

# The Effectiveness Of Blended Learning Models On Critical Thinking And Science Process Skills In Physics Subjects: A Literature Review

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**ABSTRACT**

The purpose of this study was to determine the effect of the blended learning model on students' critical thinking, creative thinking, and science process skills. blended learning is a model that combines conventional and online learning. Learning With a blended learning model to answer the challenges of 21st-century skills in the era of the industrial revolution 4.0, many activities are carried out online, including learning. In the era of industrial revolution 4.0, many students are required to master various abilities including critical thinking skills, creative thinking, and science process skills. Students are said to have the ability to think critically if they meet the indicators of critical thinking. Likewise, for science process skills. The subjects of this study were high school students and university students. while the research design used qualitative research with the case study method, the sample used was as straight as the students or students included in the articles studied using non-random sampling techniques. From the literature review it was found that this blended learning model had a positive effect on students' critical thinking or creative thinking skills. In other studies, it was also found that the blended learning model could improve students' science process skills.

## INTRODUCTION

21st-century skills are skills that are very much needed by students to face the increasingly rapid technological era, 21st century skills encourage students to take an active role in participating in learning, communicating, collaborating to access information technology from the internet, improving critical thinking skills, integrating concepts itself through learning activities or through a scientific process to solve a problem. (Saavedra, Opfer, & Wagner, in Astuti, Sugiyarto & Ikhsan, 2020).

With the development of information technology, learning is starting to be greater of a face full to online learning, online learning is not only centered on the teacher, but more involved are students, Jhonson in Mohammed Mansur Ibrahim & Musser Nat (2019), one of the study based e-learning is Blended learning, Blended learning is learning strategy that combines the conventional and the system online learning (Fauziyah, et al, 2019; H.Pujiastuti & R. Haryadi, 2020 and Chairman, Sharma, Tao, et. al, Liu, et, Ghanem, and Hamayil in Bahri. A, et al, 2021), and integrating learning face to face and online learning (Charles Dziuban, et al, 2018; Wahyudi Wahyudi, SB Waluya, Hardi Suyitno & Isnarto Isnarto, 2019 ).

Blended learning is a meaningful learning method. (Adrien Vavasseur, et al, 2020). Besides, blended learning also provides different experiences for students (Jing Ping Jong, 2016). According to Bonk & Graham in Thanuja Chandani Sandanayake (2019) blended learning is a mode of learning widely accepted by the students to have the opportunity to learn to use digital media online and in the traditional classroom. According to Cabero, Llorente, and Morales on year in Gamiz, V., Montes, R. & Pérez, MC (2014), teachers and students at Spanish universities look favorably towards online

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learning in general and learning blended particular, they have an excuse that Blended learning is flexible and strengthens students to be involved in the learning process. The same thing was also conveyed by Jacob in Li-Tze Lee & Jason C Hung (2015) which stated that blended learning in the US was accepted by both students and parents because it was more efficient and teacher administration was not too difficult, Vaughan examined views on learning. blended learning is effect high, he found learning blended learning is flexible learning over time and learning to see this kind can increase the k a p responsibility of the student to the subject ( Li-Tze Lee and Jason C. Hung, 2015 ). Furthermore, according to Lim and Wang in Ibrahim & Nat (2019) blended learning is in addition to many advantages can not be denied that the system this there are still obstacles in its implementation as well as, schools that are not prepared to facilitate teachers, student yet able to adapt. According to Rahman et al, which is followed by p from Galvis (2018) states that the characteristics of blended learning are a mix of online learning with face-to-face learning. Students or students and teachers or instructors must improve their abilities in dealing with this virtual-based learning. a study conducted by Hidi (2015) in (Dewi Kusuma W, et al, 2019) suggest that connect learning materials to the events ta be able to solve problems that can improve skill students' critical thinking, could happen if supported by the system learning a good one of the only online learning with make use of the Websites that integrate learning with technology. Learning is successful if it can form good student attitudes, have good knowledge and skills. One of these skills is critical thinking and science process skills in students.

Blended learning is a strategy that affects the skills of the student as proposed by some experts. Blended learning has an impact on critical thinking of students, creative thinking, and the science process skills of students (Fauziyah, H, et al, 2019; Yusnita, 2019; Yustina, W. Shafi'i, R. Febriyanto, 2020). Critical thinking is one of the skills to solve problems. This skill will be even better if it is supported by an online learning system. With this system, learning will be more efficient ( Collis and Vander Wende in Yusnita, et al, 2020) because students can repeat and open their lessons online again (Kerdprasop, in Yusnita, et al, 2020). Blended learning can also have an impact on student science process skills aided by video, images, animation, text, chat rooms, etc. (Kisman, 2015 in Fauziyah Harahap, et al, 2019). Also, Blended learning bridges students and lecturers in interacting to gain a constructivist and social safe learning experience. In blended learning, students have ample opportunity to ask questions, express opinions, describe the knowledge, test knowledge, and communicate their ideas to others, all of which are important elements in science. Krishnan in Fauziyah Harahap stages, et al (2019). Many countries highlight the importance of learning with science process skills. In Malaysia, Science Process Skills are built by doing a practicum in science classes (Irene Lue Ping, Lilia Halim, Kamisah Osman, 2020). In addition to having an impact on critical thinking skills and science process skills, BL is also effective for improving students' creative thinking skills because in creative thinking there is one stage of creative thinking, namely learning independently, doing activities independently, this is following the Blended learning strategy (Syakur et al. al, 2020; Wahyudi et al, 2018 in Yustina, W. Syafii, R. Febriyanto, 2020)

## Review of Literature

### *Blended learning*

In the Oxford dictionary, the word "blended" is defined as a mixture between one substance and another, so that it becomes one " so that blended learning is defined as a mixture of conventional learning with web-based learning. (Shamsuddin & Jasber 2020) Blended learning is a mixed learning context between face-to-face learning and virtual learning (Jeffrey, et al., 2014). According to Torissi-Stelle & Drew's opinion in Antonia Bralić and Blaženka Divjak (2018), there are many definitions of blended learning-based learning because blended learning is interesting learning, the essence all definitions in various kinds of literature is this blended learning integrates face-to-face learning with learning online (Yustina, 1, W. Syafii & R. Vebrianto, 2020). The same thing was stated by Garrison & Kanoka in Antonia Bralić & Blaženka Divjak (2018). Blended learning is a combination learning that emphasizes internet technology in distance learning (Najeh, et al., 2019; Han & Ellis in H. Pujiastuti & R. Haryadi, 2020; Siron, Y., Wibowo, A., & Narmaditya, BS, 2020 ).

### *Critical thinking skills*

Argues that *critical thinking* is a systematic and directed process to build and form a belief in the form of action in solving a problem (Dwi Sulisworo, et al, 2020 ). According to another opinion, *critical thinking* ( *critical thinking* ) is reflective thinking and reasoning to decide what to believe or what to do ( Ennis in Susantini E., et al, (2012). In the opinion of Paul and Elder in Astuti, TN, Sugiyarto, KH, & Ikhsan, J. (2020) stated tHAT critical thinking is the art of analyzing and evaluating thinking by improving skills and attitudes. In Bloom's taxonomy, the cognitive domain which is regarded as the definition of critical thinking is the synthesis, analysis, and evaluation. Sumarmo, et al. In Angraini & Wahyuni (2021). Based on the description above, critical thinking skills are characterized by active, reflective, systematic, directed, and reasoned processes directed to decide things that are convincing to be done. experts, there are twelve indicators of critical thinking which are summarized in five stages (Ennis, 2012) ;

- Clarification: the indicator is namely formulating questions, analyzing arguments, asking, and answering questions.
- Give reasons for making decisions: the indicators are assessing the credibility of information sources and making observations and assessing reports on the results of observations.
- Conclusion: the indicators are making conclusions by deduction, assessing deductive conclusions, making conclusions by induction, evaluating.
- Further clarification: the indicators are defining, assessing definitions, identifying assumptions.
- This assumption and integration: the indicator is suspect, and integrate.

Based on the above explanation, critical thinking is an organized process that involves mental activities such as formulating problems, providing arguments, making deductions, induction, evaluating to solve a problem. Ennis in E. Susantini et al, (2012); Wicaksana, YD, Widoretno, S., & Dwiastuti, S. (2020). Critical thinking should be taught from an early age by the teacher to students, critical thinking is useful for

analyzing problems, solving problems, and making conclusions, Jhonson's opinion in Arifin S, et al (2020). Critical thinking is very much needed in the world of work and even ranks first from other skills such as communication skills, collaboration, global awareness, mastery of technology, life and career skills, learning skills, and innovation. Critical skills form the basis for other skills. Watson's concept of critical thinking has five dimensions, namely infrastructure, assumptions, recognition, deduction, interpretation, and evaluation of arguments (Arifin S, Setiyosari, et al, 2020).

### *Creative thinking skills*

The first study on creativity was carried out in the United States in the 1950s under Guilford (Edgar., Faulkner., Franklin., Knobloch & Morgan., In Zelda Bakir, Ezra Ostekin, 2014). Creativity is a concept that is difficult to define (Ustundag., Plucker, Nowak in Zelda Bakir, Ezra Ostekin, 2014). According to Yildirim (1998) in Zelda Bakir, Ezra Ostekin (2014) states that the definition of creativity is the relationship between one concept and other concepts so that it becomes a new concept. In other words, creative thinking is an innovation from an existing concept to an invention that is different from its origin. A broader definition is that creative thinking is a distinctive way of thinking characterized by individual innovation (Zelda Bakir, Ezra Ostekin, 2014).

### *scientific process skills*

Science process skills are a person's ability both mentally and physically in studying science and solving a problem with the scientific process (Akinbobola & Afolabi in I Putu Artayas, et al, 2017). These skills not only play a role in students' scientific process skills but also train students to work while learning and apply these skills in solving problems they encounter in everyday life (Feziyonglu, Ozturk, Tezel, & Acat in I Putu Artayas, et al, 2017). To understand science, it is necessary to have concepts and procedures (Isnaningsih, DS Bimo, 2013). The concept side discusses the core material of science, while the procedure discusses basic science process skills, science process skills must be the main goal in education (Gott & Morphy, Harlen quoted from Gul Unan Coban, 2013) and (Akbar & Rustaman in I Putu Artayasa et al, 2017). In learning to use science process skills, it includes the emergence of ideas, asking questions, making hypotheses, gathering evidence, testing hypotheses through existing evidence, concluding, or interpreting test results. According to Driver, et al, Osborne, et al, Sampson, et al in Irene Lue, Ping, Lilia Halim, Kamisah Osman (2020) Science process skills can be taught to students during investigations or practicum in the laboratory and when analyzing experimental data. The role of practicum learning in science process skills has been researched by many experts including Abraham, Reis, Sharpe, Hofstein & Kind, et al, Irene Lue Leh, Ping, et al (2020). Someone has done science process skills when reaching indicator science process skills, there are fourteen indicator science process skills which are summarized in eight stages below (Sertac Arabacioglu, Oguz Ayse Unver, 2016). :

- Observation: there is one indicator, namely using the senses when observing

- Classification: there are five indicators, namely looking for similarities, looking for differences, contrasting characteristics, comparing, and looking for the basis of classification.
- Communication: there is one indicator Delivering the findings by describing empirical data through graphs, tables, or diagrams
- Predicting: there is one indicator that is making predictions about everything that will happen in the future, based on estimates on certain patterns or trends, or the relationship between facts, concepts, and scientific principles.
- Making questions: there are two indicators, namely making operational definitions, working in the laboratory, or outside the laboratory to prove a conjecture or prediction.
- Making hypotheses: there is one indicator Inference Capability is the ability to make a logical explanation that we use to describe events based on observations
- Planning an experiment: there is one indicator, which is forming ideas to explain observations or deciding the state of an object or event based on known facts, concepts, and principles.
- Concept implementation: there is one indicator, namely using a new experience concept to explain what is going on
- Announce the results: there is one indicator, namely submitting a systematic report.

From the description above, it can be seen that the scope of the scientific process has several indicators from observation to communicating the results. This statement is also supported by research conducted by Akinbolala & Folashade in MN Hayati, KI Supardi, S.S. Miswadi (2013). According to Ash in Hardianti & Kuswanto (2017) When students interact in the world of science, they find their research through the stages of questions, hypotheses, predictions, investigations, interpretation, and communication and this is called science process skills. Özgelen, Abdul Rauf, in Hardianti & Kuswanto (2017). Process skills are also important for meaningful learning (Karamustafaoglu, 2011). With process skills, students can experience direct experience with objects and events around them.

### **Purposes of the study**

The purpose of this review article is to find out how effective the blended learning model is for critical thinking and science process skills, student creative thinking skills. Based on the purpose of reviewing the article, the following problems can be formulated: 1) is the online learning system able to improve students 'or students' critical thinking skills and science process skills? 2) is learning with blended learning able to encourage students or students to think critically, think creatively, and have science process skills?

## RESEARCH METHOD

This research is a case study, a case study is defined as extracting information from time to time about a study. The research design in this study used a qualitative research design. data collection was carried out in-depth from various sources. The data were then analyzed by categorizing the results of the study over time. Research that will be in on the effects of blended learning on the thinking ability of students or students

**Table 1.** A case study of the effect of blended learning

Case	Learning strategies or models	Affects on	Educational stage	Year
Case 1	Blended learning	Critical thinking skills	College	2019, 2020
Case 2		Science process skills	College	2019
Case 3		Creative thinking skills	College	2020

Each case in table 1 above is analyzed in depth which aims to obtain in-depth information about the effects of learning strategies on critical thinking skills, science process skills, creative thinking skills.

## RESULTS AND DISCUSSION

### *Results*

### **FINDINGS**

#### *The effect of blended learning on critical thinking skills*

Based on the results of the data normality test conducted by Wardani, D. K, (2019) at the Salatiga State Islamic Institute and Sebelas State University in March. The pretest results in the control class obtained sig.  $0.017 > 0.05$  Kolmogorov - Smirnov and Sig.  $0.184 > 0.05$  Shapiro Wilk, while in the Experiment class the Sig.  $0.164 > 0.05$  Kolmogorov - Smirnov and Sig.  $0.077 > 0.05$  Shapiro Wilk. This shows that the pretest data in the control class and the experimental class are normally distributed. The post-test results in the control class obtained sig.  $0.200 > 0.05$  Kolmogorov - Smirnov and Sig.  $0.221 > 0.05$  Shapiro Wilk, while in the Experiment Class the Sig.  $0.132 > 0.05$  Kolmogorov - Smirnov and Sig.  $0.061 > 0.05$  Shapiro Wilk. This shows that the post-test data in both the control class and the experimental class is normally distributed in the control class and the experimental class is normally distributed. While the homogeneity test on the pre-test data obtained the sig value.  $0.173 > 0.05$  and the homogeneity test on the post-test  $0.731 > 0.05$ , so that each class in IAIN was homogeneous, while in the UNS homogeneity test in the pre-test the Sig value was obtained.  $0.880 > 0.05$  and the results of the homogeneity test at the post-test obtained the Sig.  $0.328 > 0.05$  indicates that each class in UNS is homogeneous, thus each class in UNS and IAIN is homogeneous.

After the normality and homogeneity tests were carried out, the t-test was carried out to test the research hypothesis, the t-test conducted at IAIN Salatiga obtained  $t$  (count) =  $0.687 < (t \text{ table}) = 2.0017$  with sig. (2 - tailed) =  $0.495 > 0.05$ , this means that there is no difference in the pre-test mean scores in the control class and the experimental class. Whereas for the t-test Post-test results, the t-test results (count) =  $-2.901 < t$  (table) = -

2.0017 with sig. (2-tailed) = 0.005 <0.05. From this, it can be seen that there are differences in the average post-test results of the control class and the experimental class, with this difference indicating that blended learning or e-learning learning has a positive effect on students' critical thinking skills. The same thing at the UNS campus is that there is no difference in the average pre-test scores for the Control class and the experimental class (Wardani, DK, 2019).

In another study conducted by W Suana, et al (2020) at the high school level, the results of the t-test in the control class and the experimental class were obtained as follows: the results of the Post-test t-test obtained the value of  $t$  (count) = 7,266 >  $t$  (table) = 0.2027 with Sig (2 - tile) = 0.000 <0.05, seen from the results of this test, blended learning has a positive effect on students' critical thinking. In another study conducted by Sri Wahyuni, et al (2019), the N-Gain results were obtained in the pre-test and post-test for indicators of students' critical thinking skills as follows: 1) Fact analysis obtained the average pre-test N-Gain value. - test 27 at post-test 53; 2) The student gave the reason that the N-Gain score was 23 on the pre-test average on the post-test 40; 3) concluding that the pre-test means N-Gain value was 33 at post-test 53; 4) giving an opinion that the average N-Gain value of the pre-test was 20 at the post-test 33; 5) Presenting and applying the obtained N-Gain mean pre-test 13 at the post-test 33. Based on the results of this analyst, it can be seen that the post-test average N-Gain value is better than the pretest in the experimental class, this shows that blended learning has an effect or can improve students' critical thinking skills, besides that, it can also be seen that the acquisition of N-Gain on each indicator. Indicators of achieving critical thinking skills are also seen, based on the results of data analysis in the article, it is known that indicators of student thinking can analyze the facts presented on the Web, Students can give reasons for each answer well, students can also give conclusions, implement concepts, can communicate well. After seeing the results of the N-Gain test, the t-test was carried out in both classes, the t-test results were as follows: In other studies, blended learning is effective on students' thinking abilities, this can be seen from the post-test results given to the control class and the experimental class.

The tests are in the form of t-test, normality, and homogeneity tests. The normality test here uses the Kolmogrove - Simirnove method with a significant level alfa 0,05 of data that is normally distributed. In the homogeneity test, the researcher used the analysis of variance test with a significant level of alfa 0,05  $F$  count <  $F$  table, this means that the post-test data was homogeneous. Then the t-test is then carried out to test the hypothesis, from the results of the t-test in the control class and experimental class, the  $t$  value is greater than  $t$  table, namely  $t$  (count) = 2.436 >  $t$  table = 2.039, this means that learning with blended learning is effective to improve students' critical thinking skills, (Aswardi & Nellitawati, 2020).

### *The Effects of Blended Learning on Science Process Skills*

From the results of research conducted by Fauziyah Harahap, Nanda Eska Anugerah & Binari Manurung (2019), the blended learning model for students' science process abilities are as follows: Post-test results scores in the normality test using the Liliefors test

in the control class and experimental class, All data are normally distributed, the standard deviation in the Experiment class is 11.82 while the standard deviation in the Control class is 9.86. This means that blended learning has a positive effect on students' process skills.

After the normality test, the post-test results were tested with the control class, and the experimental class was tested using the independent t-test, the t-test results were obtained sig-2 tiled of 0.00, this result is smaller than the significance level of 0.01, this means that learning with blended learning has a positive effect on students' science process skills in Biology Science subject tissue culture material. The next test is the independent t-test on the indicators of students' science process skills. The t-test results show that all indicators show a significant difference between the control class and the experimental class.

Blended learning is not only effective in improving students 'critical thinking but also effective in improving students' science process skills. Sertac Arabacioglu, Ayse Oguz Unver. (2016). In a study conducted by Fauziyah Harahap, Nanda Eska Anugerah, & Binari Manurung, 2019; Ping, LLI, Halim, L., & Osman, K. 2020, stated that learning with blended learning was effective in improving students' science process skills, this could be seen from the post-test results of students who had t-tested showed a higher t-value. of t table value and sig value. (2 - tiled) is smaller than the significant level of 0.05. Based on the results of research conducted by several researchers above, blended learning is more effective than conventional learning on students' critical thinking skills and science process skills have seen from the results of the t-test, N-Gain, and Anova test. This means that blended learning can improve students' critical thinking skills and science process skills but also provide new learning experiences for students and students.

*The effect of blended learning on creative thinking skills.*

Based on the results of research conducted by Yustina (2020), the posttest score in the experimental class was obtained with an average of 91 while the N-Gain was 0.62, in the conventional class or control class the average post-test score was 76 with an N-Gain of 0.51. the difference in scores of the experimental class and the control shows that the blended learning applied to the experimental class can improve students' creative thinking skills seen from the results of the Post-test and N-Gain.

## ***Discussion***

Based on the findings data, learning with the blended learning system or e-learning has a positive effect on critical thinking skills and the science process skills of students and students, both junior high school students, high school, and college. There are many ways to improve students 'or students' critical thinking skills, one of which is with a learning model that is online or blended learning ( Wardani, D. K, 2019; Sri Wahyuni, et al, 2019; Aswardi & Nellitawati, 2020; W Suana, et al, 2020;). To find out whether or not there is an effect of blended learning on students' critical thinking or students, a case study is needed, in this case, study students must determine whether they agree or disagree with every statement such as synthesizing, evaluating, and making decisions Florea and Hurjui, 2015: 566; Samah, Hassan, Wahat, and Zaremohzzabieh, 2016:122 in Wardani

(2019). This case study can use a questionnaire or can use a test instrument, if you use a questionnaire it is necessary to have a statement that supports critical thinking, one of the examples in research conducted by Wardani in college in 2019. The results of research conducted in several institutions and regions show that learning effective blended learning to improve students' critical thinking skills by referring to the t-test results and the results of Sig. (2-tailed). The t-test results show that the value of t (count) is always greater than t (table) and the value of sig. (2-tailed) is always less than 0.05 which is a level of significance. this means that learning using blended learning has a positive effect on student critical thinking.

## CONCLUSION

Based on the results of the previous discussion, in the era of the industrial revolution 4.0, many skills are needed, one of which is critical thinking skills and process skills, these skills are needed as technology advances, where humans are required to always innovate, to innovate requires the ability to think and solve problems, one of the abilities thinking that is needed is critical thinking.

Based on the research results, methods, or models blended learning is a learning model effective and can improve critical thinking, creative thinking, and science process skills of students. Thus the blended learning model or method of learning is an effective learning method or model that can improve students 'or students' critical thinking skills and science process because blended learning can make students active and independent in learning. In this research it is still not perfect, so researchers expect further research. For teachers, this research can be a reference to the learning system in the future to implement appropriate and more interesting learning. Also, educators, both teachers, and lecturers will know the concept of advanced education that combines two learning methods, namely the conventional or face-to-face method, and the second is the online method. For the government, based on the results of this literature study, learning in education requires innovations in the education system, so that students can compete in the Industrial 4.0 era.

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