Learning as immersive experiences: Using the four-dimensional framework for designing and evaluating immersive learning experiences in a virtual world	de Freitas, S; Rebolledo-Mendez, G; Liarokapis, F; Magoulas, G; Poulouvassilis, A	2	2010	139
26	Are badges useful in education?: it depends upon the type of badge and expertise of learner	Abramovich, S; Schunn, C; Higashi, RM	4	2013	137
27	A Review of Technological Pedagogical Content Knowledge	Chai, CS; Koh, JHL; Tsai, CC	3	2013	133
28	A concept map approach to developing collaborative Mindtools for context-aware ubiquitous learning	Hwang, GJ; Shi, YR; Chu, HC	2	2011	133
29	Putting twitter to the test: Assessing outcomes for student collaboration, engagement and success	Junco, R; Elavsky, CM; Heiberger, G	2	2013	131
30	A Review of Research on Mobile Learning in Teacher Education	Baran, E	3	2014	128

Table 4. Top 15 institutions based on normal count ranking and other indicators for academic publications in Educational Technology

Rank		NC	TC	CPP	FC	FTC	FCPP
1	Natl Taiwan Normal Univ	130	1256	9.66	77.7	714.8	9.2
2	Natl Taiwan Univ Sci & Technol	130	3281	25.24	68.7	1745.5	25.41
3	Natl Cent Univ	106	1843	17.39	57.6	1019.9	17.71
4	Nanyang Technol Univ	80	2038	25.48	54	1358.6	25.16
5	Natl Cheng Kung Univ	75	1378	18.37	40.1	681.4	16.99
6	Univ Hong Kong	60	561	9.35	40.9	435	10.64
7	Univ Georgia	47	601	12.79	26	351.4	13.52
8	Natl Univ Tainan	47	1452	30.89	22.5	647.8	28.79
9	Natl Sun Yat Sen Univ	47	789	16.79	20.3	335.9	16.55
10	Open Univ	47	729	15.51	34	571.6	16.81
11	Athabasca Univ	46	950	20.65	24.8	447.2	18.03
12	Natl Chiao Tung Univ	42	514	12.24	23.2	259.3	11.18
13	Beijing Normal Univ	42	307	7.31	22.3	134.8	6.04
14	Univ Sydney	39	388	9.95	22.3	237.4	10.65
15	Monash Univ	39	349	8.95	22.1	222.2	10.05

Figure 2. Seven clusters with 21 sets of items for academic publications in Educational Technology from 2010 to 2019: Representative tree with dendrograms

	Natl Taiwan Normal Univ	Natl Taiwan Univ Sci & Technol	Natl Cent Univ	Nanyang Technol Univ	Natl Cheng Kung Univ	Univ Hong Kong	Natl Univ Tainan	Natl Sun Yat Sen Univ	Open Univ	Univ Georgia
2010	12	6	15	17	7	3	4	2	4	5
2011	4	7	13	10	6	4	5	5	6	6
2012	17	19	15	16	9	3	8	9	5	3
2013	17	21	13	10	9	6	9	7	2	1
2014	14	21	15	6	13	3	5	8	6	4
2015	9	13	9	1	11	2	4	5	2	7
2016	11	9	5	3	6	7	5	3	5	7
2017	11	15	9	7	7	11	3	4	4	5
2018	24	11	11	5	5	5	3	3	5	3
2019	11	7	1	5	2	15	1	1	7	6
Total	130	129	106	80	75	59	47	47	46	47

Moreover, Table 6 reveals cluster trends when the numbers are separated by year. For cluster one, it remains a steady growing trend with a slight slip in 2014, similar trends also show on other clusters, except for cluster two, which decreased dramatically in 2013 and 2018, and yet come back strong in 2019 with 33 articles.

Table 5. Top countries in each word cluster for academic publications in Educational Technology from 2010 to 2019

Cluster 1		USA	Taiwan	Australia	UK	China	Spain	Hong Kong	Netherlands	Canada	Turkey	South Korea
Total:	2808	513	506	273	149	131	107	97	92	86	86	67
Cluster 2		USA	Australia	UK	Taiwan	Netherlands	Spain	New Zealand	Malaysia	South Korea	China	Ireland
Total:	168	47	33	23	9	7	6	5	5	5	4	4
Cluster 3		Australia	Taiwan	UK	USA	Hong Kong	Spain	New Zealand	Canada			
Total:	67	19	16	9	7	5	4	4	3			
Cluster 4		Australia	Taiwan	USA	UK	Canada	Netherlands	China	Israel	Singapore	Turkey	South Korea
Total:	141	33	26	22	17	9	7	5	5	4	4	3
Cluster 5		UK	Australia	South Africa	USA	Taiwan	Spain					
Total:	37	14	7	5	5	3	3					
Cluster 6		USA	Australia	Taiwan	Greece	Spain	Germany	China	Netherlands			
Total:	41	9	8	5	5	4	4	3	3			
Cluster 7		USA	UK	Spain	Taiwan	Australia	Germany	Turkey	China	Malaysia	Canada	South Africa
Total:	110	20	13	11	10	9	7	6	5	5	5	4

Table 6. Overview of number of publications in Educational Technology by word cluster from 2010 to 2019

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cluster 1	161	184	238	223	197	213	224	267	246	262
Cluster 2	6	15	17	7	18	17	20	15	7	33
Cluster 3	13	15	8	10	3	6	6	4	9	5
Cluster 4	21	11	12	13	12	11	10	13	18	7
Cluster 5	2	4	3	13	2	3	7	4	2	4
Cluster 6	9	6	4	2	5	2	4	6	2	4
Cluster 7	14	7	12	13	7	13	9	5	7	10

4. CONCLUSIONS

In this study, the researchers analyzed Educational Technology articles published in five journals in that field from 2010 to 2019. Reviewing the results, USA, Taiwan and Australia are the top three contributing countries regarding publications on Educational Technology topics during the designated period.

Reviewed by institution, universities from Asian countries occupy most of the affiliations, and the top three institutions, National Taiwan Normal University, National Taiwan University of Science and Technology and National Central University are all located in Taiwan. The top three authors based on number of publications are as follows: Dr. Gwo-Jen Hwang (NC= 75), Dr. Yueh-Min Huang (NC=48), and, Dr. Chin-Chung Tsai (NC=47). When the ranking is displayed as Citation Per Paper, the top three authors are Dr. Mark JW Lee (CPP=134.67), followed by Dr. Hendrik Drachsler (CPP=108.00), and Dr. Rebecca Ferguson (CPP=81.00).

The researchers also used CATAR to classify seven clusters according to co-word analysis, which revealed the representing items within each cluster, and listed the top contributors within these clusters. USA is the top contributor to clusters one, two, six and seven, Australia is the top contributor to clusters three and four, and UK is the top contributor to cluster five.

By analyzing the statistics, graphics and cluster items, this research provides teachers, institutional administrators, and readers who are interested in topics related to Educational Technology some ideas on popular topics and trends in this field. This study may provide some insights for researchers in using analytic tools such as CATAR to explore the possibilities that technology can offer. Finally, the authors in this study expect that the findings can reveal implications for educators when adopting technologies for their students, and for researchers in the field of Educational Technology when selecting variables for their studies.

As it explores the structures and research topics within five journals, this review study serves as a starting point for further in-depth research into technology uses in education. This study has some limitations. First, because this analysis focuses on past publications, the enabling technology of big data and applications of artificial intelligence, which are expected to draw attention from researchers in the future, are not reveal in these publications. Second, this review focused on articles published in the most highly cited core journals in the Social Science Citation Index (SSCI). A number of high-quality articles are published in journals cited in the Emerging Sources Citation Index, the Conference Proceeding Citation Index, and other indices that were not included in these analyses. Further investigations with comparable journals are suggested to investigate the research field of educational technology more thoroughly. Finally, the research scope of educational technology is relatively broad; a more detailed level, for example, learning domains such as business or science, as well as technological domains such as mobiles, could be considered in future research to provide insights within a particular domain.

REFERENCES

- Arnold, D., & Sangrà, A. (2018). Dawn or dusk of the 5th age of research in educational technology? A literature review on (e-)leadership for technology-enhanced learning in higher education (2013-2017). *International Journal of Educational Technology in Higher Education*, 15(1), 24. doi:10.1186/s41239-018-0104-3
- Borgman, C. L., & Furner, J. (2002). Scholarly communication and bibliometrics. In B. Cronin (Ed.), *Annual Review of Information Science and Technology*, 36 (pp. 3–72). Information Today.
- Chen, X., Zou, D., Cheng, G., & Xie, H. (2020). Detecting latent topics and trends in educational technologies over four decades using structural topic modeling: A retrospective of all volumes of Computers & Education. *Computers & Education*, 151, 1–21. doi:10.1016/j.compedu.2020.103855
- Chou, T. L., Wu, J. J., & Tsai, C. C. (2019). Research trends and features of critical thinking studies in E-learning environments: A review. *Journal of Educational Computing Research*, 57(4). doi:10.1177/0735633118774350
- Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016). Digital games, design, and learning: A systematic review and meta-analysis. *Review of Educational Research*, 86(1), 79–122. doi:10.3102/0034654315582065 PMID:26937054
- Doyle, A., Seery, N., Canty, D., & Buckley, J. (2019). Agendas, influences, and capability: Perspectives on practice in design and technology education. *International Journal of Technology and Design Education*, 29(1), 143–159. doi:10.1007/s10798-017-9433-0
- Jack, C., & Higgins, S. (2019). Embedding educational technologies in early years education. *Research in Learning Technology*, 27(0). Advance online publication. doi:10.25304/rlt.v27.2033
- Lai, J. W., & Bower, M. (2019). How is the use of technology in education evaluated? A systematic review. *Computers & Education*, 133, 27–42. doi:10.1016/j.compedu.2019.01.010
- Lazar, S. (2015). The importance of educational technology in teaching. *International Journal of Cognitive Research in Science, Engineering and Education*, 3(1), 111–114.
- Lee, C., Yeung, A. S., & Cheung, K. W. (2019). Learner perceptions versus technology usage: A study of adolescent English learners in Hong Kong secondary schools. *Computers & Education*, 133, 13–26. doi:10.1016/j.compedu.2019.01.005
- Li, J., Antonenko, P. D., & Wang, J. (2019). Trends and issues in multimedia learning research in 1996-2016: A bibliometric analysis. *Educational Research Review*, 28, 1–21. doi:10.1016/j.edurev.2019.100282
- Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education*, 70, 29–40. doi:10.1016/j.compedu.2013.07.033
- Moed, H., De Bruin, R., & Van Leeuwen, T. H. (1995). New bibliometric tools for the assessment of national research performance: Database description, overview of indicators and first applications. *Scientometrics*, 33(3), 381–422. doi:10.1007/BF02017338
- Morrison, G. R., Ross, S. M., Kemp, J. E., & Kalman, H. (2010). *Designing effective instruction: Applications of instructional design* (6th ed.). Wiley.
- Pedro, L. F. M. G., & de Oliveira Barbosa, C. M. M. (2018). A critical review of mobile learning integration in formal educational contexts. *International Journal of Educational Technology in Higher Education*, 15(1), 10. doi:10.1186/s41239-018-0091-4
- Shafique, M. (2013). Thinking inside the box? Intellectual structure of the knowledge base of innovation research (1988-2008). *Strategic Management Journal*, 34(1), 62–93. doi:10.1002/smj.2002
- Tseng, Y. H., & Tsay, M. Y. (2013). Journal clustering of library and information science for subfield delineation using the bibliometric analysis toolkit: CATAR. *Scientometrics*, 95(2), 503–528. doi:10.1007/s11192-013-0964-1
- Warner, C. K., Bell, C. V., & Odom, A. L. (2018). Defining technology for learning: Cognitive and physical tools of inquiry. *Middle Grades Review*, 4(1), 2.

Waxman, H. C., Boriack, A. W., Lee, Y. H., & MacNeil, A. (2013). Principals' perceptions of the importance of technology in schools. *Contemporary Educational Technology*, 4(3), 187–196. doi:10.30935/cedtech/6102

Yuan, Y., Gretzel, U., & Tseng, Y. H. (2015). Revealing the nature of contemporary tourism research: Extracting common subject areas through bibliographic coupling. *International Journal of Tourism Research*, 17(5), 417–431. doi:10.1002/jtr.2004

Yih-Ping Cheng is an associate professor in the Department of Information Management at Ming Chuan University in Taiwan. She received her MBA and PhD at National Chiao Tung University in Taiwan. Her research interests include educational technology, flipped classroom and instructional design, e-learning in programming.

Chun-Hung Huang is an assistant professor of Department of Information Management, Ming Chuan University, Taiwan.

Lynne Cheng Hsu is a staff member of Teacher Education Center, Ming Chuan University, Taiwan. Readers can contact her by email: lynnehsu@mail.mcu.edu.tw