Advancements and paradigm shifts in mobile and ubiquitous learning: a bibliometric analysis of the 16 years of the *International Journal of Mobile Learning and Organisation*

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Abstract: Among international journals, the *International Journal of Mobile Learning and Organisation* (*IJMLO*) is one of a small number that focus on mobile-enabled schooling and professional training. *IJMLO* has been widely referred and has been included in the SCOPUS database since its first publication in 2007. In 2022, *IJMLO* was included in the Emerging Sources Citation Index (ESCI) due to its high citation rates. To clearly understand the advancements and paradigm shift in mobile and ubiquitous learning over the past 16 years, a bibliometric analysis was performed to analyse publications in *IJMLO* from 2007 to 2022. The analysis included several key issues such as the publication and citation structure of the journal, the most cited articles, the relationship of leading authors and countries/regions in the journal, and the topics and thematic evolution.

Keywords: bibliometrics; citation analysis; mobile learning; ubiquitous learning; augmented reality.

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1 Background and objectives

Owing to the advancement and popularity of mobile and wireless communication technologies, mobile and ubiquitous learning has been widely adopted in school settings

and enterprise training in the past two decades (Crompton and Burke, 2018; Lai, 2020; Wu et al., 2012). Mobile learning refers to 'using mobile technologies to facilitate learning', while ubiquitous learning generally refers to 'learning anywhere and at any time' (Hwang and Tsai, 2011; Shih et al., 2011). Scholars have indicated the coming of the mobile era, and have emphasised the importance of knowing how to effectively consider the use of mobile and wireless communication technologies in learning designs (Hwang and Tsai, 2011; Hwang and Wu, 2014). That is, it is important to know the advancements and paradigm shifts of mobile and ubiquitous learning. Among various well-recognised journals, the *International Journal of Mobile Learning and Organisation* (*IJMLO*) is an international academic journal which focuses on the use of mobile and wireless communication technologies in school settings and profession training. The publications in *IJMLO* have been highly cited, and hence it is included in Emerging Sources Citation Index (ESCI) as well as the SCOPUS database. Nowadays, *IJMLO* is the most representative journal in the field of mobile and ubiquitous learning over the past 16 years. Consequently, to investigate the advancements and paradigm shifts in mobile and ubiquitous learning, this study analysed the *IJMLO* publications from 2007 to 2020 by adopting the bibliometric analysis method.

Bibliometrics is a quantitative literature review method that is widely used by researchers to provide objective and reliable analysis with structured information related to influential authors (number of citations and publications) and research topics (Crane, 1972; Pinto et al., 2020). In recent years, bibliometrics has been widely applied in many disciplines, such as mathematics (Hwang and Tu, 2021), mobile learning and humanities education (Koon, 2022), shadow education (Hajar and Karakus, 2022), tourism and hospitality education (Menon et al., 2022) and information literacy (Pinto et al., 2020). Moreover, there has been some research on the research trends through bibliometrics, such as the *Journal of Computer Assisted Learning* (Akturk, 2022), *Interactive Learning Environments* (ILE) (Chen et al., 2022), and the *Journal of Business and Industrial Marketing* (Valenzuela et al., 2017).

This study analysed the critical factors that influence *IJMLO* via the bibliometric analysis method based on articles, authors, countries, topics, and thematic evolution. Using bibliometric analysis can obtain objective findings that are published in *IJMLO* only considering the data from the Scopus database. Thus, the research questions of the study are addressed below:

1 What is the publication and citation structure in *IJMLO*?

2 Which are the most influential publications in *IJMLO*?

3 Who are the most productive and most cited authors in *IJMLO* and what are their country/region affiliations?

4 What are the topics of the *IJMLO* publications? What is the thematic evolution of the journal publications?

2 Research methods

Based on the research questions of the study, the bibliometric analysis method was adopted to analyse the number of publications, the number of citations, the productivity of authors (author productivity) and the authors' countries/regions (Merigó et al., 2015).

A bibliometric study was conducted on January 30, 2023 for *IJMLO* from 2007 to 2022, which is based on the results obtained from the Scopus database, the largest database of abstracts and bibliographic references of peer-reviewed scientific literature, which includes over 27,100 peer-reviewed journals from 7,000 publishers.

IJMLO was ranked 75 out of 1,406 education journals by CiteScore in 2021. From the Scopus database, it was found that a total of 353 journal articles were published in *IJMLO* up until December 31, 2022, with 12 editorials, 25 conference papers, 307 publications, and nine review studies. As for the topics of the published articles in *IJMLO*, the author keywords contain important information of research publications, so we conducted co-word analysis through author keywords. In co-word analysis, co-word means keywords that are extracted from papers, representing a unique research direction, trend, research topic or subject of a field. Thus, co-word analysis is a procedure to investigate the association between research papers and the discipline structure through statistics of co-words (He, 1998; Van Eck and Waltman, 2010).

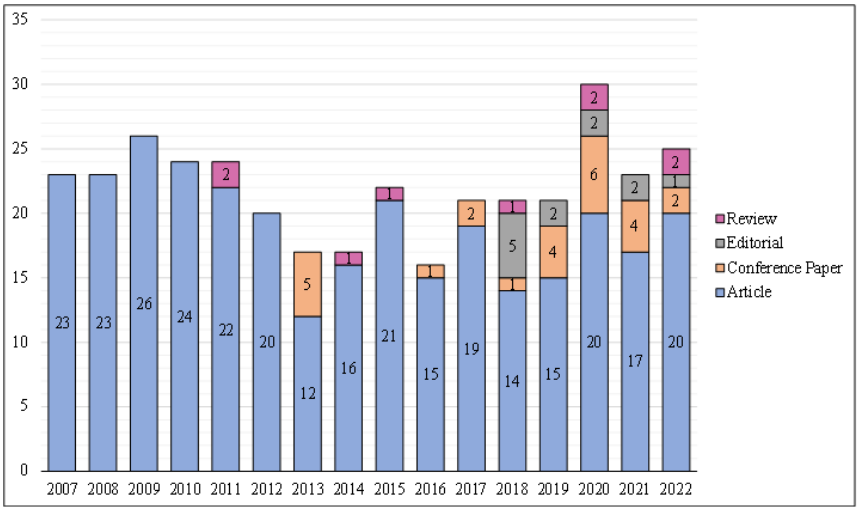
In this study, VOSviewer was used to perform the authors' keywords co-occurrence analysis of the journal publications, to explore the research topics, and to present the results in visualisation form (Chang et al., 2022; Guo et al., 2016; Van Eck and Waltman, 2010). In addition, to illustrate the thematic evolution, the bibliometrix R-package was used to produce a strategic diagram of the thematic evolution in order to quantitatively analyse the research focus in *IJMLO* (Cobo et al., 2011). A strategic diagram is a two-dimensional diagram with both centrality and density as parameters, where the horizontal axis (X-axis) represents centrality and the vertical axis (Y-axis) represents density. The principle of a strategic diagram is based on the co-word matrix and cluster analysis, and the analysis results are used to draw a strategic diagram of the clusters (Callon et al., 1991). Centrality represents the strength of external connections with other topics, and is also a measure of the importance of a topic in the field. Density indicates the strength of the connection between keywords in terms of research topics. The larger the circle in a strategic diagram, the greater the topic relevance (e.g., number of publications and citations, etc.) will be. For better understanding of the thematic evolution in *IJMLO* from 2007 to 2022, we utilised the bibliometrix R-package.

3 Research results

3.1 Research question 1: what is the publication and citation structure in IJMLO?

The study mainly investigated the topics, thematic evolution, and trends of *IJMLO* over the past 16 years. The number of yearly publications in *IJMLO* from 2007 to 2022 is shown in Figure 1. The average number of articles published in the journal is 22.06 each year. In the early years of *IJMLO*, the journal mainly accepted articles, but it started to accept review papers in 2011 and conference papers in 2013. The highest number of publications was in 2020, when conference papers, editorials, and review papers were all accepted.

Figure 1 Number of publications by year (see online version for colours)



As can be seen in Table 1, the citation structure of *IJMLO* has evolved over the years. There are six articles that have been cited more than 100 times, 14 articles more than 50 times, 43 articles more than 20 times, 101 articles more than ten times, 167 articles more than five times, and 284 articles at least once, which means that 80.45% of the articles have been cited.

To further investigate the trends of *IJMLO* publications over the past 16 years, we analysed and compared all publications through two periods of time: the first period (2007–2014) accounted for 55.79% of all citations, peaking in 2014 (490 citations), while the second period (2016–2020) had more than 230 citations per year. In detail, the number of citations in the journal was 3,687, or about 10.44 citations per publication.

In 2007, the highest number of citations was reached with 479, while the lowest number of citations (137) was in 2013, excluding the last two years (2021–2022). In addition, 2007 was the first year for one paper to be cited more than 100 times. Overall, there were six papers cited more than 100 times over the past 16 years, two papers in the first period and four in the second period.

3.2 Research question 2: which are the most influential publications in IJMLO?

Table 2 shows the list of the most cited papers (more than 17 times) in *IJMLO*. As can be seen, there are 26 papers that were published in the first period (total citations 1,218) and 25 papers in the second period (total citations 1,103), showing that *IJMLO* has received continuous attention in the field. Besides, six papers have been cited at least 100 times, two of which were published in the first period. The most cited paper was published in 2014 due to the citation window, which means that the total number of citations was accumulated in the past 3 to 7 years (Wang, 2013; Valenzuela et al., 2017).

Table 1 Annual citation structure of *IJMLO*

Year	*≥ 100*	*≥ 50*	*≥ 20*	*≥ 10*	*≥ 5*	*≥ 1*	*TP*	*TC*
2007	1	2	6	10	17	21	23	479
2008	0	2	2	5	12	20	23	213
2009	0	0	1	5	12	24	26	171
2010	0	0	3	10	18	24	24	258
2011	0	0	1	5	10	18	24	141
2012	0	0	2	8	9	20	20	168
2013	0	0	1	4	9	17	17	137
2014	1	2	7	11	13	15	17	490
2015	0	1	4	5	10	20	22	192
2016	1	1	3	8	10	14	16	251
2017	1	2	3	7	9	17	21	318
2018	1	1	2	8	11	16	21	266
2019	1	2	4	9	12	19	21	316
2020	0	1	4	6	12	25	30	249
2021	0	0	0	0	2	12	23	32
2022	0	0	0	0	1	2	25	6
Total	6	14	43	101	167	284	353	3687
Percentage	1.70	3.97	12.18	28.61	47.31	80.45	100	-

Note: TP = total papers; ≥ 100, ≥50, ≥ 20, ≥ 10, ≥ 5, ≥ 1 = number of papers with equal or more than 100, 50, 20, 10, 5 and 1 citations.

Source: Own elaboration based on Scopus data

The most cited paper in Table 2 is 'Applications, impacts and trends of mobile technology-enhanced learning: A review of 2008–2012 publications in selected SSCI journals' published in 2014, which reviewed seven well-recognised Social Science Citation Index (SSCI) journals of technology-enhanced learning to investigate the applications and impacts of mobile technology-enhanced learning from 2008 to 2012. The research findings showed that mobile learning could help improve students' learning achievement, learning motivation, and interests; moreover, smartphones and tablet PCs were becoming widely adopted mobile learning devices, which may affect the adoption of sensing technologies in the future (Hwang and Wu, 2014).

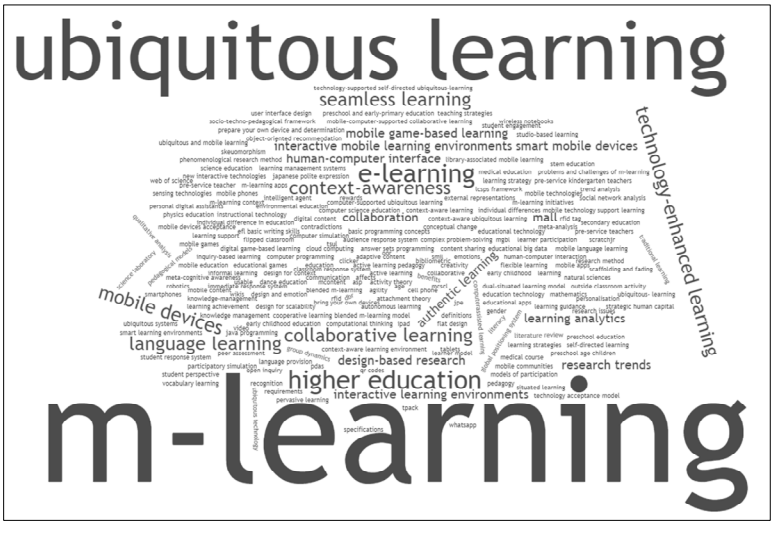
Mobile computing can provide students with potential opportunities in learning; Uden (2007) pointed out that mobile devices equipped with useful and flexible user interfaces for learners are important for the operational understanding of the context. It is worth noting that the articles with the 3rd-6th total number of citations were published in the second issue.

For example, Papadakis and Kalogiannakis (2017) noted that the popularity and rapid growth of smart mobile devices has made it difficult for educators to select appropriate educational apps for children, and therefore there is a need to recognise the new digital divide (i.e., the gap between students who simply use technology to consume media passively and those who use technology to create, design, build, explore, and collaborate). A series of investigations were made, like teaching programming concepts

to preschoolers (Papadakis et al., 2016), pre-service teachers' attitudes towards mobile devices (Papadakis, 2018), as well as examining pre-service kindergarten teachers' ICT (Information and Communication Technologies) skills and their attitudes to mobile devices for instruction (Kalogiannakis and Papadakis, 2019). Another noteworthy point is that among the most cited papers in Table 2, a paper with an average number of citations per year (i.e., C/Y) of 36.50 was published in 2020 (Dorouka et al., 2020). The paper considered the unresolved issues and challenges in the successful integration of interactive technology in preschool and early elementary education, exploring the impact and potential of mobile devices applied in the fields of robotics, mathematics, STEM, and literacy.

A total of 213 author keywords were analysed from 51 articles that ranked in the top 49 in Table 2. As can be seen in Figure 2, these author keywords were used to generate a word cloud, where the larger words represent more frequently used author keywords. Based on the frequency of author keywords, the topics of these articles include m-learning (f = 23), ubiquitous learning (f = 13), higher education (f = 4), collaborative learning (f = 3), context-awareness (f = 3), language learning (f = 3), mobile-assisted language learning (MALL) (f = 2), learning analytics (f = 2) and smart mobile devices (f = 2).

Figure 2 Word cloud obtained from 51 papers in the top 49 ranking



VOSviewer was adopted to analyse the co-occurrence of author keywords to explore the hot topics from the 51 papers, as shown in Figure 3. It shows the analysis results of the co-occurrence of author keywords, revealing that m-learning and ubiquitous learning were the most frequently used keywords in these papers, and were the more frequently discussed topics in the first period. The early-mentioned topics included authentic learning, collaborative learning, design-based research, MALL, collaboration, language learning, and seamless learning (i.e., Kurti et al., 2008; Uden, 2007; Wong et al., 2012; Yin et al., 2010). The latest topics discussed include learning analytics, interactive mobile learning environments, and mobile devices (Daungcharone et al., 2019; Li and Wong, 2020).

Table 2 The most cited papers in *IJMLO* (TC ≥ 17)

R	*TC*	*Title*	*Author/s*	*Year*	*C/Y*
1	201	Applications, impacts and trends of mobile technology-enhanced learning: a review of 2008–2012 publications in selected SSCI journals	Hwang, G.J. and Wu, P. H.	2014	25.13
2	190	Activity theory for designing mobile learning	Uden, L.	2007	12.67
3	143	Mobile educational applications for children: what educators and parents need to know	Papadakis, S. and Kalogiannakis, M.	2017	28.60
4	111	Developing fundamental programming concepts and computational thinking with ScratchJr in preschool education: a case study	Papadakis, S., Kalogiannakis, M. and Zaranis N.	2016	18.50
5	105	Evaluating pre-service teachers' acceptance of mobile devices with regards to their age and gender: a case study in Greece	Papadakis, S.	2018	26.25
6	104	Evaluating pre-service kindergarten teachers' intention to adopt and use tablets into teaching practice for natural sciences	Kalogiannakis, M. and Papadakis, S.	2019	34.67
7	85	Effects of mobile learning time on students' conception of collaboration, communication, complex problem-solving, meta-cognitive awareness and creativity	Lai, C.L. and Hwang, G.J.	2014	10.63
8	73	Tablets and apps for promoting robotics, mathematics, STEM education and literacy in early childhood education	Dorouka, P., Papadakis, S. and Kalogiannakis, M.	2020	36.50
9	66	Trends in digital game-based learning in the mobile era: a systematic review of journal publications from 2007 to 2016	Chang, C.Y. and Hwang, G.J.	2019	22.00
10	63	Combining mobile technologies in environmental education: a Greek case study	Kalogiannakis, M. and Papadakis, S.	2017	12.60
11	58	LOCH: supporting mobile language learning outside classrooms	Ogata, H., Li Hui, G., Yin, C., Ueda, T., Oishi, Y. and Yano, Y.	2008	4.14
12	57	High school teachers' perspectives on applying different mobile learning strategies to science courses: the national mobile learning program in Taiwan	Lai, C.L. and Hwang, G.J.	2015	8.14
13	57	Bridging outdoors and indoors educational activities in schools with the support of mobile and positioning technologies	Kurti, A., Spikol, D. and Milrad, M.	2008	4.07
14	55	Mobile learning – challenges and potentials	Denk, M., Weber, M. and Belfin, R.	2007	3.67
15	49	IPadagogy: appropriating the iPad within pedagogical contexts	Cochrane, T., Narayan, V. and Oldfield, J.	2013	5.44
16	46	Supporting the acquisition of Japanese polite expressions in context-aware ubiquitous learning	Yin, C., Ogata, H., Tabata, Y. and Yano, Y.	2010	3.83
17	44	Mobile technology in education: uses and benefits	Eschenbrenner, B. and Fui-Hoon Nah, F.	2007	2.93

Note: R = rank; TC = total citations; C/Y = citations per year.

Source: Own elaboration based on Scopus data

Table 2 The most cited papers in *IJMLO* (TC ≥ 17) (continued)

R	*TC*	*Title*	*Author/s*	*Year*	*C/Y*
18	42	Skeuomorphism or flat design: future directions in mobile device user interface (UI) design education	Page, T.	2014	5.25
19	34	The role of mobile learning on the learning environment shifting at high school in Indonesia	Sulisworo, D. and Toifur, M.	2016	5.67
20	33	LORAMS: linking physical objects and videos for capturing and sharing learning experiences towards ubiquitous learning	Ogata, H., Matsuka, Y., El-Bishouty, M.M. and Yano, Y.	2009	2.54
21	31	Studio-based learning via wireless notebooks: a case of a Java programming course	Barak, M., Harward, J. and Lerman, S.	2007	2.07
22	30	Adaptive multimedia content delivery for contextaware u-learning	Zhao, X. and Okamoto, T.	2011	2.73
23	29	Trends of mobile technology-enhanced medical education: a review of journal publications from 1998 to 2016	Chang, C.Y. and Hwang, G.J.	2018	7.25
24	28	From traditional learning into mobile learning in education at the university level: undergraduate students perspective	Sarrab, M., Alzahrani, A., Al Alwan, N. and Alfarraj, O.	2014	3.50
25	28	Keynote paper: developing knowledge and learning strategies in mobile organisations	Liebowitz, J.	2007	1.87
26	27	Prepare your own device and determination (PYOD): a successfully promoted mobile learning mode in Taiwan	Hwang. G.J., Chu. H.C. and Lai, C.L.	2017	5.40
27	27	Effects of a personalised ubiquitous learning support system on university students' learning performance and attitudes in computer-programming courses	Chookaew, S., Wanichsan, D., Hwang, G.J. and Panjaburee, P.	2015	3.86
28	27	Mobile game-based learning with local content and appealing characters	Shiratuddin, N. and Zaibon, S.B.	2010	2.25
29	26	Advancement and research trends of smart learning environments in the mobile era	Hwang, G.J. and Fu, Q.K.	2020	13.00
30	24	A mobile game-based C programming language learning: results of university students' achievement and motivations	Daungcharone, K., Panjaburee, P. and Thongkoo, K.	2019	8.00
31	24	User attachment to smartphones and design guidelines	Thorsteinsson, G. and Page, T.	2014	3.00
32	24	Towards a seamless language learning framework mediated by the ubiquitous technology	Wong, L.H., Chai, C.S., Chin, C.K., Hsieh, Y.F. and Liu, M.	2012	2.40
33	24	Participatory simulation framework to support learning computer science	Yin, C., Ogata, H. and Yano, Y.	2007	1.60
34	23	Writing through WhatsApp: an evaluation of students writing performance	Allagui, B.	2014	2.88
35	23	Integrating students' mobile technology in higher education	Lundin, J., Lymer, G., Holmquist, L.E., Brown, B. and Rost, M.	2010	1.92

Note: R = rank; TC = total citations; *C/Y* = citations per year.

Source: Own elaboration based on Scopus data

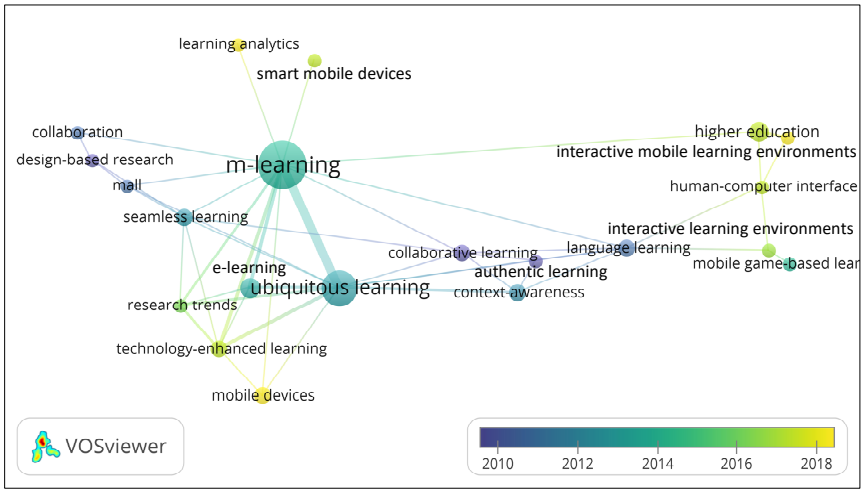
Table 2 The most cited papers in *IJMLO* (TC ≥ 17) (continued)

R	*TC*	*Title*	*Author/s*	*Year*	*C/Y*
36	22	The use of student response systems with learning analytics: a review of case studies (2008–2017)	Li, K.C. and Wong, B.T.M.	2020	11.00
37	22	Identifying learning features and models for contextaware ubiquitous learning with phenomenological research method	Liu, G.Z., Liu, T.C., Lin, C.C., Kuo, Y.L. and Hwang, G.J.	2016	3.67
38	22	Dedicated design and usability of a context-aware ubiquitous learning environment for developing receptive language skills: a case study	Liu, G.Z., Kuo, F.R., Shi, Y.R. and Chen, Y.W.	2015	3.14
39	21	A bibliometric analysis of m-learning from topic inception to 2015	Elaish, M.M., Shuib. L., Ghani. N.A., Mujtaba. G. and Ebrahim, N.A.	2019	7.00
40	21	The effect of simulation-based inquiry on students' conceptual learning and its potential applications in mobile learning	Srisawasdi, N. and Sornkhatha, P.	2014	2.63
41	21	A new trend of mobile and ubiquitous learning research: towards enhancing ubiquitous learning experiences	Ogata, H. and Uosaki, N.	2012	2.10
42	20	Effects of a mobile technology-supported peer assessment approach on students' learning motivation and perceptions in a college flipped dance class	Hsia, L.H. and Sung, H.Y.	2020	10.00
43	20	An empirical study on cloud computing requirements for better mobile learning services	Sarrab, M., Alalwan, N., Alfarraj, O. and Alzahrani, A.	2015	2.86
44	18	A development of ubiquitous learning support system based on an enhanced inquiry-based learning approach	Thongkoo, K., Panjaburee, P. and Daungcharone, K.	2019	6.00
45	18	Preparing pre-service teachers to integrate mobile technology into science laboratory learning: an evaluation of technology-integrated pedagogy module	Srisawasdi, N., Pondee, P. and Bunterm, T.	2018	4.50
46	18	Challenges in designing seamless-learning scenarios: affective and emotional effects on external representations	Otero, N., Milrad, M., Rogers, Y., Santos, A.J., Veríssimo, M. and Torres, N.	2011	1.64
47	18	Charting unknown territory: models of participation in mobile language learning	Kukulska-Hulme, A.	2010	1.50
47	18	Context-aware support for self-directed ubiquitous-learning	El-Bishouty, M.M., Ogata, H., Ayala, G. and Yano, Y.	2010	1.50
49	17	Proposal of personalised mobile game from inquiry-based learning activities perspective: relationships among genders, learning styles, perceptions, and learning interest	Komalawardhana, N. and Panjaburee, P.	2018	4.25
49	17	The effectiveness of integrating mobile devices with inquiry-based learning on students' learning achievements: a meta-analysis	Zheng, L., Li, X., Tian, L. and Cui, P.	2018	4.25
49	17	The roles of sensing technologies and learning strategies in library-associated mobile learning: a review of 2007–2016 journal publications	Tu, Y.F. and Hwang, G.J.	2018	4.25

Note: R = rank; TC = total citations; C/Y = citations per year.

Source: Own elaboration based on Scopus data

Figure 3 Analysis results of the co-occurrence of author keywords (see online version for colours)



3.3 Research question 3: who are the most productive and most cited authors in IJMLO and what are their country/region affiliations?

The top 50 of the most cited and productive authors with affiliation and country are listed in Table 3. As can be seen, the most productive author in IJLMO is Gwo-Jen Hwang, who has published 22 articles and is also the number one most cited researcher ($f = 634$). Gwo-Jen Hwang from Taiwan is the editor-in-chief of the IJLMO and an influential researcher in the field of mobile learning (Koon, 2022; Lai, 2020). One of his publications in *IJMLO* has been cited more than 200 times. The second most productive author is Stamatios Papadakis from Greece, who has 599 citations for his publications in *IJMLO*. It is worth noting that four of his articles have been cited more than 100 times. Regarding the ratio (total citations/total publication), Pandora Dorouka is now in the best position with an average of 99.83 citations per publication in the journal. Her research focuses on the topic of mobile technology in preschool, early elementary education, and pre-service kindergarten teachers. Also, the top 50 cited authors are from Japan (24%), followed by Taiwan (12%), Greece (8%), Thailand (8%), and the USA (8%), as shown in Table 3. The table also shows that authors from Japan and Taiwan gained the most citations in the first period, while authors from Taiwan, Thailand, Hong Kong, and Greece gained the most citations in the second period.

The study analysed the geographical distribution of publications in *IJMLO* from 2007 to 2022 based on the country/region of the first author from 57 publications. The heat map in Figure 4 shows the significant breadth of authorship for *IJMLO*. It shows that *IJMLO* has gained attention in many countries around the globe over the past 16 years. It is worth noting that the first authors of all *IJMLO* publications are mainly from Asian, European, and American countries, with the top five countries/regions being Taiwan (15.30%), Hong Kong (8.78%), Thailand (7.37%), the USA (6.80%) and the UK (5.10%) in order of representation.

Table 3 Most cited and productive authors (TC ≥ 30)

R	*Name*	*Affiliation*	*Country*	*2007–2014*		*2015–2022*		*2007–2022*	
				TP	*TC*	*TP*	*TC*	*TP*	*TC*
1	Gwo-Jen Hwang	National Taiwan University of Science and Technology	Taiwan	8	335	14	299	22	634
2	Stamatios Papadakis	University of Crete	Greece	0	0	6	599	6	599
3	Michail Kalogiannakis	University of Crete	Greece	0	0	5	494	5	494
4	Hiroaki Ogata	Tokushima University	Japan	8	229	0	0	11	244
5	Po-Han Wu	National Taipei University of Education	Taiwan	1	201	0	0	2	201
6	Yoneo Yano	Tokushima University	Japan	8	201	0	0	8	201
7	Uden L.	Staffordshire University	United Kingdom	1	190	0	0	1	190
8	Chui-Lin Lai	National Taipei University of Education	Taiwan	1	85	4	99	5	184
9	Patcharin Panjaburee	Mahidol University	Thailand	0	0	12	139	12	139
10	Chengjiu Yin	Tokushima University	Japan	3	128	0	0	3	128
11	Nicholas Zaranis	University of Crete	Greece	0	0	1	111	1	111
12	Ching-Yi Chang	National Taiwan University of Science and Technology	Taiwan	0	0	2	95	2	95
13	Marcelo Milrad	Växjö University	Sweden	3	86	0	0	3	86
14	Tom Page	Loughborough University	United Kingdom	4	83	0	0	4	83
15	Niwat Srisawasdi	Khon Kaen University	Thailand	1	21	6	62	7	83
16	Pandora Dorouka	University of Crete	Greece	0	0	1	73	1	73
17	Thomas Cochrane	AUT University	New Zealand	2	61	0	0	2	61
18	Gan Li Hui	Tokushima University	Japan	1	58	0	0	1	58
19	Yasuko Oishi	Tokushima University	Japan	1	58	0	0	1	58
20	Takahito Ueda	Tokushima University	Japan	1	58	0	0	1	58
21	Arianit Kurti	Växjö University	Sweden	1	57	0	0	1	57
22	Mohamed Sarrab	Sultan Qaboos University	Oman	1	28	3	29	4	57
23	Daniel Spikol	Växjö University	Sweden	1	57	0	0	1	57
24	Brenda Eschenbrenner	University of Nebraska-Lincoln	United States	1	44	1	12	2	56
25	Roland Belfin	Austrian Regulatory Authority for Broadcasting and Telecommunications	Wien	1	55	0	0	1	55

Note: R = Rank; TC = Total citations; C/Y = Citations per year.

Source: Own elaboration based on Scopus data

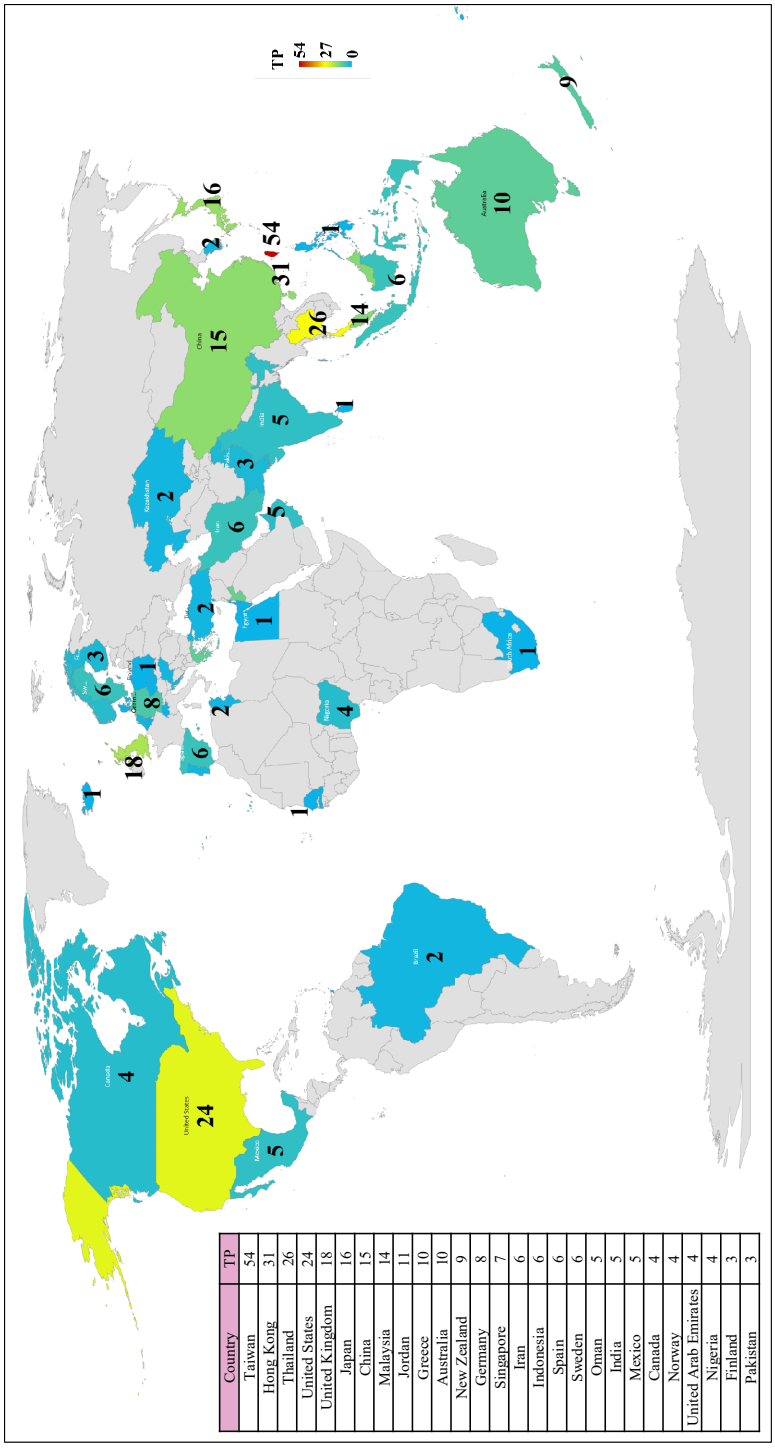
Table 3 Most cited and productive authors (TC ≥ 30) (continued)

R	*Name*	*Affiliation*	*Country*	*2007–2014*		*2015–2022*		*2007–2022*	
				TP	*TC*	*TP*	*TC*	*TP*	*TC*
26	Michaela Denk	E-Commerce Competence Centre	Wien	1	55	0	0	1	55
27	Michael Weber	E-Commerce Competence Centre	Wien	1	55	0	0	1	55
28	Noriko Uosaki	University of Tokushima	Japan	2	38	2	15	4	53
29	Moushir M. El-Bishouty	The University of Tokushima	Japan	2	51	0	0	2	51
30	Vickel Narayan	Te Puna Ako, Unitec, Auckland	New Zealand	1	49	0	0	1	49
31	James Oldfield	Department of Accounting and Finance, Unitec, Auckland	New Zealand	1	49	0	0	1	49
32	Osama Alfarraj	King Saud University	Saudi Arabia	1	28	1	20	2	48
33	Nasser Alalwan	King Saud University	Saudi Arabia	1	28	1	20	2	48
34	Kannika Daungcharone	Mahidol University	Thailand	0	0	3	48	3	48
35	Krittawaya Thongkoo.	Chiang Mai University	Thailand	0	0	3	48	3	48
36	Gi-zen Liu	National Cheng Kung University	Taiwan	0	0	3	46	3	46
37	Yoshiyuki Tabata	Kyushu University	Japan	1	46	0	0	1	46
38	Fiona Fui-Hoon Nah	University of Nebraska-Lincoln	United States	1	44	0	0	1	44
39	Hui-Chun Chu	Soochow University	Taiwan	1	4	2	39	3	43
40	Kam Cheong Li	Open University of Hong Kong	Hong Kong	0	0	8	40	8	40
41	Billy Tak-Ming Wong	Open University of Hong Kong	Hong Kong	0	0	6	40	6	40
42	Dwi Sulisworo	Ahmad Dahlan University	Indonesia	0	0	1	34	1	34
43	Moh Toifur.	Ahmad Dahlan University	Indonesia	0	0	1	34	1	34
44	Yoshiki Matsuka	The University of Tokushima	Japan	1	33	0	0	1	33
45	Miri Barak	Technion – Israel Institute of Technology, Haifa	Israel	1	31	0	0	1	31
46	Judson Harward	Massachusetts Institute of Technology	United States	1	31	0	0	1	31
47	Steven Lerman	Massachusetts Institute of Technology	United States	1	31	0	0	1	31
48	Xuejiao Li	Beijing Normal University	China	0	0	3	31	3	31
49	Toshio Okamoto	University of Electro-Communications	Japan	1	30	0	0	1	30
50	Xinyou Zhao	University of Electro-Communications	Japan	1	30	0	0	1	30

Note: R = Rank; TC = Total citations; C/Y = Citations per year.

Source: Own elaboration based on Scopus data

Figure 4 The geographical distribution of publications in *IJMLO*, 2007–2022 (N = 353 documents) (see online version for colours)



3.4 Research question 4: what are the topics of the IJMLO publications? What is the thematic evolution of the journal publications?

VOSviewer was adopted to execute the co-word analysis of author keywords to explore the hot topics in *IJMLO* as shown in Figure 5. The co-word network of author keywords revealed that a total of 1,259 author keywords were extracted from all of the publications from 2007 to 2022. Moreover, the co-word network shows 55 most used keywords in *IJMLO* in Figure 5. As can be see in Figure 4 and Table 4, the most frequently used keywords (f >10) are m-learning (f = 176), ubiquitous learning (f = 37), e-learning (f = 18), higher education (f = 15), mobile technologies (f = 15), MALL (f = 13), mobile devices (f = 13), learning (f = 18), higher education (f = 15), mobile technologies (f = 15), small (f = 13), mobile devices (f = 13), collaborative learning (f = 12), language learning (f = 11), blended learning (f = 10), and mobile phones (f = 10), which are also the relevant topics discussed in *IJMLO*. These topics can be categorised into three different coloured clusters: red, green, and blue. The red cluster is related to the topic of mobile technology-supported across-context learning, which contains the keywords ubiquitous learning, e-learning, higher education, mobile technologies, mobile devices, blended learning, and mobile phones. The green cluster has something to do with the topic of MALL, and contains the keywords collaborative learning, language learning, technology-enhanced learning, vocabulary learning, seamless learning, smartphones, computer assisted language learning, and mobile language learning, while the blue cluster focuses on emerging mobile technologies for contextual learning, including the keywords mobile apps, augmented reality, learning analytics, context-aware ubiquitous learning, and ILE.

Figure 5 Co-occurrence of keywords in *IJMLO* (see online version for colours)

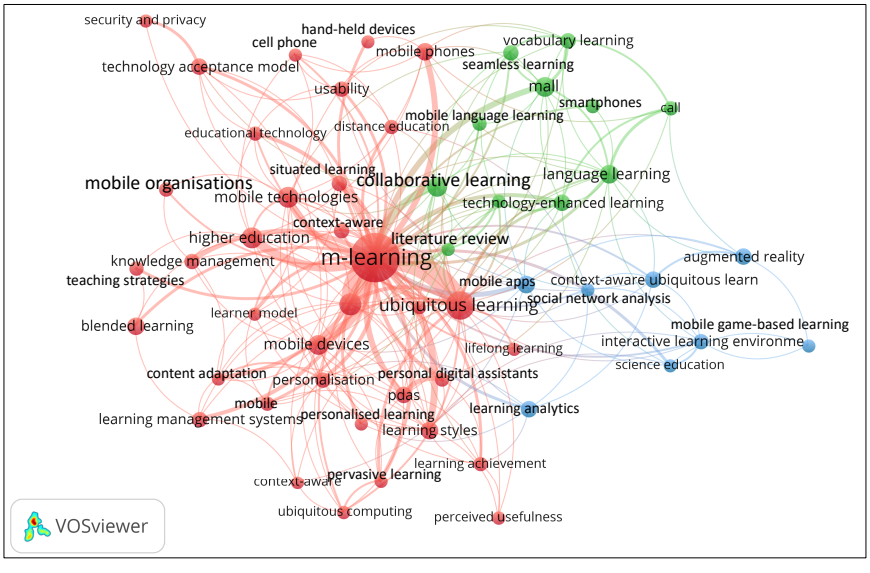


Table 4 Top keywords with the highest frequency ($f \geqq 6$)

	2007–2014	*2015–2022*	*Total*
*m-learning**	102	74	176
*ubiquitous learning**	18	19	37
*e-learning**	12	6	18
*higher education**	4	11	15
mobile technologies	10	5	15
*mall**	3	10	13
*mobile devices**	8	5	13
*collaborative learning**	7	5	12
*language learning**	3	8	11
blended learning	2	8	10
mobile phones	7	3	10
learning styles	5	4	9
mobile apps	1	8	9
augmented reality	0	8	8
technology acceptance model	6	2	8
context-aware ubiquitous learning	2	5	7
*learning analytics**	0	7	7
PDAs	7	0	7
*technology-enhanced learning**	2	5	7
*context-awareness**	4	2	6
*interactive learning environments**	0	6	6
knowledge management	5	1	6
learning management systems	3	3	6
personalisation	3	3	6
seamless learning	6	0	6
situated learning	4	2	6
usability	3	3	6
vocabulary learning	3	3	6

Note: *Keywords used in the most cited papers.

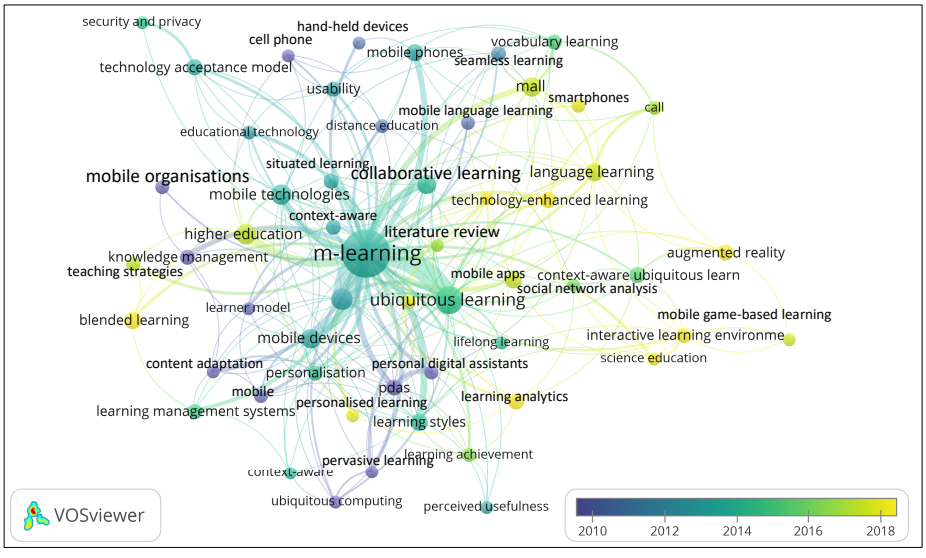
On one hand, the topics discussed in the first period of *IJMLO* mainly focused on applications of 'mobile technology-enhanced learning'. That is, learners can learn ubiquitously through mobile technology, such as m-learning, ubiquitous learning, e-learning, collaborative learning, mobile technologies, and mobile devices, as shown in Figure 6 and Table 4. For example, Ogata et al. (2008) developed the 'one-day trip with PDA' learning system, which integrates the knowledge learned in the classroom with students' needs in their daily lives to conduct language-learning outside the classroom via handhelds (LOCH). Yin et al. (2010) developed a learning environment to support foreigners to learn anytime and anywhere via a Japanese Polite Expression (JPE) system. Lai and Hwang (2014) investigated the effects of mobile learning on 606 high school

students' collaboration, communication, complex problem solving, meta-cognitive awareness, and creativity. The findings found that student engagement time and learning strategies or tools play an important role in improving students' communication, complex problem solving, and creativity.

On the other hand, some new keywords emerged in the second period of *IJMLO*, such as augmented reality, learning analytics, and ILE. In this period, the publications mainly focused on m-learning, ubiquitous learning, higher education, MALL, language learning, blended learning, mobile apps, augmented reality, and learning analytics; for example, some research developed applications of m-learning to assist learners in language learning, such as Chinese learning (Chee et al., 2017; Lin et al., 2016) and English learning (Andujar and Hussein, 2019; Jia et al., 2022; Rezaee et al., 2020).

Liu et al. (2015) developed a context-aware ubiquitous language learning (CAULL) environment that allows students to learn English in the learning context through mobile technology, handheld PDAs, wireless internet, RFID readers, and tags. The research findings showed that most students could improve their language receptivity, and showed a positive attitude towards CAULL. In addition to learning with mobile technologies, Sembiring (2018) investigated students' learning satisfaction in blended instruction, interaction, educators, administration, technology, and open educational resources.

Figure 6 The analysis of keyword co-occurrence in *IJMLO* (see online version for colours)



Recently, student response systems (SRSs) have been widely used in learning analytics, which collect student responses to exercises, learning assessments, or questionnaires. The research findings show that SRSs could help facilitate student learning achievement based on their learning engagement, learning performance, and learning experience (Li and Wong, 2020). Meekaew and Ketpichainarong (2021) investigated the effectiveness of an augmented reality-facilitated mobile game-based learning (MGAR) approach for 192 9th graders in terms of learning achievement, learning motivation and cognitive load. Besides, ILE have received a great deal of attention from researchers, and as a result, many applications and technologies are increasingly incorporated into ILE, such as

intelligent tutoring systems, concept maps, digital games, e-books, interactive response systems, digital storytelling, and augmented reality, to facilitate students in flipped learning, personalised learning, and project-based learning contexts (Chen et al., 2022).

Figure 7 Thematic map of topics discussed in the period 2007–2014 (see online version for colours)

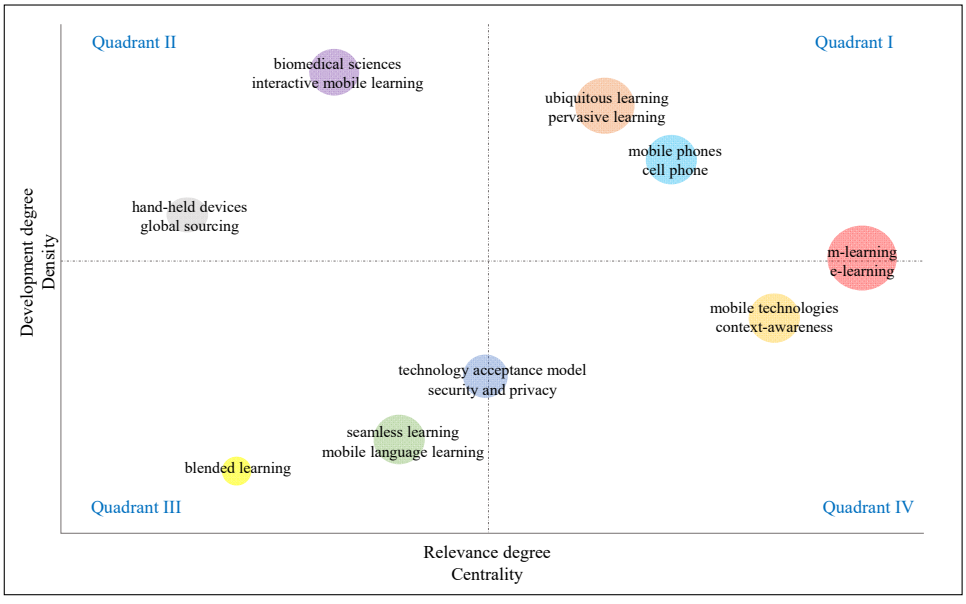
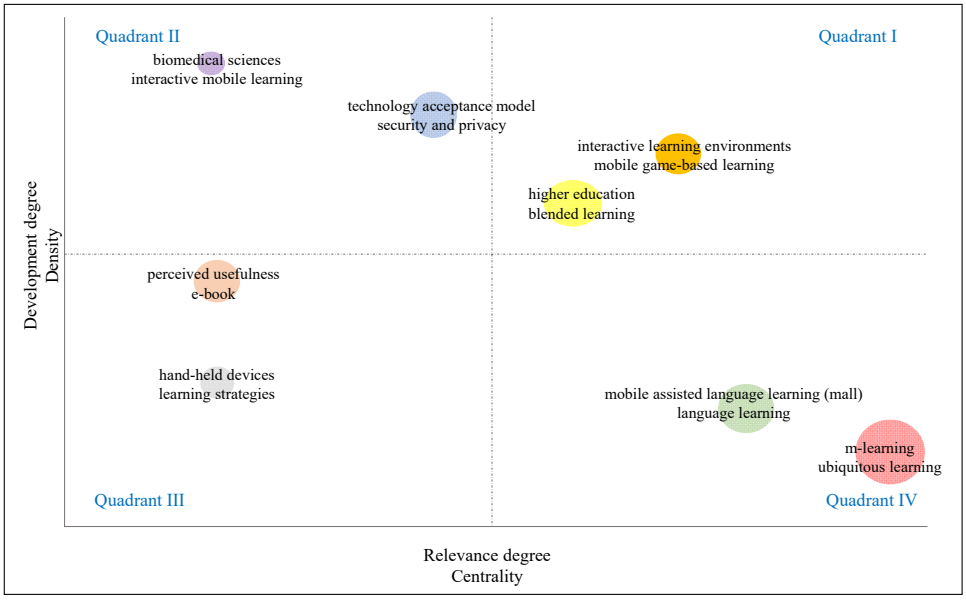


Figure 8 Thematic map of topics discussed in the period 2007–2022 (see online version for colours)



The study divided the subgroups formed by author keywords in each period into four quadrants, representing different categories of themes based on previous studies (Callon et al., 1991; Cobo et al., 2011). In the first period (2007–2014), there are nine topics being discussed in *IJMLO*, including m-learning (m-learning and e-learning), ubiquitous learning (ubiquitous learning and pervasive learning), the technology acceptance model (technology acceptance model and security and privacy), mobile technologies (mobile technologies and context-awareness), mobile phones (mobile phones and cell phones), seamless learning (seamless learning and mobile language learning), biomedical sciences (biomedical sciences and interactive mobile learning), hand-held devices (hand-held devices and global sourcing), and blended learning, as shown in Figure 7. Then, the topics changed from 2007 to 2022 based on the results of the first period, showing that m-learning (m-learning and ubiquitous learning), MALL (MALL and language learning), higher education (higher education and blended learning), ILE (ILE and mobile game-based learning), perceived usefulness (perceived usefulness and e-books), the technology acceptance model (technology acceptance model and security and privacy), hand-held devices (hand-held devices and language learning), biomedical sciences (biomedical sciences and interactive mobile learning), as seen in Figure 8.

In Figure 7 and Figure 8, the fourth and second quadrants are regarded as the basic themes (i.e., low density and high centrality), and the very specialised/niche themes (i.e., high density and low centrality), respectively. In terms of the basic themes, both topics of 'mobile learning' ('m-learning and e-learning', 'ubiquitous learning and pervasive learning', and 'mobile technologies and context-awareness' changed to 'm-learning and ubiquitous learning') and 'MALL' ('seamless learning' and 'mobile language learning' changed to 'MALL and language learning') have been identified as important topics from 2007 to 2022 in *IJMLO*. These two topics were developed based on the thematic evolution of research topics in the first period; especially, 'm-learning' is the hottest topic and includes several main research issues such as e-learning, mobile technologies, mobile devices, collaborative learning, learning styles, learning analytics, PDAs, context-awareness, knowledge management, learning management systems, personalisation, situated learning, and distance education. Moreover, the topics related to 'm-learning' include language learning, mobile phones, mobile apps, augmented reality, CALL, context-aware ubiquitous learning, technology-enhanced learning, seamless learning, usability, vocabulary learning, and smartphones. The topics of the first period were dominated by 'hand-held devices and language learning' and 'biomedical sciences and interactive mobile learning', respectively. In the second period, except for biomedical sciences, the technology acceptance model (i.e., technology acceptance model and security and privacy) in quadrants III and IV moved to quadrant II (very specialised/niche topics), indicating that the topic had gradually received a great deal of attention from researchers. Moreover, the topic of 'hand-held devices' shifted from quadrant II (very specialised/niche topics) to quadrant III (emerging or disappearing topics, i.e., low density-low centrality). In this quadrant, the topic of 'perceived usefulness', which includes perceived usefulness, e-books, authentic learning, and user experience, is found.

It is worth noting that the topic of blended learning in quadrant III in the first period shifted to quadrant I (motor themes, i.e., high density-high centrality) and formed the topic of higher education, containing higher education, blended learning, instructional strategies, COVID-19, flipped classroom, learning design, mathematics, and student engagement. For example, Lei et al. (2019) embedded the IoT application development into a flipped classroom course and further investigated students' learning effectiveness.

Moreover, the topic of ILE, including mobile game-based learning, science education, and social network analysis, was formed in quadrant I, which represents that 'higher education' and 'ILE' have attracted researchers' attention and were identified as motor themes in *IJMLO* from 2007 to 2022 (Meekaew and Ketpichainarong, 2021; Soclo et al., 2022).

4 Discussion and conclusions

This study provides a universal overview of *IJMLO* publications collected in the Scopus database from 2007 to 2022 using the bibliometric analysis method. Over the past 16 years, the number of *IJMLO* publications has increased yearly, indicating that the research topics related to mobile and ubiquitous learning have attracted the attention of many researchers; see Figure 1. It is worth noting that there have been six articles cited more than 100 times over the past 16 years. Among them, two articles were published in the first period (2007–2014), and four in the second period (2015–2022), indicating that these articles have been the most cited publications. Meanwhile, these most cited articles mainly focused on mobile learning, ubiquitous learning, higher education, collaborative learning, context-awareness, language learning, MALL, learning analytics, and smart mobile devices. Interestingly, there is little difference in the number of articles and citations of the most cited articles between the first and second period. According to Table 3, the top three most cited researchers are Hwang, G.J., Papadakis, S. and Kalogiannakis, M. who are from Taiwan and Greece respectively. Besides, analysis of the country/region of the first author or the influential authors obviously shows that *IJMLO* has gradually become an international journal over the past 16 years. In terms of authors, the top 50 cited researchers are mainly from Asian, European, and American countries. These results are consistent with the research findings of Lai (2020) who analysed the top 100 SSCI publications from 2000 to 2016, and found that the productive researchers were mainly from English-speaking countries (e.g., the UK, the USA, and Canada) and Asian countries (e.g., Taiwan, Japan, and Hong Kong).

The co-word analysis results revealed that the themes explored in *IJMLO* from 2007 to 2022 can be divided into three major clusters: mobile technology-supported a cross-context learning, MALL, and emerging mobile technologies for contextual learning. Moreover, in recent years, new keywords such as augmented reality, learning analytics, and ILE have emerged, and these keywords correspond to the strategic diagram revealing the development of the research themes in *IJMLO*. Based on the research findings of the first period, there are four themes with eight topics during the period of 2007 to 2022: basic themes (m-learning and MALL), very specialised/niche themes (technology acceptance model and biomedical sciences), emerging or disappearing themes (perceived usefulness and hand-held devices), and motor themes (perceived usefulness and ILE), respectively. Among these themes, mobile technology-supported across-context learning, MALL as basic themes are regarded as important topics for m-learning research; in addition, the topics related to higher education and ILE are crucial and well developed for the structure of *IJMLO*. Also, these topics show the current research trend in terms of mobile and ubiquitous learning.

IJMLO is an international journal focused on the latest developments in mobile learning and organisation which has had an especially great impact in the second period

(2015-2022). However, there are a couple of research limitations in the study that should be noted. First, only the records in the Scopus database were taken into account; therefore, it is possible that some important citation information was not included in the present study. As indicated by researchers, having less citations does not always mean that a topic is less important; on the contrary, it could be a potential topic in coming years. Moreover, the articles could be cited by the studies that are not included in the databases adopted by the present study (Valenzuela et al., 2017). Second, VOSviewer and the bibliometrix R-package were used to analyse and identify the research themes of the journal, and hence the analysis results could be limited by the functions provided by these tools. Therefore, it is suggested that researchers could investigate the issues of the journal in depth using different analysis approaches and discuss the influences of scholarly communication speed of *IJMLO* in the future.

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