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Trend of Mobile Learning Implementation in Science Education from 2010 to 2021

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ABSTRACT

The use of mobile learning has increased since the digitalization era. The progress of digitalization also has an impact on the world of education. The trend regarding mobile learning use is a hot topic discussed and attractive to its developers. This study aims to determine the mobile learning trend in science education for the last 11 years. This study uses qualitative bibliometric analysis of Scopus metadata. Results show that the trend of mobile learning increases yearly based on the trendline. Hence, further researchers could develop or conduct research on this keyword as an improvement to science education fields. Furthermore, future researchers can study more deeply to top contributed authors to improve the lack of previous research and complete the novelties of the research.

INTRODUCTION

In line with the development of digital technology capabilities, the world of education continues to show innovation towards developments both in the learning process and learning media that are integrated with technology. Information and communication technology has been facilitated in scientific knowledge educational programs and classroom environments compared to the advancement of information and communication technologies (Adesoji, 2020; Dzakpasu et al., 2017; Mendoza & Mendoza, 2018; Razak et al., 2018; Shatari, 2020). Furthermore, instructional e-contents have now been invented by United Nations Education and affiliated organizations by attempting to make the books efficient with advanced technologies equipped with learning (Adarkwah, 2021; Azhari & Fajri, 2022; Ormancı & Çepni, 2020; Ratheeswari, 2018; Ulas, 2019).

Mobile learning is the most recent and developing technology that colleges have adopted. It is quickly developing its position as the favored approach to education throughout many nations (Shatari, 2020). Mobile learning may be roughly characterized as using ubiquitous portable technology in conjunction with wireless mobile phone networks to enable, support, enhance, and expand the reach of instruction and learning (Liu et al., 2020; Salami & State, 2021). Mobile learning, often known as m-learning, is an area that involves the use of mobile devices for computing in education and learning (Grant, 2019; Hamidi & Jahanshaheefard, 2018; Lall et al., 2019; Nikolopoulou et al., 2021; Samuel, 2020).

However, due to the rapid of using mobile learning. The advantages and downsides of the technologies have become a contentious subject among academics (Albaom et al., 2022; Alsadoon, 2020; Oyaid & Alshaya, 2019; Rafiqi et al., 2022; Zhang & Zou, 2022). Rapid-to-read and easy-to-handle formats, aesthetics, 'task-technology fit,' anytime

availability, high reliability, and so forth are a few common reasons for utilizing mobile learning such as e-books (D'Ambra et al., 2019; Riana et al., 2021). Customers at academic libraries choose e-books for their familiarity, usefulness, utility, and hedonic characteristics (Ahmad & Brogan, 2016). Interlibrary loans eagerly accepted mobile learning, considered a gold bullet by library workers, resulting in effective resource utilization, cost reductions, student pleasure, and adapting Millenial study patterns (Casselden & Pears, 2020; Yulianto, 2022).

In science education, its benefits will help teachers increase the potential of the classes' learning. The use of mobile technologies to enhance scientific learning is being researched. According to research on mobile learning in scientific background, many types of equipment may be utilized to promote science learning. Smartphones with broadband internet can enhance learners' digital study results for reference, simulations, video, and virtual laboratories (Nikolopoulou & Kousloglou, 2019). With all of its benefits (over comprehensive desktops) in portability, accessibility, affordability, and multifunctionality, mobile technology is unlikely to help scientists' education except under use it significantly and substantially improves students' capacities to interact with conceptual knowledge (Zhai & Jackson, 2021). The view of physics education students upon that usage of mobile learning in fundamental physics practicum II at Universitas Jambi is required to create modern learning platforms that are more excellent, efficient, and adaptable in the 4.0 digital era (Lumbantoruan & Samosir, 2019). The novelties of this research are that there still needs to be more exploration of mobile learning in science education from 2010 to 2021. Hence, this research explores the trend of mobile learning in science education from 2010 to 2021.

Hence, giving the need for improvement and development to implement mobile learning in science education. This research will likely conduct a bibliometric analysis to give the readers sight into the actual condition of the use of mobile learning in the past decade. Specifically, the research objectives are: 1) To analyze the trend research; 2) To analyze documents, countries, and languages; 3) To analyze affiliate funding; 4) To identify the top 10 most productive authors; 5) To identify the novelty and opportunity on trend mapping visualization; 6) To analyze the distribution publications of mobile learning research during 2010 to 2021.

RESEARCH METHOD

This research uses descriptive analysis using Bibliometric. Bibliometrics has become an indispensable instrument for monitoring and analyzing the scientific output, university collaboration, the impact of state-owned science financing on a country's research and development achievement, and instructional efficiency, among several uses (Donthu et al., 2021; Goyal & Kumar, 2020; Lumbantoruan & Samosir, 2019). The metadata was gathered by using Scopus. However, Scopus has evolved into a prominent resource, with around 77.8 million diverse implications from multiple categories, as well as various systematic reviews and publication types, either non-academic or academic (Abad-Segura et al., 2020; Azoulay et al., 2021; Bhimani et al., 2018; Niñerola et al., 2019). The research flowchart in **Figure 1**.

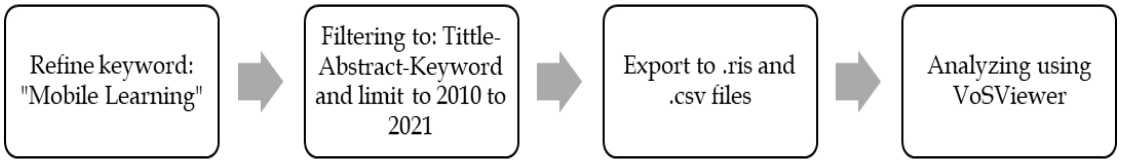

Figure 1. Research flowchart.

The data was collected on 10th October 2022 on Scopus with keywords *TITLE-ABS-KEY (MOBILE AND LEARNING AND IN AND SCIENCE AND EDUCATION) AND (LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010))*. The filtering of this keyword gathered 1,906 document results. Furthermore, the meta-data was downloaded in the form of .ris and .csv and analyzed by VosViewer for the mapping visualization.

RESULTS AND DISCUSSION

The Trend Research of Mobile Learning in Science Education Publication from 2010 to 2021

Based on the Scopus in .csv file gathered, 1,906 documents were obtained in publications on mobile learning in science education. In the average trendline, it is known that the trend tends to increase from 2010 to 2021. It is depicted in **Figure 2**. The number of publications in the year 2010 was 74 publications in total. With the increasing number of publications, in 2016, there decreased from 180 to 160. It happened in 2018, from 204 publications to 148 publications. It starts to rise from 2019 to 2020.

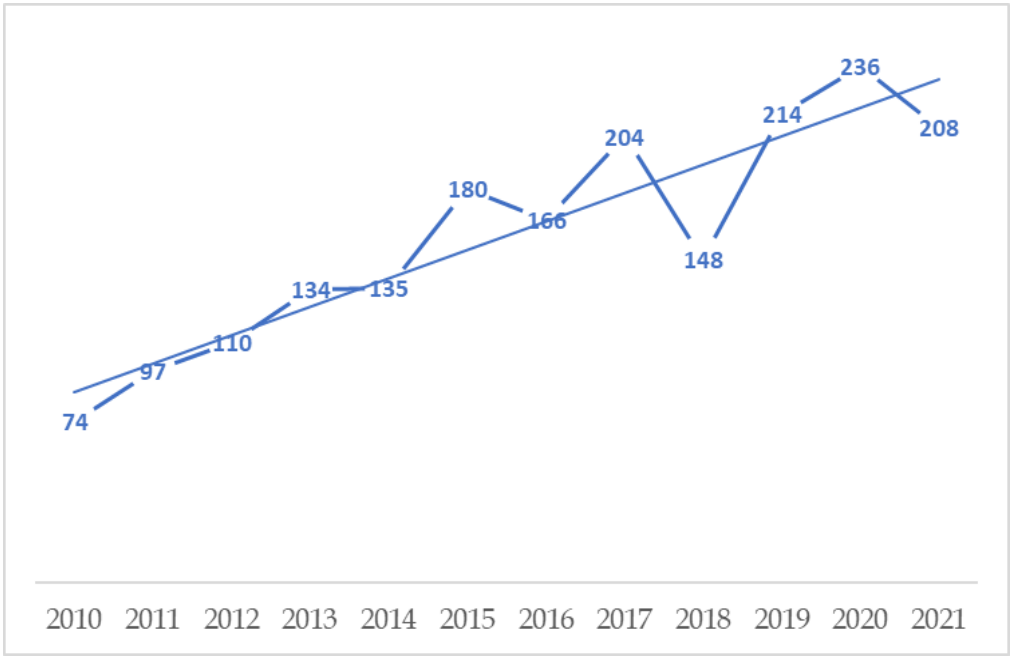

Figure 2. Publications trendlines.

Figure 2 shows that the trend of mobile learning increases yearly based on the trendline. With the expansion of mobile capabilities across different topics, there has also been a parallel rise in enthusiasm for exploring the depth, objective, and scope of mobile education learning (Baceviciute et al., 2022; Crompton et al., 2017, 2019; Drew, 2017; Lou et al., 2021). In previous research using Web of Science meta-data, exponential growth in worldwide papers published on mobile learning and scientific education research The rise appeared consistent with both the emergence of innovative mobile learning technologies and their adaptation into applications for improving students' academic achievement in science education, such as the fundamental disciplines of physics, chemistry, and biology (Odabasi et al., 2019). Specifically, research shows that the customized mobile learning program helps improve learners' biology educational objectives (Surahman & Alfindasari, 2017). Furthermore, In scientific disciplines, genuine m-learning and observed progress in learning using mobiles were much more significant than in mathematics subjects (Burke et al., 2022). Due to its strengths and weaknesses from previous research, it can be seen that researchers continue to develop innovations, developments, improvements to existing tools and in order to develop innovations to improve learning outcomes, especially in science learning.

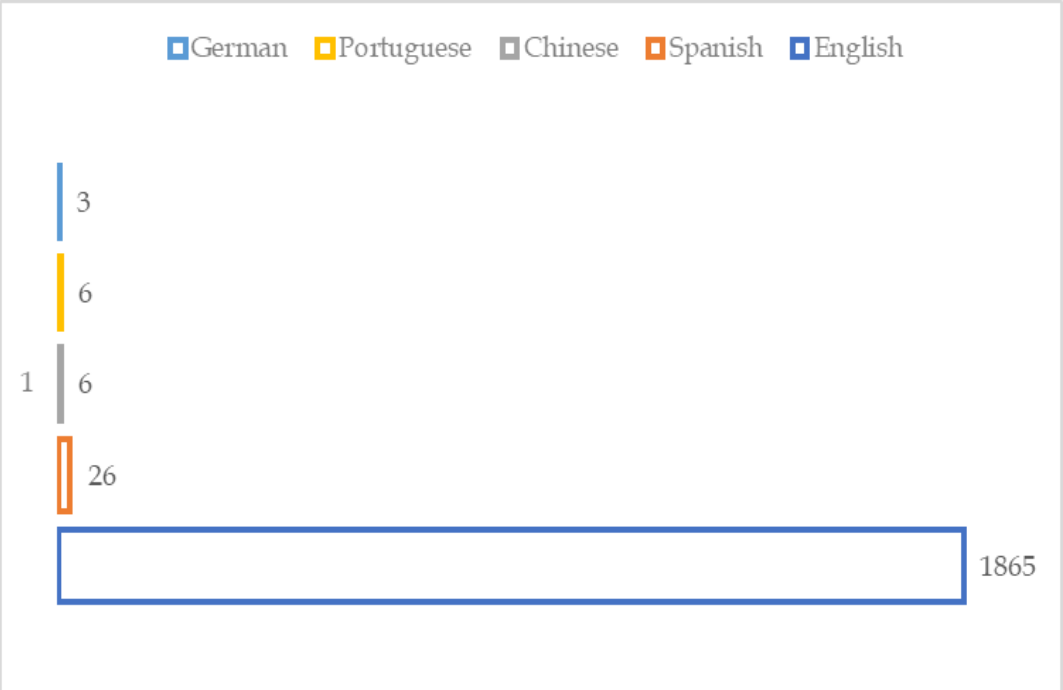

Figure 3. Top language in mobile learning publications.

Figure 3 shows that from 1,906 publications, English is the first language used in mobile learning in science education publications. However, English is an international language that everyone can globally understand by the readers (Galloway & Rose, 2018; McKay, 2018; Nartiningrum & Nugroho, 2020; Phillipson, 2017; Sofyan, 2021; Syrbe & Rose, 2018).

The Top Documents of Mobile Learning in Science Education Publication from 2010 to 2021

Furthermore, it details the most widely used types of document research. Hence, the researcher is the exploration of document types variation. It is depicted in **Figure 4.**

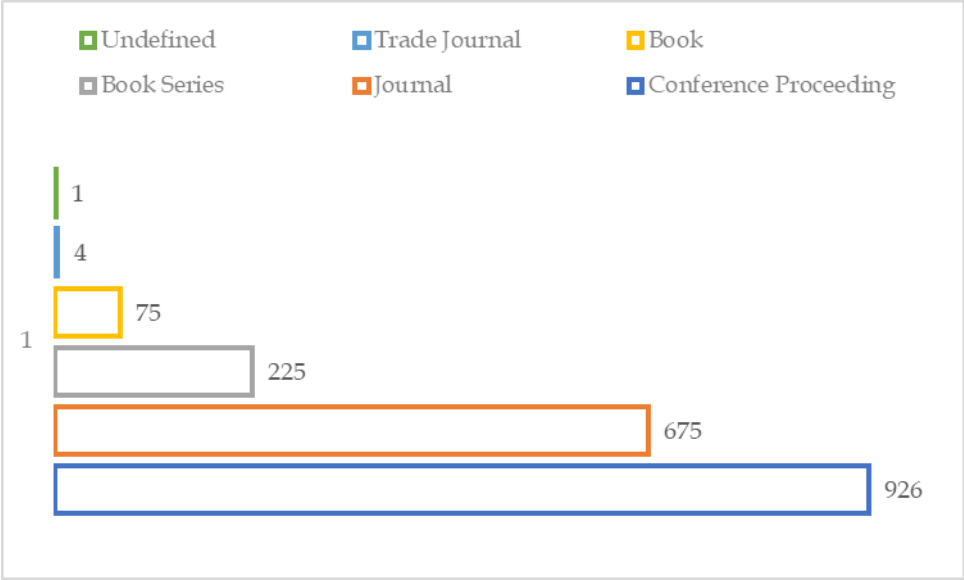

Figure 4. The top documents type.

Figure 4. shows conference papers that are more commonly employed in mobile learning in science education publications from 2010 to 2021, with 926 documents. 'Conference proceedings' have a more reachable influence nowadays since they are exhibited at a convention for specialists from many disciplines to see (Liu, 2013). Journal become the second top type of document with 675 publications. Furthermore, Book series with 225 publications.

The Top Affiliations of Mobile Learning in Science Education Publication from 2010 to 2021

To find out the affiliation to publications trend in mobile learning in science education, the researcher also explores it. It is depicted in **Table 1**.

Table 1. The top affiliation.

Affiliation	n	Affiliation	n
Khon Kaen University	27	National Institute of Education	17
National Taiwan University of Science and Technology	27	The Open University	17
Pennsylvania State University	21	Universidad de Salamanca	16
National Taiwan Normal University	21	Univerzita Hradec Králové	14
Nanyang Technological University	17	Universiti Teknologi PETRONAS	14

Table 1 shows that Khon Kaen University and the National Taiwan University of Science and Technology are the most affiliated contributors to mobile learning in science education (n=27). In the second place, Pennsylvania State University and National Taiwan Normal University have the same total publications (n=21). In the third place, three affiliations have the same publications (n=17): Nanya Technological University, the National Institute of Education, and The Open University. Next place are Universidad de Salamanca (n=16). The other top ten are Univerzita Hradec Králové and Universiti Teknologi PETRONAS (n=14), to both affiliations. All of the articles came from a limited group of editor-affiliated schools underlines the tendency for

administrative affiliation bias to worsen more significant inequities in academia (Purnell, 2022).

The Most Productive Authors of Mobile Learning in Science Education from 2010 to 2021

The most productive authors are being analyzed due to their reference to the publication. It is depicted in **Table 2.**

Table 2. The most productive authors.

Author	n	Author	n
Srisawasdi, N.	26	Land, S.M.	10
Hwang, G.J.	17	Panjaburee, P.	10
Looi, C.K.	17	Ahmad, W.F.W.	9
Qian, K.	11	Crompton, H.	8
Zimmerman, H.T.	11	Parsons, D.	8

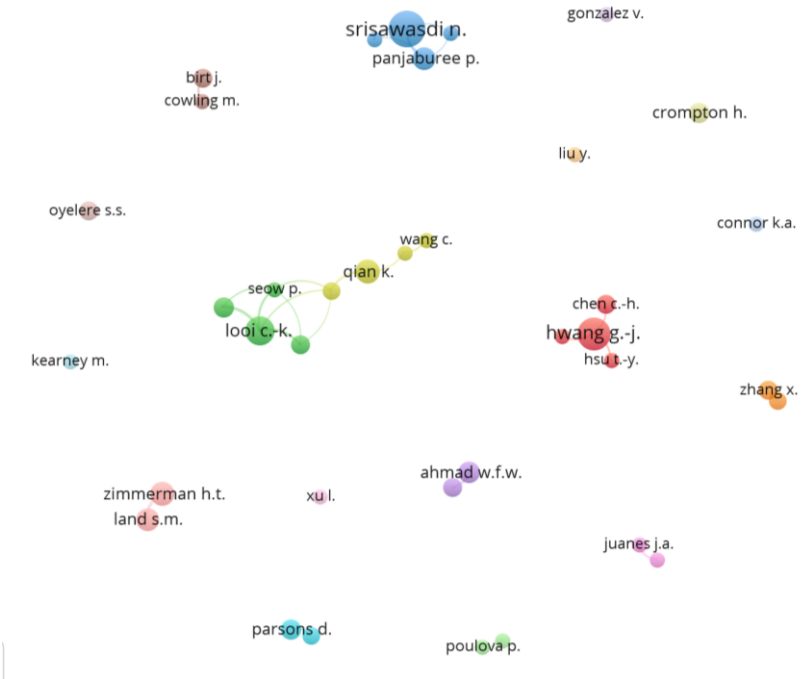

Figure 5. Author mapping visualization.

Table 2, known as Srisawasdi (n=27), is the most productive author in **Figure 5**, with a blue node. Second place, Hwang & Looi (n=17) with red and green nodes. Its authors can be referred to an idea to conduct new research on mobile learning in science education. Further research can refer to the implications of previous research (Chubb & Derrick, 2020).

The Mapping Visualization of Mobile Learning in Science Education Publication from 2010 to 2021

The researcher explores each publication's keywords to identify the innovation of mobile learning in science education. As indicated in **Table 3,** the most frequent terms are investigated before mapping out the visualization of mobile learning in science education from 2010 to 2021.

Table 3. Top Keywords.

Keyword(s)	n	Keyword(s)	n
Students	647	Teaching	402
E-learning	518	Education Computing	232
Education	498	Mobile Devices	221
Engineering Education	480	Curricula	215
Mobile Learning	439	Learning Systems	205

Examine the associations among minimal or fewer phrases to identify a study's uniqueness depending on the mapping findings (Bhatt et al., 2020; Egiebor et al., 2018; Foulon et al., 2018; Shirdastian et al., 2017). According to **Table 3**, the 'students' keyword is the top keyword in its publication (n=647). At the same time, 'mobile technology' is less in the top ten keywords (n=142). Hence, further researchers could develop or conduct research on this keyword as an improvement to science education fields.

The Distribution of Mobile Learning in Science Education Publication from 2010 to 2021

The distribution of publications is seen in **Table 4,** mobile learning in science education research over the past twelve years, with more than a million, cited publications.

Table 4. Distribution of paper from 2010 to 2021.

Year	*Paper*	*Cited*	*ACPP*	*ACPPY*	*Citable Years*
2010	74	1,198	16.189*	1.349	12
2011	97	959	9.886	0.8987	11
2012	110	1,078	9.800	0.980	10
2013	134	1,581	11.798	1.310	9
2014	135	0	0	0	8
2015	180	2,478	13.766	1.966	7
2016	166	1,701	10.246	1.707	6
2017	204	1,714	8.401	1.680	5
2018	148	1,314	8.878	2.219	4
2019	214	1,739*	8.126	2.708	3
2020	236*	1,567	6.639	3.319*	2
2021	208	592	2.846	2.846	1
Total	**1,906**	**15,921**	**107**	**21**	**-**

Description: *=the highest number; ACPP= Average Citation Per Paper ACPPY= Average Citation Per Paper Per Year

According to **Table 4,** 2020 became the year with the most publications (n=236). Furthermore, the year with the fewest publication was 2011, with 74 publications. Meanwhile, 2019 became the year with the most cited publications (n=1,739), and 2014 was the fewest cited publication year (n=0). Furthermore, 2020 is the highest citation paper per year with a noun index of 3.319 in 2-year citable. This research aims to analyze and explore the trend of mobile learning in science education so further research can develop or improve (Arici et al., 2019) throughout the mobile learning field.

CONCLUSION

The trend of mobile learning increases yearly based on the trendline. English is the first language used in mobile learning in science education publications. Due to their flexibility and reachable, conference papers are more commonly employed in mobile learning in science education publications from 2010 to 2021. Khon Kaen University and the National Taiwan University of Science and Technology are the most affiliated contributors to mobile learning in science education. Srisawasdi is the most productive author. The 'Students' keyword is the top keyword in its publication. 2020 became the year with the most publications. Furthermore, the year with the fewest publication was 2011. Meanwhile, 2019 became the year with the most cited publications, and 2014 was the fewest cited publication year. Furthermore, 2020 is the highest citation paper per year. Hence, further researchers could develop or research this keyword to improve science education. Furthermore, future researchers can study more deeply to top contributed authors to research to improve the lack of previous research and complete the novelties of the research.

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