Android and Web-Based Learning Research During the Last 10 Years: How Does It Impact Physics Learning?

https://doi.org/10.3991/ijim.v16i16.32985

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Abstract—There are many benefits from using AbL and WbL, especially in the learning process through all subjects. Also, it is necessary always to discover novelty, innovation, improvement, and development of AbL or WbL to increase the quality of the study environment. This research analyzes bibliometrics on 'AbL' and 'WbL' keywords and compares them. Scopus is used to collect the metadata, and the VOSViewer application will be an assist tool. This research is expected to reach trends, patterns, novelty, and future research in the AbL and WbL through broad fields of Education during the past ten years (2012–2021). The research results show that trends of AbL and WbL research tend to increase each year. Finally, based on the analysis of the selected papers, the use of AbL, should be more boarder and widely in the classroom. Furthermore, the use of WbL also tends to be effective and efficient. Using WbL in classrooms are believed can improve several skills of students. But, it is necessary to find a better design to improve the learning concepts in integrating WbL. These findings also can be a recommendation for future research that optimizes AbL for the teaching and learning process in schools or universities/institutions. However, the use of appropriate learning media can improve and provide a positive response from many aspects of education in the classroom, especially in generating knowledge in abstract material like a physics subject.

Keywords—android based learning, bibliometric, education, technology, web based learning

1 Introduction

Learning media is a tool that may aid in the teaching and learning processes. The material's interpretation becomes apparent, and the purpose of teaching or learning may be accomplished successfully and efficiently [1]. However, Education is listed in Sustainable Development Goals (SDGs) [2][3][4][5]. The attractiveness of technologies is gradually gaining significant attention in the educational sector, which provides several options for Education and experience [6][7][8][9][10]. The innovation of learning media that emerging technology became wider each day, such as utilized Android (AbL) and Web-based learning (WbL). Using Android mobile apps as instructional

content has been one of the future technologies with high versatility [11][12][13], which consists of student worksheets and teaching materials. Some of them are EbAR-based and laboratory simulations [14]. Meanwhile, WbL is an online teaching platform or a website with educational aims, and many institutions produce scientific instructional content as a form of media for integrated science teaching materials [15][16][17].

The reality of using AbL is known from the research by [18] STEM approaches based on android learning are viable and can increase student learning results in chemistry [19]. There is a substantial difference in the listening skill of learners teaching using the T-Mobile Learning application and listening-based aided image [20]. Not only in scientific subjects, but The Android guitar-based learning application also makes it very simple for everyone to learn and practice the guitar [21]. The AbL system presents lessons using graphics and audio to clarify the course content. As a result, it may assist learners in the Bolaang Mongondow area of North Sulawesi Province, Indonesia [22]. Depending on the local wisdom assisted by Android (CAKA), the discovered media is of high quality and may be utilized as a teaching instrument. CAKA media can help learners enhance their representation of mathematics and skills to think critically [23]. The use of AbL proved beneficial in teaching vocabulary to seventh-graders students [13]. Meanwhile, the use of WbL is beneficial shown in research by [24], WbL improves the teachers' achievement. Meanwhile, students can enhance their language skills by using web-based learning to avoid students' boredom during their knowledge [25][26]. By providing online classes, the entire community can assist in education [27].

There are many benefits from using AbL and WbL, especially in the learning process through all subjects. Also, it is necessary always to discover novelty, innovation, improvement, and development of AbL or WbL to increase the quality of the study environment. Research publications on both AbL and WbL tend to be interested in researchers. Therefore, it takes research to find out how AbL and WbL are used in each area of research to find novelty, improvement, development, and research ideas. In addition, the use of AbL and WbL in the field of Education also needs to be known to be an opportunity for research studies and learning innovations in the future. Previous research tends to analyze E-learning [28], technology-integrated [29], digital learning, and mobile learning [30] in the general learning process throughout bibliometrics. Despite this, researchers tend to conduct bibliometric research to compare an AbL and WbL trends researches through Scopus over the past ten years and the contribution to Education.

Hence, from the analysis of AbL and WbL in the all field educational, the researchers tend to writing an explanation of specific subject in school, to giving some example of the impact of using AbL and WbL and giving the implication to further research. To analyze the impact of AbL and WbL in Physics Learning. Abstract ideas, problems identifying physical variables, and trouble using formulae are all part of physics learning [31][32][33]. The utilization of AbL or WbL can also help to overcome challenges and constraints in physics learning.

This research analyzes bibliometrics on 'AbL' and 'WbL' keywords and compares them. Scopus is used to collect the metadata, and the VOSViewer application will be an assist tool. This research is expected to reach trends, patterns, novelty, and future

research in the AbL and WbL through broad fields of Education during the past ten years (2012–2021). Specifically, the objectives of this research are as follows:

1. To compare the trend research of AbL and WbL during the past ten years (2012–2021).
2. To compare documents, countries, and languages that contributed to AbL and WbL research during the past ten years (2012–2021).
3. To compare subject areas and affiliate funding in AbL and WbL research during the past ten years (2012–2021).
4. To identify the top 10 most productive authors of AbL and WbL research during the past ten years (2012–2021).
5. To identify the novelty and opportunity AbL and WbL research on trend mapping visualization during the past ten years (2012–2021).
6. To analyze the distribution publications in AbL and WbL research during the past ten years (2012–2021).
7. To explore the publications of review in AbL and WbL during the past ten years (2012–2021).
8. To analyze the impact of AbL and WbL in Physics Learning during the past ten years (2012–2021).

2 Method

This research is bibliometric in form and employs descriptive analysis. Scopus was utilized as a defined data in this research to assess published data [34][35][36]. Scopus has grown to become a leading resource, with about 77.8 million primary entries from diverse categories, with various meta-data and paper kinds, whether non-academic or academic [37][38][39][40][41][42]. Furthermore, Scopus has a publication loading that is 70% higher than Web of Science [43][44][45][46][47]. Bibliometrics is divided into four stages: (1) creating a research design, (2) gathering information using criteria, (3) data analysis, and (4) representing and displaying data [48][49][50]. The process of this research to determine the use of AbL and WbL in general fields is as in Figure 1.

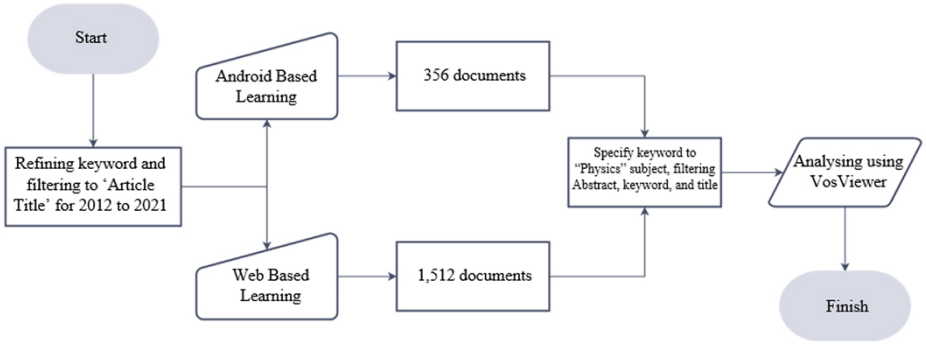

Fig. 1. Research flowchart

On May 26, 2022, data gathering was obtained. The results are arranged from top to lowest by "citation count." Then, save them as .csv or .ris files. The data was then uploaded to the VOSViewer program, which displayed the transcript specifics and visualized the bibliometric groupings [51][52][53]. Then, selected articles are analyzed to find the findings and recommendations in order to strength novelty besides to mapping visualizations.

3 Result and discussion

3.1 Research trend of AbL and WbL during ten last year

Based on the metadata processing that has been carried out, 365 documents were obtained in AbL publications, then 1,512 documents in WbL publications during the previous ten years. An interesting finding is that the research trend of both AbL and WbL is increasing every year. It is depicted in Figure 2.

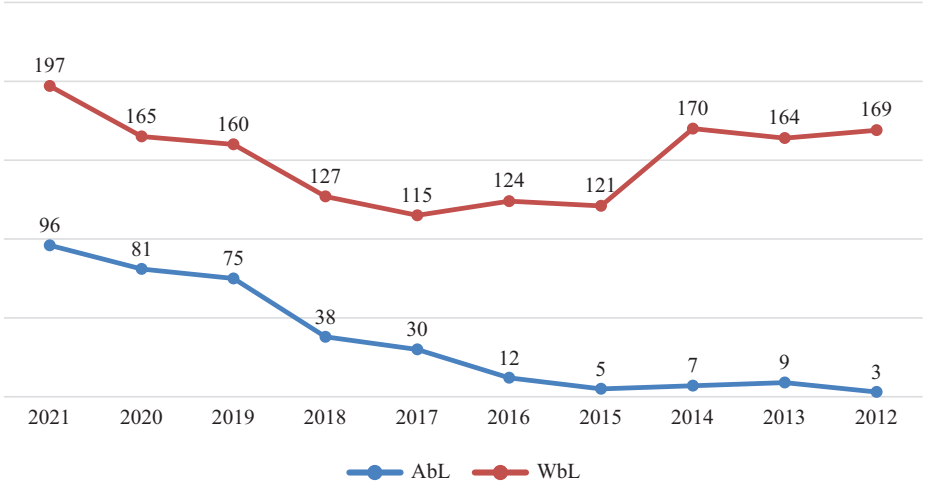

Fig. 2. Research trends in AbL and WbL during the past ten years

Figure 2 shows that the AbL trend only started in 2012 with a significant increase in 2021. It can also be known that the AbL trend rises every year, along with the increasing trend of using Android-based smartphones as a daily support tool. Every year AbL becomes an interesting research idea, and its development begins to be considered by researchers, especially in the field of Education. AbL is deemed to have the feasibility and flexibility of learning [54] and is a renewable idea in this era of globalization [55]. The WbL trend decreased in 2015 and became an uptrend again until 2021. The web is the most recent development in remote Education and is still being more utilized and developed [56][57]. The fast advent of new technologies and innovation in modern Education highlights the critical importance of the human teacher in promoting academic engagement, exploring, assisting, and producing [58].

3.2 Types of publications, countries, and language that contributed to AbL and WbL research

We know that the research trends of AbL and WbL in the field of Education over the past ten years have increased. Based on this behavior, we can explore more about what researchers' most widely used types of documents and what countries contribute the most to this research trend, as well as what languages are most commonly used—a comparison of the most frequently used types of cement in AbL and WbL at Figure 3.

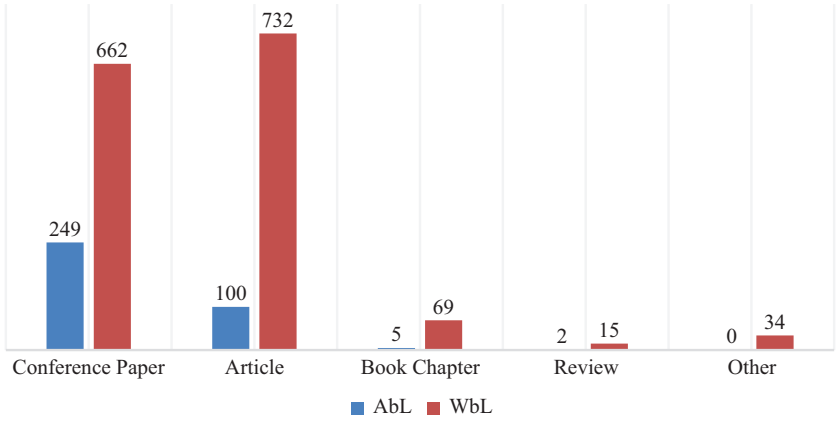

Fig. 3. Comparison of AbL and WbL document type

Figure 3 In AbL's research, conference paper is more widely used with 249 documents. Nowadays, 'conference papers' have a more approachable effect since they are shown at a conference for many experts from diverse domains to observe [59]. In the second place, an 'article' is the most used type of document in AbL research. Meanwhile, in WbL research, contrary to AbL, the 'article' type of document is more widely used with 732 papers. While the second place, 'conference paper,' followed as the most type of document used in research. Furthermore, the most significant country differences in AbL and WbL publications over the past ten years are represented in Figures 4 and 5.

Fig. 4. Countries that contributed to AbL research during the past ten years

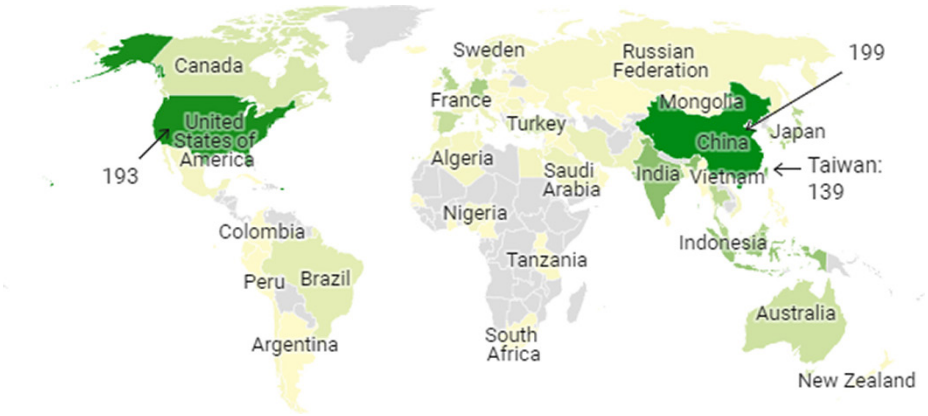

Fig. 5. Countries that contributed to WbL research during the past ten years

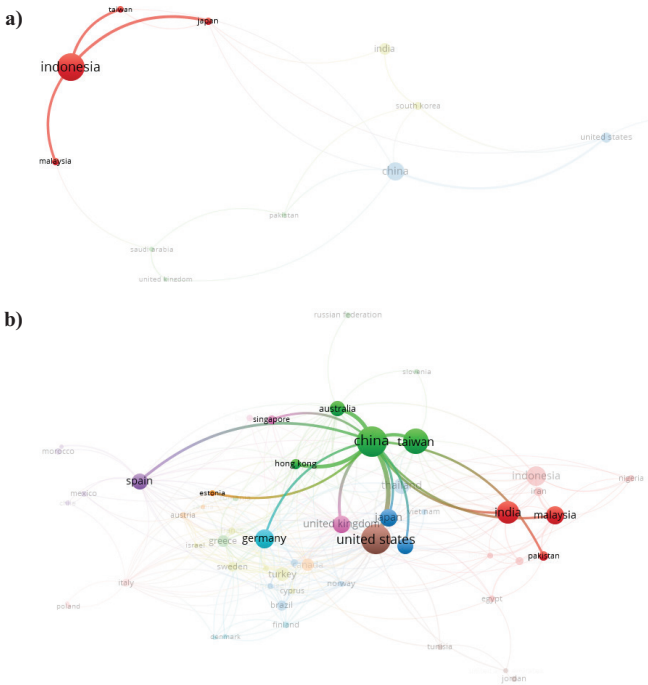

Fig. 6. Cluster mapping visualization of a) AbL and b) WbL

There is a difference in the countries that contribute the most publications in AbL and WbL—observed in Figure 6, showing that Indonesia contributed the most research in AbL with 153 publications, followed by China with 75 publications and India with 30 journals. In Indonesia itself, AbL has many advantages as a learning medium. Research by [60] is suited for enhancing higher-order thinking skills (HOTs) and an effective scaffolding learning strategy to improve HOTs. The development of AbL in

Indonesian vocational schools is effective in integrated [61]. It is possible to apply AbL media to human respiratory system content in teaching and learning [62]. Also, AbL can support self-study, especially for multidiscipline students [63]. Hence, this shows that the development of AbL in Indonesia itself still increases to find a new novelty to find the best way in the teaching and learning process. Meanwhile, for the WbL, The country with the most publications was China with 199 publications, followed by the United States of America with 193 publications and Taiwan with 139 publications. Research by [64] WbL was an effective method for improving the knowledge of primary health care. The students were pleased with the online learning (Including WbL) curriculum presented by Beijing's Institutions of Higher Education [65].

Furthermore, from mapping clustering assisted with VOSviewer in Figure 6a, AbL consists of four main clusters, namely: (1) Cluster 1 with red node (n=4 items); Indonesia, Japan, Malaysia, and Taiwan. (2) Cluster 2 with green node (n=3 items); Pakistan, Saudi Arabia, and the United Kingdom. (3) Cluster 3 with blue node (n=3 items); China, Turkey, and United States. The least Cluster is Cluster 4 with yellow nodes (n=2 items); India and South Korea. Compared to b) WbL has broader cluster regions consisting of ten main clusters, namely: (1) Cluster 1 with red node (n=10 items); Bangladesh, Egypt, India, Indonesia, Iran, Malaysia, Nigeria, Pakistan, Saudi Arabia, and Tanzania. (2) Cluster 2 with green node (n=8 items); Australia, China, Greece, Hongkong, Romania, Russian Federation, Slovenia, and Taiwan. (3) Cluster 3 with blue node (n=8 items); Brazil, Japan, Netherlands, Norway, Portugal, South Korea, Thailand, and Vietnam. And other cluster like Cluster 4 with yellow node (n=6 items), cluster 5 with purple node (n=5 items), cluster 6 with turquoise node (n=4 items), cluster 7 with orange node (n=4 items), cluster 8 with brown node (n=3 items) and cluster 10 with pink node (n=3 items). Following the countries that have many publications to AbL and WbL, we can explore the most used language in the publications of AbL and WbL. The comparison between the most used language of AbL and WbL is shown in Table 1.

Table 1. Comparison of language that used in AbL and WbL publications

Language	AbL (Doc.)	WbL (Doc.)	Language	AbL (Doc.)	WbL (Doc.)
English	351	1,487	Portuguese	–	5
German	–	9	Spanish	1	3
Chinese	3	7	Others	–	9
Turkish	1	5			

English has become the widely used language in publications to both AbL (n=351) and WbL (n=1,487). It is because English is an international language that everyone can understand [66][67][68][69].

3.3 Comparison of top funding sponsorship, subject areas, and affiliation to AbL and WbL research

To find out what subject areas publications in AbL and WbL and from which affiliates AbL and WbL research are widely produced, we present the top subject area data. Then, Table 2 states the differences in subject areas and affiliations in the AbL and WbL research.

Table 2. Comparison of top subject areas and affiliation to AbL and WbL research

AbL		WbL	
Subject Areas	**Affiliation**	**Subject Areas**	**Affiliation**
Computer Science	Universitas Negeri Yogyakarta	Computer Science	Khon Kaen University
Engineering	Universitas Pendidikan Indonesia	Social Sciences	National Taiwan Normal University
Physics and Astronomy	Universitas Negeri Malang	Engineering	National Taiwan University of Science and Technology
Mathematics	Universitas Sebelas Maret	Mathematics	National Central University
Social Sciences	Universitas Negeri Padang	Medicine	Universiti Malaya

Table 2 is known that 'Computer Science' became the most area subject used in research both AbL (n=194) and WbL (n=869). Then, in AbL, 'Engineering' ranks second (n=116); 'Physics and Astronomy' ranks third (n=101); 'Mathematics' is fourth (n=43) and 'Social Science' is fifth (n=41). Compared to WbL, 'Social Science' ranks second (n=576); 'Engineering' ranks third (n=370); The same 'Mathematics' ranks fourth (n=186) and 'Medicine' in fifth (n=125). In line with the top contributed countries, the affiliation that contributed a lot to AbL researches are mostly from Indonesia, as well as Universitas Negeri Yogyakarta, Universitas Pendidikan Indonesia, Universitas Negeri Malang, Universitas Sebelas Maret and Universitas Negeri Padang. Compared to WbL, Khon Kaen University became the most contributed affiliation, followed by National Taiwan University, National Taiwan University of Science and Technology, National Central University, and Universiti of Malaya. Furthermore, Table 2 states that these top affiliates are indeed engaged in Education and learning. Thus, the highest potential of AbL and WbL development is essentially needed by the affiliate. However, educational involvement is essential to knowledge development, especially given the dominance of teams in scientific activities [70]. The most common research topics in platform speeches were epidemiologic methodology, social demography, and cardiovascular epidemiology [71].

3.4 Top 10 most productive authors to AbL and WbL research

The comparison of the top 10 most productive authors can be analyzed by using the metadata of Scopus. Therefore, Table 3 compares the top 10 most contributed authors to the publication of AbL and WbL.

Table 3. Comparison of top 10 authors to AbL and WbL research

AbL				WbL			
Author	**Total**	**Author**	**Total**	**Author**	**Total**	**Author**	**Total**
Kuswanto, H.	11	Allix, K.	3	Chaijaroen, S.	26	Abdullah, N.A.	5
Bissyandé, T.F.	4	Arslan, R.S.	3	Hwang, G.J.	12	Kuo, F.R.	5
Chen, Z.	4	Baker, K.	3	Kashihara, A.	8	McLaren, B.M.	5
Klein, J.	4	Billah, A.	3	Samat, C.	8	Tsai, C.C.	5
Yerima, S.Y.	4	Hou, S.	3	Hwang, W.Y.	6	Tsai, C.W.	5

The entire documents of the top 10 most contributed in AbL are Kuswanto, H. (n=11 documents) from affiliation Institut Teknologi Sepuluh Nopember, Indonesia with h-index Scopus 4. Meanwhile, WbL with Chaijaroen, S. (n=26 documents) from affiliation Khon Kaen University Thailand, with h-index Scopus 4. The h-index, depending on the number of publications and citations obtained on such articles, is regarded as one of the most important indicators used to assess the impact, quality, value, and influence of an individual's work [72][73][74]. Then, the publication of top authors on AbL is less than on WbL. This is because the number of documents published is much different.

3.5 Trend mapping visualization to find the novelty of AbL and WbL

We can examine the keywords of each publication to identify the innovation of the AbL and WbL study. As indicated in Figure 7 and Table 4, the most frequent terms are investigated before mapping out the visualization of AbL and WbL research during the last ten years. To find a novelty of the study based on the mapping results, look at the relationships between minor keywords or fewer keywords [75][76][77][78].

Table 4. Trend mapping visualization of AbL and WbL research

AbL			WbL		
Keyword	**Total Link Strength**	**Occurrence**	**Keyword**	**Total Link Strength**	**Occurrence**
Android (operating system)	1954	274	E-learning	4937	632
Malware	1084	111	Websites	4004	503
Learning systems	1004	117	Computer-aided instruction	2766	304
Mobile security	734	75	Learning systems	2733	324
Machine learning	716	82	Students	2568	286
Malware detection	644	69	Education	2169	184
Android malware	625	64	Teaching	2168	191
Android	602	100	Human	1966	131
Android applications	458	59	Internet	1736	128
E-learning	413	60	Humans	1649	104
Computer crime	410	39	Article	1343	89
Learning algorithms	406	44	Female	1098	61
Students	393	74	Web-based learning	1084	125
Deep learning	367	46	Learning	997	77

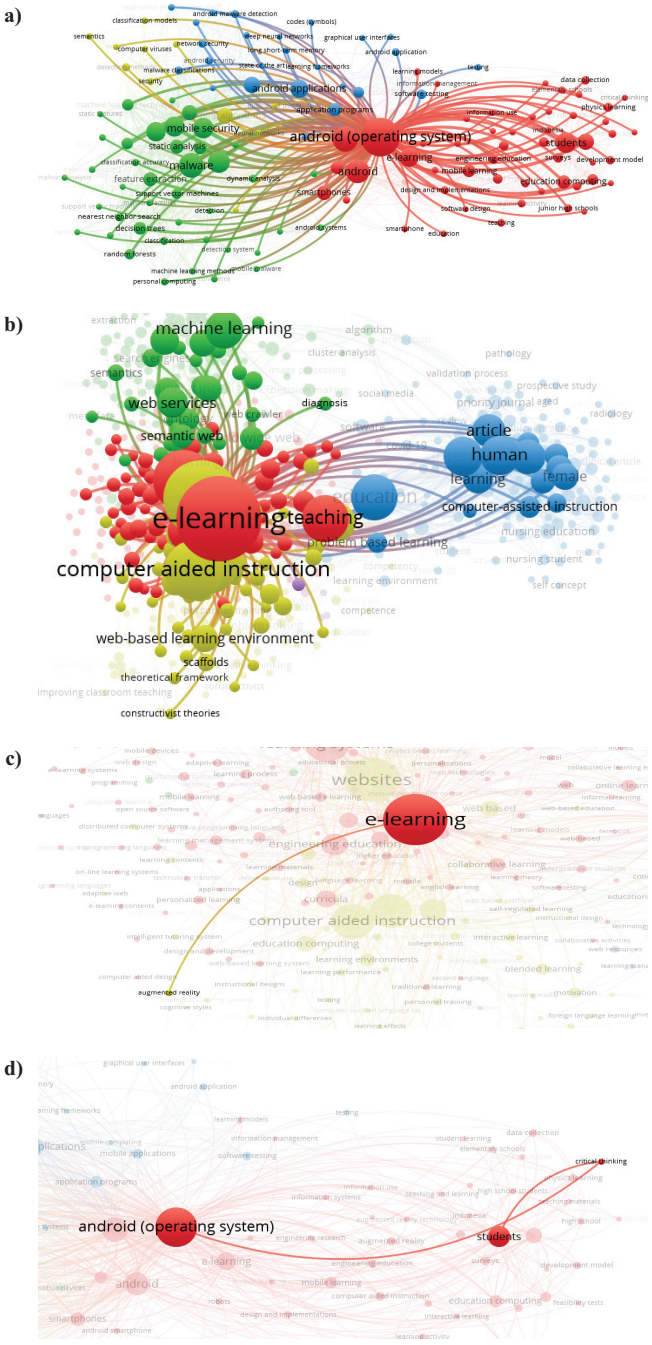

Fig. 7. Comparison of mapping visualization to a) most occurs keyword to AbL, b) most occurs keyword to WbL, c) less occurs keyword to AbL, d) less occurs keyword to WbL

Figure 7a and b are the top keywords in AbL and WbL research from 2012 to 2021, whereas Figure 7c and d are the opposite. If future researchers want to explore AbL and WbL on the top keyword, there is still any chance to explore more about AbL and WbL research because the top keyword still has a wide range and various fields of terms. Some examples of specific keyword mapping visualization results on AbL, Android (operating systems). Meanwhile, in WbL, E-learning can be developed and improved for further research. Whereas for fewer occurs keywords, such as Figure 7c and d, these can be used as an alternative future research field, especially to investigate AbL and WbL on critical thinking (AbL) and augmented reality (WbL). As a result, a prospective study indeed can develop AbL and WbL research based on keyword mapping visualizations. There are certainly chances to do research in AbL and WbL on less-used keywords or to improve on more-used terms.

3.6 Comparison of the distribution of AbL and WbL publications

The distribution of cited paper to AbL and WbL publication during the past ten years are shown in Table 5. Whereas ACPP is the Average Citation Per Paper, ACPPY is the Average Citation Per Paper Year. Between the AbL and WbL, their highest distribution is all in 2021. In line with increasing publication and cited documents in 2021. It is also known that the research on AbL and WbL tends to be more attractive to researchers nowadays [79][80].

Table 5. Comparison of distribution cited paper to AbL and WbL research

Year	AbL				WbL				
	Paper	**Cited**	**ACPP**	**ACPPY**	**Paper**	**Cited**	**ACPP**	**ACPPY**	**Citable Years**
2012	169.00	57.00	0.34	0.03	3.00	1.00	0.33	0.03	10
2013	164.00	196.00	1.20	0.13	9.00	5.00	0.56	0.06	9
2014	170.00	332.00	1.95	0.24	7.00	12.00	1.71	0.21	8
2015	121.00	504.00	4.17	0.60	5.00	10.00	2.00	0.29	7
2016	124.00	627.00	5.06	0.84	12.00	29.00	2.42	0.40	6
2017	115.00	728.00	6.33	1.27	30.00	48.00	1.60	0.32	5
2018	127.00	932.00	7.34	1.83	38.00	226.00	5.95	1.49	4
2019	160.00	1159.00	7.24	2.41	75.00	389.00	5.19	1.73	3
2020	165.00	1505.00	9.12	4.56	81.00	660.00	8.15	4.07	2
2021	197.00*	1995.00*	10.13*	10.13*	96.00*	936.00*	9.75*	9.75*	1
Total	**1512.00**	**8035.00**	**52.87**	**22.05**	**356.00**	**2316.00**	**37.65**	**18.36**	**1512.00**

Note: *=the highest number.

3.7 Publication review of AbL and WbL

Appendix compares the publication review of selected papers in AbL and WbL (Table A1). Each article was analyzed based on the citation, Cite Score accessed on www.scopus.com, Scimago Journal, and Country Rank (SJR) accessed on

www.scimagojr.com [81][82][83][84] (per May 27, 2022), also findings and recommendations in the publication. Appendix shows that the use of AbL can be a novelty to education as digital laboratories, AbL in games-based media to implement at schools. Also, for some review, show that AbL are feasible and practical to use in all level education such as kindergarten to universities. Hence, the use of AbL, should be more boarder and widely in the classroom. Furthermore, the use of WbL is also tend to be effective and efficient. Using WbL in classrooms are believed can improve several skills on students. But still, it is necessary to find a better design to improve learning concept in integrating WbL. These findings also can be a recommendation for future research that optimizes AbL for the teaching and learning process in the school or universities/institutions. The use of both AbL and WbL are already spread around all levels of education. Hence, to facilitate the development of AbL and WbL research in the future, based on the results of the review, it can be concluded that the differences between AbL and WbL in several aspects. It is shown on the Table 6.

Table 6. Differences between AbL and WbL

Differences	AbL	WbL
Definitions	Software products for mobile devices such as smartphone, tablets, and computers which assisted in learning media [85].	The use of such an Internet to get access to knowledge learning, such as discussion forums, weblogs, and Internet-based audio-visual teaching and learning [86].
Framework	Flutter, Corona SDK, Ionic Android, Xamarin, Native Android, Kotlin, React Native Android, Java libraries [87]	CSS, PHP, JavaScript, World Wide Web [88]
Trends	Tend to raise	Constantly improves
Type	Application	Website pages
Advantages	– Easy to develop an virtual laboratories – More practical and easy to used due to android smartphones are widely use – Increase students' interest, this is caused the gen Z are aware of Android smartphone – Does not require expensive costs because it is enough to install it on an android smartphone device – Equipped with a search facility for certain topics that you want to learn. – Students and teacher can learn anytime and anywhere by utilizing this AbL – Support by independent learning and assessment – The AbL can accessed rather online or offline	– Easy to create a page of website – Used through Android, IoS, Windows, etc. – Unlimited used of pages – Widely used as Learning Management System at schools or universities – Direct interact of students and teacher – Allow students to actively participate in learning process – Easy to access in every device – Effective and practical to integrated some model of learning – Don't need an extra storage to devices
Disadvantages	– Students or teacher with other than Android user could not access the AbL media – Need extra storage even bare minimum in the smartphone	– Only online accessed, then if students or teacher having problem with internet connectivity it could be obstacle to teaching and learning process – Some WbL are severe to load, so it takes sometime

Based on Table 6, AbL and WbL are have fundamental differences. Also, even the use of AbL and WbL having so much advantages, there also disadvantages of using those learning media. However, the development of learning media needs to observe and remark on its need. Based on the appendix and also Table 6, the use of AbL and WbL are still need improvement, development, new ideas to solve the limitation caused of it disadvantages. All of this is part of academics' attempts to help students receive, digest, and learn effectively, particularly. Technology-enhanced Learning (TeL) is the use of innovations to enhance learning outcomes, in which students are supposed to experience different sensations of a learning process that they cannot sense in the official education setting [89][90].

3.8 Analyze the impact of AbL and WbL in physics learning

In the specific subjects, we are tried to examine the distribution of the keyword in physics learning. The keywords of each publication to identify the innovation of the AbL and WbL study specifically in physics learning. Hence, in Figure 8 and Table 7, are the most frequent terms are investigated before mapping out the visualization of AbL and WbL in physics learning research during the last ten years.

Table 7. Trend mapping visualization of AbL and WbL research in physics subject

AbL			WbL		
Keyword	**Total Link Strength**	**Occurrence**	**Keyword**	**Total Link Strength**	**Occurrence**
Android (operating system)	160	39	Students	377	82
Students	136	31	E-learning	301	70
Physics learning	110	27	Websites	225	46
Education computing	78	18	Education	172	37
Learning media	66	20	Teaching	158	31
Research and development	44	11	Education computing	133	25
Android	43	17	Curricula	117	24
High school students	41	8	Learning systems	114	28
Learning process	37	8	Engineering education	112	22
E-learning	35	9	Physics	92	26

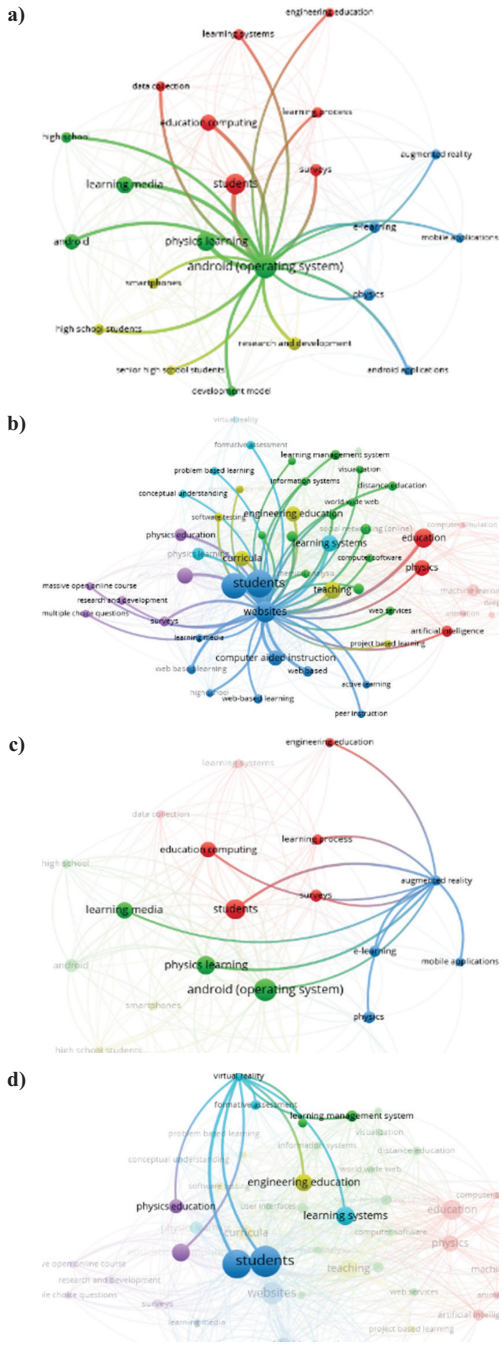

Fig. 8. Comparison of mapping visualization to a) most occurs keyword to AbL, b) most occurs keyword to WbL, c) less occurs keyword to AbL, d) less occurs keyword to WbL specific in physics

Figure 8a and b are the top keywords the utilization of AbL and WbL in physics subject research from 2012 to 2021, whereas Figure 8c and d are the keyword which still less. Based on this mapping visualization, there are still any chance to develop the AbL and WbL such as in high school students, or there are an opportunity to future researchers to conduct the development of AbL integrated with augmented reality (AR) and virtual reality (VR) as one of innovation in physics subject teaching media due to it fewer occurrence. However, Physics are an abstract and difficult subject that needs learning media that can explaining the detail of the material. Recent research indicates that learning with AR systems has a good influence in a variety of educational contexts [91][92].

Whereas not much different from the Figure 7, fewer occurs keywords, such as Figure 8c and d, these can be used as an alternative future research field, especially to investigate AbL and WbL in the specific physics subject. As a result, a prospective study indeed can develop AbL and WbL research in physics subject based on keyword mapping visualizations. There are certainly chances to do research in AbL and WbL in physics subject on less-used keywords or to improve on more-used terms and to build a new innovation of the learning media [93][94][95].

Then, it can be concluded that an implication of the results of the analysis that has been carried out is that the trend of the use of AbL and WbL which increases every year provides an understanding that the rapid use of technology today helps the fields of education to develop better teaching tools for use in schools [96][97][98]. The rise of this trend is known by the increasing number of publications related to research development and implementation of AbL and WbL both in universities and in schools. After all, the use of appropriate learning media can improve and provide a positive response from many aspects of education in the classroom [99][100][101]. The development of AbL and WbL was successively developed in Indonesia and China. As a findings of the experiment, it is suggested that distance learning be designed differently, that an improved communication channel between teacher-student-parent be established, that technological infrastructure problems be eliminated, and that teachers receive technical and psychological counseling throughout immediate emergency distance learning practices [102]. However, Digitalization usage, enterprise technology assistance, technology-based career progression, WbL environment assistance, and digitally leadership qualities [103]. With some research on the advantages of AbL and WbL, many researchers feel interested in the use of AbL and WbL which are trending among the community to become an effective learning tool. However, of course, in its development and implementation, it still has many shortcomings and recommendations, in this study, it can be seen that there is still much that can be explored from AbL and WbL. Especially in the field of Physics, AbL and WbL can be integrated together with AR and VR to abstract objects that are difficult for students to imagine. Of course, this can be an innovation for future research as a research object with many variables that can be designed. Furthermore, the usage of adaptable digital platforms with learning method appears to be an efficient method of utilizing and integrating new technology in education [104][105].

4 Conclusions

Based on the analysis can conclude that trends of AbL and WbL research tend to increase each year. Then, the documents primarily used in AbL are conference papers; meanwhile, WbL is articles. The most influential countries to AbL research are Indonesia, whereas, in WbL research, China is the most contributed countries. Following the most contributed countries, English is the most used language in the AbL and WbL publications. This is true because English is an international language. In line with the top contributed countries, the affiliation contributing to AbL research is mainly from Indonesia, Universitas Negeri Yogyakarta. Whereas WbL is Khon Kaen University become the most contributed affiliation. While the top subject area is Computer Science, this research integrates technology.

Furthermore, the leading most contributed author is Kuswanto, H. from Institut Teknologi Sepuluh Nopember, Indonesia, and WbL with Chaijaroen, S. from affiliation Khon Kaen University Thailand, with both h-index Scopus 4. To examine the novelty of AbL and WbL research, the examination of the keywords shows that prospective studies indeed can develop AbL and WbL research based on keyword mapping visualizations. There are certainly chances to do research in AbL and WbL on less-used keywords or to improve on more-used terms. Hence, Between the AbL and WbL, their highest distribution is all in 2021. In line with increasing publication and cited documents in 2021. Finally, based on the analysis of the selected papers, the use of AbL, should be more boarder and widely in the classroom. Furthermore, the use of WbL are also tend to be effective and efficient. Using WbL in classrooms are believed can improve several skills on students. But, still it is necessary to find a better design to improve learning concept in integrating WbL. These findings also can be a recommendation for future research that optimizes AbL for the teaching and learning process in the school or universities/institutions. The use of both AbL and WbL are already spread around all levels of education.

The implication of this research tends to find the trend and the novelty of the AbL and WbL for future research. To researchers, it can build innovation and decrease the limitation caused of disadvantages to these characteristics of AbL and WbL. This type of research is presented, allowing the further investigation to develop and improve AbL and WbL in Education. Hence, it also helps to narrow down the following trends that can be developed in the Education field of research. To practitioner, can be a source of primary study and information about the advancement of TeL era. It is can be seen that there is still much that can be explored from AbL and WbL. Especially in the field of Physics, AbL and WbL can be integrated together with AR and VR to abstract objects that are difficult for students to imagine. Of course, this can be an innovation for future research as a research object with many variables that can be designed. Furthermore, the usage of adaptable digital platforms with learning method appears to be an efficient method of utilizing and integrating new technology in education.

5 Acknowledgment

The author's gratitude goes to the Directorate General of Higher Education, Research, and Technology; Ministry of Education, Culture, Research and Technology, Indonesia who has supported funding in *Penelitian Dasar Unggulan Perguruan Tinggi* – DRTPM 2022 [Contract Number: 29551/UN38.9/LK.04.00/2022].

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7 Appendix

Table A1. Review of selected papers to AbL and WbL

Author(s)	SJR / Citation / CiteScore*	Percentile	Recommendations
AbL			
Arista & Kuswanto [106]	0.5 (Q2) / 51 / 2.7	76th (to Education)	Teachers might utilize ViPhyLab to help students develop their learning independence and conceptual grasp of circular mechanics learning materials.
Wardani et al. [107]	0.46 (Q2) / 25 / 3.5	85th (to Education until 2021)	CBG need further implementation at schools
Liliarti & Kuswanto [11]	0.5 (Q2) / 25 / 2.7	76th (to Education)	Further research may can explore other students' competence such as critical thinking, problem solving, etc.
Hendikawati et al. [108]	0.38 (Q2) / 12 / 2.7	63rd (to General Computer Science)	For the future research it can be develop and improve based on this AbL to integrated in other courses.
Taufiq et al. [109]	0.46 (Q2) / 11 / 3.5	85th (to Education)	As a result, additional research into the impact of employing this AbL in schools to improve students' skills is required.
Said et al. [110]	0.2 (Q2) / 7 / 1.3	36th (to General Computer Science)	It is necessary to develop in other subjects in schools.
Murdiono et al. [111]	0.42 (Q3) / 6 / 2.9	54th (to Computer Science Applications)	Further study on the usage of this AbL in the educational process and its impact on students is required.
Lopez-Rodriguez & Cuesta [112]	0.51 (Q2) / 5 / 3.0	71st (to General Engineering)	Further research need to investigate the response of using this integrated AbL in schools in order to knowing the increase students skills and as an implementation of STEAM.
Maria et al. [113]	0.42 (Q3) / 5 / 2.9	54th (to Computer Science Applications)	Further research is needed to investigate the use of this AbL in the learning process of the higher educational level with other subjects.
Huda et al. [114]	0.42 (Q3) / 5 / 2.9	54th (to Computer Science Applications)	Further research is needed to investigate the use of this AbL in the learning process and its effects on student.
WbL			
Hwang et al. [115]	3.63 (Q1) / 208 / 14.4	99th (to Education)	This strategy has the disadvantage of lacking peer contact and cooperation, leading to progress.
Chen & Tseng [116]	0.55 (Q2) / 168 / 3.3	72nd (to Social Psychology)	Need implementation in other Junior High schools in Taiwan.
Raes et al. [117]	3.63 (Q1) / 128 / 14.4	99th (to Education)	All data were measured on an individual basis.

(Continued)

Table A1. Review of selected papers to AbL and WbL *(Continued)*

Author(s)	SJR / Citation / CiteScore*	Percentile	Recommendations
Motaghian et al. [118]	3.63 (Q1) / 125 / 14.4	99th (to Education)	These factors boosted instructors' intentions to utilize WbL systems; nevertheless, performance expectancy was the most impactful factor on teachers' intentions and actual usage of the systems (adoption).
Gaultois et al. [119]	153 (Q1) / 100 / 6.5	92nd (to General Engineering)	A framework like this might someday replace experimentation and chance in the quest for novel materials in many new fields.
Hwang et al. [120]	3.68 (Q1) / 98 / 14.4	99th (to Education)	To increase both academic achievement and acceptance of employing technology for improved learning, a better design of an integrated idea mapping learning system is required.
Kurilovas et al. [121]	3.68 (Q1) / 88 / 14.4	99th (to Education)	Additional exploration should have included facts on how to apply and assess the suggested model, as well as demonstrate how personalization is really used in this context of study as well as how the conceptual framework should be linked into the LMS.
Hattink et al. [122]	1.74 (Q1) / 82 / 6.9	85th (to Health Infomatics)	It is suggested that the RCT be repeated on a wider scale and in additional countries. STAR is now accessible in Dutch and English; the basic and intermediate modules are also available in Italian and Romanian, with certain modules being available in Swedish.
Chih-Ming & Sheng-Hui [123]	1.87 (Q1) / 78 / 7.6	98th (to Education)	Further research might look at defining high-SRL and low-SRL groups using a more extreme method, such as classifying individuals with the highest SRL skills (top 27 percent) as high-SRL and those with the lowest SRL abilities (lowest 27 percent) as low-SRL.
Molinillo et al. [124]	3.68 (Q1) / 75 / 14.4	99th (to Education)	The WbL must be implemented at universities. There is relatively little understanding of the precursors of student engagement in SWBCL systems.

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All author are members from grant research and take part in the jobs.

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Article submitted 2022-06-03. Resubmitted 2022-07-17. Final acceptance 2022-07-17. Final version published as submitted by the authors.