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META-ANALYSIS OF THE EFFECT OF PROJECT-BASED LEARNING ON ENHANCING 21ST CENTURY SKILLS

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Abstract
The research objective is to investigate the effect of project-based learning on improving 21st-century skills. The research method used is a survey with documentation techniques on journals available in Indonesia One Search, which is then analyzed by meta-analysis by calculating the effect size of each research variable. From the journal search results, 25 journals were obtained, consisting of 9 journals on critical thinking skills, 10 on creative thinking skills, and six on problem-solving skills. The research findings revealed that the effect of project learning on students' necessary skills was 88%, the impact of project learning on students' creative skills was 82%, and the effect of project learning on students' problem-solving was 92%.

Keywords: meta-analysis, project, critical thinking, creative thinking, problem-solving.

INTRODUCTION

Project Based Learning (PjBL) is a learning model that develops skills required in the 21st century (Bell, 2010). Through projects, students will be trained to face the world of work that requires their ability to access, synthesize, communicate information, and collaboratively solve complex problems (Ledward & Hirata, 2010) (Cole et al.., 2002) (Saban, 2000). In line with the above opinion, PjBL is an innovative learning approach that teaches strategies critical for student success in the 21st century (Bell, 2010) (Hamurcu, 2003).

One of the goals of 21st-century education is to build students' intelligence in learning to solve problems faced in real life. In the 21st century, students must have the skills to collaborate and communicate in teams to compete in the world of work (Bell, 2010). Students' success in constructing their knowledge is not only from the achievement of predetermined learning objectives, but students must also be able to apply the concepts of knowledge gained at school to solve problems faced in everyday life in a relevant, meaningful, and contextual manner. Therefore, teachers must be able to provide learning experiences that can train students to solve problems encountered in real life through the learning process at school. Contextualized learning, practising critical thinking, creativity, mastering technology, cooperating and collaborating are needed to solve 21st-century problems (Tan, 2004).

In recent decades, there has been increased research studying PjBL in learning. Studies related to PjBL have concluded that it has contributed positively to students' academic achievement (Kanter & Konstantopoulos, 2010) (Selçuk, 2010), to meaningful learning in science subjects (Kanter, 2009), to students' learning (Chang & Tseng, 2011), students' attitude towards science learning (Tortop & Özek, 2013). In addition, technology-assisted PBL effectively increases students' motivation to learn science, problem-solving ability, solve problem and achiever movement (Hung et al., 2012).

However, problem-solving, creative thinking and critical thinking skills have been at the centre of attention from educators, researchers, employers, and mass media for several years. This can be seen from the fact that the ability to think critically will determine a person's power in competing because it will increase the competitive power of the individual, according to the opinion of researchers who state that critical thinking skills have been recognized as an essential skill for successful learning, working and living in the 21st century (Zare & Othman, 2015); (Kivunja, 2015); (Bermingham, 2015). Someone with high critical thinking and good communication skills will quickly adjust to changing conditions and be valued both in the academic context and the world of work (Mason, 2007).

The magnitude of the effect of the project learning model on critical thinking, creative and problem-solving skills can be known as one of them by calculating the effect size. Effect size shows the extent to which a variable affects other variables in a study or shows how effectively a variable affects other variables (Santoso, 2010) and can be considered a measure of the meaningfulness of research results at a practical level (Huck, 2008) (Moore, 2007). Effect size is also the magnitude of the difference or relationship, free from the influence of sample size (Olejnik & Algina, 2003). Therefore, conducting a meta-analysis of the effect of project-based learning on improving 21st-century skills is necessary.

METHOD

This research uses a survey method by collecting data through documentation on the Indonesia One Search (IOS) portal. All journals retrieved were related to the effect size caused by the application of project-based learning models on 21st-century skills. Journal search restrictions with keywords such as the effect of project-based learning, 21st-century skills (critical thinking, creative thinking and problem-solving) and science, including physics/chemistry/biology. In the initial search stage from September 15, 2018, to October 15, 2018, 682 journals related to project-based learning were found. Next, 25 journals were selected that met the criteria, namely: (1) Journals published limited from 2012 to 2018 to determine the effect of project-based learning models on 21st-century skills; (2) Results that state the effect size of the learning model used have an impact on student development; (3) Some journals that have been found are not

selected because they do not mention or explicitly describe the quantitative analysis so that the effect size cannot be calculated.

The data analysis technique to calculate the effect size uses several statistical equations, as shown in Table 1 (Becker & Park, 2011).

Table 1. Some Effect Size Formulas

Diberikan data statistik	Formulas
Mean and standard deviation in one group	$ES = \frac{\bar{x}_{post} - \bar{x}_{pre}}{SD_{pre}}$
Mean and standard deviation in each group (two groups only conducted posttest)	$ES = \frac{\bar{x}_{eksperimen} - \bar{x}_{kontrol}}{SD_{kontrol}}$
Mean and standard deviation in each group (two groups conducted pre-posttest)	$ES = \frac{\left(\bar{x}_{post} - \bar{x}_{pre}\right)_{ekspeirmen} - \left(\bar{x}_{post} - \bar{x}_{pre}\right)_{kontrol}}{\left(\frac{SD_{pre\,kontrol} + SD_{pre\,eksperimen} + SD_{post\,kontrol}}{3}\right)}$
Chi-square	$ES = \frac{2r}{\sqrt{1-r^2}};\ r = \sqrt{\frac{\chi^2}{n}}$
t hitungs	$ES = t\sqrt{\frac{1}{n_{eksprimen}} + \frac{1}{n_{kontrol}}}$

After obtaining the effect size value, the results can be interpreted into high, medium and low categories, as shown in Table 2 (Becker, 2000) (Cohen, 1988).

Table 2. Effect Size Classification

Effect Size (ES)	Cohen's standard category
$0 \le ES \le 0{,}2$	**Small**
$0{,}2 \le ES \le 0{,}8$	**Medium**
$ES \ge 0{,}8$	**High**

Once obtained, the ES value is interpreted to determine how much influence the independent variable has on the dependent variable with the provisions shown in Table 3 (Coe, 2002).

Table 3. Interpretation of ES Effect on Independent Variables

ES	0,0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0	1,2	1,4	1,6	1,8	2,0	2,5	3,0
Effect (%)	50	54	58	62	66	69	73	76	79	82	84	88	92	95	96	98	99	99,9

RESULTS AND DISCUSSION

In this study, the number of journals fit the research objectives was 25 journals. The details can be seen in Tables 4, 5 and 6.

Critical thinking skills

The calculation of effect size is done to determine the effect of project learning on students' critical thinking skills shown in Table 4.

Table 4. Effect Size Category of Project-Based Learning on Thinking Skills Kritis

No.	Author	Dependent variable	Research design	$\bar{x}_{eksperimen}$	$\bar{x}_{kontrol}$	$SD_{kontrol}$	ES	Category
1.	(Hikmah, Budiasih, & Santoso, 2016)	High school critical thinking	Postest only control group	t hitung=3,56 n_E=26 n_K=26			0,9	High
2.	(Sastrika, Sadia, & Muderawan, 2013)	High school critical thinking	Postest only control group	49,75	43,20	8,49	0,7	Medium
3.	(Susanawati, Diantoro, & Yuliati, 2013)	High school critical thinking	Postest only control group	t hitung=8,13 n_E=34 n_K=33			1,9	High
4.	(Hilmi, Sunarno, & Saputro, 2015)	High school critical thinking	Postest only 1 group	88,5	84,2	7,73	0,5	Medium
5.	(Yunus, Ali, & Rusli, 2016)	High school critical thinking	Postest only control group	16,59	13,00	2,77	1,3	High
6.	(Sutrio, Gunawan, Harjono, & Sahidu, 2018)	College critical thinking	Postest only 1 group	69,8	38,1	15,2	2,0	High
7.	(Sofiah, Peniati, & Lisdiana, 2016)	High school critical thinking	Pretest-Postest control group	t hitung=6,36 n_E=36 n_K=36			1,4	High
8.	(Husamah, 2015)	College critical thinking	Postest only control group	19,74	16,71	2,36	1,3	High
9.	(Widyantari, Parmiti, Dsk, & sudana, 2015)	Elementary critical thinking	Postest only control group	44,13	33,40	7,21	1,4	High
			Rata-rata				**1,2**	**Tinggi**

Table 4 shows the effect size price calculation result is 1.2. This means that project learning can improve students' critical thinking skills by 88% (Coe, 2002). The effect size price is in the high category (Cohen, 1988). Representation of the effect size of students' critical thinking skills based on education level is shown in Figure 1.

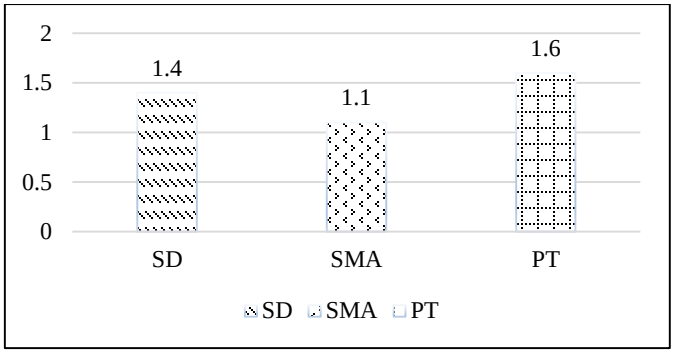

Figure 1. Effect size of students' critical thinking skills based on education level

In Figure 1, it can be seen that at the elementary, high school, and university levels, respectively, it is 1.4 (high category), 1.1 (high category), and 1.6 (high category). The effect of project learning on improving critical thinking skills is included in the high category because PjBL learning focuses on the main concepts and principles of a discipline, involves students in problem-solving and other meaningful tasks, provides students with opportunities to work autonomously to construct their learning, and culminates in producing valuable and realistic student work products (Thomas, 2000). It is also reinforced by the opinion that through projects, students will be trained to face the world of work that requires their ability to access, synthesize, communicate information, and collaboratively solve complex problems (Ledward & Hirata, 2010) (Cole et al., 2002) (Saban, 2000) so that through this process it is expected that students' critical thinking skills will increase (Grant, 2002).

Creative thinking skills

The effect size calculation is done to determine the effect of project learning on students' creative thinking skills, as shown in Table 5.

Tabel 5. Effect size category of project-based learning on creative thinking skills

No	Author	Dependent variable	Research design	$\bar{x}_{eksperimen}$	$\bar{x}_{kontrol}$	$SD_{kontrol}$	ES	Category
1.	(Fajrina, Handayanto, & Hidayat, 2018)	High school creative thinking	Postest only control group	82,19	67,50	10,78	1,4	High
2.	(Marlinda, 2012)	Junior high creative thinking	Postest only control group	28,86	26,73	3,63	0,5	Medium
3.	(Mulhayatiah, 2014)	College creative thinking	Pretest-postest 2 grup	t hitung=4,43 n_E=26 n_K=37			1,1	High
4.	(Sari, Hidayat, & Kusairi, 2018)	High school creative thinking	Pretest-postest 1 grup	Not written down respectively, directly ES value			0,8	High
5.	(Sugiyastini, Sudana, & Suartama, 2013)	Elementary school creative thinking	Postest only control group	25,14	20,75	6,30	0,7	Medium
6.	(Hilmi et al., 2015)	High school creative thinking	Postest only control group	88,2	84,1	6,29	0,6	Medium
7.	(Sugiyarti, Sunarno, & Aminah, 2015)	High school creative thinking	Postest only control group	81,86	73,3	7,84	1,1	High
8.	(Sugiyarti et al., 2015)	High school creative thinking	Postest only control group	80,94	75,18	7,85	0,7	Medium
9.	(Utami, Probosari, & Fatmawati, 2015)	High school creative thinking	Postest only control group	82,72	77,12	4,98	1,1	High
10.	(Husamah, 2015)	College and High school creative thinking	Postest only control group	14,32	11,79	2,37	1,1	High
			Average				**0,9**	**High**

From Table 5, it can be seen that the calculation of the effect size price is 0.9. Project learning can improve students' creative skills by 82% (Coe, 2002). The effect size price is in the high category (Cohen, 1988). A representation of the effect size of creative thinking skills based on education level is shown in Figure 2.

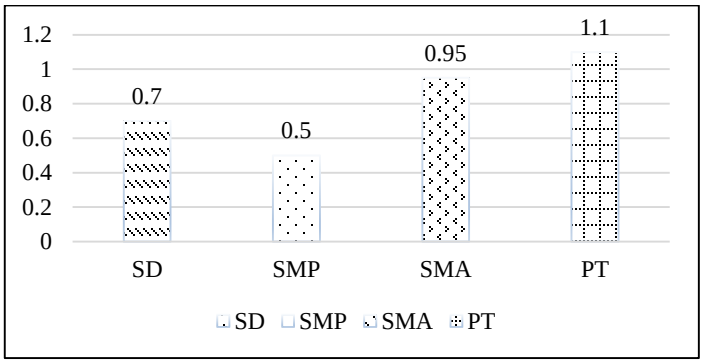

Figure 2. Effect size of creative thinking skills by education level

In Figure 2, it can be seen that at the levels of elementary, junior high, high school, and university, it is 0.7 (medium category), 0.5 (medium category), 0.95 (high category) and 1.1 (high category), respectively. The effect of project-based learning on improving critical thinking skills is in the medium category at the elementary and junior high school levels while in the high category at the high school and university levels because the Project-based learning model is learning that refers to the philosophy of constructivism through student activities so that students can construct their own and meaningful knowledge through real experiences (Kanter, 2009) (Chang & Tseng, 2011). Project-based learning can improve creative thinking skills by involving students in actual or simulated experiences and becoming autonomous and independent learners. Students develop their creative thinking skills by fulfilling aspects of creative thinking such as fluency thinking in solving problems, flexibility thinking to generate problem-solving ideas, originality thinking to provide different ideas and elaboration thinking to develop their ideas (Munandar, 2004).

Problem solving skills

The effect size calculation is done to determine the effect of project learning on students' problem-solving skills, as shown in Table 6.

Table 6. The effect size calculation is done to determine the effect of project learning on students' problem solving skills

No	Author	Dependent variable	Research design	$\bar{x}_{eksperimen}$	$\bar{x}_{kontrol}$	$SD_{kontrol}$	ES	Category
1.	(Wulandari, Kusmariyatni, & Suarjana, 2013)	Elementary Problem Solving	Postest only control group		t hitung=6,24 n_E=28 n_K=27		1,6	Tinggi
2.	(Ariwibawa, Sadia, & Tika, 2013)	Junior High Problem Solving	Postest only control group	58,60	41,20	10,35	1,6	Tinggi
3.	(Karina, Sadia, & Suastra, 2014)	Junior High Problem Solving	Pretest-postest 2 grup	x_1=48,81 x_2=73,32	x_1=46,48 x_2=68,21	SD-E_1=2,63 SD-E_2=5,70 SD-K_1 =2,74 SD-K_2 =7,52	0,8	Tinggi
4.	(Makrufi, Hidayat, & Muhardjito, 2018)	High School Problem Solving	Postest only control group	74,57	38,72	12,89	2,7	Tinggi
5.	(Sintadevi, Sedanayasa, & Japa, 2015)	Elementary Problem Solving	Postest only control group	31,72	25,3	5,30	1,2	Tinggi
6.	(Dewi, Khoiri, & Kaltsum, 2017)	High School Problem Solving	Pretest-postest control grup		t hitung=3,68 n_E=43 n_K=43		0,8	Tinggi
			Average				**1,4**	**Tinggi**

From Table 6, the result of the calculation of the effect size price is 1.4. Project learning can improve students' problem-solving skills by 92% (Coe, 2002). The effect size price is in the high category (Cohen, 1988). Representation of the effect size of problem-solving skills based on education level is shown in Figure 3.

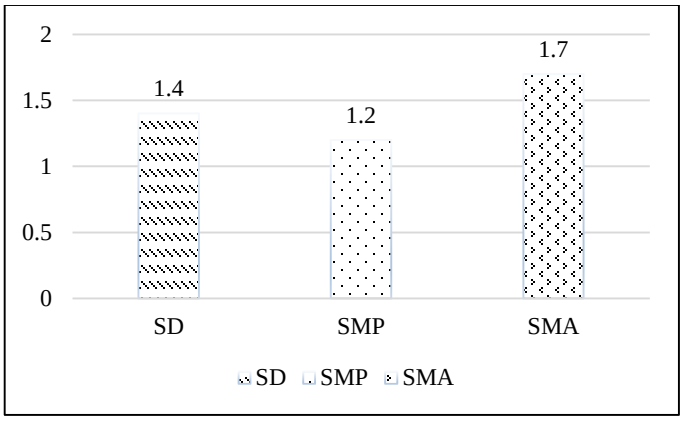

Figure 3. Effect size of problem-solving skills by education level

In Figure 3, it can be seen that at the elementary, junior high, and senior high school levels, respectively, it is 1.4 (high category), 1.2 (high category), and 1.7 (high category). The effect of project learning on improving problem-solving skills is included in the high category at the elementary, junior high and high school levels because it is inseparable from the stages of the project-based learning model applied to the learning environment, such as conducting in-depth investigations of the problems being faced (Fajarwati et al., 2017), has provided meaningful experiences and improved problem-solving ability (Chua et al., 2004) (Hung et al., 2012).

Linkage Of Critical, Creative and Problem-Solving Skills

After calculating the average total effect size on each 21st-century skill, the relationship between skills can be displayed in Table 7.

Tabel 7. Average Total Effect Size of 21st Century Skills

21st Century Skills	$\overline{ES}_{\text{total}}$	Effect (%)	Category
Critical thinking	1,2	88	High
Creative thinking	0,9	82	High
Problem solving	1,4	92	High

Table 7 shows that the effect of project learning on students' critical skills is 88%, which is classified as a high category; the effect of project learning on students' creative skills is 82%, which is classified as high category, and the effect of project learning on students' problem solving is 92% which is classified as high category. This is because contextualized learning, practising the ability to think critically and creatively, mastering technology, cooperating and collaborating are needed in solving 21st-century problems (Tan, 2004). Contextualized learning includes project-based learning (PjBL), which can develop the skills required in the 21st century (Bell, 2010). Learning through projects will train students to face the world of work that requires their ability to access, synthesize, communicate information, and collaboratively solve complex problems (Ledward & Hirata, 2010) (Cole et al., 2002) (Saban, 2000).

CONCLUSIONS

Based on the results of the meta-analysis, the effect size of the effect of project learning on improving critical thinking skills is 1.2, which is classified as high; the effect of project learning on improving creative thinking skills is 0.9 which is classified as high; and the effect of project learning on improving problem-solving skills is 1.4 which is classified as high. Based on the research results, the project-based model can potentially develop students' 21st-century skills.

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