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Meta-Analysis of the Influence of Science Teaching Materials Based on Inquiry Models on 21st Century Skills

Nadya Syahdi[1] , Korry Nilyani[1] , Hilmi Rizki Anjani[1] , Asrizal[2] , Fatni Mufit[2*]

[1] Masters Study Program of Physics Education, Universitas Negeri Padang, West Sumatera, Indonesia.
[2] Department of Physics, Universitas Negeri Padang, West Sumatera, Indonesia.

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Correspondence
Email: fatni_mufit@fmipa.unp.ac.id
Phone :

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ABSTRACT

The 21st century is the era of rapid knowledge, technology and talent development. Teaching materials are needed to increase these skills to support student learning. The research objective was to determine the effect of inquiry-based science teaching materials on 21st-century skills. The research method used was a meta-analysis of 32 articles in national and international journals. The results of the study obtained by varying the level of education, subjects, teaching materials used, and components of the 21st-century skills of the students stated that the use of inquiry model-based science teaching materials significantly influenced students' 21st-century skills. This meta-analysis research concludes that inquiry-based and educationally diverse science teaching materials significantly impacted students, impacted by science showing materials in light of request models with various, impacted by science guidance materials that utilise various showing strategies and depend on request models. The last skill components have a significant impact on students' 21st-century.

INTRODUCTION

The 21st century has rapidly progressed in knowledge, technology, and talent. The essential goal is to make unmatched HR in the 21st hundred years. According to Prattiwi et al., 2019, "training plays a crucial role in ensuring that understudies can learn and improve, use innovation and data, collaborate with others, and foster abilities pertinent to life in the 21st century". The educational program accentuates the significance of abilities for the 21st century, for example, the capacity to think fundamentally, imaginatively, and tackle issues. It likewise focuses on the significance of abilities for correspondence and cooperation, imagination and development, learning accurate settings, and data and media proficiency (Nilyani et al., 2023; Zan et al., 2023).

Increasing learning patterns in Indonesia is a response to the demands and challenges of the 21st century. In this case, significant changes have occurred in the education unit level curriculum (KTSP), which has undergone improvements to become the 2013 curriculum, then through the 2013 curriculum revision, and is undergoing further refinement to become an independent curriculum. Actions to improve educational standards are always carried out through curriculum revisions or procurement of new textbooks, as emphasised by Festiyed (2014). In the context of learning physics and science, students are expected to have

the ability to master various competencies, including attitudes, knowledge, and abilities that are by the 2013 curriculum. Physical science and science education students must use supporting learning resources like instructional materials to accomplish this. These resources can help students improve their learning outcomes and abilities. According to Desnita et al. (2018), learning media can be a teaching tool to help students better understand a subject (Maida et al., 2019; Nilyani et al., 2023).

The existing reality has not met the desired expectations. According to research conducted by (Harjilah et al., 2019), students lack encouragement to develop thinking skills in learning. The focus of learning in class tends to be on memorising information or concepts given to students. Students are less engaged in class, whether responding to questions from the instructor or voicing their opinions when they have questions about material they do not comprehend. Teachers' observations indicate that only about 25% of students are brave enough to do so. Another issue is the student's lack of enthusiasm for enhancing learning (Asrizal et al., 2019). There should be an answer to the issues that have been found. As previous researchers demonstrated, this issue can be resolved by integrating instructional materials and inquiry models. One strategy educators can use to improve student's skills for the 21st century is to include effective learning models in their materials. The inquiry learning model is one option for enhancing students' capacity for critical thinking while studying physics. In this model, students are considered learning subjects, so every student is encouraged to be drawn in with learning works (Amijaya et al., 2018; Pramesti et al., 2020).

For students to find and conduct investigations, educators must assist them in developing active thinking skills. This means using facilitation to improve students' thinking abilities. Understudies learn in the request model through a speculative cycle, which empowers free reasoning and the immediate revelation of ideas (Anggraini et al., 2018). Using this strategy, students can use their knowledge to find solutions to each problem, which can help them develop higher-order thinking skills. Understudies will undoubtedly be active throughout the growing experience, particularly when expressing their points of view. Students with high conclusive thinking skills similarly influence high learning results (Handriani et al., 2015). Showing materials are planned as apparatuses that can assist teachers and understudies in learning handling so that learning is more viable (Asrizal et al., 2018). Showing materials is planned to help teachers and understudies grow their experience so learning is more compelling (Asrizal et al., 2018).

The results of previous studies have some limitations. The following are some of these restrictions: 1) The findings have not explained how several studies employing a similar inquiry model-based physics teaching material affected students' 21st-century skills; 2) Only one educational level was utilised; 3) There was only one subject that utilised the inquiry model. To find out how inquiry model-based physics teaching materials affected students' 21st-century skills, this meta-analysis-based study aimed to integrate all previous comparable studies. The meta-analysis is a quantitative investigation and utilises a considerable lot of information. Many additionally apply factual strategies by rehearsing them in sorting out data obtained from an enormous example whose capability is to supplement different purposes (Mardianti et al., 2020). Meta-investigation combines the results of at least two comparative examinations using factual procedures to produce quantitative informational indices (Zan et al., 2023). Meta-investigation is done to look into other people's studies and find the correct information. In quantifiable assessment, results can be merged in critical ways. In order to make it possible to compare studies between them, the effects of each study were converted into an impact size. The selection of meta-scientific investigation as the method for the study was based on several factors, including the fact that 1) many articles discussed the impact of request model-put together physical science supporting materials on students' 21st-century skills, 2) meta-logical investigation

did not rely on school conditions, thereby reducing the risk of research delays, 3) there is no research on the impact of request model-put together physical science training materials on students' 21st-century skills, and 4) it is not yet known the effect of several similar studies using teaching materials based on inquiry model on 21st-century skills which have a significant effect based on educational level, subjects, teaching material used and 21st-century skills component.

Incorporating the inquiry model into the science curriculum can potentially improve students' skills for the 21st century. Various past examiners have shown it in such a way yet gave different finishes. Because of this, it is essential to direct meta-examination research regarding request model-assembled physical science supporting materials about students' abilities in the 21st century. This study aims to determine how much inquiry-based science teaching materials affect students' education levels, subjects, teaching methods, and skills for the 21st century.

METHODS

This research uses a meta-analysis method. As part of the research, meta-analysis reviews several research results on similar issues (Haspen et al., 2019). The data collection technique in this meta-analysis uses Literature study techniques from research conducted regarding research methods inquiry. The sampling in this meta-analysis was carried out purposively sampling. This is because the information and data are on the research theme. This meta-analysis uses qualitative data analysis for the result of data research that has been conducted (Usman et al., 2019). Research undertaken through summarising, reviewing, and analysing data from numerous previous studies is known as meta-analysis (Pangesti et al., 2017). The narrative study data that were discovered were analysed using qualitative data analysis. The samples used 32 articles related to science teaching material based on the inquiry model, with 20 Physics articles, 3 Biology articles, and 9 Chemistry articles, gleaned from articles published in national and international journals summarising earlier studies' findings. By computing the examination of the article's information, a quantitative strategy was utilised for the investigation. The following steps are followed when tabulating the data: 1) identifying the factors found, 2) determining the mean and standard deviation of the two groups, and 3) utilising the Glass, McGaw, and Smith condition to calculate the impact size, specifically:

Table 1. Determination of Effect Size

Statistics	Equality
Effect size formula for comparison test	$ES = \frac{x_{post} - x_{pre}}{SD_{pre}}$
Effect size formula for a comparison test of two independent sample	$ES = \frac{x_E - x_C}{SD_C}$
Formulas with t count	$ES = t\sqrt{\frac{1}{n_E} + \frac{1}{n_C}}$

Furthermore, the researcher uses Cohen's equation to determine each article's effect size and the random and fixed effect models to determine the overall effect size. The effect size, according to Cohen, is categorised at the following levels:

Table 2. Effect Size Criteria

Effect Size	Criteria
0 – 0.20	Weak Effect
0.21 – 0.50	Enough Effect
0.51 – 1.00	Moderate Effect
> 1.00	Strong Effect

(Cohen, 2007)

RESULTS AND DISCUSSION

Results

This study looked at 32 public and international articles to analyse the data. Based on the articles' educational levels, subjects, teaching methods, and skills relevant to the 21st century, this study's findings are divided into four categories. The following is a list of the results of the research:

The Influence of Inquiry Model-Based Science Teaching Materials on 21st-Century Skills

The summary effect size of the influence of inquiry model-based science teaching materials on 21st-century skills abilities first uses hypothesis testing. This test produces a Q to determine which model to use. A heterogeneous test of the effect of inquiry model-based STM on 21st-century skills is shown in Table 3.

Table 3. Heterogeneity Testing of the Influence of Science Teaching Materials Based on Inquiry Models on 21st Century Skills

Article Code	Effect Size Yi	Q	Df	I^2
AR1	1.210	157.247	31	80.29
AR2	0.810	157.247	31	80.29
AR3	0.246	157.247	31	80.29
AR4	1.077	157.247	31	80.29
AR5	2.738	157.247	31	80.29
AR6	0.770	157.247	31	80.29
AR7	1.403	157.247	31	80.29
AR8	2.333	157.247	31	80.29
AR9	0.534	157.247	31	80.29
AR10	0.590	157.247	31	80.29
AR11	0.095	157.247	31	80.29
AR12	0.862	157.247	31	80.29
AR13	1.176	157.247	31	80.29
AR14	0.028	157.247	31	80.29
AR15	0.840	157.247	31	80.29
AR16	0.510	157.247	31	80.29
AR17	0.248	157.247	31	80.29
AR18	1.769	157.247	31	80.29
AR19	0.681	157.247	31	80.29
AR20	2.868	157.247	31	80.29

AR21	0.591	157.247	31	80.29
AR22	1.087	157.247	31	80.29
AR23	1.037	157.247	31	80.29
AR24	0.886	157.247	31	80.29
AR25	0.711	157.247	31	80.29
AR26	1.224	157.247	31	80.29
AR27	0.920	157.247	31	80.29
AR28	1.612	157.247	31	80.29
AR29	1.176	157.247	31	80.29
AR30	0.890	157.247	31	80.29
AR31	0.899	157.247	31	80.29
AR32	0.899	157.247	31	80.29

Based on the heterogeneity test, it is found that Q > df, then the estimation of the variance between articles is quite large, and the data is heterogeneous. The model that is suitable for calculating summary effect sizes is the random effects model. The heterogeneity value of the article data is 80.29%, indicating a population difference between articles of 80.29%. This heterogeneity value indicates differences in the population between articles on 21st-century skills.

The calculation of the effect size summary of the effect of the STEM-based inquiry model on 21st-century skills is used to test a hypothesis. Based on the results of hypothesis calculations on the influence of science teaching material based on the inquiry model on 21st-century skills, it was found that the 32 articles used showed that inquiry teaching materials had a significant effect. The results of the hypothesis testing can be seen in Table 4.

Table 4. Hypothesis Testing of the Influence of Science Teaching Materials Based on Inquiry Models on 21st-Century Skills

Article Code	Effect Size Yi	ES average	M	SE_M	LL_M	UL_M	Z	p-values
AR1	1.210	1.02	0.979	0.098	0.787	1.171	10.004	0.000
AR2	0.810		0.979	0.098	0.787	1.171	10.004	
AR3	0.246		0.979	0.098	0.787	1.171	10.004	
AR4	1.077		0.979	0.098	0.787	1.171	10.004	
AR5	2.738		0.979	0.098	0.787	1.171	10.004	
AR6	0.770		0.979	0.098	0.787	1.171	10.004	
AR7	1.403		0.979	0.098	0.787	1.171	10.004	
AR8	2.333		0.979	0.098	0.787	1.171	10.004	
AR9	0.534		0.979	0.098	0.787	1.171	10.004	
AR10	0.590		0.979	0.098	0.787	1.171	10.004	
AR11	0.095		0.979	0.098	0.787	1.171	10.004	
AR12	0.862		0.979	0.098	0.787	1.171	10.004	
AR13	1.176		0.979	0.098	0.787	1.171	10.004	
AR14	0.028		0.979	0.098	0.787	1.171	10.004	
AR15	0.840		0.979	0.098	0.787	1.171	10.004	
AR16	0.510		0.979	0.098	0.787	1.171	10.004	
AR17	0.248		0.979	0.098	0.787	1.171	10.004	
AR18	1.769		0.979	0.098	0.787	1.171	10.004	
AR19	0.681		0.979	0.098	0.787	1.171	10.004	
AR20	2.868		0.979	0.098	0.787	1.171	10.004	

AR21	0.591	0.979	0.098	0.787	1.171	10.004
AR22	1.087	0.979	0.098	0.787	1.171	10.004
AR23	1.037	0.979	0.098	0.787	1.171	10.004
AR24	0.886	0.979	0.098	0.787	1.171	10.004
AR25	0.711	0.979	0.098	0.787	1.171	10.004
AR26	1.224	0.979	0.098	0.787	1.171	10.004
AR27	0.920	0.979	0.098	0.787	1.171	10.004
AR28	1.612	0.979	0.098	0.787	1.171	10.004
AR29	1.176	0.979	0.098	0.787	1.171	10.004
AR30	0.890	0.979	0.098	0.787	1.171	10.004
AR31	0.899	0.979	0.098	0.787	1.171	10.004
AR32	0.899	0.979	0.098	0.787	1.171	10.004

Based on the results of hypothesis calculations on students' 21st-century skills, it was found that from the 32 articles used, it was shown that teaching materials based on inquiry models had a significant effect. The weighted summary effect size results obtained were 0.979, indicating that STEM-based teaching materials were in the very high category with confidence intervals below 0.787 and above 1.171. The results of hypothesis testing also show that the p-value <α, which shows that the hypothesis testing H0 is rejected. The results of H0 rejected indicate that as many as 32 similar articles influenced inquiry model-based teaching materials on students' 21st-century skills.

The Influence of Inquiry Model-Based Science Teaching Materials Based on Education Level

Furthermore, the influence of inquiry model-based STM on 21st-century skills abilities based on education level. The summary effect size value of inquiry model-based STM on 21st-century skills abilities based on education level was obtained through the initial stage, namely testing heterogeneity at each education level. Testing the heterogeneity of the effect of inquiry model-based STM on 21st-century skills and abilities based on student education levels can be seen in Table 5.

Table 5. Heterogeneity Testing of the Influence of Science Teaching Materials Based on Inquiry Models on 21st Century Skills Based on Education Level

Educational level	Article Code	Effect Size	Q	Df	I^2
Junior High School	AR17	0.248	27.957	3	89.27
	AR18	1.769	27.957	3	89.27
	AR19	0.681	27.957	3	89.27
	AR22	1.087	27.957	3	89.27
Senior High School	AR1	1.21	137.301	26	81.06
	AR2	0.81	137.301	26	81.06
	AR3	0.245	137.301	26	81.06
	AR4	1.076	137.301	26	81.06
	AR5	2.737	137.301	26	81.06
	AR6	0.769	137.301	26	81.06
	AR7	1.403	137.301	26	81.06
	AR8	2.333	137.301	26	81.06
	AR9	0.534	137.301	26	81.06
	AR10	0.590	137.301	26	81.06
	AR11	0.095	137.301	26	81.06
	AR12	0.862	137.301	26	81.06

	AR14	0.028	137.301	26	81.06
	AR15	0.840	137.301	26	81.06
	AR16	0.510	137.301	26	81.06
	AR20	2.868	137.301	26	81.06
	AR21	0.591	137.301	26	81.06
	AR23	1.037	137.301	26	81.06
	AR24	0.886	137.301	26	81.06
	AR25	0.711	137.301	26	81.06
	AR26	1.224	137.301	26	81.06
	AR27	0.920	137.301	26	81.06
	AR28	1.612	137.301	26	81.06
	AR29	1.176	137.301	26	81.06
	AR30	0.890	137.301	26	81.06
	AR31	0.899	137.301	26	81.06
	AR32	0.899	137.301	26	81.06

Based on the heterogeneity test results, it can be seen that at two levels of education, it shows Q > df. Hence, estimating the variance between articles is quite large and heterogeneous. The model that is suitable for use at this class level is the random effects model. The heterogeneity value of the articles at each level of education, namely at the junior high school level, was 89.27%, and the high school level was 81.06%. This heterogeneity value indicates differences in the population between articles at each level of education. The next stage is testing the hypothesis of the effect of inquiry model-based STM on education-level students' 21st-century skills and abilities.

Hypothesis calculation based on education level can be seen in Table 6. This table summarises the findings of hypothesis testing regarding the impact of inquiry model-based science teaching materials on mastering 21st-century abilities. This analysis is differentiated by level of education. The data presented in the table provides a clearer understanding of how the inquiry model influences 21st-century abilities at various levels of education.

Table 6. Hypothesis Testing of the Influence of Science Teaching Materials Based on Inquiry Models on 21st Century Skills Based on Education Level

Educational level	Article Code	Effect Size Yi	ES average	M	SE_M	LL_M	UL_M	Z	p-values
Junior High School	AR17	0.248	0.95	0.937	0.392	0.168	1.705	2.388	0.008
	AR18	1.769		0.937	0.392	0.168	1.705	2.388	
	AR19	0.681		0.937	0.392	0.168	1.705	2.388	
	AR22	1.087		0.937	0.392	0.168	1.705	2.388	
Senior High	AR1	1.21	1.03	0.981	0.108	0.770	1.192	9.104	0.000
	AR2	0.81		0.981	0.108	0.770	1.192	9.104	
	AR3	0.245		0.981	0.108	0.770	1.192	9.104	
	AR4	1.076		0.981	0.108	0.770	1.192	9.104	
	AR5	2.737		0.981	0.108	0.770	1.192	9.104	
	AR6	0.769		0.981	0.108	0.770	1.192	9.104	
	AR7	1.403		0.981	0.108	0.770	1.192	9.104	
	AR8	2.333		0.981	0.108	0.770	1.192	9.104	
	AR9	0.534		0.981	0.108	0.770	1.192	9.104	
	AR10	0.590		0.981	0.108	0.770	1.192	9.104	
	AR11	0.095		0.981	0.108	0.770	1.192	9.104	

School	AR12	0.862	0.981	0.108	0.770	1.192	9.104
	AR14	0.028	0.981	0.108	0.770	1.192	9.104
	AR15	0.840	0.981	0.108	0.770	1.192	9.104
	AR16	0.510	0.981	0.108	0.770	1.192	9.104
	AR20	2.868	0.981	0.108	0.770	1.192	9.104
	AR21	0.591	0.981	0.108	0.770	1.192	9.104
	AR23	1.037	0.981	0.108	0.770	1.192	9.104
	AR24	0.886	0.981	0.108	0.770	1.192	9.104
	AR25	0.711	0.981	0.108	0.770	1.192	9.104
	AR26	1.224	0.981	0.108	0.770	1.192	9.104
	AR27	0.920	0.981	0.108	0.770	1.192	9.104
	AR28	1.612	0.981	0.108	0.770	1.192	9.104
	AR29	1.176	0.981	0.108	0.770	1.192	9.104
	AR30	0.890	0.981	0.108	0.770	1.192	9.104
	AR31	0.899	0.981	0.108	0.770	1.192	9.104
	AR32	0.899	0.981	0.108	0.770	1.192	9.104

Based on the results of hypothesis testing at each level of education, it shows that both levels of education affect student learning outcomes. Middle and high school levels show that the effect of inquiry-based teaching materials on students' 21st-century skills is in the high category because they have effect sizes of 0.95 and 1.03. The results of hypothesis testing at the junior and senior high school levels show that the p-value <α indicates that the hypothesis testing H0 is rejected.

The Influence of Inquiry Model-Based Science Teaching Materials Based on Subjects

The third result is in the study of the effect of inquiry model-based STM on 21st-century skills and abilities based on moderator variables, namely based on subjects. Articles that discuss the effect of inquiry model-based STM on 21st-century skills and abilities in science subjects can be seen in Table 7.

Table 7. Heterogeneity Testing of the Influence of Science Teaching Materials Based on Inquiry Models on 21st-Century Skills Based on Subjects

Subjects	Article Code	Effect Size	Q	df	I^2
Physics	AR1	1.21	110.083	19	82.74
	AR2	0.81	110.083	19	82.74
	AR3	0.245	110.083	19	82.74
	AR4	1.076	110.083	19	82.74
	AR5	2.737	110.083	19	82.74
	AR6	0.769	110.083	19	82.74
	AR7	1.403	110.083	19	82.74
	AR9	0.534	110.083	19	82.74
	AR10	0.590	110.083	19	82.74
	AR11	0.095	110.083	19	82.74
	AR12	0.862	110.083	19	82.74
	AR13	1.176	110.083	19	82.74
	AR14	0.028	110.083	19	82.74
	AR15	0.840	110.083	19	82.74
	AR16	0.510	110.083	19	82.74
	AR17	0.248	110.083	19	82.74

	AR18	1.769	110.083	19	82.74
	AR19	0.681	110.083	19	82.74
	AR20	2.868	110.083	19	82.74
	AR27	0.920	110.083	19	82.74
Biology	AR8	2.333	19.788	2	89.89
	AR24	0.886	19.788	2	89.89
	AR30	0.890	19.788	2	89.89
Chemistry	AR21	0.591	10.625	8	24.70
	AR22	1.087	10.625	8	24.70
	AR23	1.037	10.625	8	24.70
	AR25	0.711	10.625	8	24.70
	AR26	1.224	10.625	8	24.70
	AR28	1.612	10.625	8	24.70
	AR29	1.176	10.625	8	24.70
	AR31	0.899	10.625	8	24.70
	AR32	0.899	10.625	8	24.70

Based on the results of the heterogeneity test, it can be seen that the three subjects show Q > df. Hence, estimating the variance between articles is quite large and heterogeneous. The model that is suitable for use at this class level is the random effects model. The heterogeneity value of the articles in each subject, namely in physics subjects, was 82.74%, biology subjects were 89.89%, and chemistry subjects were 24.70%. This heterogeneity value indicated differences in population between articles on each subject. The next stage is testing the hypothesis of the effect of inquiry model-based STM on 21st-century skills and abilities towards subjects.

Hypothesis calculation based on subjects can be seen in Table 8. This table describes the results of hypothesis testing regarding the influence of inquiry model-based science teaching materials on developing 21st-century skills, which are analysed based on physics, biology and chemistry subjects. The data presented in the tables provide an in-depth look at how much inquiry models impact a subject.

Table 8. Hypothesis Testing of the Influence of Science Teaching Materials Based on Inquiry Models on 21st-Century Skills Based on Subjects

Subjects	Article Code	Effect Size Yi	ES	M	SE_M	LL_M	UL_M	Z	p-values
Physics	AR1	1.21	0.97	0.905	0.128	0.655	1.155	7.098	0.000
	AR2	0.81		0.905	0.128	0.655	1.155	7.098	
	AR3	0.245		0.905	0.128	0.655	1.155	7.098	
	AR4	1.076		0.905	0.128	0.655	1.155	7.098	
	AR5	2.737		0.905	0.128	0.655	1.155	7.098	
	AR6	0.769		0.905	0.128	0.655	1.155	7.098	
	AR7	1.403		0.905	0.128	0.655	1.155	7.098	
	AR9	0.534		0.905	0.128	0.655	1.155	7.098	
	AR10	0.590		0.905	0.128	0.655	1.155	7.098	
	AR11	0.095		0.905	0.128	0.655	1.155	7.098	
	AR12	0.862		0.905	0.128	0.655	1.155	7.098	
	AR13	1.176		0.905	0.128	0.655	1.155	7.098	
	AR14	0.028		0.905	0.128	0.655	1.155	7.098	
	AR15	0.840		0.905	0.128	0.655	1.155	7.098	

	AR16	0.510		0.905	0.128	0.655	1.155	7.098	
	AR17	0.248		0.905	0.128	0.655	1.155	7.098	
	AR18	1.769		0.905	0.128	0.655	1.155	7.098	
	AR19	0.681		0.905	0.128	0.655	1.155	7.098	
	AR20	2.868		0.905	0.128	0.655	1.155	7.098	
	AR27	0.920		0.905	0.128	0.655	1.155	7.098	
	AR8	2.333		1,371	0.484	0.421	2.320	2.830	
Biology	AR24	0.886	1.36	1,371	0.484	0.421	2.320	2.830	0.002
	AR30	0.890		1,371	0.484	0.421	2.320	2.830	
	AR21	0.591		1.016	0.101	0.818	1.214	10.068	
	AR22	1.087		1.016	0.101	0.818	1.214	10.068	
	AR23	1.037		1.016	0.101	0.818	1.214	10.068	
	AR25	0.711		1.016	0.101	0.818	1.214	10.068	
Chemistry	AR26	1.224	1.03	1.016	0.101	0.818	1.214	10.068	0.000
	AR28	1.612		1.016	0.101	0.818	1.214	10.068	
	AR29	1.176		1.016	0.101	0.818	1.214	10.068	
	AR31	0.899		1.016	0.101	0.818	1.214	10.068	
	AR32	0.899		1.016	0.101	0.818	1.214	10.068	

The results of testing the hypothesis in each subject show that the three subjects influence student learning outcomes. Physics, biology and chemistry subjects show that the influence of inquiry-based teaching materials on students' 21st-century skills is in the high category because they have effect sizes of 0.97, 1.36 and 1.03. The results of hypothesis testing in physics, biology and chemistry subjects show that the value of $p < \alpha$, which shows that the hypothesis testing H0 is rejected.

The Influence of Inquiry Model-Based Science Teaching Materials Based on the Teaching Materials Used

The fourth result of the study is related to the effect of inquiry model-based STM on 21st-century skills and abilities based on teaching materials. Testing the hypothesis on the effect of inquiry model-based STM on 21st-century skills abilities can be known by testing the teaching materials' heterogeneity. Heterogeneity testing based on the teaching material used can be seen in Table 9.

Table 9. Heterogeneity Testing of the Influence of Science Teaching Materials Based on Inquiry Models on 21st Century Skills Based on the Teaching Materials Used

Types of Teaching Materials	Article Code	Effect Size	Q	df	I^2
Student Worksheets	AR3	0.245	42.561	18	57.71
	AR4	1.076	42.561	18	57.71
	AR6	0.769	42.561	18	57.71
	AR7	1.403	42.561	18	57.71
	AR9	0.534	42.561	18	57.71
	AR10	0.590	42.561	18	57.71
	AR15	0.840	42.561	18	57.71
	AR16	0.510	42.561	18	57.71

	AR17	0.248	42.561	18	57.71
	AR18	1.769	42.561	18	57.71
	AR19	0.681	42.561	18	57.71
	AR21	0.591	42.561	18	57.71
	AR22	1.087	42.561	18	57.71
	AR23	1.037	42.561	18	57.71
	AR25	0.711	42.561	18	57.71
	AR26	1.224	42.561	18	57.71
	AR29	1.176	42.561	18	57.71
	AR30	0.890	42.561	18	57.71
	AR31	0.899	42.561	18	57.71
Module	AR1	1.210	48.249	7	85.49
	AR2	0.810	48.249	7	85.49
	AR5	2.738	48.249	7	85.49
	AR8	2.333	48.249	7	85.49
	AR13	1.176	48.249	7	85.49
	AR20	2.868	48.249	7	85.49
	AR28	1.612	48.249	7	85.49
	AR32	0.899	48.249	7	85.49

Based on the results of the heterogeneity test, it can be seen that the two types of teaching materials used show Q > df. Hence, estimating the variance between articles is quite large and heterogeneous. The model that is suitable for use at this class level is the random effects model. The heterogeneity value of the articles in each teaching material, namely in the student worksheets, is 57.71%, and the module is 85.49. This heterogeneity value indicates population differences between articles in each subject. Next is testing the hypothesis of the influence of inquiry model-based STM on 21st-century skills and abilities based on the teaching material used.

The results of hypothesis testing on the teaching materials used are shown in Table 10. This table summarises the results of hypothesis testing, which reveal the impact of inquiry model-based science teaching materials on developing 21st-century skills. The data in this table provides an in-depth perspective on how inquiry models in science teaching materials can influence mastery of 21st-century skills.

Table 10. Hypothesis Testing of the Influence of Science Teaching Materials Based on Inquiry Models on 21st Century Skills Based on the Teaching Materials Used

Types of Teaching Materials	Article Code	Effect Size Yi	ES average	M	SE_M	LL_M	UL_M	Z	p-values
Student Worksheets	AR3	0.245	0.85	0.847	0.085	0.681	1.013	9.997	0.000
	AR4	1.076		0.847	0.085	0.681	1.013	9.997	

	AR6	0.769		0.847	0.085	0.681	1.013	9.997	
	AR7	1.403		0.847	0.085	0.681	1.013	9.997	
	AR9	0.534		0.847	0.085	0.681	1.013	9.997	
	AR10	0.590		0.847	0.085	0.681	1.013	9.997	
	AR15	0.840		0.847	0.085	0.681	1.013	9.997	
	AR16	0.510		0.847	0.085	0.681	1.013	9.997	
	AR17	0.248		0.847	0.085	0.681	1.013	9.997	
	AR18	1.769		0.847	0.085	0.681	1.013	9.997	
	AR19	0.681		0.847	0.085	0.681	1.013	9.997	
	AR21	0.591		0.847	0.085	0.681	1.013	9.997	
	AR22	1.087		0.847	0.085	0.681	1.013	9.997	
	AR23	1.037		0.847	0.085	0.681	1.013	9.997	
	AR25	0.711		0.847	0.085	0.681	1.013	9.997	
	AR26	1.224		0.847	0.085	0.681	1.013	9.997	
	AR29	1.176		0.847	0.085	0.681	1.013	9.997	
	AR30	0.890		0.847	0.085	0.681	1.013	9.997	
	AR31	0.899		0.847	0.085	0.681	1.013	9.997	
Module	AR1	1.210	1.70	1.644	0.260	1.135	2.153	6.333	0.000
	AR2	0.810		1.644	0.260	1.135	2.153	6.333	
	AR5	2.738		1.644	0.260	1.135	2.153	6.333	
	AR8	2.333		1.644	0.260	1.135	2.153	6.333	
	AR13	1.176		1.644	0.260	1.135	2.153	6.333	
	AR20	2.868		1.644	0.260	1.135	2.153	6.333	
	AR28	1.612		1.644	0.260	1.135	2.153	6.333	
	AR32	0.899		1.644	0.260	1.135	2.153	6.333	

The results of testing the hypothesis on each type of teaching material show that the two teaching materials influence student learning outcomes. LKS and modules show that the effect of inquiry-based teaching materials on students' 21st-century skills is high because it has an effect size of 0.85 and 1.70. The results of hypothesis testing on worksheets and modules show that the value of $p < \alpha$, which shows that the hypothesis testing H0 is rejected.

The Influence of Inquiry Model-Based Science Teaching Materials Based on 21st-Century Skills Components.

The final result of the study is related to the effect of inquiry model-based STM on 21st-century skills abilities based on 21st-century skills components. Testing the hypothesis on the effect of inquiry model-based STM on 21st-century skills abilities can be known by testing the heterogeneity of the 21st-century skills components. Heterogeneity testing based on the 21st-century skills components can be seen in Table 11.

Table 11. Heterogeneity Testing of the Influence of Science Teaching Materials Based on Inquiry Models on 21st Century Skills Based on 21st Century Skills Components

The 21st Century Skills	Article Code	Effect Size	Q	df	I^2
Critical thinking	AR1	1.210	127.783	13	89.83
	AR4	1.077	127.783	13	89.83
	AR5	2.738	127.783	13	89.83
	AR7	1.403	127.783	13	89.83

	AR8	2.333	127.783	13	89.83
	AR9	0.534	127.783	13	89.83
	AR10	0.590	127.783	13	89.83
	AR11	0.095	127.783	13	89.83
	AR13	1.176	127.783	13	89.83
	AR14	0.028	127.783	13	89.83
	AR15	0.840	127.783	13	89.83
	AR16	0.510	127.783	13	89.83
	AR17	0.248	127.783	13	89.83
	AR20	2.868	127.783	13	89.83
Creative Thinking	AR2	0.810	10.769	5	53.57
	AR6	0.770	10.769	5	53.57
	AR18	1.769	10.769	5	53.57
	AR19	0.681	10.769	5	53.57
	AR23	1.037	10.769	5	53.57
	AR27	0.920	10.769	5	53.57
Communication	AR12	0.862	9.243	6	35.08
	AR21	0.591	9.243	6	35.08
	AR22	1.087	9.243	6	35.08
	AR24	0.886	9.243	6	35.08
	AR26	1.224	9.243	6	35.08
	AR28	1.612	9.243	6	35.08
	AR31	0.899	9.243	6	35.08

Based on the results of the heterogeneity test, it can be seen that the critical thinking, creative and communication skills show Q > df. Hence, estimating the variance between articles is quite large and heterogeneous. The heterogeneity value of the articles in each component, namely in critical thinking, is 89.83%, creative thinking is 53.57%, and communication is 35.08%. This heterogeneity value indicates population differences between articles in each subject.

Next is testing the hypothesis of the influence of inquiry model-based STM on 21st-century skills abilities based on the 21st-century skills components. Based on the results of hypothesis calculations on the influence of science teaching material based on the inquiry model on 21st-century skills, it was found that the 32 articles used showed that inquiry teaching materials had a significant effect. Calculation of the hypothesis based on the 21st-century skills components in Table 12.

Table 12. Hypothesis Testing of the Influence of Science Teaching Materials Based on Inquiry Models on 21st Century Skills Based on the Teaching Materials Used

The 21st Century Skills	Article Code	Effect Size Yi	ES average	M	SE_M	LL_M	UL_M	Z	p-values

Critical thinking	AR1	1.210	1.11	1.060	0.199	0.671	1.450	5.339	0.000
	AR4	1.077		1.060	0.199	0.671	1.450	5.339	
	AR5	2.738		1.060	0.199	0.671	1.450	5.339	
	AR7	1.403		1.060	0.199	0.671	1.450	5.339	
	AR8	2.333		1.060	0.199	0.671	1.450	5.339	
	AR9	0.534		1.060	0.199	0.671	1.450	5.339	
	AR10	0.590		1.060	0.199	0.671	1.450	5.339	
	AR11	0.095		1.060	0.199	0.671	1.450	5.339	
	AR13	1.176		1.060	0.199	0.671	1.450	5.339	
	AR14	0.028		1.060	0.199	0.671	1.450	5.339	
	AR15	0.840		1.060	0.199	0.671	1.450	5.339	
	AR16	0.510		1.060	0.199	0.671	1.450	5.339	
	AR17	0.248		1.060	0.199	0.671	1.450	5.339	
	AR20	2.868		1.060	0.199	0.671	1.450	5.339	
Creative Thinking	AR2	0.810	0.99	0.967	0.141	0.690	1.243	6.852	0.000
	AR6	0.770		0.967	0.141	0.690	1.243	6.852	
	AR18	1.769		0.967	0.141	0.690	1.243	6.852	
	AR19	0.681		0.967	0.141	0.690	1.243	6.852	
	AR23	1.037		0.967	0.141	0.690	1.243	6.852	
	AR27	0.920		0.967	0.141	0.690	1.243	6.852	
Communication	AR12	0.862	1.02	1.015	0.124	0.771	1.258	8.170	0.000
	AR21	0.591		1.015	0.124	0.771	1.258	8.170	
	AR22	1.087		1.015	0.124	0.771	1.258	8.170	
	AR24	0.886		1.015	0.124	0.771	1.258	8.170	
	AR26	1.224		1.015	0.124	0.771	1.258	8.170	
	AR28	1.612		1.015	0.124	0.771	1.258	8.170	
	AR31	0.899		1.015	0.124	0.771	1.258	8.170	

Testing the hypothesis on each skill shows that the three skills influence student learning outcomes. Critical thinking, creative and communication skills show that the influence of inquiry-based teaching materials on students' 21st-century skills is in the high category because it has effect sizes of 1.11, 0.99 and 1.02. The results of testing the hypothesis on critical thinking, creative and communication skills show that the value of $p < \alpha$, which shows that hypothesis testing H0 is rejected.

Discussion

It demonstrates that science teaching materials based on the request model positively and significantly impact students' abilities in the 21st century in light of the results of speculation testing. ICT-based learning media have a significant impact, as evidenced by the summary effect size. Because students can effectively engage with the educational experience through science showing materials based on the request model, these students' abilities in the 21st century are impacted by these materials. This test's discoveries are steady with those of (Abdullah et al., 2019; Rizka et al., 2022), that inquiry model-based teaching materials significantly impact students' skills for the 21st century.

The testing of the third hypothesis demonstrates that inquiry model-based science curriculum has a positive and significant effect on 21st-century skills at all educational levels, including junior and senior high schools. The secondary school level makes a more significant difference, which is critical for the 21st 100 years, as per the synopsis impact size

of the two degrees of training. The magnitude of the effect at the high school level demonstrates the effectiveness of inquiry-based science teaching materials. This shows that the higher the class level, the more enticing it is for students' 21st-century capacities.

This is due to the discoveries of a recent report (Hasibuan et al., 2018) that found that when request-based showing materials were applied to understudies' abilities for the 21st hundred years, the imaginative reasoning skills of class X secondary school understudies expanded. In light of the discoveries of testing the topic speculation, it illustrates that request-based science showing materials affects understudies' abilities for the 21st 100 years. According to the size of the summary effect, physics classes significantly impact students' skills for the 21st century. This aligns with research (Irkham et al.2017) that found that students' critical thinking skills improve when they take physics classes on dynamic electricity.

The fourth hypothesis was tried, and the results show that, according to the request model, all science teaching materials affect students' abilities for the 21st century. There is a significant impact on modules and LKS. This demonstrates that students produce more data and have a unique educational experience when using science-based materials considering demand models. This is backed up by a study (Purwanto & Suwasono, 2019) that found that students who used inquiry model-based worksheets to study had better critical thinking skills than traditional models.

The results of speculation testing demonstrate that science teaching materials positively and significantly impact students' abilities in the 21st century. The outcomes of the once-over influence size show that science showing materials have a high effect. Understudies can foster their reasoning abilities because of the opportunity to track down media and learning assets and use various existing innovations, so science showing materials in light of the request model affects their decisive reasoning, imaginative, and relational abilities. Students can actively participate in the learning process through inquiry-based science teaching materials. According to research (Purnamawati et al., 2017), it has been demonstrated that worksheets based on higher-order thinking skills influence and enhance students' capacity for critical thinking.

CONCLUSION

Considering the data and results of the meta-assessment research, a couple of finishes can be communicated. First, the inquiry-based and educationally diverse science teaching materials significantly impacted students' skills for the 21st century. Second, understudies' abilities in the 21st century are impacted by science showing materials in light of request models with various subjects. Thirdly, understudies' abilities in the 21st century are impacted by science guidance materials that utilise various showing strategies and depend on request models. Fourth, science instruction materials based on inquiry models with variations in 21st-century skill components significantly impact students' 21st-century skills. This study can be used as a reference when developing inquiry-based science teaching materials as it is relevant to students' 21st-century skills.

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