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The Relationship of E-Learning Intensity to Improve students' Critical Thinking Ability

Mahdiyah[1], Faisal Madani[2], Fildzah Rudyah Putri[3], Mutiara Dahlia[4], Jarudin[5]
[1]Lecture, Faculty of Engineering, Universitas Negeri Jakarta, Indonesia, Jl. Rawamangun Muka No. 11 East Jakarta 13220, mahdiyah@unj.ac.id.
[2]Lecture, Postgraduate, Universitas Negeri Jakarta, Indonesia, Jl. Rawamangun Muka No. 11 East Jakarta 13220, faisalmadani@unj.ac.id.
[3]Lecture, Faculty of Psychology, Universitas Negeri Jakarta, Indonesia, Jl. Rawamangun Muka No. 11 East Jakarta 13220, fildzahrudyah@gmail.com, +6281314424213.
[4]Lecture, Faculty of Engineering, Universitas Negeri Jakarta, Indonesia, Jl. Rawamangun Muka No. 11 East Jakarta 13220, mdahlia@unj.ac.id.
[5]Lecture Faculty of Information Engineering, Institut Teknologi dan Bisnis Bina Sarana Global, Indonesia, Jl. Aria Santika No. 43 Tangerang, Banten 15113, jarudin@global.ac.id , +6285158831740

Abstract
The potential of e-learning to facilitate the cultivation of critical thinking abilities remains a subject of inquiry, as the precise nature of the association between the intensity of e-learning engagement and the development of critical thinking skills has yet to be comprehensively elucidated. The objective of this study is to examine the correlation between the level of engagement in e-learning and the development of critical thinking skills among students engaged in online education. The present study aimed to examine the correlation between the level of engagement in e-learning activities and the development of critical thinking abilities within a cohort of 210 students. The measurement of e-learning intensity was conducted by quantifying the weekly duration of engagement with the e-learning platform. The assessment of critical thinking skills was conducted through the utilization of the Critical Thinking Questionnaire (CThQ). The findings of the study revealed a statistically significant and favourable association between the level of engagement in e-learning activities and the development of critical thinking abilities. This suggests that students who spend more time using e-learning platforms tend to have higher levels of critical thinking skills.

Keywords: E-learning interventions; critical thinking, online learning; distance learning.

I. Introduction

E-Learning as distance learning is the most appropriate choice to be used when conditions do not allow for face-to-face meetings. Such conditions can occur with various possible obstacles. Such as the events experienced by the world recently, so shocking with the outbreak of the Covid-19 Virus, spread to almost all countries in the world starting in early 2020. In addition, conditions such as renovation or repair of campus facilities, to lecturers who are unable to attend can also be a factor in the need for e-learning in the learning process. E-learning can also be used to support students' independent learning process.

Independent learning is the readiness of students to do independent learning which is one way to improve skills in the learning process in order to obtain better and maximum learning results(Broad, 2016). This independent learning process is also a manifestation of the student centreed learning paradigm. In student centred learning, learners should be responsible for building their own knowledge, so learners must be more active and independent in the learning process(Jarudin et al., 2018). The independent learning process using e-learning is expected to affect students' critical thinking skills. Critical thinking is an ability that can be learnt and trained to be able to solve problems effectively(Boholano, 2017). Critical thinking skills are used to analyse problems, solve problems, make decisions and understand solutions to problems faced.

Student centered learning is a learning environment that facilitates students to play a more active role in the learning process by taking responsibility for the organisation, analysis and synthesis of content from teacher to learner(Arshad-Ayaz et al., 2022; C. L. Chen & Wu, 2020). In student centred learning, students can be responsible for building their own knowledge. In student centred learning, the basic principle is that students are more active and independent in the learning process. One of the solutions to support this independent learning process is by utilising and maximising e-learning.

Previous studies have shown that critical thinking skills can be improved by e-learning(Gharib et al., 2016). Moreover, in the context of the process, e-learning has been able to motivate students in learning(El-Seoud et al., 2014). Enhancing student participation levels via e-learning interaction has the potential to yield heightened cognitive engagement and increased tenacity in task completion. When correctly utilized, e-learning can offer advantages that address the challenges posed by deferral and conventionalism inside educational institutions. Additionally, it has the potential to

foster the development of critical thinking skills among students, similar to what is typically required in traditional residential practices.(Larbi-Apau, 2021). The cultivation of critical thinking abilities can be facilitated by a wide range of digital communication and collaboration tools and resources. The research under consideration provide a definition of critical thinking as a cognitive process encompassing analysis, observation, interpretation, reflection, synthesis, and assessment.(Saadé et al., 2012). The research aimed to answer questions such as whether students understand the definition of critical thinking and what is the effect of the learning environment on critical thinking. The present study aimed to assess the effectiveness of a concise online learning intervention centered around the identification of informal fallacies, a fundamental ability in the realm of critical thinking(Tan et al., 2023).

An examination of the application of critical thinking and self-regulated learning in the context of online education amidst the COVID-19 pandemic. This study analyzed online biochemistry learning during the pandemic and found that critical thinking and self-regulated learning strategies can positively impact students' critical thinking skills(Anwar & Muti'ah, 2022). This study found that e-learning media is valid, practical, and an effective criterion to improve students' critical thinking skills(Supriyatno et al., 2020). The research studies show that e-learning can be an effective tool to develop students' critical thinking skills. Critical thinking can be described as a cognitive process that involves the examination, observation, interpretation, contemplation, integration, and assessment of information or ideas.

These two things become important factors in improving students' critical thinking skills. Problems that occur today are still many students who have low critical thinking skills (Abdulah et al., 2021; Fajari et al., 2020). This problem is also found in students in higher education, one of which is seen in UNJ students. This is also supported by the still not maximising the use of e-learning in the learning process.

Therefore, it is necessary to further analyse the relationship between the role of e-learning on students' critical thinking skills. Critical thinking is an ability that can be learnt and trained to be able to solve problems effectively (Rahman, 2019). Critical thinking skills are used to analyse problems, solve problems, make decisions and understand solutions to problems faced(Butterworth & Thwaites, 2013; Heard et al., 2020). The formulation of the problem is whether the intensity of using e-learning plays a potential role in increasing student knowledge, especially in the critical thinking patterns formed.

The purpose of this study is to identify the relationship between the role of e-learning on students' critical thinking skills. This research process will be analysed using quantile regression analysis method, which is one of the regression methods used to overcome heteroscedasticity problems. Quantile regression is done by dividing or separating the data into two or more parts when it is suspected that there are differences in estimator values at certain quantiles (Koenker, 2005; Koenker et al., 2017).

The results of this study are expected to provide meaningful information for observers in the field of education, about the role of e-learning on students' critical thinking skills. This is also the basis for maximising the use of the Learning Management System (LMS) at Universitas Negeri Jakarta. All study programmes are required to utilise it, especially the Master of Education Research and Evaluation Study Programme, Postgraduate Programme, Universitas Negeri Jakarta. The results of this study are also highly expected to be able to act as a benchmark for lecturers to assess whether or not the targeted learning objectives are delivered.

II. Methodology

Participants

A quantitative research method with random sampling was used in this study. Participation was voluntary, involving 375 respondents who returned the questionnaire as many as 245 respondents gave positive responses. Usable data were 210 of the 245 respondents who returned. The researchers informed the students at the beginning of the study that they were not members of the University staff. The purpose of the data collection was explained, and students were invited via email to volunteer. Anonymity was assured and students were free to withdraw at any time. Permission to conduct the research was obtained from the relevant university authorities.

Data Collection Techniques

Data collection techniques by providing questionnaires construction and application of critical thinking test tool that has been developed by (Kobylarek et al., 2022) with google form which is freely filled in by students of Universitas Negeri Jakarta. This study uses a correlational method which aims to prove whether there is a relationship between the two variables used.

Data Analysis Techniques

The analysis process carried out to determine the form of the equation obtained in this study between the intensity of e-learning use and students' critical thinking skills, quantile regression statistical analysis was used. Quantile regression is one of the regression methods used to overcome heteroscedasticity problems(Koenker, 2005; Koenker et al., 2017). Quantile regression is done by dividing or separating the data into two or more parts when it is suspected that there are differences in estimator values at certain quantiles. On the quantile regression graph, there are several prediction lines representing various percentiles of the data. Each prediction line will have a different slope, and each line represents the

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estimated value at a particular percentile (Mizera, 2017; Ying & Sit, 2017).

In accordance with the theoretical basis described in the previous section, the researcher feels it is important and appropriate to use Quantile Regression Analysis to prove the relationship between the intensity of e-learning use and the critical thinking skills of Universitas Negeri Jakarta students. The value of the research results is obtained by estimating the values of β_0 and β_1 in the following quantile regression equation:

$$Q(\tau \mid X) = \beta_0 + \beta_1 * X \quad (1)$$

Where, $Q(\tau \mid X)$ is the τ^{th} quantile estimate of the dependent variable Y with values of the independent variable X.

III. Results

The results of this study using quantile regression analysis show some interesting findings in the context of the relationship between the role of the use of e-learning intensity on students' critical thinking skills. Based on the results of the analysis of 210 respondents obtained a critical thinking score assessment on the average of 90.04 with Std. Dev 7.88. While the critical thinking score assessment on average 17.79 with Std. Dev 2.61. The distribution of these scores can be seen in the histogram graphs in Figures 1 and 2.

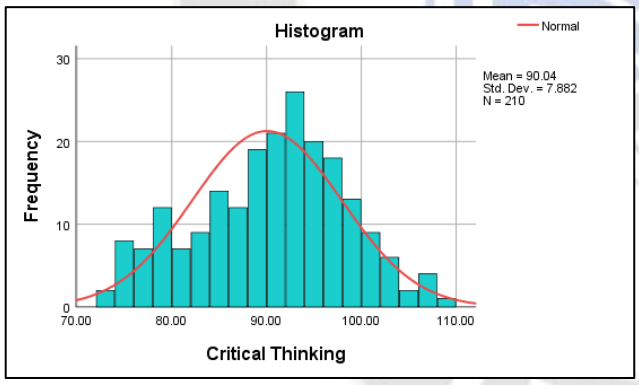

Figure 1. Critical Thinking

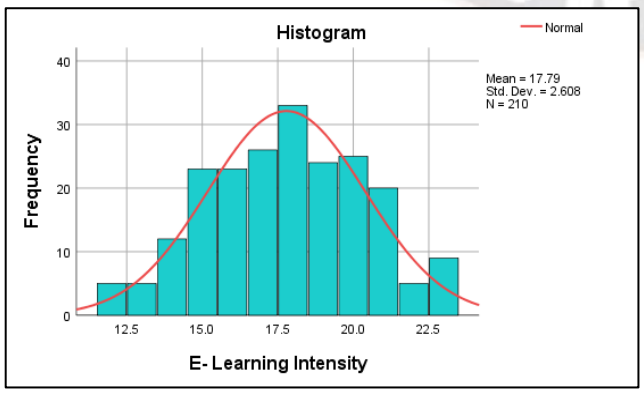

Figure 2. E-Learning Intensity

As one of the advantages of quantile regression analysis, which does not require normally distributed data because this method focuses on quantile positions, it can provide more stable estimates even if there are extremes in the data. The Pseudo R Squared value in Model Quality Table 1 indicates the extent to which the quantile regression model can explain the variation in data at various quantile distributions.

Table 1. Model Quality

Parameter	q=0.1	q=0.25	q=0.5	q=0.75	q=0.9
Pseudo R Squared	0.386	0.400	0.340	0.290	0.274
Mean Absolute Error (MAE)	7.4643	5.0548	4.1762	4.6000	7.8476

At quantile 0.25 (q=0.25), the model indicates that the intensity of e-learning use can explain about 40% of the variation in critical thinking. Likewise, this model applies to explain the variation value of critical thinking in other quantile distributions. The results of the analysis on Parameter Estimates by Different Quantiles, is information that describes how the values of regression parameters (coefficients) differ at various quantiles of the dependent variable distribution. This value indicates that the values of the regression parameters differ at various quantiles of the dependent distribution. The results of the parameter estimation analysis by different quantiles in this study are listed in Table 2.

Table 2. Parameter Estimates by Different Quantiles

Parameter	q=0.1	q=0.25	q=0.5	q=0.75	q=0.9
(Intercept)	32.500	42.000	52.143	57.000	62.000
E-learning Intensity	2.833	2.500	2.143	2.000	2.000

The Intercept value is the estimated value of the dependent variable "Critical Thinking" when all independent variables, in this case "E-Learning Intensity," are zero. As an interpretation of the analysis results from the table, at the bottom 10% quantile (q=0.1) the intercept is 32,000, which means that at this quantile, the value of Critical thinking is estimated to be 32,000 when e-learning is zero. The intercept value varies at each quantile of the distribution, for each quantile it is also illustrated in the Plot of the Estimated Parameters graph as shown in Figure 3.

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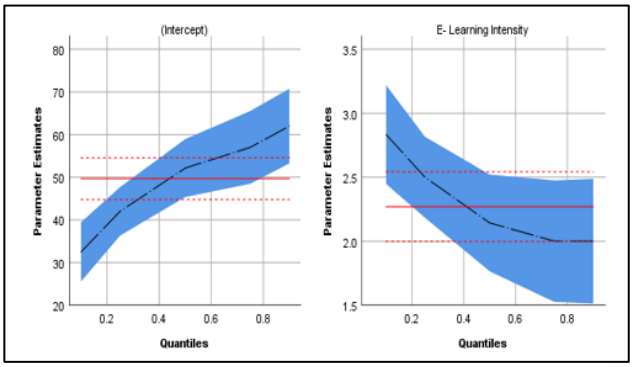

Figure 3. Estimated Parameters

Figure 3 is used to visualize how the regression coefficient parameter values and confidence intervals vary across different quantiles of the dependent variable distribution. The assessment on this graph helps us understand and recognize the condition of the sample data we are analyzing, as well as convey the generalization of the results to the study population. This graphic can facilitate our comprehension of the association between the independent variable of e-learning intensity and the dependent variable. The nature of critical thinking varies throughout different segments of the distribution. The quantile regression graph known as the prediction line looks like in Figure 4 and will clarify how the relationship between e-learning intensity and the improvement of students' critical thinking.

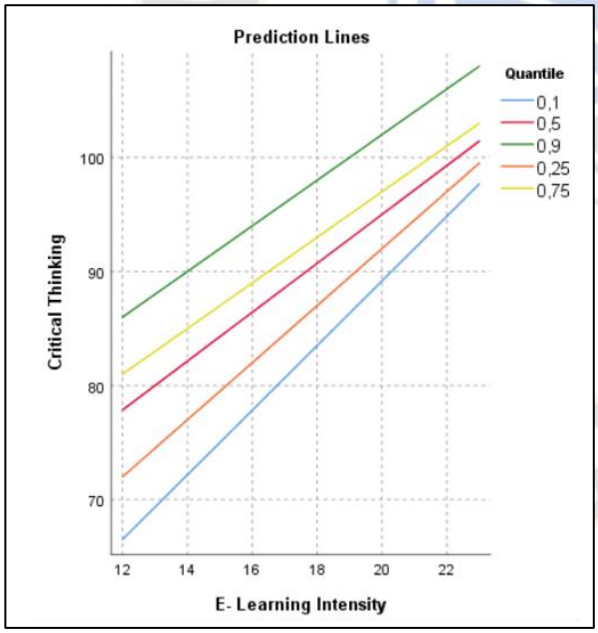

Figure 4. E-Learning Intensity

The prediction line in this study shows that the value of e-learning intensity varies for each quantile group. It can be concluded that there are differences in the value of the intercept (the intersection of the graph with the Y axis) at various points in the distribution of the dependent variable, namely critical thinking. The regression coefficient described by the degree of slope or gradient of each line varies at each quantile of the critical thinking distribution. The distribution shows that the effect of e-learning intensity is different at different levels of the distribution. The greater the value of the regression coefficient, the greater the role of e-learning intensity on students' critical thinking.

The results of this study illustrate that the initial quantile or the bottom 10% is the part of the quantile with the largest effect of e-learning intensity (2.833) on critical thinking compared to other quantiles. This coefficient means that if e-learning intensity increases by one unit, it is estimated that critical thinking will increase by 2.833 points in the 10% quantile. The varying regression coefficients are seen to sequentially give a decreasing role from the 10%, 25%, 50% (median) quantiles. At the 75% and 90% quantiles this coefficient is equal at 2.00. This illustrates the flexibility of quantile regression analysis. It is necessary to examine various quantile levels, The purpose of this study is to elucidate the correlation between the independent variable of e-learning intensity and the dependent variable of student critical thinking., changing in different parts of the data distribution. These results allow us to gain richer meaning about the relationship and can be very useful for more in-depth analysis. The quantile regression method is also better at handling heteroscedasticity, which is the difference in variability across a range of predictor values. This is because the method does not require the homoskedasticity assumption required by Ordinary Least Squares (OLS) simple regression.

Discussion

Research results between e-learning intensity and students' critical thinking skills show that higher e-learning intensity can improve critical thinking skills. The findings indicate that the utilization of e-learning can serve as a viable mechanism for enhancing students' capacity for critical thinking. Additionally, the implementation of active-learning methodologies has the potential to enhance students' aptitude for critical thinking. It is essential to pay attention to strategies to improve and develop students' critical thinking skills in the future, as critical thinking is a major skill for job placement and success in higher education. The findings are supported by the results of Wang and Seepho study (2017) found that students who took a fully online course on critical thinking outperformed students who took a traditional face-to-face course on the same topic(Wang & Seepho, 2017). The authors attributed this difference to the online course's emphasis on interactive learning activities, such as online discussions and group projects. Another study, by Foo and Quek (2019), found that students who participated in online discussion forums showed greater improvement in their critical thinking ability than students who did not participate in such forums(Foo & Quek, 2019). The author argues that online forums give students the opportunity to reflect on their own thinking and learn from the perspectives of others.

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E-learning media is valid, practical, and an effective criterion to improve students' critical thinking skills(Supriyatno et al., 2020). The implementation of active-learning methodologies has been shown to enhance students' capacity for critical thinking (Nelson & Crow, 2014). The critical thinking capability of students can be positively influenced by their capacity for flexibility and engagement in online learning, as well as their effective utilization of self-regulated learning methodologies (Stan et al., 2022). E-learning, if exploited effectively, can help to develop students' critical thinking skills, and achieve optimal education and learning outcomes. The significance of critical thinking as a fundamental ability for employment opportunities worldwide and its pivotal role in achieving academic achievement at the tertiary level are widely acknowledged(Sellars et al., 2018). Therefore, it is essential to teach and develop critical thinking skills in students.

However, it is important to note that not all e-learning programs are created equal. Some e-learning programs may be more effective in encouraging critical thinking than others. For example, e-learning programs that emphasize interactive learning activities, such as online discussions and group projects, are more likely to promote critical thinking than programs that are more lecture-based. In addition, e-learning intensity may not be the only factor that affects students' critical thinking ability. Other factors, such as the quality of the e-learning program, students' motivation to learn, and students' prior knowledge and skills, may also play a role.

A study by Chen and Hwang (2020) The study revealed that students who participated in an online course focused on critical thinking, employing a flipped classroom methodology, exhibited more substantial enhancements in their critical thinking abilities compared to students who engaged in a conventional lecture-based online course(M. R. A. Chen & Hwang, 2020). A study by Lu (2021) found that students who participated in an online blended learning program on critical thinking outperformed students who participated in a traditional face-to-face learning program on the same topic(Lu, 2021). A study by Supriyanto et al., (2020) The study revealed that students who utilized an e-learning platform for the purpose of acquiring knowledge in critical thinking exhibited superior academic performance compared to their counterparts who did not engage with an e-learning platform(Duplàa et al., 2023; Supriyatno et al., 2020). Overall, these studies suggest that e-learning can be an effective way to improve students' critical thinking skills, especially if the e-learning program is well designed and emphasizes interactive learning activities.

The implications for educators arising from the study's findings on the correlation between the intensity of e-learning and students' critical thinking abilities are manifold. First, educators should consider using e-learning to encourage critical thinking in their students. Second, educators should design e-learning programs that emphasize interactive learning activities, such as online discussions and group projects. Third, educators should realize that the intensity of e-learning is not the only factor that affects students' critical thinking skills. Other factors, such as the quality of the e-learning program, students' motivation to learn, and the knowledge and skills students have, also play a role.

IV. Conclusion

The current body of research pertaining to the correlation between the level of e-learning engagement and the development of critical thinking skills is very nascent; however, the preliminary results are encouraging. Multiple studies have demonstrated that students engaging in high-intensity e-learning activities exhibit a greater propensity for the development of critical thinking skills compared to their counterparts participating in low-intensity e-learning activities. There are several reasons why e-learning intensity may be beneficial for critical thinking. First, e-learning can provide students with access to a wide range of resources, including online courses, tutorials, and discussion forums. This allows students to learn from a variety of sources and to explore different perspectives on a given topic. Second, e-learning can encourage students to be more active learners. In an online environment, students are often required to complete assignments, participate in discussions, and reflect on their learning. This can facilitate the enhancement of critical thinking abilities among students.

In general, the findings of the study indicate that the level of engagement in e-learning can potentially enhance students' capacity for critical thinking. Nevertheless, it is crucial to acknowledge that the quality of e-learning holds significant importance. E-learning activities that are well-designed and engaging, and that are facilitated by skilled instructors, are more likely to promote critical thinking. In addition to the above, I would also like to add that e-learning intensity can be particularly beneficial for students who are struggling with critical thinking. For example, students who have difficulty asking critical questions or evaluating information can benefit from participating in high-intensity e-learning activities that focus on these skills. Overall, e-learning intensity is a promising strategy for improving students' critical thinking ability. However, more research is needed to fully understand the relationship between e-learning intensity and critical thinking.

One limitation is that the quality of e-learning is important. E-learning activities that are poorly designed or boring are less likely to promote critical thinking. Additionally, e-learning instructors play an important role in facilitating critical thinking. Instructors who are not skilled in facilitating critical thinking are less likely to be able to help students develop their critical thinking skills. Finally, it is important to note that e-learning is not a substitute for face-to-face

instruction. Face-to-face instruction can provide students with opportunities to interact with their instructors and classmates in a way that is not possible in an online environment. This interaction can be beneficial for developing critical thinking skills.

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