Meta Analysis: The Influence of Instrument Assessment on Project-Based Learning Models to Improve 4C Skills

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Abstract: This study aims to 1) analyze the effect of the project-based learning model in terms of 4C skills, 2) analyze the influence of the project-based learning model in terms of education level, and 3) analyze the influence of the project-based learning model in terms of learning materials. The type of research applied to this study is meta-analysis. The results of this study are: 1) the project-based learning model has an influence to improve 4C skills with an average effect size on critical thinking skills of 2.23 high categories, creative thinking skills of 0.92 high categories, communication skills of 2.43 high categories and collaboration skills of 4.79 high categories; 2) the project-based learning model has an influence on improving 4C skills at the education level, namely junior high school, high school and university with an average effect size at each level, namely 1.6 high categories at the junior high level, 1.05 high categories at the high school level and 2.9 high categories at the higher education level; and 3) the project-based learning model has an effect on improving 4C skills with the highest average effect size on substance change material of 5.04 high categories and the lowest average effect size in motion dynamics material of 0.18 small categories.

Keywords: Meta-analysis; Project Based Learning; 4C Skills.

Introduction

The 21st century is a period where science and technology develop rapidly which requires human resources to be able to learn independently, use higher-order thinking skills, seek information and have good competence (Arnyana, 2019; Sani, 2014). In improving the quality of these resources, students must have learning skills, skills to use technology, and be able to learn and survive using life skills (Arifin, 2017). Students' skills can be assessed using an assessment instrument. Assessment instruments are tools used by educators or appraisers to collect data on the characteristics of students by taking measurements. By taking measurements obtained objective data needed to assess student learning outcomes. In addition to obtaining objective data, using instruments makes the assessment work easier and the results are better in the sense of being thorough, complete and systematic (Widoyoko, 2012).

Permendikbud No 23 of 2020 article 13 (1) concerning educational assessment standards states that the procedure for evaluating learning processes and learning outcomes by educators is carried out in the order of: a) setting the objectives of the assessment with reference to the lesson plan, that has been prepared; b) develop assessment grids; c) create assessment instruments and assessment guidelines; d) perform an analysis of the quality of the instrument; e) conduct an assessment; f) process, analyze and interpret the results of the assessment; g) reporting the results of the assessment and h) utilizing the report on the results of the assessment. The assessment was carried out to determine the extent to which learning success was able to improve skills. One of them is the 4C skill (Critical Thinking, Creativity, Collaboration, Communication) (Center, 2010).

Many researchers have conducted research to improve 4C skills, one of which is by using the project based learning (PjBL) model. The results of the analysis that has been carried out show that the use of the PjBL model has an effect on improving 4C skills (Ekawati eit al., 2019; Riskayanti, 2021). In line with this, researchers who developed the 4C skills assessment instrument included (Asmawati et al., 2018; Budiarta et al., 2021).

The assessment instrument developed produces a product in printed form with the type of essay question.

Thei real conditions found in the field are not in accordance with the expected ideal conditions. Based on initial observations made in three schools in Padang City, it was found that critical thinking skills (52.75%), creative thinking skills (42.50%), communication skills (59.93%) and collaboration skills (59.89%). This shows that the 4C skills of students are still lacking.

Based on the explanation above, it can be concluded that the skills of students are still low. This is due to the low 4C skills and the lack of use of the PjBL model in the learning process. To overcome this problem, the researchers put forward a solution, namely the development of a physics learning assessment instrument in a project-based learning model to improve students' 4C skills.

This study aims to 1) analyze the effect of the project based learning model in terms of 4C skills, 2) analyze the influence of the project-based learning model in terms of education level, and 3) analyze the influeince of the project-based learning model in terms of learning materials.

Method

This study uses the effect size analysis method. Effect size is a measure of the magnitude of the effect of a variable on other variables, then the magnitude of the difference or relationship of a sample. Analysis is made by summarizing data from several studies in the form of determining research themes, collecting article sources, selecting publication sites, recording data from research sources, determining effect sizes and making conclusions on the analysis data obtained. The advantages of this analytical research are that it combines several quantitative research results, is able to provide a good description of the research results, and is objective in describing research data without any element of subjectivity from the researcher. The stages of analysis can be explained as follows:

Preparatory stage
Collecting data from Google Scholar for the 2016-2022 period, so that a total of 33 articles were obtained in Table 2. The research variables in this article consist of two variables, namely the independent variable in the project-based learning model, while the dependent variable is in the 4C skills.

Implementation stage
Collecting data through literature sources from November 1 - December 2022. Resume research article data in the form of 4C skills, educational level and learning materials. Research coding to facilitate analysis. Analyze the effect size of the results of the collection of research articles. Conclude the results of data analysis.

Data analysis techniques
Analyzing the domain effect size of the research in the form of: Mean pre-test, Mean post-test, Experimental standard deviation, Standard deviation of control, Experimental mean, Mean control.

The coefficient of the t value
Analyze the influence between variables.

The effect size can be determined in the following statistical parameters (Becker & Park, 2011). Research design and method should be clearly defined.

Average in one group

$$ES = \frac{\bar{x}_{posttest} - \bar{x}_{pretest}}{SD_{pretest}} \tag{1}$$

Average in each group

$$ES = \frac{\bar{x}_E - \bar{x}_C}{SD_C} \tag{2}$$

Mean and standard deviation of two group pre-post test

$$ES = \frac{\left(\bar{x}_{post} - \bar{x}_{pre}\right)_E - \left(\bar{x}_{post} - \bar{x}_{pre}\right)_C}{\frac{SD_{preC} + SD_{preE} + SD_{postC}}{3}} \tag{3}$$

If the standard deviation is not known, it can be done with the t test

$$ES = t\sqrt{\frac{1}{n_E} + \frac{1}{n_C}} \tag{4}$$

Information:
ES = *Effect size*
$X_{postest}$ = Posttest average
$X_{pretest}$ = Pretest average
$SD_{pretest}$ = Standard deviation pretest
$SD_{posttest}$ = Standard deviation posttest
X_E = Experimental group mean
X_C = Control group mean
t = t value
n = Number of samples
x_{postE} = Mean posttest experimental group
x_{preE} = Mean pretest experimental group
x_{postC} = Mean posttest control group
x_{preC} = Mean pretest control group
SD_E = Standard deviation experimental group
SD_C = Standard deviation control group

The criteria for effect size are as follows (Cohen, 1988):

Table 1. Effect Size Criteria

Effect Size	Category
ES < 0.2	Low
0.2 < ES < 0.8	Medium
ES > 0.8	High

Result and Discussion

The results of this study consist of three categories, namely the influence of the project based learning model in terms of 4C skills, educational level and learning materials. To make it easier to understand the three results of the analysis of 33 articles related to the project based learning model can be seen in Table 2.

Table 2. Description of the Articles Analyzed

Article Source	Journal Code	Publication Year	Journal Type
Astri et al.	M1	2022	National
Saenab et al.	M2	2019	National
Utami et al.	M3	2019	National
Ramadiyanti et al.	M4	2016	National
Andi et al.	M5	2018	National
Firdaus et al.	M6	2022	National
Khoiri et al.	M7	2016	National
Rahardhian	M8	2022	National
Fajrina et al.	M9	2018	National
Mawarni & Sani	M10	2020	National
Hijrawatu et al.	M11	2020	National
Sumardiana et al.	M12	2019	National
Kristiani et al.	M13	2020	National
Putri et al.	M14	2016	National
Ratu et al.	M15	2021	National
Pratama & Prastyaningrum	M16	2016	National
Permata et al.	M17	2018	National
Yunus et al.	M18	2016	National
Wulansari et al.	M19	2019	International
Rahim et al.	M20	2019	International
Abdullah et al.	M21	2016	National
Nurfa & Nana	M22	2020	National
Khoiri & Putri	M23	2020	National
Chasanah et al.	M24	2016	National
Khanifah & Saefan	M25	2016	National
Khoiri & Putri	M26	2020	National
Andriani	M27	2022	International
Biazus & Mahtari	M28	2022	International
Umamah & Andi	M29	2019	National
Bulu & Tanggur	M30	2021	National
Anggito et al.	M31	2021	National
Listiaji et al.	M32	2022	National
Farcis et al.	M33	2022	National

Based on Table 2, it can be seen the description of the article regarding the effect of the project based learning model on 4C skills. The analyzed articles were given a code for each of them and some data were obtained from the analyzed articles. The first result of this effect size analysis is related to the effect of project based learning in terms of 4C skills, which can be seen in Table 3.

Table 3. Effect Size on 4C Skills

Critical Thinking Skills		Creative Thinking Skills		Collaboration Skills		Communication Skills	
Journal Code	Effect Size	Journal Code	Effect Size	Journal Code	Effect Size	Journal Code	Effect Size
M1	2.64	M3	1.86	M2	6.76	M1	1.97
M4	0.68	M5	1.07	M30	2.82	M2	4.26
M8	2.62	M6	1.23			M26	1.05
M11	0.52	M7	0.44				
M12	4.13	M9	1.36				
M14	1.13	M10	0.64				
M15	6.13	M13	0.98				
M16	2.16	M14	1.52				
M17	1.09	M19	0.72				
M18	1,30	M21	0.18				
M20	0,12	M22	0.66				
M27	5.04	M23	0.59				
M30	5.6	M24	0.95				
M31	0.53	M25	0.66				
M32	1.36	M28	1.34				
M33	0.62	M29	0.57				

From Table 3 it is known that the effect size of the 4C skills in terms of critical thinking skills, creative thinking skills, collaboration skills and communication skills. On critical thinking skills it consists of 16 articles with an average effect size of 2.23 in the high category. Creative thinking skills consist of 16 articles with an average effect size of 0.92 in the high category. Communication skills consist of 3 articles with an average effect size of 2.43 in the high category. Collaboration skills consist of 2 articles with an average effect size of 4.79 in the high category. Because in the project-based learning (PjBL) model students are faced with an innovative learning, and places more emphasis on contextual learning so as to provide opportunities for students to work independently in constructing their own knowledge and producing real products (Lawe, 2019).

The advantages of the project-based learning model as a learning model are increasing students' ability to solve problems, making students more active, increasing students' ability to work together, and encouraging students to practice communication skills (Sani, 2014). This indicates that students who study using the project-based learning model provide more optimal results than students who learn not to use the learning model. In the project based learning model, there are eight stages, namely choose a focus for the project, identify essential knowledge and skill areas to be learned through project activities, introduce the project and involve students in shaping it, select a balance of teacher-led and student-centered activities, establish project timelines and milestones, monitor student progress using planning, reporting, and feedback tools, evaluate project impact

and learning results, and reflect on gathered data and plan next steps (Fleming, 2000).

In general, the project based learning model relies on developing students' abilities to analyze problems, then explore, collect information, interpret, and evaluate in working on projects related to the problems being studied. This learning allows students to develop their creativity in designing and creating projects that can be used to solve problems through scientific learning activities (Sani, 2014). So, the project based learning model has an effect on improving 4C skills, because students find the concepts they learn directly through scientific activities themselves so that these concepts will be easier to understand and will stick to the minds of students and difficult to forget (Sumarni et al., 2020).

The second result of this effect size analysis is related to the influence of the project based learning model in terms of educational level, which can be seen in Table 4.

Table 4. Effect Size at Education Level

Education Level	Journal Code	Effect Size
Junior High School	M1	2.31
	M4	0.68
	M8	2.62
	M13	0.98
	M28	1.34
Senior High School	M3	1.86
	M5	1.07
	M6	1.23
	M7	0.44
	M9	1.36
	M10	0.64
	M11	0.52
	M12	4.13
	M14	1.33
	M17	1.09
	M18	1.3
	M19	0.72
	M20	0.12
	M21	0.18
	M22	0.66
	M23	0.59
	M24	0.95
	M25	0.66
	M26	1.05
College Student	M2	5.51
	M15	6.13
	M16	2.16
	M27	5.04
	M29	0.57
	M30	4.21
	M31	0.53
	M32	1.36
	M33	0.62

The influence of the project-based learning model in terms of educational level, namely junior high school, high school and university students. At the junior high

school level it consisted of 5 articles with an average effect size of 1.6 in the high category. The SMA level consists of 19 articles with an average effect size of 1.05 in the high category. at the student level it consists of 9 articles with an average effect size of 2.9 in the high category.

The third result of the effect size analysis is related to the influence of project based learning in terms of learning materials, which can be seen in Table 5.

The effect of the project based learning model is 13 learning materials. Material changes in substance have the highest average effect size in the twenty-seventh article (M27) with a value of 5.04 in the high category. The motion dynamics material has the lowest average effect size in the twenty-first article (M21) with a value of 0.18 in the small category.

Table 5. Effect Size on Learning Materials

Learning Materials	Journal Code	Effect Size
Dynamic Fluid	M3	1.86
Optical Tools	M5	1.07
Momentum and Impuls	M6	1.23
	M8	0,12
Dynamic Electricity	M9	2.62
Static Fluid	M10	1,36
	M12	0.64
Temperature and Heat	M19	4.13
	M20	0.95
Effort and Energy	M21	0.72
Motion Dynamics	M23	0.18
Measurement	M24	0.59
Harmonious Vibrations	M25	0.66
Substance Change	M27	5.04
Temperature	M28	1.34
Thermodynamics	M33	0.62

Conclusion

Based on the data that has been analyzed it can be concluded from this study. The conclusions are: 1) the project based learning model has an influence on improving 4C skills with an average effect size on critical thinking skills 2.23 high category, creative thinking skills 0.92 high category, communication skills 2.43 high category and collaboration skills 4.79 high category; 2) the project based learning model has an influence on improving 4C skills at educational levels, namely junior high school, high school and tertiary education with an average effect size at each level, namely 1.6 high category for junior high school level, 1.05 high category for high school level and 2.9 Higher Education level category; and 3) the project based learning model has an influence on improving 4C skills with the highest average effect size in substance change material of 5.04 in the high category and the lowest average effect size in motion dynamics material of 0.18 in the small category.

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