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Trends of Web-Based Instructional (WBI) in Physics Learning: A Literature Review

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Abstract. This research provides a literature review of the trend of using websites in physics learning. The literature review was carried out by collecting 30 journals from the Science Direct and Google Scholar databases from 2019 to 2022. A content analysis method was adopted to analyze the selected articles. This review examines research that has been done on the use of websites in physics learning and categorizes them into 10 topics, namely knowledge construction, learning environment, collaborative and autonomous learning, misconception, attitude and motivation, assessment and achievement, inquiry skills, conceptual knowledge, conceptual change, and problem solving. The results show that the overall use of websites over the past few years has increased, especially on the topic of collaborative and autonomous learning, which positively impacted the physics learning process during the COVID-19 pandemic. Meanwhile, many researchers have not studied the topic of problem solving, conceptual change, and misconception. In addition, the use of websites in physics learning has become a challenge in online learning during the COVID-19 pandemic. These issues have huge potential for further research

1. Introduction

Physics is a science that contains rational, objective, and systematic theories about the universe. Physics can be claimed as scientific knowledge, that is, science that has been tested for truth through systematics or the scientific method [1]. Physics contains abstract concepts, so it requires learning media to visualize them. Integrating technology in developing suitable learning media can make it easier for students to understand abstract concepts as a whole [2]. The ease of distributing media is also very important to pay attention to. One of the uses of technology to increase the accessibility of learning media is using websites in physics learning.

A website is an information page provided through the internet so that it can be accessed worldwide as long as it is connected to the internet [3]. A web is a component or collection of components consisting of text, images, sounds, and animations so that it is interesting to visit [4]. Web-based instruction (WBI) is a rapidly growing research field aiming to fully integrate text, images, sounds, and animations into a website page to support the learning process. WBI is one of the methods and technologies used in distance learning. Through WBI, learning materials can be widely distributed without being hindered by time and space [5].



Research on WBI has been widely carried out, based on published journals that report on how to use it, advantages, limitations, challenges, and effectiveness of using the website in the learning process. However, since websites are an emerging technology, it is important to get an idea of the progress and the real impact of their use in education especially on physics learning.

Previous studies of WBI in physics learning can be used to guide future studies. Therefore, a systematic review is essential to present the current situation and explain future studies. Reviewing previous studies helps researchers to make decisions about issues such as topics, methods, and sampling. It is possible to find many systematic reviews in the literature on the use of technology in education. However, only a few systematic reviews examine the WBI study. Therefore, this WBI study aims to bridge the gaps in the literature by analyzing all educational studies found in various databases (ScienceDirect and Google Scholar). From the identification results, what journals are used in this literature study? What are the trends of WBI research in physics learning from 2019 to 2022? And what are the challenges of applying WBI in physics learning?

2. Method

A content analysis method was adopted for this review of the literature. This study synthesized and analyzed articles on WBI in physics learning from 2019 to June 2022. Articles were collected using Publish or Perish software with the keyword "Web-based physics instructional" in the Science Direct and Scopus databases. There are several criteria used to select the article to be analyzed shown in Table 1.

Table 1. Article criteria selected

Criteria	Inclusion	Exclusion
Article type	Indexed publication	Non-indexed publication
Language	English	Non-English
Timeline	2019-June 2022	Before 2019
Research field	Science Learning	Non-science learning
Types of research	Empirical research	Meta analysis, literature review

3. Result and Discussion

3.1 Number of Journals Published

The thirty WBI studies analyzed consisted of 21 journals and 9 conference proceedings. Table 2 provides the distribution of items from 2019 to June 2022.

Table 2. Type of publication and the number of articles selected.

Publication Type	Journals and Conference Selected	Number of % of	
		Articles Selected	
Journal	Journal of Educational Sciences	1	3.33%
Journal	Education and Information Technologies	1	3.33%
Journal	Jurnal Inovasi Pendidikan IPA	1	3.33%
Journal	Journal of Education Technology	1	3.33%
Conference	International Conference on Human-Computer Interaction	1	3.33%
Journal	Interactive Learning Environments	1	3.33%
Journal	Journal of Educational Research and Evaluation	1	3.33%
Journal	International Journal of Evaluation and Research in Education	1	3.33%
Conference	Journal of Physics Conference Series	9	30%
Journal	Jurnal Penelitian & Pengembangan Pendidikan Fisika	3	10%
Journal	Cadernos de Educação Tecnologia e Sociedade	1	3.33%

Publication Type	Journals and Conference Selected	Number of Articles Selected	% of
Journal	Higher Education and Oriental Studies	1	3.33%
Journal	Journal of Science Learning	1	3.33%
Journal	BMC Medical Education	1	3.33%
Journal	Journal of Turkish Science Education	1	3.33%
Journal	Journal of Educational Computing Research	1	3.33%
Journal	Jurnal Ilmu Pendidikan Fisika	1	3.33%
Journal	Global Journal of Engineering Education	1	3.33%
Journal	Journal Taman Vokasi	1	3.33%
Journal	Jurnal Pendidikan IPA Indonesia	1	3.33%
Total		30	100%

3.2 Web-based Instructional trends in Science Learning

Using WBI in an educational environment is a topic of research that has recently gained popularity, especially since the world experienced the COVID-19 pandemic. In this review, thirty papers were included in the research on the use of WBI in physics learning that was grouped under ten topics, namely 1) knowledge construction, 2) learning environment, 3) collaborate and autonomous learning, 4) misconception, 5) attitude and motivation, 6) assessment and achievement, 7) inquiry skill, 8) conceptual knowledge, 9) conceptual change, and 10) problem-solving. As well, the use of WBI is mainly applied in universities and high schools. Students have a relatively high learning independence factor compared to secondary and primary levels. Table 3 shows the distribution of the thirty analyzed studies.

Table 3. Study of the use of WBI in Physics Learning

Study	Physics Topic	Education level	Research Topic
[5]	Optics	Senior high school	Knowledge Construction
[6]	Physics material	Secondary school	Learning environment, Collaborate and autonomous learning
[7]	Center mass	Senior high school	Knowledge Construction
[8]	Buoyancy	Senior high school	Misconception
[9]	Electromagnetic	Senior high school	Learning environment
[10]	Optics	Junior high school	Attitude and motivation
[11]	Natural science	Junior high school	Assessment and achievement
[12]	Mechanics	University	Collaborate and autonomous learning, Knowledge construction
[13]	Force and motion	Vocational high school	Attitude and motivation
[14]	Natural science	Junior high school	Inquiry skill, Conceptual knowledge
[15]	Digital system	University	Assessment and achievement
[16]	Fundamental physics	University	Attitude and motivation, Achievement
[17]	Force and motion	Secondary school	Conceptual Change, Knowledge Construction
[18]	Natural science	University	Learning environment, Attitude and motivation
[19]	Natural science	University	Learning environment, Knowledge Construction
[20]	Biophysics	Junior high school	Conceptual knowledge
[21]	Biophysics	University	Attitude and motivation, Knowledge Construction
[22]	Semiconductor	University	Problem solving
[23]	Kinematic	Secondary school	Knowledge construction, Collaborate and autonomous learning

Study	Physics Topic	Education level	Research Topic
[24]	Work and energy	Vocational high school	Assessment and achievement
[25]	Simple harmonic	Senior high school	Problem solving
[26]	Electric circuit	Senior high school	Misconception, Conceptual Change
[27]	Kinetic theory of Gases	Senior high school	Collaborate and autonomous learning
[28]	Optics	Senior high school	Attitude and motivation, Collaborate and autonomous learning
[29]	Biophysics	Senior high school	Collaborate and autonomous learning
[30]	Wave	Senior high school	Learning environment
[31]	Work and energy	Senior high school	Collaborate and autonomous learning, Knowledge construction
[32]	Gravitation	Senior high school	Inquiry skill, Inquiry skill
[34]	Optics	Senior high school	Collaborate and autonomous learning, Inquiry skill
[35]	Dynamics	University	Collaborate and autonomous learning

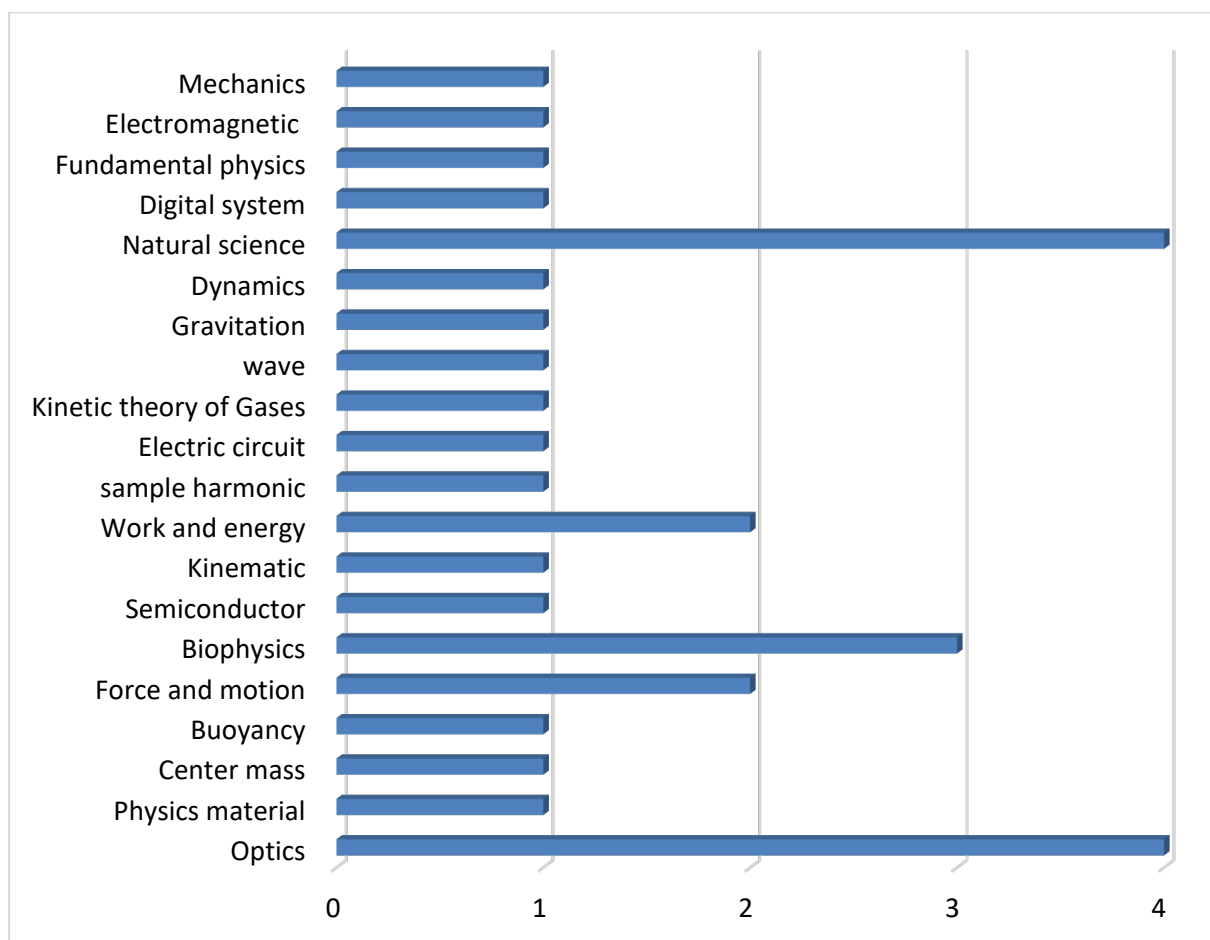


Figure 1. Trends in WBI Research Subjects in Physics Learning

Figure 1 and 2 shows the key physics topic for the use of WBI in physics learning in 2019-June 2022 are optics and natural science. For the major research topics, collaborative and autonomous learning is the most studied topic. This topic can positively impact physics learning, especially due to the global COVID-19 pandemic that forces students to learn online. On the other hand, the research topics of problem solving, conceptual change, and misconception were less studied by many researchers.

Research trends inform further research that can strengthen the research field, particularly the WBI in physics learning.

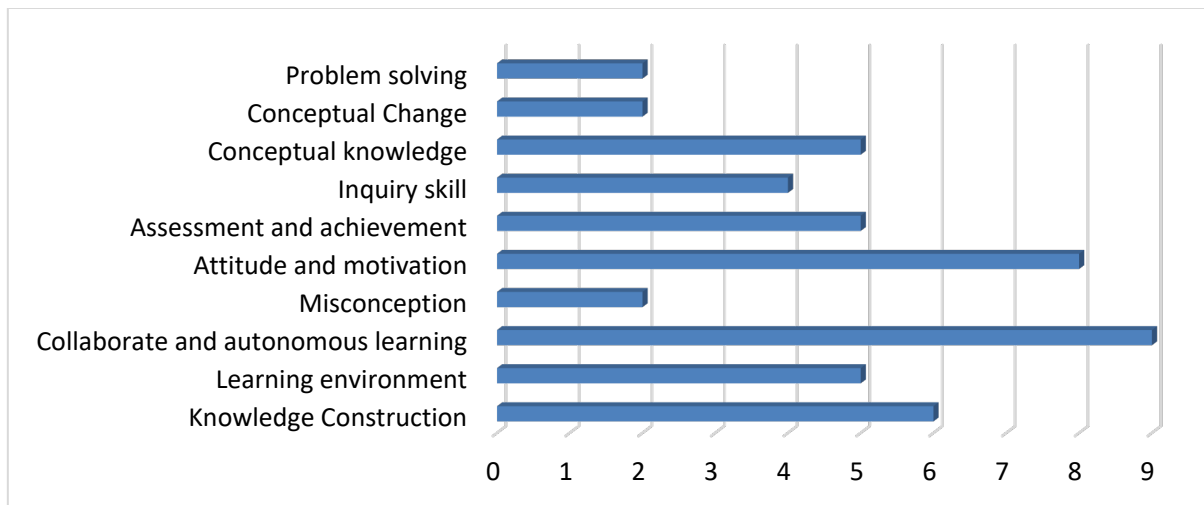


Figure 2. The trend of Research Articles on the use of WBI for Some Variables in Physics Learning in 2019–June 2022

3.3 Challenges of Using Web-based Instructional in Physics Learning

Based on the results of the analysis that has been carried out, several studies do not explicitly write about the difficulties in using WBI in physics learning and only focus on the benefits of its implementation. There are some challenges to using WBI for educational purposes. The technical issues experienced while using WBI are the main and most important limitations. The use of WBI is generally limited due to technical problems related to internet coverage. Other limitations include insufficient information from teachers to develop learning materials with WBI.

In addition, there are challenges encountered by students, namely not being accustomed to using WBI media in learning. Based on the results of the analysis that has been carried out, the use of WBI in physics learning is grouped into three categories: student difficulties, teacher difficulties, and technical difficulties, as shown in Table 4.

Table 4. Challenges of Applying Web-based Instructional in Physics Learning

Challenge		Article Example
Student	Unaccustomed to using, difficulty in using and accessing it	[8][10][11][13][17]
Teacher	Lack of information in developing WBI	[7][12][18][22]
Technical	Devices and internet networks	[14][15][27][32]

4. Conclusion

This study reviewed 30 papers related to WBI in physics learning Indexed in ScienceDirect databases by means of a content analysis method. Data analysis was established to establish trends in the WBI study of physics learning. The number of WBI education studies has increased over the past few years. The importance of using WBI for educational purposes and the increasing number of WBI studies will likely continue in the coming years, especially when the impact of the COVID19 pandemic lasts for a more extended period, even after the pandemic ends. It can be said that the results of this systematic review are important for guiding future studies.

The results showed that the major research topic studied is the topic of collaborative and autonomous learning, which can have a positive impact on physics learning. This particular research topic is critical, especially for the post-pandemic era where students will need to become more independent learners in WBI settings, where they rely less on teachers and are more collaborative in learning with peers. Nonetheless, a part from the advantages of using WBI in physics learning, there are challenges for

students, teachers, and technical challenges in applying it to the learning process. Those challenges need to be acknowledged appropriately and solved, probably by enhancing the internet speed and use of quality equipment.

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