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A Case-based Study in ERP Instructional Model: Fostering Critical Thinking Skills and Portraying Independence on Solving Problems

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Abstract

Case-based study has a lot of potential in supporting the success of learning outcomes needed in the 21st century, one of which is critical thinking skills. However, there are very few studies related to case-based study to promote critical thinking skills. Therefore, this study will analyze the effectiveness of case-based study in improving students' critical thinking skills. In this research, case-based study is carried out with engage, research, present (ERP) instructional model. The ERP model has potential and is in accordance with case-based study schemes for the university level. In addition, this study was also conducted to analyze the achievement of student independence in conducting research to solve a problem. This study used a non-equivalent control group research design with 70 samples divided into the experimental group (N = 35) and the control group (N = 35). The instrument used is a standardized test of critical thinking skills developed by Ennis, namely the Cornell Critical Thinking Test (CCTT) level X and an observation sheet for student independence in solving problems. The results showed that case-based learning using the ERP model (experimental group) was more effective than case-based learning without the ERP model (control group). However, the learning process carried out in groups is effective in improving critical thinking skills. This shows that case giving is quite effective in supporting critical thinking skills. In addition, the dominance of the achievement of student independence in conducting research (in the experimental group) to solve problems is at level 3, namely scaffolded research. The implication is that case-based learning is suitable for use in improving critical thinking skills at the university level.

Keywords: Case base study, ERP instructional model, critical thinking skills, independence, problem solving.

Introduction

Case base study is a learning approach that emphasizes students as learning actors, often referred to as student center learning. This learning process facilitates so that students are able to construct their own knowledge through investigating a case/problem (Günther et al., 2019; Sudzina, 1997). Several studies have shown that the learning process that emphasizes the investigation of a case provides many benefits to students (Flynn & Klein, 2001; Kim et al., 2006; Levin, 1995; Luo et al., 2018). Among them, being able to develop and use critical thinking skills, as well as problem solving to analyze situations and recommend realistic solutions through a better understanding of theory.

On case based study, students are given a realistic and contextual problem scenario (case) to be solved by students (Luo et al., 2018; Sudzina, 1997). Students actively try to solve the problem. The cases/problems presented contain many things that can facilitate students to get the knowledge they are studying (Günther et al., 2019). Thus, his efforts to solve the problem directly also facilitate the acquisition of knowledge.

The obstacle faced in the application of case-based studies to learning at the university level is the learning syntax that has not been designed by adjusting the characteristics of learning for the tertiary level, namely integrating research activities in case investigations. according to Junpeng & Tungkasamit (2014), research is an important part that cannot be separated in the world of higher education which must be integrated in the teaching and learning process. Research activities that are integrated in the learning process provide benefits including increasing student learning outcomes in depth (Srikoon et al., 2014)there are not many studies about the body of knowledge on research-based learning in Thailand. So, the objective of this research is to synthesize the research-based learning. Variables consists of two sets. First set is the description of research. Second set is the effect sizes of research. Tool for collecting data is the recording data form for research synthesis. Data were analyzed by frequency, percentage and meta-analysis.

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The results showed that (1, both the achievement of cognitive, affective, and psychomotor learning outcomes (Sota & Peltzer, 2017). Research activities facilitate students with research skills that are essential to their education (Hutagaluh et al., 2020) and construct their own knowledge (Wannapiroon, 2014).

Therefore, seeing the benefits of case-based learning and also the importance of research activities to be integrated in the learning process, this research will implement case-based learning that emphasizes research activities in case investigations. The researcher implemented the engage, research, and present (ERP) learning model. ERP learning model (Engage, Research, Present) is a learning model designed to practice research activities in an effort to acquire knowledge (Haryati et al., 2020; Sukarno et al., 2020). This learning model provides opportunities for students to discover, explore, and develop knowledge and skills to solve problems they face by building connections between intellectual activities (thinking processes) and practical activities through research activities that are integrated into learning activities. The learning process carried out in the ERP model also emphasizes students to learn actively and independently (Sukarno et al., 2020).

In this study, the implementation of the ERP learning model as a case-based learning tool was carried out to develop students' critical thinking skills. In addition, the achievement of student independence in conducting research activities to solve the given problem is also analyzed. The development of critical thinking skills and efforts to photograph the achievement of student independence in solving a problem through research activities is important to do because it is part of higher order thinking skills/Higher Order Thinking Skills (HOTS) (Saido et al., 2018). The learning process in higher education should not rule out HOTs, because the essence of the learning process in higher education is to train HOTs (Karim & Darwish, 2018; Miller-Rushing et al., 2012; Zohar & Dori, 2003), in order to be able to face challenges or problems in everyday life (Saido et al., 2018). In addition, according to (Binkley et al., 2014), both of which are important skills for students to master in the 21st century.

The novelty of this research is to apply a learning model (ERP model) with a syntax that is by research and the character of students in higher education. In addition, the analysis of the impact of the learning model on aspects of critical thinking skills and independence is the leading study in this research, where no research examines a model to support these two abilities. Finally, this study aims to analyze the effectiveness of case study-based learning conducted using the ERP learning model in improving students' critical thinking skills and achievement of independence in conducting research to solve a problem. Specifically, the formulation of the problem in this research are:

1. How to improve students' critical thinking skills after applying case-based learning using the ERP learning model?
2. How is the achievement of student independence in conducting research to solve a problem after applying case-based learning using the ERP learning model?

Method

Research Design

This study uses a non-equivalent control group research design (Robson & McCartan, 2016). In this research design, two groups were used, one as the experimental group and the other as the control group. In the experimental group, case-based learning was implemented using the ERP learning model, while in the control group case study-based learning was applied without using the ERP model. The learning process is carried out in science programs, especially in electricity and magnetism courses. See Table 1 for more details on learning in the experimental and control groups. Each group is taught by the same teacher in a duration of 6 meetings, each meeting is 120 minutes. There were two cases investigated by the students, and each case was solved in a duration of 3 meetings. Before and after the meeting, a critical thinking skill test was conducted. During the learning process, observations were made on students (in groups) to obtain data about the achievement of student independence in conducting research to solve the problems given.

Participants

The research subjects were 70 prospective science teacher students at one of the state universities in Indonesia, precisely in the province of Central Java. The research subjects were divided into 2 groups, namely the experimental group and the control group where each group consisted of 35 students. This research was conducted when students were in semester 4 (end of the second year), in electrical lectures.

Data Collection and Analysis

In this study, data were collected using a standardized test instrument to measure critical thinking skills, namely the Cornell Critical Thinking Test (CCTT) Level X developed by

Table 1: Research Design

Before giving treatment	*Giving treatment*	*After giving treatment*
Pretest experimental group	Case-based learning using the ERP model	Experimental group posttest
Pretest control group	Case-based learning without using an ERP model	Control group posttest

Ennis. According to Gedik (2013), this test can be used for high school and college students. The CCTT-LX instrument consists of 71 items in the form of multiple choice, where each question consists of three answer choices. Correct questions will be given a score of 1, and incorrect questions will be given a score of 0. Students complete the entire test in about 50 minutes.

The test was carried out 2 times, namely as a pretest and posttest. The data obtained in the form of pretest and posttest data were analyzed based on the experimental group and the control group. In addition to the test instrument, an observation instrument was also used to assess student independence in solving cases.

Classroom intervention

In this study, the learning process is carried out by using cases as a lighter in learning activities. Case-based learning is designed to help students think critically in solving problems. The cases given are contextual cases in everyday life. Case content can be manipulated to include clear descriptions of related content, thereby supporting learning and knowledge transfer (Bagdasarov et al., 2013).

Giving cases to the experimental group is based on research activities. Research activities are carried out using the ERP (Engage, Research, Present) model syntax with a case learning design. In the engage phase, students are given cases that must be solved. In more detail the subphases on the ERP model syntax (Haryati et al., 2020) shown in table 2.

In the experimental group, cases were solved through all sub-phases of the ERP model, so that students could solve cases scientifically and in detail. In the control group, the given cases were solved without using the ERP model. In this case, the lecturer gives a problem, then students are asked to analyze the problem directly, then make a report and present it in front of the class.

Table 2: Details of activity stages in ERP model

No	*Phase (P)*	*Sub Phases (SP)*
1.	Engage	Reading case-based phenomena Identifying the phenomena Writing the research question Reviewing related literature Creating the map of investigating stage
2.	Research	Formulating hypothesis Doing investigation Analyzing data and doing discussion Concluding the discussion Writing report
3.	Present	Making mind mapping or research activities Presenting the research result by using mind mapping

Findings

Achievement of students' critical thinking skills

The results of students' critical thinking skills are shown through quantitative data analysis of pretest and posttest scores. The differences in the results of critical thinking skills from the two groups with different treatments were compared and discussed the theoretical and actual results. Both groups were tested for normality and homogeneity to determine the data analysis performed. The results of the normality test using the Kolmogorov-Smirnov test in the control group pretest ($z = 0.200$, $p>0.05$), control group posttest ($z = 0.108$, $p>0.05$), and experimental group posttest ($z = 0.200$, $p> 0.05$) indicates that the data is normally distributed, while in the pretest data of the experimental group ($z = 0.041$, $p > 0.05$) the data is not normally distributed. Furthermore, the homogeneity test ($z = 0.229$, $p<0.05$) showed that the data were homogeneous. This data analysis information becomes a reference for determining data analysis in more depth in relation to the research questions posed. Based on the normality and homogeneity test data, the average difference test involving the experimental group's pretest data was carried out using non-parametric statistics, while those that did not involve the experimental group's pretest data were carried out using parametric statistical tests.

The difference test for the average pretest and posttest of the experimental group was carried out using the Wilcoxon test to get the Asymp value. Sig. (2-tailed) of 0.00 and $p < 0.05$. These results indicate that there is a significant difference between the results of the pretest and posttest in the experimental group. Then, in the control group, the average difference test for pretest and posttest was also carried out using the paired sample T-test. The results of the calculation of the data obtained the value of Sig. (2-tailed) of 0.00, $p <0.05$, so it can be concluded that there is a significant difference between the results of the pretest and posttest in the control group. The results of this test indicate that the treatment given to both the experimental group and the control group has an impact on students' critical thinking skills. To see the significant impact of case-based learning using the ERP model, it was done by comparing the data between the experimental group and the control group.

Then, the experimental group pretest and control group pretest mean difference test using the Mann Whitney test. The test results obtained the Asymp value. Sig. (2-tailed) of 0.00 and $p < 0.05$. This shows that the value obtained is > 0.05, so it can be concluded that there is no difference in the pretest value between the experimental group and the control group. These results indicate that before the groups received different treatment, the results of the critical thinking abilities of the two groups did not differ significantly. The impact of different treatments was seen through a different test of the average post-test of the experimental group and the control group

using the independent T-test. The results show that the value of Sig. (2-tailed) of 0.00, p <0.05, so it can be concluded that there is a significant difference in the post-test scores between the experimental group and the control group. Based on the achievement of critical thinking skills after treatment in the experimental group (N = 35, Mean = 70.02) which was greater than the control group (N = 35, Mean = 59.75), it was concluded that the treatment carried out in the experimental group more effective than the control group. Statistically it was answered that the case-based learning model using the ERP model was effective in improving critical thinking skills. The test of the effectiveness of improving critical thinking skills between the experimental group and the control group can be seen with the gain value presented in Table 3.

Table 3 shows that the increase in critical thinking skills in the experimental group and the control group is on the same criteria, but the gain value for the experimental group is greater than the gain value for the control group. These results indicate that case-based learning using the ERP model is higher in improving students' critical thinking skills compared to case-based learning without using the ERP model.

Student independence in doing research

Based on the results of observations during the case-based learning process using the ERP model, there are various levels of student independence in solving cases. Student independence is based on observations in groups. The level of student independence in completing case learning uses the level of independence in the research skill development (RSD) framework (Willison & O'Regan, 2007). Level 1 (Prescribe research), research activities are carried out with very structured direction and modeling from lecturers in encouraging research. Level 2 (Bounded research) research activities are carried out by lecturers by setting limits and limited directions from the research to be carried out. Level 3 (Scaffolded research), scaffolding is placed by lecturers to form independent research. Level 4 (Open-ended research), students initiate research and receive guidance from lecturers. Level 5 (Unbounded research), students determine their own research guidelines that are appropriate to the discipline or context. The results of the level of student independence in learning are shown in table 4. Table 4 shows that the dominance of student independence in conducting research to solve problems is at level 3. Other student independence levels are at level 2 and level 4.

Table 3: Improving students' critical thinking skills in the experimental group and control group

Group	*Gain value*	*Upgrade criteria*
Experiment	0.52	Moderate
Control	0.34	Moderate

Table 4.: The level of student independence in case-based learning using the ERP model

Research independence level	*Achievement (number of groups)*
Level 1	-
Level 2	2
Level 3	4
Level 4	1
Tier 5	-

Discussion

The results showed that students' critical thinking skills increased both in the group that applied case-based learning with the ERP model or those without the ERP model. However, the increase in critical thinking skills in the group using the ERP model was higher than the group without the ERP model (Research Question 1). In the learning process, both in the experimental group and the control group, students solve cases through problem analysis in group discussions. Both groups experienced an increase in critical thinking skills because in case learning students were asked to critically solve cases through group discussion. These results are supported by research by Li et al. (2019) and Kaddoura, M.A. (2011) in different programs, namely the nurse program. Case-based studies can effectively improve students' critical thinking skills by solving real problems. This is reinforced by research results which show that discussion affects the ability to think about cases (Levin, 1995; Weil et al., 2011). Through discussion in case-based learning, students get the benefit of obtaining information that supports improving their ability to critically review case information (Weil et al., 2011). In this case, case study-based learning, whether conducted in the experimental group or the control group, has a role in supporting critical thinking skills (Akins et al., 2019).

In the experimental group, the case-based learning model using the ERP model can effectively improve critical thinking skills higher than learning without ERP in the control group. This can happen because at the stage of the ERP model students are required to be critical in planning solutions, taking actions, and explaining these solutions. The cases given in the case-based learning model using the ERP model are carried out in the phase *engage,* where the first stage is reading the phenomenon or in this case the case given by the educator. The ERP model aims to strengthen students' research abilities because it consists of several sub-phases that highlight research skills (Haryati et al., 2020), so that students can solve cases well. Each sub-phase in this model invites students to be involved in all activities that lead to how to solve cases scientifically. Research skills in solving problems helped academics and casual staff develop students' critical thinking (Mataniari et al., 2020).

Research activities carried out in an effort to solve cases in the experimental group support the achievement

of critical thinking skills. According to Junpeng (2014) and Minner (2010), the learning process that facilitates students to carry out investigation activities like a scientist is able to facilitate students to achieve learning outcomes as planned. In addition, the learning process that facilitates students to solve contextual cases through a scientific stage is able to support the achievement of critical thinking skills (Williams, W.M., *et al*, 2004; Fensham, PJ, 2009; Brundiers, K., *et* al, 2010).

The results of this study also show the achievement of student independence in conducting research to solve a problem after applying case-based learning using the ERP learning model. The results showed that by applying the ERP model, students' independence was at level 3, namely scaffolded research (research question 2). Scaffolding is given by lecturers to form independent research. Scaffolding provides students with the help they need and allows them to solve cases independently (Larkin, 2001; Radford, et al., 2015). More than 50% of students (table 4) can carry out research activities independently with only a little guidance from the lecturer. The independence of these students affects their critical ability in solving problems. These results are supported by research on independence in the ability to solve problems (Amalia et al., 2021). This is because in the ERP model there are already sub-phases that direct students to be able to solve cases scientifically, so that students can solve cases independently. Achievement of student independence in solving cases up to level 4, where students can initiate their own research with guidance from lecturers.

The main weakness of this research is the small number of samples, and this is because the models in the electricity and magnetism courses are limited. This research was carried out in certain subjects only because it was related to the technical implementation of the learning process. In addition to the limitations of this study, the research has implications for the importance of applying case-based learning design. In higher education, case-based learning can be used by applying the ERP learning model because students can learn to research and solve problems through this model. By applying case-based learning through the ERP learning model, it can have a positive effect on student independence in learning, namely through problem-solving

Conclusion

Based on the research conducted, the results show that case-based learning using the ERP model can effectively improve students' critical thinking skills. The results of the analysis of students' critical thinking skills whose learning uses case-based learning with the ERP model are higher than students whose learning uses case-based learning without the ERP model. The results of other studies show that more than 50% of students' independence in solving cases is at level 3, where with the ERP model students can do research with scaffolding from lecturers.

Limitation and Suggestion for Future Work

Some of the shortcomings in this study are described as follows. First, the research was conducted on a small number of samples and at one level, so that the generalizability of the research results is limited. Second, the instrument used to assess critical thinking skills is only at the beginning and end, so it cannot describe students' thinking skills at each phase carried out in ERP. Other similar studies can pay attention to the following points, namely: 1) increasing the number of samples at several levels of students, so that the scope of generalization is wider, 2) using instruments to assess critical thinking skills when students are solving cases. This can be done to see which sub-phase can have the strongest impact on students' critical thinking skills.

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