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Meta-Analysis: The Influence of Teaching Material to Improve 21st Century Skills in Physics Lessons

Vivi Mardian and Asrizal
Physics Education/Natural Sciences and Math/ Universitas Negeri Padang, Indonesia
vivimardian1111@gmail.com

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Abstract

The rapid progress of science and technology is marked by easy access to education quickly. Skills that are needed today are often called 21st-century skills. 21st-century skills have become a necessity for students to continue their careers in the future. Physics is one of the lessons that are very close to nature. This research aims to show the influence of the use of physics teaching materials on the 21st-century skills of students is seen from the level of education, learning materials, and student learning outcomes. This research is a literature study of 16 articles on the description of Effect Size in educational studies. Overall, the effect size of the use of teaching materials on physics learning is 3.7. Based on the data analysis, it can be concluded that there is a strong influence in the use of physics teaching materials on the 21st-century skills of students seen from the level of education, learning materials, and student learning outcomes.

Keywords: Physics; Teaching Materials; 21st-Century Skills of Students

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INTRODUCTION

The rapid progress of science and technology is marked by easy access to education quickly. Curriculum changes are one of the government's efforts to improve the quality of education in Indonesia. The curriculum is learning material arranged sequentially to make it easier for teachers to teach (Xu et al., 2020). Curriculum 2013 revised 2017 is the newest curriculum which was last modified by the government. The curriculum change is based on the government's anxiety to face global challenges. Skills that are needed today are often called 21st-century skills.

21st-century skills have become a necessity for students to continue their careers in the future. Several important concepts must be mastered in the 21st century. The first is having creative thinking, innovation, critical thinking, solving problems, and developing metacognitive. Furthermore, the way of working is based on communication and collaboration. While the tools needed are related to ICT literacy. Finally, students must master skills based on knowledge, skills, attitudes, values, and ethics.

There are four skills that students must have to answer the challenges of the 21st century. First, Critical thinking is a person's ability to solve problems,

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generate new ideas, dare take risks, and be persistent in finding solutions to problems (Mahdi et al., 2020). In general, critical thinking consists of identifying problems, finding related information or data, evaluating and making conclusions (Danczak et al., 2020). Collaborative skills are a person's ability to work together in diverse teams and show mutual respect to achieve a common goal (Sipayung, 2018). Finally, communication skills are often defined as a person's ability to convey positive information in writing and directly (Ab Rahman et al., 2020). Overall, these skills must be included in learning tools such as teaching materials.

In a pandemic situation, learning is transferred to the network or online. The role of technology is needed for the sustainability of the teaching and learning process. However, learning cannot be separated from the learning tools provided by the teacher. One of the essential learning tools is teaching materials or student worksheets. Teaching materials consist of systematic learning and play an important role in learning (Ononye & Obiakor, 2021). Teaching materials have benefits for teachers and students in learning. The benefits of teaching materials for teachers are as follows: (1) saving teachers' time in teaching; (2) changing the teacher's role from a teacher to a facilitator; and (3) improving the learning process to be more interactive. The benefits of teaching materials for students include: (1) increasing student motivation; (2) after the evaluation, the teacher and students know the true level of students' abilities based on the mastery of the material by students; (3) students achieve results according to their abilities; (4) education is more efficient because teaching materials are arranged according to academic levels (Oktaviani et al., 2017). Therefore, teaching materials are needed by teachers and students for the continuity of learning both online and offline.

Physics is one of the lessons that are very close to nature. Various natural phenomena can be explained using the laws of physics. However not all physics material can be explained directly to students. Physics material that is easy to understand directly, for example, Newton's laws, circular motion, optical devices, and others. While physics materials such as dynamic electricity, Kepler's laws, temperature, and heat require detailed explanations so that students can easily understand them. Teacher skills in developing physics teaching materials are needed to be interested and do not feel bored. Based on interviews with several students at one of the senior high schools in Padang, the students felt lazy and thought physics was complicated. The teacher has not provided interactive teaching materials and uses the old version without being updated. Therefore, the teaching materials used should follow the times.

On this basis, it is necessary to analyze the influence of teaching materials to improve students' 21st-century skills. The formulation of the problem of this research is how the influence of the use of teaching materials on the 21st-century skills of students is seen from the level of education, types of electronic teaching materials, and the realm of student skills. There are three aims of this research. The first, to see how much influence is given using teaching materials seen from the level of education. The second is to see how much influence is given by teaching materials seen from the type of teaching materials. The third is to describe the influence the use of teaching materials has on students' 21st-century skills.

METHOD

This research is a literature study of 16 articles on the description of Effect Size in educational studies. Effect size is

defined as the magnitude of the effect between two or more variables expressed in ES. The purpose of this research is to see the influence of the use of physics teaching materials on the 21st-century skills of students is seen from the level of education, learning materials, and student learning outcomes.

There are several research procedures carried out. The first stage is to determine the formulation of the research problem. Second, the researcher collects and selects journals that are relevant to the topic to be studied. The topic under study is adjusted to the formulation of the research problem. Third, the effect size of each relevant journal is calculated. Calculations are obtained from formulas that match the data provided by the journal. Fourth, the effect size is averaged and categorized according to the moderator variable whose size is to be seen. After obtaining the effect size value, the effect size value can be categorized at levels such as in Table 1.

Table 1 The Effect Size Categories

Effect Size	Categories
$0 \leq ES \leq 0{,}2$	Low
$0{,}2 \leq ES \leq 0{,}8$	Medium
$ES \geq 0{,}8$	High

(Source: Grass in Agustin, 2021)

Fifth, make conclusions from this descriptive research simply and comprehensively.

RESULT AND DISCUSSION

This study was conducted to see the effect of using STEM integrated teaching materials on 21st-century skills of students by analyzing several moderator variables. The data were obtained from journals relevant to this research and support the calculation of the effect size of each journal. Researchers collect data from various sources such as Google Scholar, ERIC, Crossref, and others.

The number of 16 journals was selected based on specific criteria. The first research is related to the development of electronic and non-electronic teaching materials. Furthermore, the criteria on the level of validity of the teaching development are used. Third, the application or software applied to teaching materials. After that, the research model was applied. Fourth, the criteria for obtaining scores in the experimental class and the control class. Fifth, material selection criteria. Sixth, the criteria for independent and dependent variables. Finally, the criteria for indexed journals and the level of journal publication. The result of the effect size of the articles can be seen in Table 2.

Table 2 The result of the effect size of the articles

Code	Journal Source	Effect Size
Z1	(Retnowati, 2020)	15.8
Z2	(Sandi & Bachri, 2020)	1.1
Z3	(Permata et al, 2021)	3.1
Z4	(Susanti et al, 2020)	3.4
Z5	(Diansah & Asyhari, 2020)	1.5
Z6	(Kurniawati et al, 2021)	2.5
Z7	(Khairunnisa et al, 2018)	3.3
Z8	(Cahyati, 2021)	1.9
Z9	(Sujanem & Suwindra, 2020)	3.9
Z10	(Mayanty et al, 2020)	1.3
Z11	(Nasution et al, 2019)	4.1
Z12	(Wesnawati et al, 2017)	5.5

Z13	(Sriyanti et al, 2020)	4.3
Z14	(Ramli et al, 2020)	4.1
Z15	(Sutrio et al, 2018)	2.1
Z16	(Sukmagati et al, 2020)	1.1

In Table 2 it is explained the result of the effect size of the articles. The effect size of each article is obtained on the effect of teaching materials on student and learning outcomes. The effect size of each article varies from 1.1 to 15.8. Overall, the effect size of the use of teaching materials on physics learning is 3.7. It shows that the use of teaching materials in physics learning is very important. Teaching materials foster independent learning in students.

The first result of this Effect Size analysis research is related to the influence of physics teaching materials in material selection, as shown in table 3. In Table 3, 11 learning materials have been analyzed by effect size. The highest effect size obtained is 5.5 in a dynamic fluid material. Meanwhile, the smallest effect size is 1.1 but still in the high category. The average effect size obtained is 3.1 obtaining the high category. The development of electronic teaching materials influences students' skills as research conducted by Mayanty et al. (2020) the development of Electronic Problem Based Learning (PBL) modules about effective temperature and heat to be able to improve students' science process skills with an effect size of 1.3, which is included in the high category.

Table 3 Data effect size by material

Code	**Material**	**Effect Size**	**Effect Size's Average**	**Category**
Z2	Rotation dynamics	1.1	3.1	High
Z3	Global Warming	3.1		
Z4	Global Warming	3.4		
Z5	Dynamic Fluid	1.5		
Z6	Momentum and impulse	2.5		
Z7	Parabola motion, Circular motion, and Hooke's Law	3.3		
Z10	Heat and Temperature	1.3		
Z11	geometry optics	4.1		
Z12	Dynamics Fluid	5.5		
Z13	Transversal Waves	4.3		
Z14	Waves and Sound	4.1		

The second result of this research is the influence of physics teaching materials in terms of education level. At the junior high school level, some articles have an average effect size of 3.4. At the SMK education level, there is only 1 article included in the high category with a value of 3.9. At the high school level, there are ten articles with an average effect size of 2.6. Meanwhile, there are three articles for higher education that are classified in the high category with a score of 3.7.
The results analysis data of education level presented in Table 4.

Table 4 Analysis data of Education level

Education level	Code	Effect Size's Average	Category
Junior high school	Z1 Z16	3.4	High
Vocational School	Z9	3.9	High
Senior high school	Z2 Z3 Z4 Z5 Z6 Z7 Z8 Z10 Z11 Z13	2.6	High
High education	Z12 Z14 Z15	3.7	High

The last is Table 5, which shows the effect size of teaching materials on student learning outcomes. The results of data analysis on learning outcomes consist of students' knowledge and skills. Student skills in the analyzed articles consist of critical thinking skills, creative thinking skills, and scientific literacy skills.

Table 5 The effect of teaching materials on the result of student

Result	Code	Effect Size's Average	Category
Knowledge	Z2 Z3 Z4 Z5 Z7 Z11 Z12 Z13	3.3	High
Skill	Z1 Z6 Z8 Z9 Z10 Z14 Z15 Z16	2.8	High

The effect of teaching materials on increasing student knowledge is high on the average effect size, which is 3.3. It is supported by research conducted by Sandi (2020) and Wesnawati (2017), namely electronic modules can

effectively improve student learning outcomes. In comparison, the effect of teaching materials on improving students' skills is classified as high in the effect size, namely 2.8. It shows the influence of the development of teaching materials on student skills. Based on the research of Cahyati (2021) and Sukmagati (2020), teaching materials based on the inquiry learning model with the CTL approach improve students' creative thinking skills with effective criteria. Then, it was followed by the research results by Kurniawati (2021) and Mayanty (2020), namely the development of electronic modules utilizing professional 3D page flip applications that can improve students' scientific literacy skills.

CONCLUSION

Based on a meta-analysis study of 16 articles that have been analyzed, applying physics teaching materials on learning materials with an average gain of effect size 3.7 in the high category. It can be concluded that there is a strong influence in the use of physics teaching materials on the 21st-century skills of students seen from the level of education, learning materials, and student learning outcomes. The results of this study will provide convenience for subsequent research in developing more perfect teaching materials. However, this research is limited to the effect of using teaching materials on physics learning only. It is because the time needed by researchers is not much to research an enormous scope. For further research, it is hoped that there will be research related to the effect of teaching materials on all subjects.

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