

Research Article

The effect of PjBL plus 4Cs learning model on critical thinking skills

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Abstract

The PjBL Plus 4Cs is an alternative learning model for geography. The PjBL Plus 4Cs can teach, train, and improve critical thinking skills. The research aimed to find out the effect of the PjBL plus 4C learning model on critical thinking skills. The research used a quasi-experimental design with a pretest-posttest nonequivalent control group approach. Students of Class XI IPS-1 and XI IPS-2 in Islamic Senior High School of Sabilillah Malang were the subjects of this research. Critical thinking skills were measured using validated critical thinking instruments in 7 essay tests, including the competencies of analyzing and formulating problems, giving logical arguments, conducting deductive reasoning (C4), synthesizing/conducting inductive reasoning (C5) and evaluating (C6). Based on the T-test analysis, the significance value (2-tailed) was obtained 0.01 (< 0.05), indicated a significant effect of PjBL Plus 4Cs on critical thinking skills. Therefore, the PjBL plus 4Cs learning model can increase critical thinking skills.

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Introduction

The 4.0 era education leads to learning that can equip students to have competencies of “The Four C’s” of 21st Century skills. 4Cs is life skills required by students to be able to exist and overcome the challenges of 21st-century community activities (Ağaoğlu & Demir, 2020). One of the competencies that students need to have is high-level thinking or often called as critical thinking (Badan Standar Nasional Pendidikan, 2010). Critical thinking needs to be taught in geography learning because there are basic skills in analyzing each competency standard in the geography subject of Senior High School (Kemendikbud, 2016).

Critical thinking is a deeper kind of thinking or High-Order Thinking Skills (HOTS) at the cognitive level of C-4 to C-5 in Bloom’s taxonomy, including analyzing, synthesizing and evaluating (Pramusinta et al. 2019). Furthermore, (Lorin W. Anderson et al. 2000) modified critical thinking into analysis, evaluation, and creativity. According to (Thomas et al. 2001), critical thinking is a way of thinking more than just memorizing and retelling. Critical thinking skills direct students to be able to formulate problems, identify problems, find solutions to the problems by providing logical arguments (Samsudin et al. 2020). In linear, (Ennis, 2015) revealed that the criteria of critical thinking skills are competent in identifying problems, making logical arguments, conveying deductive reasoning, expressing inductive reasoning, evaluating, making and implementing decisions appropriately.

Critical thinking skills need to be trained to students because these skills are the main elements in the process of mental development to receive, process, and use knowledge and information (Gul et al. 2014). This is supported by (Elbow & Sharma, 2000) stating that critical thinking skills are not an automatic response, so these skills need to be

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learned. Furthermore, (Utomo, 2016) stated that the strategic way to learn and develop critical thinking skills is implementing learning models appropriately.

Critical thinking skills are needed to do work and solve life's problems (Pramusinta et al. 2019). If the critical thinking skills possessed by students are good, they will be able to do various school assignment quickly and accurately (Gul et al. 2014). Critical thinking skills support students in criticizing and discussing a phenomenon or problem. (Feldman, 2010) stated that critical thinking can increase intelligence, help complete assignments, and research other solutions to a problem. (Woolfolk, 2007) argued that a person with critical thinking skills will be able to distinguish between facts and opinions as well as identify and analyze various information to be able to make conclusions. PjBL Plus 4Cs is a model that facilitates learning.

The accuracy of applying the learning model is an important element to train and improve critical thinking skills. PjBL Plus 4Cs is a learning model that can train, sharpen, and improve critical thinking skills. PjBL Plus 4Cs is the dissemination result of Sabilillah Malang reference and superior school learning models that integrate PjBL models and the 4Cs "Super Skills" through planning, referring to optimal achievement of 21st century super skills, programmed teacher discussion and forums, and good management (Fini et al. 2018).

The advantages of PjBL Plus 4Cs are optimally designed to (1) teach and train students to have competencies in critical thinking, working together, modifying/ creating, and providing information and presentations, and (2) emphasizing student-centered, contextual, authentic, and meaningful learning in daily life. The PjBL plus 4Cs learning model stages with PAPER syntax include: Presenting, Analyzing, Planning, Executing, and Reporting (Priyatni & As'ari, 2019).

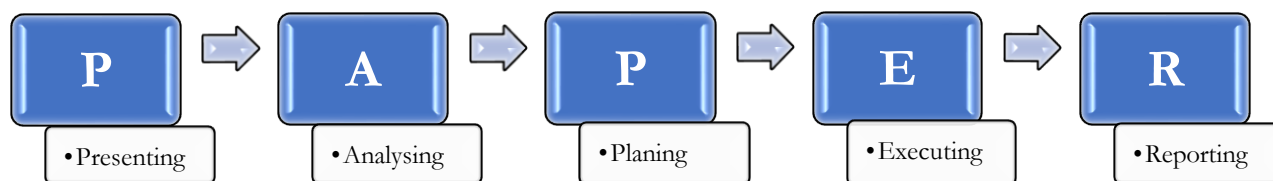


Figure 1.

The PjBL Plus 4Cs Learning Model Stages (PAPER) (Anderson & Krathwohl, 2010)

Some studies have explained the effectiveness of the PjBL. It could improve students' problem-solving ability (Kokotsaki et al. 2016; Samsudin et al. 2020; Somjai & Soontornwipast, 2020). PjBL also could improve students' critical thinking ability (Alawi & Soh, 2019; Amin, 2017; Feldman, 2010; Guo et al. 2020; Mutakinati et al. 2018; Sularmi et al., 2018). PjBL could improve learning outcomes (Amin, 2017; Fini et al. 2018; Guo et al. 2020; Samsudin et al. 2020; Somjai & Soontornwipast, 2020). However, research related to the application of PjBL to develop creativity, cognitive, communication and collaboration on students' critical thinking ability is not widely studied.

Problem of Study

Excellent learning is learning that can develop critical thinking skills (Alawi & Soh, 2019; Fitriani et al. 2020). Students need critical thinking skills as cognitive abilities to face the challenges in global competition. Therefore, it requires learning that can develop critical thinking skills. The study aimed to find out the effect of PjBL and 4Cs to the critical thinking ability. So, the research problems:

- How is the implementation of PjBL Plus 4Cs for senior high school students?
- How is the effect of PjBL Plus 4Cs to critical critical thinking for senior high school students?

Method

Research Method

The research used a quasi-experimental design with a pretest-posttest non-equivalent control group approach (Reichardt, 2019). The implementation process was compared the increase in critical thinking skills occurring in the two groups. The treatment was the application of PjBL Plus 4Cs while the control group was provided with the application of conventional learning. Look at the following Figure 2.



Figure 2.

Research Model Design

Note:

X = Project Based Learning Plus 4Cs Model

Y = Critical Thinking Skill

Participants

The subjects of this research covered all students of Class XI IPS in [Sabilillah Islamic Senior High School Malang](#), Indonesia. Two classes were selected using the purposive sampling method as research subjects. It was chosen because both classes gained the same average score for the geography learning outcomes. Specifically, Class XI IPS-1 was determined as the control group and Class XI IPS-2 was determined as the experiment group. The selection of Class XI IPS-2 as the experiment group was based on the fact that the students were more active in the session of questioning and answering (Q & A) and discussion during learning in the odd semester of 2019 before the treatment ([Sugiyono, 2006](#)). In other words, Class XI IPS-2 was more suitably used as an experiment class to make projects in the PjBL plus 4Cs learning model.

Instrument and Procedures

Critical thinking skills were measured using validated critical thinking instruments in the form of 7 essay tests on the topic of the distribution of flora and fauna. The question items include critical thinking skills based on Bloom’s taxonomy with the cognitive level of analyzing/ formulating problems, giving logical arguments, doing deductive reasoning (C4), synthesizing/ conducting inductive reasoning (C5) and evaluating (C6) ([Anderson & Krathwohl, 2010](#)). Before use, these instruments were validated by experts who are competent in their fields. The instrument was developed from indicators that can determine critical thinking skills. The following are indicators and instruments for critical thinking questions.

Table. 1.

Indicator of Critical Thinking Ability on the Biome Topic

No	The Indicators of Critical Thinking Ability	Questions
1	Analyzing (C4): Classifying the types of flora based on their biomes	Classify the types of flora based on their biomes by completing the table below!
2	Giving Arguments (C4): Describing 4 factors that influence the distribution of flora and fauna	Describe the 4 factors that influence the distribution of flora and fauna, according to Alfred Russel Wallace?
3	Analyzing (C4): Analyze the reasons for Wallace divides Indonesia into 3 fauna regions	Based on the fauna distribution map above, explain the reason for Alfred Russel Wallace divides Indonesia into 3 regions!
4	Analyzing (C4): Connecting the distribution of fauna with the distribution of flora	Explain the relationship between the distribution of fauna and the distribution of flora in a certain area!
5	Deducting (C4): Explain the problem cause of flora and fauna extinction	Study the 4 causes of extinction of flora and fauna in Indonesia and the world!
6	Inducting (C5): Divine the impact of the extinction of flora and fauna	Project 3 negative impacts that will occur due to the extinction of various types of flora and fauna!
7	Evaluating, deciding, and doing (C6): Provide personal solutions, conclusions, and ideas to determine actions that can be implemented in daily life related to overcoming the problem of flora and fauna extinction	Compared to flora and fauna conservation efforts, as community members, mention and explain 4 real actions that you can do in everyday life!

Source: [Research Analysis Results \(2020\)](#)

Data of critical thinking skills were obtained through the critical thinking question instruments with pretest and posttest activities. The data were in the form of gain scores, which are the calculation of the difference between

posttest and pretest scores (posttest score – pretest score). The gain score describes an increase in critical thinking skills.

Instrument Validity and Reliability

Before collecting the data, a test instrument of critical thinking was conducted to a total of 35 students. Following are the validity test and the reliability test of the critical thinking instrument.

Table. 2

The Instrument Validity and Reliability of the Critical Thinking Ability

Questions	Basic Competency	Criteria	Item Validity	Criteria	Reliability	Criteria
1	Fit	Valid	0,559	Less Valid	0,795	High
2	Fit	Valid	0,676	Valid	0,779	High
3	Fit	Valid	0,593	Less Valid	0,801	Very High
4	Fit	Valid	0,589	Less Valid	0,805	Very High
5	Fit	Valid	0,784	Valid	0,751	High
6	Fit	Valid	0,784	Valid	0,752	High
7	Fit	Valid	0,826	Very Valid	0,748	High

Source: [Research Analysis Results \(2020\)](#)

Based on table 2, it can be explained that all critical thinking skills instruments are aligned with the basic competencies. The basic competencies are basic skills that are required by the curriculum. The validity test showed criteria of 3 questions are less valid, 3 questions are valid, and 1 question is very valid. In comparison, the reliability test obtained criteria of 5 questions are high, and 2 questions are very high. The table concluded that the instrument for critical thinking ability to measure students' understanding of the biome topic is valid and reliable.

Analysis Data

The Gain Score data were then analyzed through the following stages: Normality test of data distribution, homogeneity test of data variance and independent sample t-test using SPSS application. Critical thinking skills are classified with the following categories: Score of 0-40 for the uncritical category, score of 41-55 for the less critical category, score of 56-65 for the quite critical category, score of 66-80 for the critical category, and score of 81-100 for the highly critical category ([Purwanto, 2005](#)).

Implementation of the PjBL plus 4Cs

The PjBL plus 4Cs learning in this study involved two classes. The control group applied conventional learning, and the experimental group applied PjBL plus 4Cs learning. The control class was used the lecture method and divided the students into 5 groups to make presentations to the topic that had been learned. In the final stage, students discussed the presentations to provide suggestions and criticism. The score was obtained from the paper that was presented.

At the first stage in the experimental class, students listened to the presentation of the teacher. Furthermore, in the analyzing stage, students conducted a group analysis after the presentation. In the planning stage, students identify the problems in groups and look for alternative solutions. The executing stage, students have worked on several projects as alternative solutions, such as making posters, interactive media, pamphlets and videos. Then, students present the project to their classmates. The following pictures are the implementation of the PjBL plus 4Cs learning.



Figure 3.
The Stages of Implementing the PjBl 4Cs Model

Based on Figure 3, it can be explained that the implementation of PjBL 4Cs was carried out in 6 stages. In the final stage, the teacher assesses the students' critical thinking skills using essay (post-test). The post-test results then analyzed to see the changes that occur after the learning treatment used the conventional model and the PjBL plus 4Cs model.

Results

Critical Thinking Skill Data

The results of this research were scores of pretest and final posttest critical thinking skills in the control group and experiment group. Furthermore, the gain score data were calculated by reducing the posttest score with the pretest score. The gain score describes an increase in critical thinking skills. The comparison of the pretest, posttest, and gain scores of critical thinking skills is presented in Table 3 below.

Table 3.
Comparison of Pretest, Posttest, and Gain Scores of Critical Thinking Skills

Group	Pretest	Posttest	Gain Score
Control	51.08	76.11	25.03
Experiment	51.67	88.96	37.29

Source: [Research Analysis Results \(2020\)](#)

Table 1 illustrates that at first, the average pretest scores of critical thinking skills of the two groups were equal. Furthermore, in the posttest, both groups experienced an increase in average critical thinking skill scores. The average gain score obtained by the experiment group was $\bar{X}=37.29$, higher than the control group which was only $\bar{X}=25.03$. The difference between the gain scores of the two groups was 12.26, indicating that the increase in critical thinking skills of the experiment group (with the application of PjBL plus 4Cs) was greater than the control group. In detail, the comparison of the pretest, posttest, and gain scores of the critical thinking skills is depicted in Figure 3.

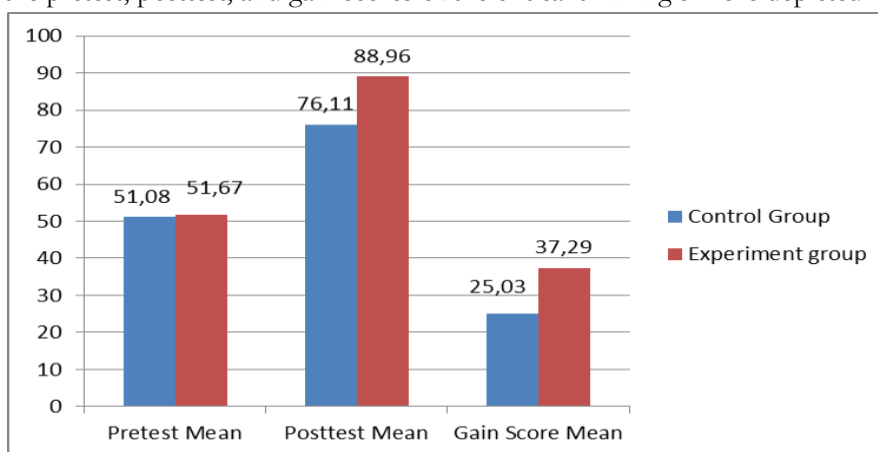


Figure 4.
Diagram of Comparison of Critical Thinking Skill Pretest, Posttest and Gain Scores

As a condition of conducting analysis, the gain score data for critical thinking skills were first tested for normality to ensure that the data had a normal distribution and then tested for homogeneity to ensure that the data started with the same variance. The results of the normality and homogeneity tests showed that the data had a normal distribution and came from an equivalent variance. Due to meeting the requirements, the results of data tests were considered feasible to be tested for parametric statistics. The detailed data results of this research are shown in Table 4 and 5 below.

Table 4.
Normality Test Results

Class	N	Mean	Std. Deviation	Sig. Value (p)	Value Criteria (p)	Normality Test Decision
Control	21	25.10	10.193	0.985	> 0.05	Normal
Experiment	26	37.23	13.039	0.347	> 0.05	Normal

Source: [Research Analysis Results \(2020\)](#)

Taking into account that the average gain score of the experiment group (37.29) was greater than the control group (25.03) with a difference of 12.26, it can be concluded that the application of PjBL Plus 4Cs learning model has a significant effect on critical thinking skills. Before the independent sample t-test is carried out, it is necessary to conduct a homogeneity test to see the average homogeneous score of the experimental class and the control class. The following are the results of the homogeneity test showed in table 5

Table 5.
Homogeneity Test Results

Levene Statistic	df1	df2	Sig. Value (p)	Value Criteria (p)	Homogeneity Test Decision
.408	1	45	0.526	> 0.05	Homogenous

Source: [Research Analysis Results \(2020\)](#)

The hypotheses were tested using the independent sample t-test. The hypothesis testing results of the effect of PjBL plus 4Cs learning model on critical thinking skills are presented in Table 6.

Table 6.

Hypothesis Test Results of the Effect of PjBL plus 4Cs Learning Model on Critical Thinking Skills

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	T	df	Sig. (2-tailed)
Critical Thinking Skills	.408	.526	-3.488	45	.001

Source: [Research Analysis Results \(2020\)](#)

The t-test analysis results revealed that the significance value was 0.01 (< 0.05), meaning that H_0 was rejected and thus H_1 (alternative hypothesis) must be accepted. That is, the two groups have a significant difference related to critical thinking skills.

Discussion and Conclusion

The PjBL Plus 4Cs learning model applied to the experimental group empirically is proven to be able to improve critical thinking skills. Students taught with the application of PjBL plus 4Cs are trained to improve critical thinking skills (Amin, 2017; Sularmi et al. 2018). An increase in critical thinking skills is a consequence of carrying out each stage/syntax of PjBL Plus 4Cs learning model. The PjBL Plus 4Cs learning model can increase student motivation, learning meaningfulness, and student learning experience (Fini et al. 2018; Guo et al. 2020; Samsudin et al. 2020).

The series of learning syntaxes positively affects the improvement of critical thinking skills based on Bloom's taxonomy and also according to the critical thinking indicators (Derry, 2013; Fitriani et al. 2020). Through the PjBL plus 4Cs syntaxes, the students are taught, trained and improved to think critically, including analyzing/formulating problems, giving logical arguments, doing deductive reasoning (C4), synthesizing/ conducting inductive reasoning (C5), and evaluating (C6). The PjBL Plus 4Cs with detailed PAPER Syntaxes is as follows: Presenting, Analyzing, Planning, Executing, and Reporting (Anderson & Krathwohl, 2010).

The first syntax is presenting a significant issue. In this stage, the students listened to the important information presented in the form of videos and articles related to the distribution and conservation of flora and fauna. Initially, the students listened to the teacher's explanation as an introduction, then watched the video presentation, and proceed with reading the article that had been prepared. The issue of extinction of flora and fauna provided opportunities for students to care about the life around them to inspire them related to what can be done and contributed to the community at this time and in the future (Feldman, 2010). Developing issues becomes lighters for students to develop their projects. Moreover, the students were stimulated by formulating problems or making fundamental questions related to the distribution of flora and fauna. In the first syntax, the students were trained to think at a high cognitive level of C-4 in the form of analyzing issues to formulate problems (Kokotsaki et al. 2016). In detail, the first syntax was carried out by conditioning the students to do these following activities: watching a video of the distribution of flora and fauna, followed by a video of the extinction of sharks caused by environmental damage, reading articles presented in the form of workbooks with the theme of thousands of species endangered due to human activities, making fundamental questions based on observations of the given video presentations and article readings. The basic question formulation was written in the workbook. The formulation of the students' problems all led to the causes, consequences and solutions to overcome the problems (Alawi & Soh, 2019).

The second syntax is analyzing the existing condition. At this stage, the students were facilitated to analyze the practices related to the issue of the distribution and conservation of flora and fauna. Through discussion, the students conducted a simple SWOT analysis by examining some strengths, finding weaknesses, analyzing opportunities potentially becoming project ideas, and predicting threats possibly occurring. This stage can develop the students' way of critical thinking, analyze issues, and come up with ideas/ actions that can benefit the community and are expressed in the form of projects (Sari et al. 2019). Raising this idea is directed to encourage students to find original unconventional ideas and find solutions to solve problems (Jo & Bednarz, 2014). Doing a SWOT analysis includes developing the cognitive level of analyzing/ formulating problems. This is supported by the research results that critical thinking skills on the item of analyzing/ formulating problems in the experiment group obtained a greater average gain score than the control group (Alawi & Soh, 2019; Amin, 2017; Guo et al., 2020; Kokotsaki et al. 2016).

Increased critical thinking skills on the item of analyzing/ formulating problems is a consequence of the implementation of PjBL plus 4Cs. This stage also develops the 4Cs “Super Skills” of creativity by teaching students to design products that can explain their thinking. The students were taught creatively by bringing up their ideas, designing and creating products representing the results of their thinking in the form of pamphlets and posters shared on Instagram, videos shared on IG-TV, and interactive media autoplay applications that become interactive learning media (Bayram et al. 2019; Pattanapichet & Wichadee, 2015). In more detail, the second syntax was carried out by conditioning the students to do these following activities:

- Conducting a SWOT analysis related to the issue of extinction of flora and fauna species due to environmental damage caused by human activities. The analysis was carried out together through group discussion.
- Identifying the problem formulation that had been made before. The identification was written in the workbook.
- Identifying a project to be made based on the analysis results
- Bringing up ideas/ actions to make a project. The ideas generated are a form of students’ critical thinking processes. The ideas lead to something that will be useful for the preservation and conservation of flora and fauna.

The third syntax is planning the project. At this stage, the students ensured and determined the project to be developed. Furthermore, the students made plans according to their interests, desires and abilities. The plans were discussed with the group. The plans include design/ sketch, contents, tools, materials, schedules and costs. To make designs and contents, the students looked for various information on the internet to support the success of their projects. At this stage, critical thinking skills were also taught. From the information obtained or the initial design, the students could analyze for a better change. Design analysis can be related to changes in the design form or additional function to produce project plans that are truly meaningful and contribute to the community (Priyatni & As’ari, 2019; Samsudin et al. 2020). Up to the stage of designing from new ideas or the result of a modification, it shows that the students have done synthesis thinking (Sularmi et al. 2018). That is, this stage teaches the students critical thinking of analyzing (C4) and synthesizing (C5) (Fini et al. 2018; Somjai & Soontornwipast, 2020). Bringing in expert consultants at this stage can more motivate and help students to develop their detailed project designs. The schedule was also really designed so that project completion did not exceed the predetermined time limit. In more detail, the third syntax was carried out by conditioning the students to do these following activities: Rediscovering products that had been determined in the previous stage (Sari et al. 2019); Completing various product contents from various sources including the internet and expert figures (Bayram et al. 2019); discussing in a group and focusing on preparing designs, developing contents, determining tools and materials, compiling time schedules and designing budgets (Somjai & Soontornwipast, 2020); and completing the workbook until the planning stage (Mutakinati et al. 2018).

The fourth syntax is executing the project that has been made. To make each student contributed to the project, there must be work division. The students collaborated and learned to communicate well. At this stage, critical thinking is developed in more detail. While working on the project, the problems emerging must be solved by giving arguments to the group to accept the solutions offered. The cognitive skill taught to the students was giving argument and giving deductive reasoning (C-4), conducting inductive reasoning to explain the impact of the extinction of flora and fauna (C-5), and evaluating, giving solutions and implementing the solutions taken when executing the project (C-6). This is supported by the research results stating that for all items which are the critical thinking indicators, the experiment group has a greater average gain score than the control group (Elbow & Sharma, 2000; Fini et al. 2018; Mutakinati et al. 2018). In linear, (Utomo, 2016) confirmed that in practicing critical thinking, students must be conditioned to do group discussion, develop reasoning, arguing logically and based on evidence, taking appropriate decisions, and looking for various alternative solutions. At this stage, the 4Cs “Super Skill” of Collaboration also seemed to develop, in which the students worked together in their groups. Cooperation and communication between students made them more understand about analyzing, giving arguments and seeking solutions to increase their critical thinking (Fitriani et al. 2020; Somjai & Soontornwipast, 2020; Sularmi et al. 2018). This is supported by Vygotsky stating that through communication, discussion and collaboration, the students' mental function can be improved (Derry, 2013). The increased mental function indicates critical thinking skill improvement. In more detail, the fourth syntax was carried out by conditioning students to do the following activities: Making products following the project

being designed; filling out the activity journal on the workbook; collaborating between group members in working on their project, supervised by the teacher or advisor; collaborating in gathering references from various sources and speakers; looking for expert help, and finalizing the project. In project finalization, changes often occur as part of the evaluation conducted by students and their groups to get the best results on a project (Alawi & Soh, 2019; Kokotsaki et al. 2016).

The fifth syntax is reporting the project. At this stage, the students compiled reports on the project working process, the thinking process undertaken, and the products produced. The emphasis is not on product results so that what is exhibited can be in the form of prototypes (Somjai & Soontornwipast, 2020). The main emphasis is on presenting and communicating related ideas/ thoughts developing during the process. At this stage, the 4Cs “Super Skills” of Communication developed, in which the students were taught to present their ideas, opinions and thoughts to others. In more detail, the fifth syntax was carried out by conditioning the students to do these following activities: Preparing the display by improving and perfecting the project appearance, collecting project reports including workbooks, practicing to present and communicate within the group, holding an assembly/ performance to show products that had been made by making product identification and also working steps on a banner, presenting the product to other students, teachers, and parents. This stage includes answering visitors’ question in a strict, straightforward and polite manner.

The findings discussed above suggest that the application of PjBL Plus 4Cs can improve student intelligence, especially critical thinking skills. The PjBL Plus 4Cs also teaches and sharpens the students’ creative, collaborative, and communicative skills (Alawi & Soh, 2019; Feldman, 2010; Fini et al. 2018; Jameson, 2019; Puspitasari et al. 2016; Somjai & Soontornwipast, 2020). This is consistent with explanation that PjBL can improve multiple intelligences. Thus, PjBL Plus 4Cs can equip students to have the 4C “Super Skills”.

The advantage of the PjBL Plus 4Cs model is contextual and meaningful learning (Fini et al. 2018; Guo et al. 2020). Students are faced with real problems and they have to seek solutions to overcome the problems by making a project (Amin, 2017; Somjai & Soontornwipast, 2020; Sularmi et al. 2018). The project is then directed to be able to contribute to the community (Samsudin et al. 2020). Projects can make students more active when it is in accordance with their interests (Guo et al. 2020). Conformity with interests makes them more eager to search and find knowledge independently. Student activities in realizing and working on the project provide them with learning experiences building knowledge (Fini et al. 2018; Guo et al. 2020). Also, students are motivated by the meaningfulness and importance of their projects for the community (Fini et al. 2018; Samsudin et al. 2020). In other words, through their projects, students have taken local action for global interest. In addition to focusing on improving critical thinking skills, PjBL Plus 4Cs in the syntax stages also trains cooperative, creative and communicative skills and the presentation skill (Ridhwan et al. 2020; Sari et al. 2019).

The 4Cs connection in PjBL Plus 4Cs learning is described as follows: The 4C “Super Skills” are trained through the PjBL Plus 4Cs learning model that develops student multicompetence. The combination of PjBL Plus 4Cs teaches students through projects, focusing on training students’ skills in critical thinking, creativity, collaboration, and communication (Sasson et al. 2018; Fitriani et al. 2020). Furthermore, the skills trained in PjBL Plus 4C learning are described as follows:

- *Critical thinking*: high order level thinking taught in the 1-4 syntax, including formulating problems, conducting a SWOT analysis, giving arguments, doing inductive-deductive reasoning, taking and carrying out decisions and evaluating.
- *Collaboration*: learning process trained in Syntax 2-5 which is conducted through group work and discussion.
- *Creativity*: learning processes trained in Syntax 3-4, including designing projects from new ideas or modification.
- *Communication*: learning processes trained in Syntax 5, in which students are required to make presentations at an assembly/ display.

The researchers noted the weaknesses and strengths of PjBL Plus 4Cs learning as follows: The students’ ideas are sometimes too wild, considered imaginary out of the subject matter and sometimes difficult or even unable to be realized. That is, the projects only stop at ideas or prototypes, and logical reasons leading to solutions to realize the ideas. The students are more likely to make IT-based projects, indicating that no group chooses projects like making

popup-books which are considered rather complicated by the work of cutting and glueing paper. The teachers are not able to facilitate student projects that all rely on IT skills, so it is necessary to involve expert consultants. The students waste time by chatting or telling stories out of the materials during the discussion session of problem analysis to design realization. The students feel disappointed with the limited time (changing class hours) while they are enthusiastic about completing their projects. In other words, one of the advantages of PjBL Plus 4Cs is its ability to motivate students to learn. Outside the learning hours, the students are willing to do their projects. To realize the projects, the students also learn and seek information independently (Mutakinati et al. 2018). Meanwhile, in the control class, the students are still less enthusiastic to read and learn the prepared materials and articles (Mutakinati et al. 2018). Several groups depend only on students who have ideas while the other students lack the courage to change their friends' agreed ideas. As a consequence, the agreed project designs are difficult to realize when the students who have the main idea are absent while the other students lack encourage to modify or change the ideas (Sasson et al. 2018; Alawi & Soh, 2019). There are several students (4 students) found to be inactive or only follow or depend on their friends' ideas. However, these students help work while executing the projects (Guo et al. 2020). Several students are interested in other group projects, so they often leave their groups to look for information and learn from other group projects. In this research, it happened to the poster groups who were interested in learning to create and edit videos (Bayram et al. 2019). The students tease each other arguments in changing or maintaining a better form/design. These arguments make the group work alive when executing projects. The contribution of learning is more toward creative thinking, but to be creative, students need to think at a high level. Good collaboration between students makes their shortcomings covered.

Recommendations

Based on the empirical evidence and discussion above, it can be concluded that the application of PjBL Plus 4Cs has a significant effect on the increase in critical thinking skills. This is based on the calculation of the gain score illustrating the increase in critical thinking skills. The results indicate that the experiment group applying PjBL Plus 4Cs experiences a higher increase in critical thinking skills than the control group with conventional learning. The gain score of the increased critical thinking skills in the experiment group was $\bar{X} = 37.29$ and in the control group was $\bar{X} = 25.03$. Based on the conclusion, we suggest and expect that PjBL Plus 4Cs learning can be an alternative learning model to improve the quality of learning in geography, especially critical thinking skills. Qualitative research is needed to find out more about the teachers' and students' role in PjBL. Other learning can be studied to find out the effectiveness in developing critical thinking abilities.

Limitations of Study

The research is limited to high school students. Besides, there was only one dependent variable in this study, namely critical thinking. Other factors that influence the results of critical thinking in this research are still ignored. Further research is needed to determine the effectiveness of the PjBL plus 4Cs model on a broader subject with different school and class levels. Other cognitive variables can be investigated as dependent variables in further research.

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Appendix 1.*PjBL Plus 4Cs Instructional Design Example*

Starting PjBL plus 4Cs learning, the teacher greets students and motivates them to participate in the lesson.

First Stage (Presenting): At this stage, the teacher presents the topic using power points while students listen. In this activity, students are allowed to ask questions about the difficult topic. At the end of the presentation, the teacher gave students problems to be solved. One of the problems presented is reduced biodiversity, including the reduction of protected animals.

Second Stage (Analyzing): At this stage, the group of students analyzes the problems given by the teacher. The teacher acts as a facilitator for students. Each group can share ideas and solutions for problems related to fauna and flora.

Third Stage (Planning): At this stage, students plan solutions based on the problems found. One of the students' solutions was to provide information and education to the community regarding the importance of protecting and preserving protected animals.

Fourth Stage (Executing): At this stage, students prepare topics to convey information and campaign for protecting plants and animals. Students make posters in groups, make interactive media using adobe flash, and play video documentaries related to protecting plants and animals.

Fifth Stage (Presenting Poster) and Sixth Stage (presenting media): At this stage, students share campaigns and publish the work. The teacher can assess students' communication skills, collaboration, critical thinking, and creativity.