The Effect of the Multiliteracy Learning Model on Critical Thinking Skills in Terms of College Students' Self-Regulated Learning

Fadhil Purnama Adi[1], Idam Ragil Widianto Atmojo[2*], Roy Ardiansyah[3], Milenia Suci Rachmawati[4] (iD)

[1,2,3,4] Elementary School Teacher Education, Faculty of Teacher and Training, Universitas Sebelas Maret, Surakarta, Indonesia

A B S T R A K

Sebagai calon guru, seorang mahasiswa harus menguasai keterampilan abad 21. Berpikir kritis merupakan salah satu arah pendidikan abad ke-21. Sebagai calon pendidik, mahasiswa juga perlu menguasai kemampuan berpikir kritis yang didukung dengan self-regulated learning yang baik sebagai bekal agar nantinya dapat melaksanakan pembelajaran bermakna di kelas. Penelitian ini bertujuan untuk menganalisis pengaruh penerapan model pembelajaran multiliterasi terhadap kemampuan berpikir kritis mahasiswa ditinjau dari self-regulated learning. Metode penelitian yang digunakan adalah eksperimen kuantitatif dengan desain faktorial 2 x 3. Instrumen tes yang digunakan adalah esai dua tingkat dengan total enam butir soal yang dinyatakan valid dan reliabel. Analisis data dilakukan setelah seluruh data dari responden terkumpul kemudian melanjutkan hipotesis. Berdasarkan hasil pengujian hipotesis menggunakan uji ANOVA dua arah dengan sel berbeda diperoleh hasil Fobs > Fα, dengan rincian Fa > Fα (18.03901 > 3.986269479), Fb > Fα (27.5862 > 3.135917934), dan Fab > Fα (139,2992 > 3,135917934). Hasil penelitian menunjukkan bahwa model pembelajaran multiliterasi berpengaruh terhadap kemampuan berpikir kritis mahasiswa, self-regulated learning berpengaruh terhadap kemampuan berpikir kritis mahasiswa, dan model pembelajaran multiliterasi berinteraksi dengan tingkat self-regulated learning pada kemampuan berpikir kritis.

A B S T R A C T

As a teacher candidate, a college student should master 21st-century skills. Critical thinking is one of the directions of 21st-century education. As prospective educators, college students also need to master critical thinking skills supported by good self-regulated learning as a provision so that they can carry out meaningful learning in class later. This study aims to analyze the effect of applying the multiliteracy learning model on college students' critical thinking skills in terms of their self-regulated learning. The research method used was a quantitative experiment with a 2 x 3 factorial design. The test instrument employed a two-tier essay with a total of six items, which had been declared valid and reliable. Data analysis was performed after all data from respondents had been collected then continuing hypotheses. Based on the results of testing the hypothesis employing a two-way ANOVA test with different cells, the results obtained were Fobs > Fα, with details of Fa > Fα (18.03901 > 3.986269479), Fb > Fα (27.5862 > 3.135917934), and Fab > Fα (139.2992 > 3.135917934). These results reveal that the multiliteracy learning model affected college students' critical thinking skills, self-regulated learning influenced college students' critical thinking skills, and the multiliteracy learning model interacted with the level of self-regulated learning on critical thinking skills.

1. INTRODUCTION

The results of an international study conducted by the International Association for Evaluation of Educational Achievement (IEA) in the Trends in International Mathematics and Science Study (TIMSS) revealed that there had been a decline in Indonesia's ranking from 2003 to 2015 in educational achievement, particularly in mathematics and science. From the TIMSS 2015 results, Indonesia was ranked 46th out of 51 participating countries (Hadi & Novaliyosi, 2019; Jerrim et al., 2023). In 2019, Indonesia did

*Corresponding author
E-mail addresses: idamragilwa@staff.uns.ac.id (Idam Ragil Widianto Atmojo)

not participate in TIMSS. Then, the PISA results held in 2018 uncovered that Indonesia's position was in the bottom ten, to be precise, 74 of the 79 countries that participated. Based on the TIMSS and PISA assessment results, most students still tended to think short-term (short-term memory), refer without processing (recite), restate, and recall (Hidayah et al., 2021; Megawati & Sutarto, 2021).

This state of mind is still limited to managing information presented repeatedly and routinely taught. The TIMSS and PISA assessment results also support the opinion of previous study that explaining that the teaching that has been going on so far still prioritizes delivery related to the content of the subject matter and ignores the cultivation of thinking skills; as a result, some students were still found who had not mastered thinking skills, even though thinking skills are crucial to be mastered by individuals, specifically in solving problems and is one of the goals of 21st-century education (Dishon & Gilead, 2020).

Mastery of critical thinking skills is deemed essential since it is one of the focuses of mastery in 21st-century education. 21st-century education focuses on students mastering the four competencies (4C): critical thinking, creative thinking, communication, and the ability to work collaboratively (Frydenberg & Andone, 2011; Taar & Palojoki, 2022). In addition, it is vital to develop critical thinking skills not only for students but also for teachers. Teachers are the primary factor determining an education program's success or failure, especially at an elementary level. The teacher plays a role in improving students' critical thinking skills by applying learning models that can stimulate students' critical thinking skills (Dudu & Vhurumuku, 2012; Liao et al., 2018). Consequently, it is important for a prospective teacher, i.e., a college student, to have critical thinking skills to develop learning in elementary school, which can familiarize students with critical thinking and make critical thinking a learning capital. This statement proves that critical thinking skills must be developed in college, particularly in the early semester. It is also crucial to emphasize critical thinking during the learning process at college so that college students can have good professionalism in an increasingly complex world of work (Sasson et al., 2018; Yaacob & Lubis, 2022).

Based on identifying problems on campus 4 FKIP UNS in August 2022 with semesters 1, 3, and 5 students, with four respondents each, the result demonstrated that several courses were considered difficult, namely subjects related to natural science (IPA). The reasons underlying these assumptions included much material, repeated remedial after the end of semester exams with unsatisfactory results, and students' difficulties understanding the material. Then, the research focused on semester 1 students who entered semester 2 in 2023. It was based on the results of interviews with respondents, revealing a problem that college students felt science subjects in high school were still theoretical. In contrast, subjects related to science in college emphasize deeper thinking processes, especially critical thinking skills in solving problems and scientific attitudes, not only memorizing or pouring formulas into answering questions. This critical thinking is related to scientific thinking. Critical thinking skills grow in line with how individuals solve new problems by using and associating information they already have (Aulia & Aulia Zahroh, 2021; Yaacob & Lubis, 2022). Therefore, the development of thinking habits needs to be carried out for college students from the early semester so that after graduation, they can have critical thinking skills and conduct learning that trains their students' thinking processes. Critical thinking is also needed to develop meaningful curriculum plans and create learning activities (Aslan & Aybek, 2020; Ongesa, 2020).

Developing habits and improving thinking skills can be performed by applying 21st-century literacy learning through a multiliteracy learning model. Previous study defines the multiliteracy learning model as building an understanding of knowledge utilizing language skills related to other knowledge during inquiry activities (M. A. Rahman et al., 2022). Multiliteracy learning needs to be developed for Elementary School Teacher Education (PGSD) students. It is because PGSD students as prospective educators will later have the provision as educators with high competency standards in dealing with curriculum changes to form a balance in the psychomotor, cognitive, and affective domains for students (Machmud et al., 2021; Setyaningrum & Purwati, 2020). Previous study also explained that high understanding and critical thinking skills can be mastered through teaching by applying a multiliteracy learning model (Rasi et al., 2019). It indicates that the application of the multiliteracy learning model influences critical thinking.

Additionally, previous study elucidated that self-regulated learning is important for students, specifically in taking the right steps to achieve the expected goals by adjusting to changes that continue to occur in the surrounding environment, organizing, and directing themselves in facing challenges in lectures, both doing assignments and taking exams (Araka et al., 2021). A study by previous study showed that the application of the multiliteracy learning model received a positive response from teachers and students, so its application provided effectiveness for students in increasing their critical thinking (M. A. Rahman et al., 2022). The similarities between these studies and this research lie in multiliteracy learning models, while the difference is in the research subjects. While the research subjects used in this case were college students, the previous research subjects were elementary school students. Further, this research focuses on the effect

of the multiliteracy learning model on college students' critical thinking skills in terms of self-regulated learning.

Furthermore, based on relevant previous studies, several similarities and differences exist in this research. The similarities of previous relevant research to this research can be seen in multiliteracy learning models, while the differences with previous relevant research lie in 1) research subjects, 2) research locations, 3) research methods used, and 4) research data. The novelty of the research compiled compared to existing research can be observed in the research topic raised regarding the effect of the multiliteracy learning model on critical thinking skills in college students' self-regulated learning. Based on the described background, previous relevant research was developed by raising the topic of "The effect of the multiliteracy learning model on critical thinking skills in terms of college students' self-regulated learning."

2. METHOD

The type of research used by the researchers was quantitative. The choice of a quantitative research method was based on the reasons that the researchers examined samples from certain populations, used research instruments in data collection, analyzed quantitative data, and tested hypotheses that had been made (Sugiyono, 2018). The researchers employed a factorial research design. Factorial design evaluates the impact of two or more treatments on related variables. Factorial design is also a form of experimental design adapted to the use of moderator variables, which can influence the treatment of the independent variables on the dependent variable (Laksana et al., 2019). For this reason, a quantitative experiment with a 2 x 3 factorial design was chosen as the research method in this study.

The sampling technique in this study used cluster random sampling. The researchers applied the research design by dividing the sample into two classes, i.e., the experimental and the control classes, which were selected randomly. While the control class was given the application of the direct instruction learning model, the experimental class was given the application of the multiliteracy learning model. The research subjects were PGSD UNS students, class of 2022. Then, campus 4 of Universitas Sebelas Maret, Surakarta, was used as the research location. The variables utilized were the independent variable in applying the multiliteracy learning model, the moderator variable in self-regulated learning, and the dependent variable in the form of critical thinking skills. In addition, collecting research data employed instruments in the form of test questions (pre-test and post-test) and self-regulated learning scales, which were tested first before being applied to control and experimental classes.

The test instrument in this study was to measure the critical thinking skills of PGSD students in the human environment subject (physics). This course contained material on vertical upward motion, free fall, and parabolic motion. The test instrument employed a two-tier essay with a total of six items, which had been declared valid and reliable. The researchers also used a Likert scale with the value of the existing answers. Moreover, self-regulated learning (SRL) was a score obtained by college students after working on questions in the form of a scale related to their efforts to foster independent learning by carrying out self-regulation, both covering the evaluation process and preparing learning strategies during the learning process involving behavior, motivation, and metacognition to achieve learning objectives (Rembulan et al., 2020). Data analysis was performed after all data from respondents had been collected, with a series of activities in the form of grouping data based on the type of respondents and variables, tabulating data based on variables from all respondents, presenting data from each research variable, carrying out calculations to answer the predetermined problem formulations, and testing the truth of the hypotheses made.

3. RESULT AND DISCUSSION

Result

The self-regulated learning scale instrument had 40 statements. Measuring the instrument's validity used five expert raters, with a scoring scale of 1-5 and an error rate/error probability of 5%. Based on Aiken's V table, the instrument is said to be valid if each statement item achieves a minimum score of 0.80. Based on calculations performed using Aiken's V to test the validity of the self-regulated learning scale, items 2, 3, 5, 7, 9, 14, 15, 16, 20, 23, 26, 27, 28, 30, 33, 34, 35, 37, 38, and 39 met the feasibility presented from the Aiken validity index but needed to be corrected if the validator continued to provide input. Meanwhile, items 1, 4, 6, 8, 11, 12, 13, 17, 18, 19, 21, 22, 24, 25, 29, 31, 32, 36, and 40 did not meet feasibility, so they should be revised based on validator input if the items were still used. To find out the quality of the language aspect of the self-regulated learning scale instrument, the researchers involved two experts in the fields of Indonesian and linguistics. The suggestions and input provided by the experts were used by the researchers to improve the grammar and writing of the instrument.

The self-regulated learning scale instrument tested was 40 items, which were improved by considering the suggestions and input from the validators. The next step was to calculate the internal consistency index using the Microsoft Excel application for each item on the self-regulated learning scale, with the result that items 10, 13, 25, and 32 did not meet the requirements. These items were discarded since they had a score of less than 0.3. Then, the stage of determining the reliability of the self-regulated learning scale instrument employed the Cronbach Alpha formula in the Microsoft Excel application, with each application showing the same result, i.e., 0.816. The self-regulated learning scale instrument was reliable because the results showed a score of more than 0.7. In addition, the two-tier essay research instrument containing 11 items had a maximum score for each item 10. Each item had two levels, with the first level being used to find out the respondent's understanding of the concept of the material provided, while the second level was employed to determine the reasons underlying the answers given at the first level. The maximum score at the first level was 6, whereas the maximum score at the second level was 4.

Afterward, measuring the instrument's validity used three expert raters, with a score scale of 1-5 and an error rate/error probability of 5%. Based on Aiken's V table, the instrument is said to be valid if each item achieves a minimum score of 0.92. Based on calculations performed using Aiken's V to test the validity of the two-tier essay research instrument, items 1, 3, 4, 5, 6, and 7 met the feasibility presented by Aiken's V validity index but still needed to be improved if the validator continued to provide input. Meanwhile, items 2, 8, 9, 10, and 11 did not meet feasibility, so they needed to be revised based on validator input if these items would still be used. To determine the quality of the language aspect of the two-tier essay research instrument, the researchers involved two experts in Indonesian and linguistics. The suggestions and input provided by the expert were then used by the researchers to improve the grammar and writing of the instrument.

The two-tier essay instrument tested consisted of 11 items, which were improved by considering the suggestions and input from the validators. The next step was to calculate the discriminatory power of the two-tier essay research instrument, and the results showed that items 1 to 11 met the requirements for discriminatory power, with scores obtained above 0.3. The next step was to calculate the difficulty level index of the two-tier essay test, and the results revealed that items 1, 3, 4, 5, 6, 7, and 9 met the requirements, namely $0.30 \leq P \leq 0.70$, while items 2, 8, 10 and 11 did not meet the requirements and had to be discarded. Then, the next step was to calculate the reliability of two-tier essay questions using the Cronbach Alpha formula, utilizing the Microsoft Excel application, with each application showing the same result, i.e., 0.73962. Since the results uncovered a score of more than 0.7, the two-tier essay instrument was reliable.

Data Regarding the Level of College Student Self-Regulated Learning

Self-regulated learning is related to students' attitude in exercising self-control regarding everything done and planning everything related to learning. Self-regulated learning was measured using a research instrument in the form of a Likert scale. The preparation of the Likert scale used two directions of trend, namely the positive/favorable and negative/unfavorable directions; unfavorable items were made as a form of distraction/bait/ distractor from the correct answer, and scale 3 (the scale in the middle/the scale considered neutral/the scale considered ambivalent) was removed. The average and standard deviation were employed in categorizing self-regulated learning. The scores obtained in the control and experimental classes are presented in Table 1.

Table 1. Acquired College Student Self-Regulated Learning Scale

SRL Level	Provision	Control Class	Experiment Class
High	SRL Scale Value (x) $\geq \bar{x} + SD$	x ≥ 88.3423572	x ≥ 89.3223
Moderate	$\bar{x} - SD <$ SRL Scale Value (x) $< \bar{x} + SD$	74.7131984 < x < 88.3423572	75.3305 < x < 89.3223
Low	SRL Scale Value (x) $\leq \bar{x}$ - SD	x ≤ 74.7131984	x ≤ 75.3305

The categorization in Table 1 was used to categorize college students' self-regulated learning, and the following details were obtained. Categorization of samples in control and experimental classes is show in Table 2.

Based on Table 2, the samples with moderate self-regulated learning levels were larger than those with low and high self-regulated learning. In the pre-test results data, a normality test was carried out with the results: L-count < L-table (0.06409 < 0.14767) in the control class and L-count < L-table (0.06682 < 0.14767) in the experimental class, so the sample came from a normally distributed population. The homogeneity test was then conducted using the Bartlett test with α = 0.05, and the Chi-Square test statistic ($x2$) obtained the test decision: x2 count < x2 table (1.76165 < 3.841459). These results indicate that the abilities of the sample were the same in both the control and the experimental classes. The t-test also

revealed a t-count value of 0.210171594, and the t-count was not a member of the critical area or could be written as $-t1-\frac{1}{2}\alpha < t < t1-\frac{1}{2}\alpha$, namely $-1.994437112 < 0.038794591 < 1.994437112$ or t-count = $0.038794591 \notin DK\{t \mid t > -1.994437112$ or $t < 1.994437112\}$, with the Ho test decision being accepted, so that the samples from each class came from a balanced population.

Table 2. Categorization of Samples in Control and Experimental Classes

Level of Self-Regulated Learning	Class	
	Control	Experiment
High	6	4
Moderate	26	25
Low	4	7

Data Regarding College Students' Critical Thinking Skills

The two-tier diagnostic tests had several provisions: the disclosure of certain concepts could be known through the first level, and the disclosure of reasons underlying the answers in the previous point was known through the second level. The two-tier essay was used as a test instrument because its application was to discover the thinking process of finding answers to the questions or solving questions based on the results of interpreting the questions into students' understanding. Data regarding critical thinking skills were measured using a research instrument in a two-tier essay with six items related to the material about motion. Value of critical thinking skills based on the interaction of learning models and college student self-regulated learning is show in Table 3.

Table 3. Value of Critical Thinking Skills Based on the Interaction of Learning Models and College Student Self-Regulated Learning

Level of Self-Regulated Learning	Critical Thinking Skills			
	Control Class		Experiment Class	
	$\bar{x}$	Standard Deviation	$\bar{x}$	Standard Deviation
High	67.22222222	4.791968589	91.66666667	2.357022604
Moderate	81.7308	4.701790848	84.7333	3.525042684
Low	90	1.360827638	72.14281	4.586084312

From Table 3, information was obtained that the difference in marginal means revealed a relationship between the level of self-regulated learning in each class, which gave different values of critical thinking skills. When subjected to a multiliteracy learning model, college students with high and moderate self-regulated learning had better critical thinking skills. On the other hand, college students with low self-regulated learning had better critical thinking skills when subjected to the application of the direct instruction model. Based on calculating the post-test results and classifying college students' self-regulated learning, the hypothesis testing results can be summarized in Table 4.

Table 4. Results of Two-Way Anava Test Analysis with Different Cells

Source	JK	dk	RK	Fobs	Fα	Test Decision
Row (A)	143.5562	1	143.5562	18.03901	3.986269479	H0A is rejected.
Column (B)	439.0672	2	219.5336	27.5862	3.135917934	H0B is rejected.
Interaction (AB)	2217.113	2	1108.556	139.2992	3.135917934	H0AB is rejected.
Error	525.2343	71	7.958096	-	-	-
Total	**3324.97**	**66**	**-**	**-**	**-**	**-**

From Table 4, information was obtained on the interlinear effect (A), and it was found that Fobs > Fα, so H0A was rejected or H1A was accepted. It denotes that applying the multiliteracy learning model could influence critical thinking skills. For the inter-column effect (B), it was uncovered that Fobs > Fα, so H0B was rejected or H1B was accepted. It indicates that self-regulated learning influences critical thinking skills. Furthermore, the main effect of row and column interaction (AB) obtained Fobs > Fα, so H0AB was rejected. In other words, the multiliteracy learning model and the level of self-regulated learning interacted with critical thinking skills.

Discussion

The Influence of the Multiliteracy learning model on Critical Thinking Skills

Based on the results of the two-way analysis of the variance test with different cells, it was found that H0A was rejected (Fa > Fα or 18.03900986 > 3.986269479). It indicates the influence of the multiliteracy learning model on critical thinking skills. The magnitude of the impact caused by the two effects could be determined significantly by conducting advanced Anava tests using the Scheffe method. Based on the results of the marginal mean between rows, the marginal mean of the experimental class was greater than that of the control class (82.8476 > 79.651). Therefore, it can be seen that the critical thinking skills of college students who learned using the multiliteracy learning model were better than college students who learned using the direct instruction learning model (Anwar, 2020; Budiyono, 2020).

In this regard, previous study reveals that applying the multiliteracy learning model requires the active role of students during the learning process (Adriansyah et al., 2022). The multiliteracy learning model aligns with the constructivism learning theory. Constructivism learning theory views that students must build their understanding of knowledge and form a thinking pattern by involving their active role during the learning process (Anwar, 2020; Mulyadi, 2022). So that the model is consistent with the characteristics of implementing human-environment subject learning, especially in critical thinking skills. Constructivism theory also explains that students' active participation and independence during the learning process are necessary for building an understanding of knowledge (Umbara, 2017). The research results conducted by also demonstrated that the active role of students contributed strongly to critical thinking skills (Zahranie et al., 2020).

During the research process, college students applying the multiliteracy learning model actively participated in learning to construct knowledge by emphasizing critical thinking skills in solving the problems they faced. It could be seen in the involvement of college student learning experiences at the stage of the multiliteracy learning process (especially at the activity stage, which included involving, responding, elaborating, reviewing, and presenting) so that, at the end of learning, they understood more about related learning material. College students in the experimental class were also given more opportunities to develop 21st-century learning skills through the use of various learning resources and language skills, with educators as facilitators (Irfan et al., 2021; F. A. Rahman & Damaianti, 2019).

On the other hand, college students applying the direct instruction model tended not to emphasize critical thinking skills in solving problems. During the research process, they did not participate actively during the learning process. It was because educators functioned as learning centers so that college students' knowledge was limited to information conveyed by educators, and they did not find challenges during the learning process (Ristanto et al., 2022; Rosyada et al., 2021; Suwarto, 2010). It is supported by the opinion explaining that educators functioning as learning centers can lead to one-way communication, which causes students' skills not to develop optimally (N. F. Sari, 2017).

Improving students' critical thinking skills can be performed by applying a learning model with a learning cycle that can develop and relate to aspects of critical thinking. In addition, previous study explained that in general, multiliteracy learning has a learning cycle: 1) The involving stage, meaning that the teacher involves the active role of students in the learning process to generate students' prior knowledge/schemata; 2) Responding stage, indicating that students respond to learning challenges given by the teacher through simple research activities, observations, and various investigations related to questions made by students; 3) The elaboration stage, denoting that students together with their group mates elaborate on the findings obtained, produce joint ideas in answering the questions made, and write them down in group reports (Pratama et al., 2018; Santrock, 2017); 4) The review stage, implying a process of reviewing the truth of the draft group report made by examining the data obtained by each individual, examining the validity of the reference source, and investigating the accuracy of the results obtained; and 5) Presenting stage, meaning that group representatives present the results of group reports in front of the class. Based on this explanation, the multiliteracy learning model cycle is related to aspects of critical thinking in its application.

Critical thinking skills assist students in analyzing, responding to, and managing information obtained during learning in college, so critical thinking skills must be used and built-in students (as prospective teachers) by applying appropriate learning models (Nadeak et al., 2020; Pamungkas et al., 2020). Moreover, previous study stated that it is important for students to learn by applying a multiliteracy learning model, specifically in developing the skills of searching, processing, communicating, and involving themselves (Lockyer & Harper, 2006). Based on this explanation, critical thinking skills can be developed by applying a multiliteracy learning model. The research results regarding the effect of applying the multiliteracy learning model on critical thinking skills are supported by relevant research conducted explaining that high understanding and critical thinking skills could be obtained through teaching by applying the multiliteracy learning model (F. A. Rahman & Damaianti, 2019). It indicates that the application

of the multiliteracy learning model influences critical thinking. A study by other study showed that the multiliteracy learning model influenced student critical thinking (Rosidah, 2018). Besides, research revealed that applying the multiliteracy learning model received a positive response for teachers and students, so its application improved students' critical thinking (Dafit et al., 2018). Based on the description of the relevant theory and research presented, it can be concluded that applying the multiliteracy learning model impacted college students' critical thinking skills. The research results are useful for improving critical thinking skills by applying a multiliteracy learning model.

Self-Regulated Learning on Critical Thinking Skills

Based on the results of the two-way analysis of the variance test with different cells, it was found that H0B was rejected (Fb > Fα or 27.58619735 > 3.986269479). It denotes an effect of self-regulated learning on critical thinking skills. The magnitude of the influence caused by the two effects could be significantly known by carrying out an Anava advanced test using the Scheffe method. Based on the results of the marginal mean between rows, (1) the marginal mean of college students' critical thinking skills with a high level of self-regulated learning was smaller than the marginal mean of college students' critical thinking skills with a medium level of self-regulated learning (79.44444444 < 83.2321); (2) the marginal mean of college students' critical thinking skills with a high level of self-regulated learning was smaller than the marginal mean of college students' critical thinking skills with a low level of self-regulated learning (79.44444444 < 81.0714); and (3) the marginal mean of college students' critical thinking skills with moderate levels of self-regulated learning was higher than the marginal mean of college students' critical thinking skills with low levels of self-regulated learning (83.2321 > 81.0714) (Ristanto et al., 2022; Rosyada et al., 2021; Suwarto, 2010).

The data analysis results exposed that the critical thinking skills of college students with a high level of self-regulated learning were smaller than the critical thinking skills of college students with a moderate level of self-regulated learning; the critical thinking skills of college students with a high level of self-regulated learning were smaller than the critical thinking skills of college students with a low level of self-regulated learning; and the critical thinking skills of college students with moderate levels of self-regulated learning were greater than the critical thinking skills of college students with low levels of self-regulated learning (Budiyono, 2020; F. P. H. Sari et al., 2022). Several factors cause moderate self-regulated learning critical thinking skills to be greater than high and low self-regulated learning, including the following.

Previous study explain that college students who do not have self-regulated learning have characteristics, one of which is difficulty in thinking critically (Manuella & Mangunsong, 2017). In line with that, the environment influences college students' self-regulated learning. It is reinforced by other study describing humans as a causal structural result of three important aspects, namely person (personal aspect), behavior (attitude aspect), and environment, which are interrelated (interdependent) (Bandura, 1997). Concerning college students' self-regulated learning, the environment is associated with individual efforts in utilizing the surrounding environment to find relevant learning resources, either by utilizing books in the library or using digital resources.

Additionally, college students with low self-regulated learning had difficulty adapting to applying a multiliteracy learning model that demands critical thinking skills in solving a problem by utilizing various relevant sources. Meanwhile, college students with low self-regulated learning in the control class had no difficulty adapting to the application of direct instruction, which does not require college students' critical thinking skills to solve problems by seeking information and knowledge from relevant sources because they had obtained information and knowledge directly through the lecturer. It is supported by the mean between cells, showing that the critical thinking skills of college students with low self-regulated learning in the control class were greater than those with low self-regulated learning in the experimental class (90 > 72.14281). Other factors affect critical thinking skills, namely the different levels of college student self-confidence. College students with low self-regulated learning tended not to be confident in expressing their opinions. It agrees with other study which asserted that college students who were not confident in their abilities caused them to be unable to maximize their self-regulated learning (Bintoro et al., 2013). There is study also stated that a decrease in the level of self-regulated learning aligns with a decrease in self-efficacy/self-confidence and social support (Rahmalia et al., 2019).

College students with low self-regulated learning also found it difficult to participate in learning in the experimental class. The multiliteracy learning model requires students to confidently express their opinions to support the multiliteracy learning syntax in the activity section, especially in the section presenting group work results. Hence, the direct instruction model is considered more suitable for conveying information or knowledge to students who tend to be inactive and lack confidence. It is supported by research results related to inter-cell mean, which showed that the critical thinking skills of college

students with low self-regulated learning in the control class were greater than those with low self-regulated learning in the experimental class (90 > 72.1428) (Defira, 2021). The data analysis results are also relevant to the research conducted by other study that there was an influence between students with a level of self-regulated learning and critical thinking (Roslinda et al., 2022). However, it was found that students with a low level of self-regulated learning had higher critical thinking skills than students with a high level of self-regulated learning, caused by other influencing factors, i.e., the level of confidence and learning styles of students. Based on the description of the relevant theory and research presented, it can be concluded that applying the multiliteracy learning model affected students' critical thinking skills. The research results are useful for improving critical thinking skills in terms of the level of self-regulated learning.

Multiliteracy Learning Model and the Level of self-Regulated Learning on Critical Thinking Skills

Based on the results of the two-way analysis of variance with different cells, it was uncovered that H0AB was rejected. It implies an interaction between the multiliteracy learning model and the level of self-regulated learning on critical thinking skills. Previous study explicated that internal and external factors influence critical thinking skills (Zahranie et al., 2020). Other study also mentioned that internal factors are accuracy, mastery of the material obtained, individual learning interest, and student learning independence (Widyasari et al., 2019). Another term for independent learning is self-regulated learning. Meanwhile, the learning model is one of the external factors influencing critical thinking skills (Kusuma, 2020; Ongesa, 2020; Ranti et al., 2017). Based on this statement, self-regulated learning is an internal factor, while applying learning models is an external factor impacting critical thinking skills. Based on the description of the relevant theory and research presented, it can be concluded that there was an interaction between the multiliteracy learning model and the level of self-regulated learning on critical thinking skills. The research results are useful for improving critical thinking skills through applying multiliteracy learning models in self-regulated learning.

4. CONCLUSION

The multiliteracy learning model influenced college students' critical thinking skills. The critical thinking skills of college students who studied using the multiliteracy learning model had higher results than students who learned using the direct instruction learning model. Self-regulated learning influenced critical thinking skills. The critical thinking skills of college students with moderate levels of self-regulated learning were greater than those with high and low levels of self-regulated learning. The multiliteracy learning model affected college students with highly self-regulated learning. The critical thinking skills of students with high self-regulated learning who learned using the multiliteracy learning model were more significant than those with high self-regulated learning who learned using the direct instruction learning model.

5. REFERENCES

Adriansyah, Salsabilla, B., Sabila, N. P., & Dafit, F. (2022). Multiliterasi Penerapan Menulis. *JPDK:Jurnal Pendidikan Dan Konseling*, *4*(1), 59–65. http://www.jpdk.org/index.php/jpdk/article/download/170/116.

Anwar, S. (2020). Pengaruh Problem Based Learning Dan Self Regulated Learning Terhadap Pemahaman Matematis. *GeoMath*, *I*(1), 54–67. https://doi.org/10.55171/geomath.v1i1.712.

Araka, E., Maina, E., Gitonga, R., Oboko, R., & Kihoro, J. (2021). University students' perception on the usefulness of learning management system features in promoting self-regulated learning in online learning. *International Journal of Education and Development Using Information and Communication Technology (IJEDICT*, *17*(1), 45–64. http://erepository.uonbi.ac.ke/handle.

Aslan, S., & Aybek, B. (2020). Testing the Effectiveness of Interdisciplinary Curriculum-Based Multicultural Education on Tolerance and Critical Thinking Skill. *International Journal of Educational Methodology*, *6*(1). https://doi.org/10.12973/ijem.6.1.43.

Aulia, D., & Aulia Zahroh, D. (2021). The Development of Scientific Literacy Based E-LKPD to Train Student's Critical Thinking Skills in Growth and Development Materials. *BioEdu Berkala Ilmiah Pendidikan Biologi*, *10*(3). https://doi.org/10.29407/e.v8i2.16207.

Bandura, A. (1997). *Self-Efficacy: The Exercise of Control* (H. Cristine (ed.)). United State of Amerika.

Bintoro, W., Purwanto, E., & Noviyani, D. I. (2013). Hubungan Self Regulated Learning Dengan Kecurangan Akademik Mahasiswa. *Educational Psychology Journal*, *2*(1), 57–64. https://journal.unnes.ac.id/sju/index.php/epj/article/view/2587.

Budiyono. (2020). *Pengantar Penilaian Hasil Belajar*. UNS Press.

Dafit, F., Mustika, D., & Ain, S. Q. (2018). Efektivitas Pembelajaran Multiliterasi Terhadap Kemampuan Berpikir Kritis Siswa Sekolah Dasar pada Materi Ekosistem. *JMIE: Journal of Madrasah Ibtidaiyah Education*, *2*(2), 181–193. https://doi.org/10.32934/jmie.v2i2.71

Defira, R. (2021). Peningkatan Hasil Belajar Perencanaan dan Instalasi Sistem Audio Video dengan Penerapan Model Pembelajaran Langsung (Direct Instruction) Siswa Kelas XII TAV1 SMK N 1 Bangkinang. *Jurnal Pendidikan Tambusi*, *5*(2), 3322–3334. https://jptam.org/index.php/jptam/article/view/1394.

Dishon, G., & Gilead, T. (2020). Adaptability And Its Discontents : 21st- Century Skills And The Preparation For An Unpredictable Future. *British Journal of Educational Studies*, *00*(00), 1–21. https://doi.org/10.1080/00071005.2020.1829545.

Dudu, W. T., & Vhurumuku, E. (2012). Teacher practices of inquiry when teaching investigations: A case study. *Journal of Science Teacher Education*, *23*(6), 579–600. https://doi.org/10.1007/s10972-012-9287-y.

Frydenberg, M. E., & Andone, D. (2011). Learning for 21st Century Skills. *IEEE's International Conference on Information Society*, 314–318. https://doi.org/10.1109/i-Society18435.2011.5978460.

Hadi, S., & Novaliyosi. (2019). TIMSS Indonesia (Trends in International Mathematics and Science Study). *Prosiding Seminar Nasional & Call For Papers*, 562–569. http://jurnal.unsil.ac.id/index.php/sncp/article/view/1096.

Hidayah, I. R., Kusmayadi, T. A., & Fitriana, L. (2021). Minimum Competency Assessment (AKM): An Effort To Photograph Numeracy. *Journal of Mathematics and Mathematics Education*, *11*(1), 14–20. https://doi.org/10.20961/jmme.v11i1.52742.

Irfan, A. M., Hidayatullah, & Apud. (2021). Pengembangan Model Pembelajaran Multiliterasi Pada Mata Pelajaran Aqidah Akhlak Materi Pergaulan Remaja. *Qathruna:Jurnal Keilmuan Dan Pendidikan Islam*, *8*(1), 248–253. https://jurnal.uinbanten.ac.id/index.php/qathruna/article/view/4799.

Jerrim, J., Sims, S., & Oliver, M. (2023). Teacher self-efficacy and pupil achievement: much ado about nothing? International evidence from TIMSS. *Teachers and Teaching: Theory and Practice*, *29*(2), 220–240. https://doi.org/10.1080/13540602.2022.2159365.

Kusuma, D. A. (2020). Dampak Penerapan Pembelajaran Daring Terhadap Kemandirian Belajar (Self-Regulated Learning) Mahasiswa Pada Mata Kuliah Geometri Selama Pembelajaran Jarak Jauh Di Masa Pandemi Covid-19. *Teorema: Teori Dan Riset Matematika*, *5*(2), 169. https://doi.org/10.25157/teorema.v5i2.3504.

Laksana, D. N. L., Dasna, I. W., & Degeng, I. N. S. (2019). The effects of inquiry-based learning and learning styles on primary school students' conceptual understanding in multimedia learning environment. *Journal of Baltic Science Education*, *1*(1). https://doi.org/10.33225/jbse/19.18.51.

Liao, S., Hong, J. C., Wen, M. H., & Pan, Y. C. (2018). Applying technology acceptance model (TAM) to explore users' behavioral intention to adopt a performance assessment system for E-book production. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(10), 1–12. https://doi.org/10.29333/ejmste/93575.

Lockyer, L., & Harper, B. (2006). A Technology-Enhanced Multiliteracies Learning Design for Geography Education. *3L The Southeast Asian Journal of English Language Studies*. https://ro.uow.edu.au/edupapers/613/.

Machmud, M. T., Rosidah, Fadhilatunnisa, D., & Fakhri, M. M. (2021). Indonesia Teacher Competencies in Integrating Information and Communications Technology for Education. *Athens Journal of Technology and Engineering*, *8*(4), 331–348. https://www.researchgate.net/profile/Muhammad-Machmud-3/publication/356834830.

Manuella, B. D., & Mangunsong, F. M. (2017). Enhancing an Underachieving Middle School Student's Motivation and Self-Regulation in Learning Mathematics with Self-Regulated Learning Program. *1st International Conference on Intervention and Applied Psychology (ICIAP 2017)*, *135*, 222–233. https://doi.org/10.2991/iciap-17.2018.19.

Megawati, L. A., & Sutarto, H. (2021). Analysis numeracy literacy skills in terms of standardized math problem on a minimum competency assessment. *Unnes Journal of Mathematics Education*, *10*(2), 155–165. https://doi.org/10.15294/ujme.v10i2.49540.

Mulyadi, M. (2022). Teori Belajar Konstruktivisme dengan Model Pembelajaran (Inquiry). *Al Yasini : Jurnal Keislaman, Sosial, Hukum Dan Pendidikan*, *7*(2), 174–187. https://doi.org/10.55102/alyasini.v7i2.4482.

Nadeak, B., Juwita, C. P., & Sormin, E. (2020). Hubungan Kemampuan Berpikir Kritis Mahasiswa dengan Penggunaan Media Sosial Terhadap Capaian Pembelajaran pada Masa Pandemi Covid-19. *Jurnal Konseling Dan Pendidikan*, *8*(2), 98–104. https://doi.org/10.29210/146600.

Ongesa, C. M. (2020). Critical Thinking Skill Gap in the Kenyan Educational Curriculum:The 21st-Century skills for the Global Citizen. *OJED:Journal of Interdisciplinary Studies in Education*, *9*(SI), 178–191. https://doi.org/10.32674/jise.v9isi.1860.

Pamungkas, S. F., Widiastuti, I., & Suharno. (2020). 21st century learning: Experiential learning to enhance critical thinking in vocational education. *Universal Journal of Educational Research*, *8*(4), 1345–1355. https://doi.org/10.13189/ujer.2020.080427.

Pratama, B. A., Subali, B., & Dwijananti, P. (2018). Developing Two-Tier Essay for Diagnostic Test Instrument to Identify Student Learning Difficulty. *Scientiae Educatia: Jurnal Pendidikan Sains*, *7*(2), 117–128. https://doi.org/10.24235/sc.educatia.v7i2.2683.

Rahmalia, P., Kardinah, N., & Kurniadewi, E. (2019). Tipe Kepribadian Conscientiousness Dan Self-Regulated Learning Mahasiswa Dalam Menghafal Alquran Juz 30. *Jurnal Psikologi Islam*, *6*(2), 63–78. http://jpi.api-himpsi.org/index.php/jpi/article/view/85.

Rahman, F. A., & Damaianti, V. S. (2019). Model Multiliterasi Kritis dalam Pembelajaran Siswa Sekolah Dasar. *Jurnal Pendidikan Dasar*, *10*(1), 27–34. http://journal.unj.ac.id/unj/index.php/jpd/article/view/11140.

Rahman, M. A., Melliyani, M., Handrianto, C., Erma, E., & Rasool, S. (2022). Prospect and promise in integrating multiliteracy pedagogy in the english language classroom in indonesia. *Eternal (English, Teaching, Learning, and Research Journal)*, *8*(1), 34–52. https://doi.org/10.24252/Eternal.V81.2022.A3.

Ranti, M. G., Budiarti, I., & Trisna, B. N. (2017). Pengaruh Kemandirian Belajar (Self Regulated Learning) Terhadap Hasil Belajar Mahasiswa Pada Mata Kuliah Struktur Aljabar. *Math Didactic:Jurnal Pendidikan Matematika*, *3*(1), 75–83. https://jurnal.stkipbjm.ac.id/index.php/math/article/download/57/50

Rasi, P., Kangas, M., & Ruokamo, H. (2019). Promoting Multiliteracy in The Finnish Educational System. *Introduction to the Finnish Educational System*, 96–157. https://doi.org/10.1163/9789004394278.

Rembulan, G. D., Wijaya, T., Ruslie, A., Jordy, & Sunadynatha, R. A. S. (2020). Mereduksi Voice of Customer pada Pengembangan Produk Alat Pembuka Tutup Galon Menggunakan Analisis Faktor. *JIEMS (Journal of Industrial Engineering and Management Systems)*, *13*(2), 87–99. https://doi.org/10.30813/jiems.v13i2.2281.

Ristanto, R. H., Miarsyah, M., & Ekosistem, K. (2022). *Two-Tier Test : Development of Critical Thinking Instruments for Ecosystem Concepts Two-tier Test : Pengembangan Instrumen Berpikir Kritis*. *12*(1), 48–62. https://doi.org/10.21580/phen.2022.12.1.11829.

Rosidah, C. T. (2018). Pengaruh Pembelajaran Berbasis Multiliterasi Terhadap Kemampuan Berpikir Kritis. *PINUS: Jurnal Penelitian Inovasi Pembelajaran*, *4*(1), 38–43. https://doi.org/10.29407/pn.v4i1.12368.

Roslinda, F., Sulistyaningsih, D., & Suprapto, R. (2022). Pengaruh Self -Regulated Learning Terhadap Kemampuan Berpikir Kritis Matematis Siswa. *Prosiding Seminar Nasional UNIMUS*, *5*, 677–690. https://prosiding.unimus.ac.id/index.php/semnas/article/view/1232.

Rosyada, F., Supardi, K. I., Kasmui, K., & Sriwijayanti, N. (2021). Desain Tes Diagnostik Two-Tier Untuk Analisis Pemahaman Konsep Kelarutan Dan Hasil Kali Kelarutan. *Jurnal Inovasi Pendidikan Kimia*, *15*(2), 2873–2884. https://doi.org/10.15294/jipk.v15i2.15878.

Santrock, J. W. (2017). *Educational psychology*. McGraw-Hill Education.

Sari, F. P. H., Atmojo, I. R. W., & Ardiansyah, R. (2022). Pengaruh problem based learning berbantuan video animasi terhadap keterampilan berpikir kritis pada pembelajaran ipa kelas V SD se-kecamatan laweyan. *JPI:Jurnal Pendidikan Indonesia: Jurnal Ilmiah Pendidikan*, *8*(4), 1–6. https://digilib.uns.ac.id/dokumen/detail/98193/.

Sari, N. F. (2017). Perbandingan Hasil Belajar Siswa yang Diajar Menggunakan Model Pembelajaran Quantum Teaching dengan Model Pembelajaran Langsung (Direct Instruction) Pada Sub Bab Materi Pokok Sistem Respirasi Pada Manusia di Kelas XI SMA Swasta Medan Putri Tahun Pembelaja. *Edu Science*, *4*(2), 18–24. https://doi.org/10.36987/jes.v4i2.935.

Sasson, I., Yehuda, I., & Malkinson, N. (2018). Fostering the skills of critical thinking and question-posing in a project-based learning environment. *Thinking Skills and Creativity*, *29*, 203–212. https://doi.org/10.1016/j.tsc.2018.08.001.

Setyaningrum, R. W., & Purwati, O. (2020). Projecting the implementation feasibility of clil approach for teyl at primary schools in indonesia. *JEES (Journal of English Educators Society)*, *5*(1), 23–30. https://doi.org/10.21070/jees.v5i1.352.

Sugiyono. (2018). *Metode Penelitian Kuantitatif. Bandung: Alfabeta.*

Suwarto. (2010). Pengembangan The Two-Tier Diagnostic Tests pada Bidang Biologi secara Terkomputerisasi. *Jurnal Penelitian Dan Evaluasi Pendidikan*, *14*(2), 206–224.

https://doi.org/10.21831/pep.v14i2.1079.

Taar, J., & Palojoki, P. (2022). Applying interthinking for learning 21st-century skills in home economics education. *Learning, Culture and Social Interaction*, *33*(April 2021). https://doi.org/10.1016/j.lcsi.2022.100615.

Umbara, U. (2017). Implikasi Teori Belajar Konstruktivisme Dalam Pembelajaran Matematika. *Jurnal Matematika Ilmiah STKIP Muhammadiyah Kuningan*, *3*(1), 31–38. http://jurnal.upmk.ac.id/index.php/jumlahku/article/view/348.

Widyasari, Rasmitadila, Asri Humaira, M., Rusmiati Aliyyah, R., Abdul Gaffar, A., & Rachmadtullah, R. (2019). Preliminary study on the development of blended learning (BLM) model: Based on needs analysis and learning independence. *Journal of Physics: Conference Series*, *1175*(1). https://doi.org/10.1088/1742-6596/1175/1/012207.

Yaacob, A., & Lubis, A. H. (2022). The Development of Web-Based Teaching Materials Integrated with Indonesian Folklore for Indonesian Language for Foreign Speakers Students. *International Journal of Language Education*, *6*(1), 46–62. https://eric.ed.gov/?id=EJ1343101.

Zahranie, M., Andayani, Y., & Loka, I. N. (2020). Hubungan Keaktifan Bertanya dengan Kecenderungan Berpikir Kritis Siswa Kelas XI IPA di SMA/MA Se-Kecamatan Narmada Tahun Ajaran 2019/2020. *Chemistry Education Practice*, *3*(1), 5–11. https://doi.org/10.29303/cep.v3i1.1426.