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Systematic literature review: effects of digital teaching materials on learning achievement

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ABSTRACT

This research aims to examine the effect of digital teaching materials based on their classification on learning achievement at various levels of education. The research design is a systematic literature review (SLR). The stages of conducting a review consist of three major parts: planning, conducting, and reporting. The articles reviewed in this study were drawn from reputable academic databases. The inclusion criteria for this research are as: i) indexed by Scopus; ii) the specified time is 15 years; iii) the research subjects must be students; iv) the minimum number of research participants is 15 people; and v) the article must be a scientific research article. The exclusion criteria in this study are article topics that are outside the field of education. The procedure used to analyze the results of the research obtained using a literature survey. The results showed that the advantages of digital teaching materials, in general, are: i) easy to apply; ii) low-cost; iii) highly flexible; and iv) broad. Each type of digital teaching material has several impacts on learning achievement, including: increasing scientific activities; improving students' independent learning, self-reflection and metacognitive; reducing learning difficulties; and creating the impression that learning is fun.

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1. INTRODUCTION

The world is currently in the development phase of an evolutionary system where the circulation of knowledge is not only high but also increasingly beyond human control. The condition makes life seem to be increasingly difficult to manage. Such a condition is called a digital era which is characterized by increasingly dominant technological functions [1], [2]. Current technological development cannot be avoided because digital technology has even penetrated all aspects of life including education. Education in the digital era is education that must integrate information and communication technology into all subjects [3], [4]. The development of the digital era in education allows students to get abundant knowledge more quickly and easily. In the development of the digital era, the use of technology should be maximized to achieve active and innovative learning goals [5]–[8].

The emergence of the digital era and the conditions of the COVID-19 pandemic have forced the rise of digital or online learning methods where students and teachers do not need to meet face to face [3]. So far, online learning has only been a concept, a technical tool, not a way of thinking and a learning paradigm [2],

[5]. Online learning is not a method to change face-to-face learning with digital applications, nor does it burden students with stacked assignments every day [4]. Online learning should encourage students to be creative in accessing as many sources of knowledge as possible, produce works, hone insights, and ultimately form students into lifelong learners [3], [8], [9]. Therefore, teachers need to think about digital teaching materials that are suitable for today's learning.

Digital teaching materials are a set of learning tools that are designed systematically and attractively to achieve the expected objectives in the form of achieving competencies or sub-competencies with all their complexity online. They consist of learning materials, learning methods, methods, limitations, and evaluation technics [10]–[12]. Digital teaching materials are documents created using certain applications to be read using digital devices [13]–[15]. An example of digital teaching is using smartphones, cellphones, laptops, or other devices to create digital teaching materials in the form of DOC, PDF, XLS, PNJG, JPG files, and other similar things. The types of digital-based teaching materials are audio and video, texts, models, overhead projectors (OHP), PowerPoint slides, and interactive multimedia [14], [15]. In line with the opinion, the types of digital teaching materials include audio, audio-visual, video, multimedia, and display [16]–[18]. The types of digital teaching materials studied in this research are audio, visual, and audio-visual.

The advantages of digital teaching materials are: i) easy to apply because students can access the material they want to study by using smartphones or other technological devices such as a laptop connected to the internet; ii) cheap because students can access various learning materials without worrying about missing lessons if they don't attend their classes; iii) highly flexible because digital teaching materials can be used for learning without being bound by space and time; and iv) broad and full of knowledge because students can find many things and are not limited to printed content such as printed books [12]–[14], [16], [19]. Thus, it is expected that the existence of digital teaching materials can attract the attention and interest of students so that they are motivated to learn and prepare themselves before learning in classes, help students to learn independently, increase the students' competence, lighten the burden on students because there is no need to bring it in printed forms, and can reduce global warming by reducing paper use [15], [16], [18], [19].

Students' learning achievement cannot be separated from their learning activities because learning is a process while learning achievement is the result of the learning process [20]–[22]. Learning achievement is the ability to solve difficult things, master, surpass, match, and surpass other students while overcoming obstacles and achieving high standards [23], [24]. Learning achievement is the results or changes in learning that are achieved and a process that allows the emergence or changes of a behavior as a result of the formation of the main responses as long as the changes or emergence of new behavior is not caused by maturity or by a temporary change due to something [20], [25]–[27].

The aspects of learning achievement are: i) the cognitive domain (knowledge), includes knowledge, understanding, application, and assessment; ii) the affective domain (feeling/attitudes/behaviors/morals), includes attitudes and values in the form of behavioral traits such as feelings, interests, attitudes, emotions, and values; and iii) the psychomotor domain (skills) of movement and action skills, verbal and non-verbal expression skills [20], [21], [28], [29]. Learning achievement has several main functions. The first function is as an indicator of the quality and quantity of knowledge and mastery of students. The second is a symbol of satisfying curiosity. The third is as information material in innovation which is used by students in improving the quality of education [22], [23], [25]. Learning achievement obtained by students through the learning process at school, apart from being determined by students as learning subjects, is also influenced by other factors [29]. Therefore, there is a need for comprehensive research that examines learning achievement at various levels of education.

Technology integration in learning from online class applications to educational platforms is increasingly becoming a necessity for teachers, especially after going through a pandemic that required them to carry out online learning. However, a UNICEF study published last year showed that many teachers in various countries still cannot use learning technology to its fullest even though they have undergone online learning for 2 years [12], [30]. In fact, teachers who successfully run classes via online conferencing applications like Zoom, often stick with the old methods, from teaching with one-way lectures to being limited to physical textbooks again [21], [22]. Many teachers have a 'deterministic' perception that sees technology as a one-stop solution for all educational problems. Deterministic perceptions can make teachers view the use of educational technology as the goal, without focusing on the outcomes and evaluation of the use of technology itself [29], [31]. These problems can be handled with an in-depth study of the effectiveness of digital teaching materials on learning achievement. Education providers need the support of knowledge resources related to the use of digital teaching materials in learning. This in-depth research will help teachers or education practitioners to increase their digital capacity and pedagogic competencies related to the use of digital-based digital teaching materials so they can maximize learning in this digital era. There have been many studies related to the effect of digital teaching materials on learning achievement. However, there has not been a single systematic literature review (SLR) study that discusses the effect of digital teaching materials on learning achievement from various levels of education, from various countries and only analyze

the articles from reputable journals. Based on the aforementioned background, this research aims to examine the effect of digital teaching materials based on their classification on learning achievement at various levels of education. This research will help identify various perspectives related to digital teaching materials on learning achievement by examining and uncovering theories that are relevant to this research case.

2. METHOD

2.1. Research design

A systematic literature review is a research design carried out to systematically synthesize existing research evidence in terms of searching research articles, critical review (critical appraisal), and synthesis of research results to answer a question [32]. SLR research is carried out for various purposes, including identifying, reviewing, and interpreting all available research on interesting topical phenomena with specific relevant research questions [33]. SLR research provides a summary of evidence for clinicians and decision-makers who don't have much time to go through a large amount of primary evidence and review them one by one because SLR can build on evidence from previous research and represents information from the various research questions available in this research [34]–[36]. This article is a SLR to examine the effect of digital teaching materials based on their classification on student achievement. The digital teaching materials studied in this research consist of audio, visual, and audio-visual digital teaching materials. The audio teaching materials are in the form of podcasts, the visual digital teaching materials are in the form of e-modules, e-handouts, e-books, and e-worksheets. While audio-visual teaching materials are in the form of animation, interactive multimedia, and augmented reality.

In general, the stages of conducting a review consist of three major parts: planning, conducting, and reporting [37]. At the planning stage, researchers who are ready to write a review must pay attention to the questions that will be used, including the development of the protocol used as a framework for preparing the review. At the conducting stage, researchers must pay attention to whether or not the literature is relevant, how to do the selection, the process of extracting data, doing a review, deepening, and synthesizing to get a good review article. At the reporting stage, the results of writing systematics must be written on paper. The systematic review procedure is shown in Figure 1.

Figure 1. The procedure of systematic review

2.2. Research identification

Referring to the aforementioned explanation, the articles reviewed in this research must be related to the topic. The sources studied in this SLR research are guaranteed credibility and can be accounted for their truth. The articles reviewed in this study were drawn from reputable academic databases such as Scopus, Taylor and Francis, Science Direct, Wiley Online Library, and SAGE Publications. The keywords used in searching for study articles consisted of “e-books and learning achievement”, “digital books and learning achievement”, “electronic books and learning achievement”, “e-handouts and learning achievements”, “digital handouts and learning achievement”, “electronic handout and learning achievement”, “e-module and learning achievement”, “digital module and learning achievement”, “electronic module and learning achievement”, “e-worksheet and learning achievement”, “digital worksheet and learning achievement”, “electronic worksheet and learning achievement”, “e-radio and learning achievement”, “podcast and learning achievement”, “interactive multimedia and learning achievement”, “animation and learning achievement”, “animation video and learning achievement”, “mobile learning and learning achievement”, and “augmented reality and learning achievement”.

To obtain good research quality, inclusion and exclusion criteria are applied [33], [38]. Inclusion criteria are criteria or standards that are set before the research or review is carried out. Inclusion criteria are used to determine whether certain research can be used as a research subject in this research and then proceed to systematic reviews. The inclusion criteria for this research are as: i) it can be ascertained if all the articles reviewed are indexed by Scopus the highest index in the world of scientific publications; ii) the specified time is 15 years, that is, research articles published from 2007 to 2022; iii) the topics must be relevant to digital teaching materials and their relation to student achievement; iv) the research subjects must be students not teachers, and school principals; v) the minimum number of research participants is 15 people; and vi) the

article must be a scientific research article. The exclusion criteria are criteria that can cause certain research unable to be used in this research [33], [38]. The exclusion criteria in this study are article topics that are outside the field of education (for example the effect of augmented reality on TBC patients' understanding) and come from scientific research which is not the results of literature studies (such as meta-analyses, bibliometrics, or SLR).

2.3. Analysis procedure

The procedure used to analyze the results of the research obtained using a literature survey. Literature surveys are useful to develop arguments and map the subject/topic in question. The literature survey is carried out by cataloging the results of a literature search with tabulations of several columns containing the author's name, year of publication, article title, journal or conference name, article index, research variables, method, research instruments, participants, research locations, and research results. Then, it is continued with the literature criticism stage which is carried out by determining and compiling logic related to research questions, examining arguments and organizing them into a logical sequence of stories, and building final arguments to analyze the knowledge obtained and answer research questions. Finally, the conclusion of the analysis process of the literature review is drawn.

3. RESULTS AND DISCUSSION

3.1. Description of research data

This research aims to examine various types of digital teaching materials on student achievement at all levels of education. There are a total of 58 research articles studied with range from 2007 to 2022. There are 4,986 participants consisting of 2,896 university students and 1,205 high school students, 776 junior high school students, and 109 elementary school students involved in this research. The participant distribution data from the 58 articles studied is shown in Figure 2.

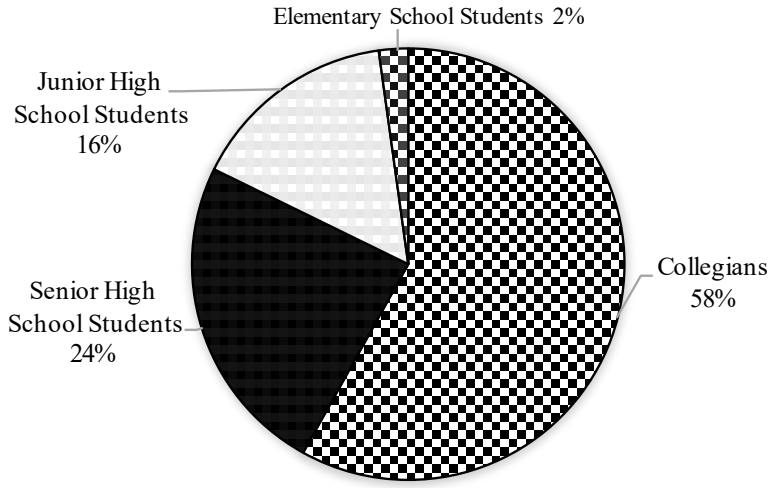

Figure 2. The frequency of participant distribution

The forms of digital teaching materials studied in this research consisted of audio, visual, and audio-visual digital materials. The audio teaching materials are in the form of podcasts. The visual digital teaching materials are in the form of e-modules, e-handouts, e-books, and e-worksheets. The audio-visual teaching materials are in the form of animation, interactive multimedia, and augmented reality. Based on the results of the data review, podcast teaching materials were the most frequently studied with a percentage of 21% or 12 studies, then animation and e-book teaching materials were reviewed in 11 articles with a presentation of 19%, and e-worksheet teaching materials were reviewed in 10 articles with presentation 17%. The frequency distribution of each topic studied in this research is shown in Table 1. The articles studied in this research can be ascertained that all are reviewed and indexed by Scopus as the highest index in the world of scientific publications with the highest index Q1 to No-Q (newly indexed but already has an SJR value). The comparative distribution of each index of the origin of the scientific articles studied is shown in Figure 3.

Table 1. The frequency distribution of the digital teaching material types

No.	Variable	Frequency
1.	Animation (audio-visual)	11
2.	Interactive multimedia (audio-visual)	3
3.	Augmented reality (audio-visual)	5
4.	Podcast (audio)	12
5.	E-module (visual)	4
6.	E-handout (visual)	2
7.	E-book (visual)	11
8.	E-worksheet (visual)	10

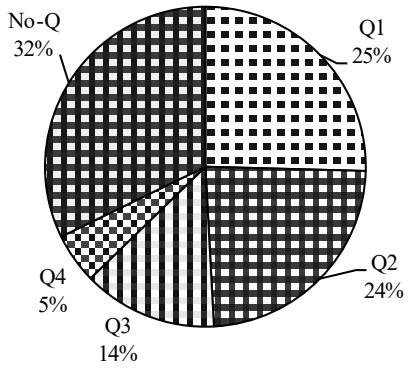

Figure 3. The comparison of the studied article index

Figure 3 implied that the index articles that are most widely studied in this research are Scopus No-Q (or non-quartile) articles with a percentage of 32% because they are in the form of proceedings or new Scopus is indexed so there is no Q-No and the Scopus is discontinued. Furthermore, the selected studied articles do not only come from one region. To get valid results for this research, researchers reviewed some articles from various countries in the world. The comparison results of the countries where the articles are published shown in Table 2.

Table 2. Comparison of the origin of the studied articles

No.	Country	Frequency
1.	Australia	1
2.	Indonesia	29
3.	California	1
4.	Canada	2
5.	China	3
6.	German	1
7.	Korea	1
8.	Japan	1
9.	Malaysia	3
10.	Rusia	1
11.	Saudi Arabia	2
12.	Taiwan	1
13.	Turkey	7
14.	UK	4
15.	USA	1

The country with the most research on digital teaching materials is Indonesia with a percentage of 50%, followed by Turkey with 12%, then the United Kingdom with 7%. Indonesia is a country that is very active in the digital world, out of 276.4 million people (2021 survey), there are 63 million active internet users every day and 191 million people are social media users in 2022. This allows Indonesians to involve digital media in their education and many studies examine the involvement of digital media.

From the research method used, it is known that the studied articles are very diverse. However, this research does not focus on just one research method. Based on the review of the research results, it is known that the most often used research method in studying the effect of digital teaching materials on learning achievement was the quasi-experimental method with a percentage of 40%. The comparative data for each of the article research methods studied in this research is shown in Figure 4.

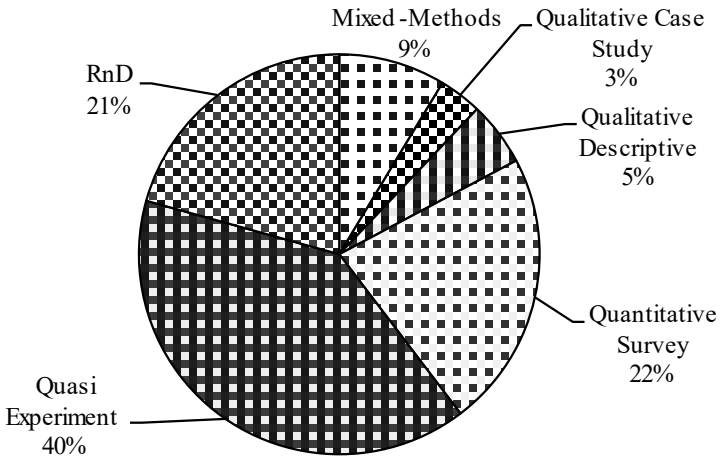

Figure 4. Comparison of the research methods of the reviewed articles

3.2. Digital visual teaching materials

From 27 articles studied on the topic of digital visual teaching materials and their effect on learning achievement, there are 4 e-module articles, 2 e-handout articles, 11 e-book articles, and 10 e-worksheet articles. There were 23 articles conclude the positive effect of visual digital teaching materials on student achievement and four articles conclude the ineffectiveness of visual digital teaching materials in learning. This type of visual digital teaching material is stated to have a positive effect on learning outcomes because it is considered more interesting and easier to understand than printed visual learning media. Visual-type digital teaching materials are very practical because they can be carried everywhere on students' smartphones. Besides, they can help students reduce the use of notes because many notes are quite time-consuming [22], [30], [37]. Furthermore, carefully designed visual type digital teaching materials can encourage students to be able to carry out activities such as problem-solving, independent and group investigations, presenting the results of observation reports, and process analysis and evaluation in problem-solving [11], [39]–[41]. In addition, visual-type digital teaching materials are considered cheaper because free e-books, e-handouts, e-worksheets, and e-modules are available. Visual-type digital teaching materials are also definitely more durable than conventional books or other visual media which are made of paper and can easily be damaged if not cared for properly. Visual-type digital teaching materials can provide dynamic visualization for moving objects better than static visualization so that student learning outcomes increase [7], [31], [42].

On the other hand, some obstacles arise as a result of the use of digital teaching materials. Common barriers to using e-books are navigation and download difficulties. E-books are considered to continue to frustrate and disappoint students. When reading e-books, students are required to keep staring at smartphone or laptop screens, causing pain, especially to the eyes [12], [30]. Students also feel that if teachers use e-books during their teaching, learning activities become boring because they are encouraged to engage in individual activities and focus on the material, not in discussions or activities that involve other active activities [42]–[44]. The devices used to search for and access e-books is a problem for respondents, especially when using iPads and smartphones. Most of the time, e-book downloads (if permitted by the publisher) are dependent on appropriate hardware, and access to a reliable internet connection. Several e-books are only suitable for certain operating systems such as Android. Not all e-book platforms provide free e-books which are sometimes much more expensive than ordinary printed books [12], [30]. Furthermore, students love the unique experience of reading books such as the experience of holding a book, the texture of the paper that can be touched directly (each publisher has a different type of paper), and the aroma of the book every time each page is opened, nothing can be replaced by digital technology [44], [45].

Based on the effects and contribution of visual-type digital teaching materials from the aforementioned studies, the researchers recommend that educators can apply visual-type digital teaching materials with several prerequisites. The ideal type of visual digital teaching materials is they should have multi-dimensional contents that are conveyed through a combination of hyperlinks, multi-dimensional words, images, videos, movement, and audio so that learning can be much more interesting, effective, and fun. Learning with digital teaching materials can motivate students to increase their performance so that they are more interested in doing assignments and their learning achievement increases [45]–[47]. Teaching materials should also be able to facilitate scientific activities such as observation, experimentation, and demonstrations so that there must be an explanation of the competencies to be achieved in a lesson and clear instructions for visualizations to follow. Visual digital teaching materials should also be accompanied by discussion

worksheets, reflective questions, or interactive exercises where students can find out the scores they have obtained [48]–[50]. Furthermore, this teaching material must facilitate the cognitive aspects of Bloom's taxonomy, namely students' competence to remember, understand, apply, analyze, evaluate, and create. Visual teaching materials with the characteristics are considered capable of exploring ideas and creativity in designing problem solutions, optimizing students' abilities to operate digital applications, and improving collaboration and communication skills in groups [20], [25], [40], [51].

3.3. Digital audio teaching materials

The 12 articles examine the topic of digital audio teaching materials and their influence on learning achievement. Among them, 10 articles stated the positive effects of audio-type digital teaching materials on learning achievement and two other articles stated the negative effects. Podcasts are considered capable of increasing students' speaking fluency and accuracy. Podcasts can also increase learning independence, self-reflection, and the ability to self-regulate without others' help. For example, students can take the positive side of the podcast played during learning and assess the negative side of speakers who are not to be imitated. They can assess the wrong speaker's pause, inappropriate vocabulary, and wrong pronunciation. In short, podcasts can increase metacognitive awareness [52]–[54].

The use of podcasts increases learning efficiency and multitasking. This is because, through podcast learning, students can learn while doing routine activities as usual, such as traveling, cooking, and cleaning. This also makes it possible for students not to physically attend classes and record subject matter continuously [52]–[54]. In addition, there are several cases where students do not need to read pages of books but these activities can be replaced by listening to podcasts that discuss these matters/topics [55]–[57]. Students also think that podcasts are a new and fun learning experience for them and are referred to as "education" [43], [58]. Students also think that podcasts can be a medium that can be used repeatedly so they need them if one day they want to study a topic again [8], [59], [60]. Students think that podcasts are important and they should equip themselves with the skills they need to perform in their teaching context and prepare themselves for their future careers by mastering 21st instructional technology [61]–[64].

On the other hand, several studies state that there is a negative side to the application of podcasts in learning. Students will no longer attend lectures and break away from the academic environment because all teaching materials can be listened to individually anywhere. Podcasting has also been argued for enabling learning that leads to passive learning with students focusing on audio facilities rather than actively engaging with lecture content. Podcasting is indeed a new thing in the world of digital education so many students like it. However, research shows that podcasting is indeed more interesting, fun, efficient, and effective than textbooks, but not much more interesting than live lectures where there is feedback from teachers, students, and among students [52]. Furthermore, if students perceive podcasts as entertainment or edutainment learning without the role of the teacher as a guide, some students do not fully understand the potential of podcasts for learning because they perceive them as a form of light and easy listening or associate them with radio entertainment or news. So, learning with podcasts is less meaningful and does not facilitate students in forming their understanding [56].

Based on the effects and contribution of audio-type digital teaching materials from the aforementioned studies, it is recommended that educators apply audio-type digital teaching materials, especially podcasts. Podcasts must be designed well so that they can be applied in collaborative learning to increase students' involvement and skills in building collaboration and actively carrying out assignments [65]–[67]. In addition, for maximum utilization of podcasts, teachers must remain involved as mentors so students can fully understand the function of podcasts in actual edutainment learning [62], [68].

3.4. Digital audio-visual teaching materials

From the 19 analyzed articles whose topic is digital audio-visual teaching materials and their effect on learning achievement, there were 11 animation articles, three interactive multimedia articles, and five augmented reality articles which concluded that there was a positive effect of using these learning media on student achievement. None of those articles stated that there was no influence or even a negative influence of digital audio-visual teaching materials on student achievement. It happens because the audio-visual teaching materials can change visual abstract materials into concrete ones. Besides, they can reduce students' learning difficulties that students face in conventional material presented in a static format [69]. Therefore, they encourage students to build their understanding, encourage learning efficiency, and create the impression that learning is fun and not difficult to understand so that learning tasks feel easier [8]. Consequently, learning achievement increases due to this impression [22], [28], [70], [71].

Digital audio-visual teaching materials provide learning media features that move to make learning materials more interactive [8], [60], [61]. Presentations of the material require intensive cognitive processes and complex problem-solving. The fewer problems students have regarding visualizing material in their

minds, the better their learning achievement will be [28], [71]–[73]. Audio-visual teaching materials can also improve students' 21st-century skills with attractive animated displays, encourage student independent learning activities, facilitate students to study online and offline from both smartphones and laptops, provide explanations of material supplemented with text, images, audio and animation, and supply questions that have feedback in the form of discussion of each question and information on correct and incorrect answers [23], [26], [74]–[77]. Audio-visual teaching materials also offer optimal learning alternatives for applicable topics and require student practice so that they are suitable for applied subjects [21]–[23].

Based on the effects and contribution of audio-visual digital teaching materials from the previous studies, educators should apply audio-visual digital teaching materials. The most optimal condition for audio-visual teaching materials to improve student achievement is audio-visual teaching materials that are combined with the application of student-centered learning methods/models, create directed discussion activities, examine students' daily life problems, pay attention to individual differences and the level of students' development, and must be equipped with technological facilities for operating adequate teaching materials [21]–[24], [26], [28], [29], [76].

4. CONCLUSION

Based on the results and discussion of this research, it can be concluded that digital teaching materials can be divided into three, namely visual, audio, and audio-visual types. The advantages of digital teaching materials, in general, are easy to apply, low-cost, highly flexible, and broad. Each type of digital teaching material has several impacts on learning achievement including: i) increasing scientific activities such as problem-solving, independent and group investigations, presentation of the results of observation reports, and process analysis, and evaluation in problem-solving; ii) improving students' independent learning, self-reflection and metacognitive; iii) reducing learning difficulties and encourage students to build their understanding; and iv) creating the impression that learning is fun so that learning tasks are considered easier. This research will help identify various perspectives related to digital teaching materials on learning achievement by examining and uncovering theories that are relevant to this research case. So, the recommendation from the findings of this study for teachers and practitioners is to increase learning achievement through the use of digital teaching materials. Future researchers who are interested in the same topic should conduct more systematic and strategic research through a SLR which can help researchers to understand digital teaching materials and their impact on today's digital generation more easily.

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