The effect of the Collaborative Learning Models and Learning Motivation on Collaborative Skill and Critical Thinking Abilities in Students.

Casimiro Relvas Amaral*[1], Agostinha Barreto*[2], Anselmus Yata Mones*[3]
*[1]Lecture, Department of Biology, Instituto Superior Cristal, Timor Leste
*[2]Lecture, Department of Biology, Instituto Superior Cristal, Timor Leste
*[3]Lecture, Sekolah Tinggi Pastoral St. Petrus Keuskupan Atambua, Indonesia

Corresponding Author: casimiro78amaral@gmail.com*[1],
agostinhabarreto@gmail.com*[2,] anselmojata@gmail.com*[3]

ABSTRACT

This research aims to test the influence of collaborative learning models on collaborative skills; the influence of collaborative learning models on critical thinking; the influences of learning motivation on collaborative skills; influence of motivation of learning on critical thinking; Influence between collaborative learning models and the learning motivations and collaborative skill on critical thinking; and the interaction between collaborative skills and learning motivations and the ability to critically think. This study employs experimental methods with a pretest-posttest control (30) and treatment (30) group design on semester I student of biological major. Data collection includes observations, tests, and questionnaires. The normality test, homogeneity, and Manova are utilized to analyze the data through SPSS version 25. The results show that there is a considerable influence (0,000 < 0.05) between the use of the collaborative skills model and learning motivation on the ability to critical thinking and collaborative skills. An interaction between the model of collaborative skills and learning motivation against the ability of critical thinking.

Keywords: collaborative, learning, motivation, skills, critical-thinking.

INTRODUCTION

The 21st century is marked by rapid advances in science, information, and communication technology that have driven the acceleration of globalization. The era of globalization has brought about major changes with the melting of space and time dimensions, thus driving the world to become more open. Nation and nation interact, compete, and become interdependent. The impact of bilateral, regional, and multi-territorial cooperation is growing, followed by the emergence of various intercountry problems. On the other hand, life in a changing global world opens opportunities and challenges for education to strengthen the skills of graduates to compete globally. The core competencies and skills of human resources in the 21st century include critical thinking skills, critical thinking, creativity, innovation, collaboration, and communication.

The World Economic Forum (WEF, 2016) has identified 10 skills deemed necessary in 2015 that will change by 2020 as artificial intelligence and robots take over in the workplace. The WEF publishes the "Top 10" skills considered important in the 2020 workplace, namely: (1) complex problem-solving, (2) critical thinking, (3) creativity, (4) HRM management, (5) coordination with others, (6) emotional

intelligence, (7) judgment and decision-making, (8) service orientation, (9) negotiation, and (10) cognitive flexibility.

(Rosenbaum et al., 2023) To meet the number of human resources competencies and skills required, education needs to be developed concerning several such global competencies. To meet global urgency, the education paradigm must change. Education needs to be transformative, with an approach that enables learners to develop creative thinking, be flexible in working together to solve problems, and be collaborative and innovative in achieving career and life success (Mones, et al., 2024). Learning should provide an opportunity for learners to interact with learners and peers, as well as to practice and apply new skills and knowledge. Without the opportunity to practice and apply new knowledge in various contexts, the adaptation and integration of new knowledge competencies that are expected will not be achieved (Schott, 2015).

The learning principles developed in the educational paradigm of the 21st century are the embodiment of the learning concept adopted by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in 1996 as the four pillars of education, namely: (1) learning to know, (2) learning to do, (3) learning to live together, and (4) learning to be (Delors, 2013) What about the existing human resource competence and skills? According to research, in general, the competence of graduates is still not in line with the need for competence and skills required in the 21st century. Graduates from pre-emptive schools and higher education have not yet demonstrated the expected level of competence. Some competencies are still lacking, such as (1) ability to communicate both orally and in writing; (2) ability to think critically and problem-solve; (3) work ethics and professionalism; (4) working in groups or collaborating; (5) working with diverse groups; (6) using technology; and (7) management and leadership skills (Rilling, & Fadel, 2009).

Critical thinking and collaborative skills are skills that involve rational involvement in the learning process, consisting of interrelated components between each situation that should include analyzing evidence and arguments and then generating meaningful perspectives and successful solutions. Collaboration is a skill that includes the ability to respect and work with different learners. According to Rachmawati et al., (2021) define thinking is one of the objectives of education. An educator or teacher is expected to create learning immersion and can train critical thinking skills in students independently to find learning information as well as actively build cognitive structures in students themselves (Patonah, 2014) For its achievement, an interactive learning approach is required, where students are seen as active thinkers and engaged in the learning process. Teachers act as mediators, facilitators, and motivators, guiding students as needed in the process of learning and not as suppliers of material alone (Patonah, 2014).

According to Johnson & Smith, (2014) objective critical thinking involves mental activities such as sorting out problems, making decisions, analyzing assumptions, and conducting scientific research. The purpose of critical thinking is to gain a deep understanding of a subject. Critical thinking encompasses the ability to analyze facts, generate and organize ideas that support opinions, make comparisons, draw conclusions, argue, and solve problems. According to Nasution et al., (2023) critical thinking encourages a person to look for truth, think flexibly, analyze problems systematically, have a high desire, think maturely, and have the capacity to consider different perspectives for decision-making based on careful analysis.

The emergence of increasingly complex problems in the lives of people, nations, and nations may require the ability to collaborate to compete effectively. That can

motivate individuals or groups to achieve; it also needs to be added to the spirit of collaboration for mutual success. Supportive interaction and dependency between individuals, groups, and supportive states make collaboration essential. Applying the CLM encourages students to provide real experiences that stimulate the development of skills such as coordination, communication, conflict resolution, decision-making, problem-solving, and negotiation.

According to Davidson, et al., (2013)a supporter of collaborative learning, describes knowledge as something built by talking together. Bebrapa's empirical studies have applied the CLM to learning and its influence on other variables. According to Gokhale's research, the group of students using the CLM performed better than the group involved in competitive learning. Furthermore, students who used the CLM demonstrated better critical thinking abilities than those who used competitive learning. (Gokhale, 1995). Likewise, the results of research by (Gunawardena & Wilson, 2021). With critical thinking, teaching approaches can result in achievements that can transform and build a culture of critical thought in the classroom through a clear approach to support the development of student critical thinking (Chang & Wongwatkit, 2023) With increased achievement and motivation, enhanced collaboration, communication, and critical thinking, such approaches may build a critical-thinking culture in the schoolroom through clear approaches (Vera-Monroy et al., 2024; Annisa et al., 2025). Develop critical thinking skills through physics courses in engineering programs using collaborative work, problem-based learning, and interaction in virtual classrooms. (Vera-Monroy et al., 2024) With an average effect size score of 0.79, which includes moderate students, they are developing critical thinking skills while learning.

Hasanah et al., (2023) defined thinking as scientifically cricket by conducting the activity of collecting data from various sources to find the truth of a concept. Another learning model that has similarities with the CLM is the cooperative learning model (hereinafter abbreviated as the CpL model). The general difference is that the CL model is more student-centric to facilitate group activities, while the CpL model is more student-centered (Pannitz, 1999). The CpL model is effective in developing cognitive, affective, and interpersonal skills through individual accountability (King, A., & Leigh, 2009, Riyanto, 2014) ranked CpL's strengths, the ability to teach academic and soft skills, including interpersonal skills.

Slavin, (2005) explains that the CpL model needs to be applied in learning for two reasons. First, using the CPL model can improve academic achievement, enhance social relations skills, cultivate an attitude of acceptance of self-deficiency, meet students' needs in developing the thinking ability to solve problems, and also change knowledge by using skills. Several empirical studies also confirm the superiority of the CpL model. CpL models have a positive impact on students' ability to improve their oral communication skills (Guterres, et al., 2023). The experimental group outperforms the control group in terms of social skills. This is the CpL model.

Compared to the traditional methods (Jundi et al., 2023). The CpL model facilitates students working as a team towards a common goal under conditions that include several elements, one of which is the proper use of collaborative skills. student and confidence-building skills, leadership decision-making, communication, and conflict management (Surahman et al., 2025). Surahman et al., (2025), emphasizes that knowledge requires a variety of interaction capital that students should have; this interaction mode focuses on an effort to improve pupils. The learning process demands the quality of educated human beings.

Based on the existence of a paradigm of learning that focuses on learning towards teachers, learning changes the learning environment to be active, collaborative, self-regulated, and self-directed (Tan, 2003) The paradigm shift for education also includes a change in the paradigm of biological learning. The new paradigm in education that needs to be applied in biology learning is (1) the emphasis on the mastery of the scientific process of student learning skills, and (2) the stress on the understanding of the life and ability of students in solving problems of student life. (3) the cooperation of students as well as the use of technology; (4) the role of teachers as facilitators of learning; and (5) the use of authentic assessment compared to the standard test assessment (Carvalho et al., 2010). Furthermore, biological learning at the moment is highly expected, not only to convey facts, concepts, and biology precepts to students but also to encourage students to develop their scientific inquiry by conducting experiments in the natural environment.

Learning conditions are factors that are integrated with the learning method and cannot be changed. Lattu, (2022) describes student characteristics include motivation, attitude, talent, interests, learning styles, thinking skills, critical thinking skills, and others. Motivation drives individuals to be more selective in their actions (Annisa et al., 2025; Tomé et al., 2024; da Costa et al., 2019). (Latham, 2017) Individuals will determine the jobs that should be held, and which should be avoided based on their alignment with the goals they want to achieve. Individuals with high motivation tend to be more selective in their activities (Brito et al., 2024). A highly motivated student can reject activities that are considered unproductive. In the context of learning, students with high motivation can arrange time for learning, play, or even delay the pleasure of focusing on the preparation for the exam. When motivation is high, the individual is inspired to achieve good results through dedication and perseverance in the learning process (Tomé, et al., 2024; Atmoko et al., 2022).

The intensity of learning motivation directly affects the achievement of learning outcomes (Ximenes, 2025; Rachmawati et al., 2021; Da Costa, 2016). (Hidayatullah, 2018) Explain that the level of motivation is determined by internal and external factors. Internal factors involve the individual's physical and psychological conditions, whereas external factors include the social environment, interactions with friends and family, and other non-physical factors. The degree of student involvement in academic activities also reflects their level of motivation (Lopez & Tadros, 2024). I earning motivation can lower the online learning gap due to changes in the learning environment. For example, when students do not have to interact directly with classmates to discuss, their learning motivation may decrease.

Parents also feel that they need the help of a lecturer to foster motivation and involvement in learning (Hira, & Anderson, 2021).

 For access and applied learning processes at the Instituto Superior Cristal, Faculty of Educational Sciences, Department of Biology, general biology courses are programmed by students of the first semester. To find out the problems experienced by students and lecturers the title of this research, the researchers conducted a preliminary study, namely a survey, by giving a lift to the students. Things for achievement in students are active following lectures, taking responsibility for duties, and the results of lectures.

According to student surveys in general biology courses, commonly used learning approaches include lectures, questions, discussions, and practices. There are often group discussions, and students tend to be less active or passive, especially when discussions are going on. Students are often late to collect assignments. From the results of the survey obtained from 60 students in the first semester of the Biology course umm 27 students achieved the good category while 33 students achieved the category less good. If viewed

from the average value, the percentage of achievement is at least 55%. While the accuracy criterion has reached 45%. It concluded that, despite the lack of implementation, there is collaborative learning. The learning rate of general biology courses is still low.

Collaboration between lecturers and students of the study program and other interactions are essential to address the problem. For a student-centered development approach, this is done by applying a learning model that can be adapted to the characteristics faced by students. (Sugianto, 2022) defined there are four reasons why the model of CL is used in learning: (1) CL becomes the core of the learning process; (2) ensuring that all students have the opportunity to learn without exception; (3) is a form of collaboration learning for the same student; (4) Collaboration learning can involve challenges on higher-level material called leap material. According to the survey and documentary study results, most students tend to be passive in their learning. The behavior indicates a weakened lack of collaboration and a lack of motivation for students to follow the course. To recognize the importance of critical thinking and collaborative skills as part of the skills required in the age of globalization, learning is expected to be able to develop both skills.

METHOD

The research method used is experimental research, while the research design is a pretest-posttest control group design. There are randomly selected experimental classes and control classes (Sugiyono, 2019) Both groups were then given a pre-test to determine the early ability of the students to understand the material to be studied. This research includes a true experimental design, which aims to control all the external variables that affect the course of experiments. Samples used for both experimental and control groups were randomly taken from a specific population (Gay, & Mills, 2012).

The limitation of this study is that not all variables that affect the attachment variables can be controlled as in real experiments. Selection and grouping of research subjects in applying the CL (CL) model to the experimental group and the cooperative learning (CpL) model to the control group. Comparisons can only be done based on classes of general biology that already exist or are not possible to do. In addition to studying the impact of the CL (CL) model compared to the cooperative learning (CpL) model, the study also observed the influence of the learning motivation variable on the bound variable. We describe the research design as follows to elucidate the process of testing multiple free variables against these bound variables:

Design Research

Groups	Pretest	Treatments	Post test
Experimen	Q1	X_1	Q2
Control	Q3		Q4

X_1= treatment with Collaborative Learning; Q1= pretest class experiment
Q2= Post test class experimen; Q3= pretes class control; Q4= post test Class Control

The data analysis method used in this study is a comparative descriptive method using the Multivariate Analysis of Variance (MANOVA) test (Ghozali, 2009). The MANOVA test is used to determine whether there are statistically defined differences in several variables that occur simultaneously between two levels in one variable. There are four tests in the Manova analysis that are used to conclude the hypothesis. Hotelling's trace, and Roy's largest root. The test statistics are Pillai's trace, Wilk's lambda.

The MANOVA test is used in this study to test the third research hypothesis that there is a significant influence of the mathematical disposition on the ability to solve problems and think of algebra students with a significant level of $\alpha = 5\%$. So if the significant value (p-value) in the test MANOVA analyzed using SPSS has a significance value $< \alpha = 0.05$, then it can be stated that the third study hypotheses are accepted. whereas to evaluate the effect of the given treatment on the dependent variable to determine whether there are significant differences in the dependent variable between the groups of treatment. Which presents statistical values of F-values, p-values, degrees of freedom, and mean square.

RESULT AND DISCUSSION

The hypothesis was tested to see if there was an impact of CL on collaborative skills, the impact of CL on critical thinking, the influence of learning motivation upon collaborative skills, and the effect of learning motivation on the ability to think critically. The MANOVA test used in this study is the Walks' Lambda test because this statistic can be met in the study, which is a variable that meets the normality and homogeneity of the independent variables. The results of the MANOVA test can be seen in the following table:

Table 1: Multivariate Test

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.446	46.621[b]	2.000	116.000	.000
	Wilks' Lambda	.554	46.621[b]	2.000	116.000	.000
	Hotelling's Trace	.804	46.621[b]	2.000	116.000	.000
	Roy's Largest Root	.804	46.621[b]	2.000	116.000	.000
Collaborative Learning	Pillai's Trace	.208	15.207[b]	2.000	116.000	.000
	Wilks' Lambda	.792	15.207[b]	2.000	116.000	.000
	Hotelling's Trace	.262	15.207[b]	2.000	116.000	.000
	Roy's Largest Root	.262	15.207[b]	2.000	116.000	.000
Learning Motivation	Pillai's Trace	.226	16.905[b]	2.000	116.000	.000
	Wilks' Lambda	.774	16.905[b]	2.000	116.000	.000
	Hotelling's Trace	.291	16.905[b]	2.000	116.000	.000
	Roy's Largest Root	.291	16.905[b]	2.000	116.000	.000

1. The impact of CL (CL) on collaboration skills.

The Manova test used to analyze the influence of CL on collaborative skills, based on Table 1 Wilks' lambda value is 0.792 with $F(2, 116) = 15.207$ and a p-value of 0.000, where $0.000 < 0.05$ indicates that collaborative learning's influence on dependent variables is significant. Such results indicate that there are significant differences in collaborative skills. Based on CL applied to students for collaborative skills, CL enhances interaction and collaboration between students, who directly develop collaborative skills during participating activities. In a CL environment, students can collaborate, share ideas,

and solve problems collectively. Results from Wilks' Lambda show that CL has a considerable influence on collaborative skills.

Using CLM in the classroom can effectively enhance important aspects of learning. Some relevant research results were previously conducted (Kharismawati et al., 2024) CLM have an effective influence on improving student learning outcomes. (Ishimura & Fitzgibbons, 2023) CL can develop information literacy (LI). Collaboration, real-time interaction, and alignment between topic choices and student interests. Sarah & Witarsa (2023) CL is present and future learning because one's current intelligence is measured by the ability to collaborate on a particular project or field (Alp & Bulunuz, 2023). Using collaborative learning. that the critical thinking skills of students in experimental groups are higher compared to students in control groups. (Guo et al., 2024) CL can have an exclusive influence on student performance (Ramadevi et al., 2023).

CL using artificial intelligence can improve education quality and provide students with the knowledge, skills, and values needed to succeed in a changing society (He et al., 2023) A cross-cutting CL approach can explore the correlation between student participation in group activities and progress in problem-solving skills in learning contexts. (Asad & Hussain, 2023) Student collaboration and creative learning. Be able to confidently participate and interact positively with co-workers (Endrawan & Aliriad, 2023) CL is more effective in improving student learning outcomes than conventional learning.

Learning environment factors, learning methods, and the quality of teachers all have an impact on student learning results (Jundi et al., 2023) Development of cooperative learning in the educational environment and recommendations for teachers and educational practitioners to implement STAD more effectively and enhance collaboration for students. (Xu et al., 2023) With CL results, explorative factor analysis, and confirmatory support, the three-factor hierarchical model of student involvement (behavioral, cognitive, and emotional involvement), is consistent with the conceptualization of student engagement. From the above explanation, it can be concluded that the CL model has a considerable influence on collaborative skills among biology students at ISC Dili. The results of Wilks' Lambda show that CL has a major influence on collaborative skills. Using CL methods in classrooms can effectively enhance important aspects of learning. A variety of relevant previous studies have shown that CL is effective in enhancing student learning outcomes, developing information literacy, improving critical thinking skills, and improving student performance and learning outputs.

2. The impact of the CL model on critical thinking Ability

The independent variable CL has a significant influence on the ability to think critically. Lambda value of 0.792, $F(2, 116) = 15.207$, and the $p_{value} = 0.000$, where $0,000 < 0.05$, this result indicates that the impact of CL on the ability to think critically is significant. Therefore, there is a significant difference in the ability to think critically based on the level of CL applied. CL can enhance interaction and collaboration among students, which facilitates discussion and problem analysis. Through this process, students can think critically about the information they learn, evaluate different perspectives, and develop strong arguments. In a CL environment, students are encouraged to ask each other questions, criticize ideas, and find more effective solutions together for critical thinking skills.

Implementation of CL methods in the classroom can significantly improve students' ability to think critically. By involving students in collaborative activities, pupils

not only learn to collaborate but also develop critical thinking skills that are useful for academic and professional life. The results of Wilks' Lambda showed that CL has a significant influence on the ability to think critically. CL strategies are also more effective in improving critical thinking skills in biology students. The influence of learning motivation on student news writing skills shows a sufficient interpretation of relationships. With a significant score of 0,000<0,05, LM have a significant influence on students' news writing skills.

A study conducted (B et al., 2023) Results of descriptive statistical analysis showed knowledge of technicality, showing results of 78.5% in remarkably high categories, learning motivation of 76.5% in extremely high categories, and skills of 66.6% in extremely high categories. There is a positive and significant influence of student motivation on the skills of the student. A study conducted (Widiyono, Effendi, & Susanto, 2022) concluded that there is an influence of learning motivation on the level of playing skills. (Syahrin, & bin As, 2021) found a significant influence ($f_{counting}$ 5,050 and p <0,050) on student motivation to improve their English-speaking skills. The results of research conducted (Seno & Sumaryoto, 2020).

The ability to work together on speech-writing skills and learning motivation has a significant impact. With a Sig value of 0.000 < 0.05, we can improve the quality of learning and speech-text writing. Wulansari et al., (2023) a comprehensive understanding of learning motivation is essential to improving mathematical education and raising students logically and emotionally (Sampe Lino et al., 2024). Students' learning motivation is moderate, with intrinsic motivation slightly higher than extrinsic motivation for collaborative online mathematics learning.

Kasumi & Xhemaili, (2023) CL and student achievements contribute to higher achievement by influencing student motivation and activity. Graves, (2023) Learning motivations and collaborative dissemination in the context of AI writing tools such as OpenAI ChatGPT. Specification assessments can override normative standards. (Wilda et al., 2023) Increased learning spirit and motivation are seen in active participation in learning activities and the use of free time to discuss lessons with friends. With the results of the discussion above, it can be concluded that learning motivation has a significant impact on collaborative skills in students of the FSE biology major at ISC Dili. Results from Wilks' Lambda show that CL has a major impact on the ability to think critically. Some relevant research shows that learning motivation positively affects a variety of skills, such as writing skills, play skills, English-speaking skills, and speech-text writing skills.

3. Impact of Learning Motivation on Collaborative Skills

According to Wilks' Lambda results, Table 1, shows that the variable "learning motivation" has a significant influence on collaborative skills. With a p (Sig.) value of p = 0.000, it is said that the influence of learning motivation on cooperative skills is significant. where 0,000 < 0.05. This result indicates that the impact of learning motivation on collaborative skills is significant. With the increase in learning motivation correlated to the improvement of collaborative skills in students, it can be said that students have high learning motivations and good collaborative abilities. The most relevant research by (Asri, 2022) The application of CL based on highly effective lesson study can result in a significant improvement in the ability to think critically. Badara et al., (2024) found that by improving student learning outcomes, instructors can also evaluate learning problems and develop lesson study applications , (Illahi et al., 2022) concluded that thematic CL improves critical thinking skills more than expository learning (Al-Fitrie et al., 2023) The results of the material test were presented.

The average was 90.9% (very good), and media test results were obtained at 65.5% (functional). Development of digital teaching materials for improving writing skills with a CL approach using Padlets (Jundi et al., 2023) Creative thinking skills can improve high school learning outcomes. (Karaca-Atik et al., 2023) Robot-type voice skills, robotic skill levels, and careful communication influence the perception of security and confidence in agile and close human-robot collaboration (Nurjanah, 2024) Students' critical reading skills are significantly improved after using multi modal text as a medium in the learning process. (Nurjanah, 2024) The creation of collaborative script-based worksheets has the potential to improve students' collaborative skills and learning outcomes. With some of the above discussions, it can be concluded that the CL model has a significant influence on the critical thinking ability of students in the FSE Biology Department at ISC Dili.

4. Impact of Learning Motivation on Critical Thinking Ability

The variable "learning motivation" has a significant influence on the ability to think critically. At the p-value (Sig.): A p-value of 0.000 indicates that learning motivation has a significant influence on critical thinking ability. For Wilks' Lambda (0.774): The Wilks'Lambda value is approximately 1, indicating that learning motivation plays a significant role in explaining variations in critical thinking ability. For Wilk's Lambda test results, it was concluded that learning motivation significantly affects the ability to think critically. This shows that the higher the student's learning motivation, the better their critical thinking ability.

Research-relevant research conducted (Asri, 2022) shows that CL based on lesson studies can effectively improve the quality of learning, which significantly affects students' ability to think critically. (Thornhill-Miller et al., 2023) The ability to think critically of new technology users like artificial intelligence and virtual reality (Santos-Meneses & Drugova, 2023) Critical thinking has gaps in research and practice, especially in terms of integrating aspects of creativity, disposition, and ethical and citizenship dimensions into the digital ecosystem. (Rohman, et al., 2024) Critical thinking skills tend to be higher than conventional learning (Illahi et al., 2022) There is an improvement in each indicator of creative thinking after implementing PjBL, and higher post-test scores than students in conventional learning classes improve creative thinking skills (Sun et al., 2023). The ability to think critically among student.

5. Interaction between CL and learning motivation versus collaborative skills

Tabel 2: Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	KK	231.807[a]	2	115.904	15.211	.000
	KBK	3804.309[b]	2	1902.155	10.984	.000
Intercept	KK	653.419	1	653.419	85.753	.000
	KBK	1686.715	1	1686.715	9.740	.002

Source		Sum of Squares	df	Mean Square	F	Sig.
Collaborative Learning	KK	137.433	1	137.433	18.036	.000
	KBK	2326.381	1	2326.381	13.433	.000
Learning Motivation	KK	156.518	1	156.518	20.541	.000
	KBK	2500.401	1	2500.401	14.438	.000
Error	KK	891.518	117	7.620		
	KBK	20262.357	117	173.183		
Total	KK	211043.000	120			
	KBK	669400.000	120			
Corrected Total	KK	1123.325	119			
	KBK	24066.667	119			

a. R Squared = .206 (Adjusted R Squared = .193)
b. R Squared = .158 (Adjusted R Squared = .144)

In table 2, the results of the walk's Lambda test show that there is a significant influence between the CL variable and the motivation for learning on collaborative abilities (p = 0,000, where p<0.05). This result shows that the variables CL and LM have a significant impact on CS. At the F value of the CS variable with a significant value on CL (F = 18,036, p = 0,000), and the LM variable (F = 20,541, p = 0.000), each variable has a significant influence on CS. The interaction between CL and LM has an impact on overall CS, as can be judged from the variability ratio in the acquisition model (R-squared).

The $R_{squared}$ value for collaborative skill is 0.206, meaning that there is about 20.6% variability in collaborative ability. For cooperative skills, the adjusted R-squared is 0.193. For R-quared, it is 20.6%, and for adjusting R_{quared}, = 19.3%. This suggests that although the model has a significant influence, there is still 79.4% of the of the variability not explained by the CL and motivation learning variables in colaborative skills. The interaction between CL and motivational learning has a significant influence on collaborative skills. For Wilks' Lambda value and $R_{squared}$ analysis, 20.6% of the variability in collaborative skills can be explained by this model. However, there is still room to explore other factors that may contribute to collaborative skills. Relevant research conducted by (Sunita, et al. 2020).

Concluded that there was an influence of the PBL learning model simultaneously on the creativity and mathematical learning outcomes of the pupils (Belo et al., 2024; Arjay et al., 2024). The importance of applying cognitive, communicative, and group-working skills learned through play experience in the learning process, both in academic and professional settings, increases the practical value of transferability in comprehensive skills development in the digital age. Kadijevich et al., (2023) describe a deeper understanding of the variables that influence the promotion of educators is needed to provide support to teachers in meeting the growing demand for the use of educational platforms with confidence to strengthen 21st-century digital skills. The f_{test} results showed that there was a significant interaction between the CLM and LM versus CS. It emphasizes the importance of applying cognitive, communicative, and group work

skills learned through play experience in the learning process, along with supporting educators in meeting the need to use educational platforms to enhance 21st century digital skills (Annisa et al., 2025).

6. Interaction between CL and learning motivation against critical thinking

The results of Wilks-Lamnda show the influence of CL on critical learning with a value of p = 0.000 p<0.05. This indicates that both CL variables and learning motivation have a significant influence on the ability to think critically. The interaction between CL and learning motivation influences the ability to think critically. Can be derived from the ratio of variability described by the model (R-$_{squared}$). At the R-$_{quared}$ value, the critical thinking ability is 0.158, which means that about 15.8% of the variability in critical thinking ability.

Critical thinking's adjusted R-$_{squared}$ value is 0.144. Adjusting R-squared describes the accuracy of the data variability model with the number of variables used in the model. The interaction between CL variables and learning motivation has a significant influence on critical thinking. A relevant study conducted by (Udha, et al., 2022) found that the learning and learning motivation models of students together can influence the improvement of students' creative thinking abilities (Ossa et al., 2023). The relationship between motivation and metacognition affects critical thinking skills (Aisyah, et al., 2021) The impact of T$_{treffinger}$ learning models on critical thinking skills and learning outcomes in the classroom.

Santos-Meneses et al., (2023) Enhancing critical thought skills in adult education, especially through problem-based learning and e-learning, can be enhanced by paying attention to two main principles: intrinsic motivation and learning behavior. (Maor et al., 2023) discuss the importance of a combination of metacognition, creativity, and critical thinking in PBL as well as the relationship between 21st century skills and environmental education (Noris et al., 2023). The ability to think critically can be constructed through the creation of three-dimensional virtual laboratory media.

CONCLUSION

Based on the results of the research, the influence of CL and motivation of students to develop collaborative skills and critical thinking abilities in biology major Faculty of Education at ISC Dili. that corresponds to the formula of research problems can be concluded as follows: 1). CL has a significant impact on collaborative skills among Faculty of education department of biology students. 2). The learning motivation of Ffaculty of education department of biology students at ISC Dili has a significant influence on collaborative skills. 3). CL has a significant impact on student's ability critical thinking in Department od Biology in ISC Dili. 4). Learning motivation has a significant influence on faculty of education Biology students' ability to critical thinking. 5). There is a significant interaction between CL and learning motivation towards collaborative skills in students of Faculty of education department of biology. 6). There is a significant interaction between CL and learning motivation versus critical thinking skills of biology students.

REFERENCES

Aisyah, S., Riyanto, Y., & Suhanadji, S. (2021). Pengaruh Model Pembelajaran Treffinger Terhadap Kemampuan Berpikir Kritis Dan Hasil Belajar Siswa. *Jurnal Riset Dan Inovasi Pembelajaran*, *1*(1), 1–10. https://doi.org/https://doi.org/10.51574/jrip.v1i1

Al-Fitrie, A. L., Solihatin, E., & Kustandi, C. (2023). Pengembangan Bahan Ajar Digital

dengan Pendekatan Collaborative Learning Menggunakan Padlet untuk Meningkatkan Writing Skills Siswa. *Jurnal Paedagogy*, *10*(4), 1045.

Alp, G., & Bulunuz, N. (2023). Effect of Web-Based Collaborative Learning Method with Scratch on Critical Thinking Skills of 5th Grade Students. *Participatory Educational Research*, *10*(2), 82–104. https://doi.org/10.17275/per.23.30.10.2

Annisa, D. F., Utomo, P., & Costa, A. da. (2025). Digital Transformation in Guidance and Counseling: The Influence of Website Media on Students' Self-Awareness. *Al-Musyrif: Jurnal Bimbingan Dan Konseling Islam*, *8*(1), 74–89.

Arjay, R., Dela, C., Head, C., Kit, O., Kilag, T., Contado, M. B., John, S., Torreon, L., Camangyan, J. R., Janery, N., & Abalde, V. (2024). Impact of Mobile Legends Bang Bang on Critical Listening and Communicative Skills Enhancement. *International Multidisciplinary Journal of Research for Innovation, Sustainability, and Excellence*, *1*(1), 7–12.

Asad, M. M., & Hussain, S. (2023). Effect of creative and collaborative learning communities on virtual learning environment for Education 4.0: a quantitative study of Pakistan. *Journal of Applied Research in Higher Education*. https://doi.org/10.1108/JARHE-01-2023-0042

Asri, N. A. (2022). Pengaruh Pembelajaran Kolaboratif Berbasis Lesson Study Terhadap Kemampuan Berpikir Kritis Siswa (The Effect of Lesson Study-Based Collaborative Learning on Students' Critical Thinking Ability). *Prosiding SEMNAS BIO 2022 UIN Syarif Hidayatullah Jakarta*, 455–463.

Atmoko, A., Machfudz, M., Mansur, R., & Da Costa, A. (2022). Motivation contribution to religious learning behavior during the covid pandemic. *Cakrawala Pendidikan*, *41*(1), 271–283. https://doi.org/10.21831/cp.v41i1.43255

B, Y., Ardi, M., Mappalotteng, A. M., & Sari, P. N. (2023). Pengaruh Motivasi Belajar dan Pengetahuan Keteknikan Terhadap Keterampilan Peserta Didik dI SMK Negeri 1 Enrekang. *Jurnal Pendidikan Terapan*, *01*(3), 46–52.

Badara, A., Marwati, M., & Sulfiah, S. (2024). Improving Elementary School Student Learning Outcomes Through Teacher Professional Development. *… of Educational …*, *03*(01), 117–125. https://doi.org/10.55299/ijere.v3i1.798

Belo,J., Cardoso, S.L, da Costa, A. (2024). *Ethnomathematic Exploitation At Traditional House Of Bui- Lo, Sub-Village Lacodala, Lacoliu Village, Quelicai Post, Baucau Municipality Jorge*. *8*(1), 1–12.

Endrawan, B., I., & Aliriad, H. (2023). Problem-Based Collaborative Learning Model Improves Physical Education Learning Outcomes for Elementary School Students. *Mimbar PGSD Undiksha*, *11*(1), 9–17.

Brito, M., Freitas, J. C., Aleixo, A., Sonbay, Y. Y., Timuneno, A. Y. W., Manehat, B. Y., Betu, K. W., & Dawu, L. M. T. (2024). Cross Border Community Empowerment Through Selling Price Literacy: Evidence From Indonesia–Timor Leste Cross Borders. *International Journal of Professional Business Review*, *9*(3), e04179.

Carvalho, C., Susano, M., Fernandes, E., Santos, S., Gannon, B., Nicolau, A., Gibbs, P., Teixeira, P., & Azeredo, J. (2010). Method for bacteriophage isolation against target Campylobacter strains. *Letters in Applied Microbiology*, *50*(2), 192–197.

Da Costa, A. (2016). Evaluasi Program Bimbingan Kelompok Di Sekolah Menegan Atas Negeri 6 Malang: Model Kesenjangan. *Jurnal Fokus Konseling*, *2*(1), 40–47.

Da Costa, A., Hanurawan, F., Atmoko, A., & Hitipeuw, I. (2019). The model of grade point average academic of timor-leste S in Indonesia. *International Journal of Scientific and Technology Research*, *8*(6), 213–216.

Davidson, N., & Major, C. H. (2013). Boundary Crossings: Cooperative Learning, Collaborative Learning, and Problem-Based Learning. *Journal on Excellence in*

College Teaching, 25(3 & 4), 7–55.

Delors, J. (2013). The treasure within: Learning to know, learning to do, learning to live together and learning to be. What is the value of that treasure 15 years after its publication? *International Review of Education, 59*(2), 319–330.

Gay, L.R.; Geoffrey E. Mills, P. W. A. (2012). *Educational Research: Competencies for Analysis and Applications.* https://books.google.com/books/about/Educational_Research.html?id= NjGCMAEACAAJ&utm_source=chatgpt.com.

Ghozali, I. (2009). *Multivariate Analysis Application with SPSS Program.* Diponegoro University Publishing Agency.

Graves, B. C. (2023). Specifications grading to promote student engagement, motivation and learning: Possibilities and cautions. *Assessing Writing, 57*(March), 100754.

Gunawardena, M., & Wilson, K. (2021). Scaffolding students' critical thinking: A process not an end game. *Thinking Skills and Creativity, 41*(April), 100848.

Guo, H., Ma, F., & Zhou, Z. (2024). Validation of technology acceptance model for virtual reality usage in collaborative learning to enhance learner performance. *Innovations in Education and Teaching International, 00*(00), 1–15.

Hasanah, U., Astra, I. M., & Sumantri, M. S. (2023). Exploring the Need for Using Science Learning Multimedia to Improve Critical Thinking Elementary School Students: Teacher Perception. *International Journal of Instruction, 16*(1), 417–440.

He, S., Shi, X., Choi, T. H., & Zhai, J. (2023). How do students'roles in collaborative learning affect collaborative problem-solving competency? A systematic review of research. *Thinking Skills and Creativity, 50*(November), 101423.

Hidayatullah, A. R. (2018). The Implementation of Cooperative Learning Method using STAD Technique In Order To Increase Activity and The Student's Study Outcome. *Classroom Action Research Journal, 2*(1), 38–44.

Hira, A., & Anderson, E. (2021). Motivating online learning through project-based learning during the 2020 COVID-19 pandemic. *IAFOR Journal of Educatio, 9*(2), 93–110.

Illahi, P. C., Fitri, R., & Arsih, F. (2022). The Effect of Project Based Learning Model on Creative Thinking Ability in Biology Learning. *Journal of Digital Learning and Education, 2*(3), 171–177. https://doi.org/10.52562/jdle.v2i3.441

Ishimura, Y., & Fitzgibbons, M. (2023). How does web-based collaborative learning impact information literacy development? *Journal of Academic Librarianship, 49*(1), 102614. https://doi.org/10.1016/j.acalib.2022.102614

Jundi, M., Fitriani, L., & Aquil, A. (2023). Collaborative Learning: Boosting Qawaid Mastery With Stad Model. *Thariqah Ilmiah: Jurnal Ilmu-Ilmu Kependidikan & Bahasa Arab, 11*(1), 35–48. https://doi.org/10.24952/thariqahilmiah.v11i1.7639

Kadijevich, D. M., Gutvajn, N., & Ljubojevic, D. (2023). Fostering twenty-first century digital skills by the means of educational platforms in the times of COVID-19. *Interactive Learning Environments*, 1–10.

Karaca-Atik, A., Meeuwisse, M., Gorgievski, M., & Smeets, G. (2023). Uncovering important 21st-century skills for sustainable career development of social sciences graduates: A systematic review. *Educational Research Review, 39*(March).

Kasumi, H., & Xhemaili, M. (2023). Student Motivation and Learning: The Impact of Collaborative Learning in English as Foreign Language Classes. *International Journal of Cognitive Research in Science, Engineering and Education, 11*(2), 301–309.

Kharismawati, I., Waris, W., & Nuraini, L. (2024). *Effectiveness of Collaborative Learning Using an Artificial Intellegence-Based Learning Management System (LMS) to*

Enhance Scientific Literacy Skill for Early Childhood Education Teacher Candidates. *22*, 17045–17055.

Latham, G. P. (2017). Motivate Employee Performance through Goal-setting. *The Blackwell Handbook of Principles of Organizational Behaviour*, *June*, 109–124.

Lattu, J. I. (2022). Peran Guru Dalam Memanfaatkan Lingkungan Belajar Untuk Menolong Murid Memiliki Motivasi Belajar. *Aletheia Christian Educators Journal*, *3*(2), 108–114. https://doi.org/10.9744/aletheia.3.2.108-114

Lopez, R. M., & Tadros, E. (2024). Motivational Factors for Undergraduate Students During COVID-19 Remote Learning. *Family Journal*, *32*(2), 287–291.

Maor, R., Paz-Baruch, N., Grinshpan, N., Milman, A., Mevarech, Z., Levi, R., Shlomo, S., & Zion, M. (2023). Relationships between metacognition, creativity, and critical thinking in self-reported teaching performances in project-based learning settings. *Thinking Skills and Creativity*, *50*(November), 101425.

Mones, Anselmus Yata; Nursalim, Mochamad; Susarno, L. H. (2024). Critical Thinking Ability Matrix on Catholic Religious Education Test Instruments at the High School Level on the Timor-Leste Borders. *International Journal of Diversity in Education*, *24*(2).

Nasution, N. E. A., Al Muhdhar, M. H. I., Sari, M. S., & Balqis. (2023). Relationship between Critical and Creative Thinking Skills and Learning Achievement in Biology with Reference to Educational Level and Gender. *Journal of Turkish Science Education*, *20*(1), 66–83. https://doi.org/10.36681/tused.2023.005

Noris, M., Saputro, S., Muzzazinah, M., & Rahayu, A. (2023). Development of Biology Learning Media Assisted by Construct2 to Improve Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(2), 498–504. https://doi.org/10.29303/jppipa.v9i2.1921

Nurjanah, K. (2024). Fostering Undergraduate Student's Critical Reading Skill through Multimodal. *Jurnal Ilmu Pendidikan (JIP) STKIP Kusuma Negara*, *15*(2), 170–178.

Guterres, O. , da Costa, A. Goncalves, A. D. S. G. (2023). Strategy Of The Training Management And Leadership For Youth Of Partidu Kmanek Haburas Unidade Nasional Timor Oan. *Journal of Innovative Studies on Character and Education*, *7*(2), 370–374.

Ossa, C. J., Rivas, S. F., & Saiz, C. (2023). Relation between metacognitive strategies, motivation to think, and critical thinking skills. *Frontiers in Psychology*, *14*(December). https://doi.org/10.3389/fpsyg.2023.1272958

Pannitz, T. (1999). Collaborative versus Cooperative Learning: A Comparison of the Two Concepts Which Will Help Us Understand the Underlying Nature of Interactive Learning. *ERIC*, *02*(13). https://doi.org/https://doi.org

Patonah, S. (2014). Elements of objective reasoning in science learning through the metacognitive approach of junior high school students. *Indonesian Science Education Journal*, *34*(2).

Rachmawati, I., Multisari, W., Triyono, T., Simon, I. M., & da Costa, A. (2021). Prevalence of academic resilience of social science students in facing the industry 5.0 era. *International Journal of Evaluation and Research in Education*, *10*(2), 676–683.

Ramadevi, J., Sushama, C., Balaji, K., Talasila, V., Sindhwani, N., & Mukti. (2023). AI enabled value-oriented collaborative learning: Centre for innovative education. *Journal of High Technology Management Research*, *34*(2), 100478. https://doi.org/10.1016/j.hitech.2023.100478

Seno, R. A. J., & Sumaryoto, S. (2020). Pengaruh Motivasi Belajar dan Kemampuan Menyimak terhadap Keterampilan Menulis Teks Pidato (Survei pada SMA Negeri di

Kota Cilegon). *Diskursus: Jurnal Pendidikan Bahasa Indonesia*, *3*(01), 9.

Rilling, B., & Fadel, C. (2009). *21st Century Skills*. Jossey-Bass. https://doi.org/https://doi.org/10.1145/1719292.1730970

Riyanto, Y. (2014). *Paradigma Baru Pembelajaran: Sebagai Referensi Bagi Pendidik dalam Implementasi Pembelajaran yang Efektif dan Berkualitas.* Prenada Media.

Rohman, A. A. N., Jumadi, Wilujeng, I., & Kuswanto, H. (2024). The Influence of outdoor learning models on critical thinking ability. *Journal of Physics: Conference Series*, *1567*(3), 159–169. https://doi.org/https://doi.org/10.1088/1742-6596/1567/3/032093

Rosenbaum, S., Moberg, J., Chesire, F., Mugisha, M., Ssenyonga, R., Ochieng, M. A., Simbi, C. M. C., Nakyejwe, E., Ngatia, B., Rada, G., Vásquez-Laval, J., Garrido, J. D., Baguma, G., Kuloba, S., Sebukyu, E., Kabanda, R., Mwenyango, I., Muzaale, T., Nandi, P., … Oxman, M. (2023). Teaching critical thinking about health information and choices in secondary schools: human-centred design of digital resources. *F1000Research*, *12*, 481. https://doi.org/10.12688/f1000research.132580.1

Saavedra, A. R., & Opfer, V. D. (2012). Learning 21st-century skills requires 21st-century teaching. *Phi Delta Kappan*, *94*(2), 8–13.

Sampe Lino, N., Ilyas, M., & Cokroaminoto Palopo, U. (2024). Persepsi Kesiapan, Sikap dan Motivasi Belajar Mandiri terhadap Pembelajaran Matematika secara Kolaboratif Berbasis Online. *Proximal: Jurnal Penelitian Matematika Dan Pendidikan Matematika*, *7*(1), 161–171.

Santos-Meneses, L. F., & Drugova, E. A. (2023). Trends in critical thinking instruction in 21st-century research and practice: Upgrading instruction in digital environments. *Thinking Skills and Creativity*, *49*(May 2022), 101383.

Santos-Meneses, L. F., Pashchenko, T., & Mikhailova, A. (2023). Critical thinking in the context of adult learning through PBL and e-learning: A course framework. *Thinking Skills and Creativity*, *49*(March), 101358.

Schott, C. L. (2015). The Future of Learning 3: What Kind of Pedagogies for the 21st Century? *Educations Research and Foresight*, 1–21.

Slavin, R. E. (2005). *Cooperative Learning: Theory, Research, and Practice.* Allyn and Bacon.

Sugianto, E. S. (2022). The Role of Collaborative Learning and Project Based Learning to Increase Students' Cognitive Levels in Science Literacy. *Proceedings of the International Conference on Madrasah Reform 2021 (ICMR 2021)*, *633*(Icmr 2021), 67–72. https://doi.org/10.2991/assehr.k.220104.011

Sugiyono. (2019). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Alfabeta.

Sun, Y., Yin, Y., Wang, J., Ding, Z., Wang, D., Zhang, Y., Zhang, J., & Wang, Y. (2023). Critical thinking abilities among newly graduated nurses: A cross-sectional survey study in China. *Nursing Open*, *10*(3), 1383–1392. https://doi.org/10.1002/nop2.1388

Surahman, S., Kuswandi, D., Hitipeuw, I., & Costa, A. (2025). *Academic Buoyancy in Indonesian Students with Daily Academic Problems: The Roles of Anxiety, Grit, Social Support, and Mediating Self-Efficacy.* https://doi.org/10.22059/japr.2025.400382. 645 319

Syahrin, A., & bin As, A. (2021). Pengaruh penggunaan audiovisual dan motivasi belajar terhadap keterampilan berbicara bahasa Inggris di SMA Negeri 3 Takengon. *Kande: Jurnal Ilmiah Pendidikan Bahasa Dan Sastra Indonesia*, *1*(1), 21–31.

Tan, A. C., Gilbert, D. (2003). Ensemble machine learning on gene expression data for cancer classification. *If It's a Journal, Type the Journal Name. If It's a Conference, Enter the Conference Name.*

Thornhill-Miller, B., Camarda, A., Mercier, M., Burkhardt, J. M., Morisseau, T., Bourgeois-Bougrine, S., Vinchon, F., El Hayek, S., Augereau-Landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education. *Journal of Intelligence*, *11*(3).

Tomé, A. O., Ximenes, M. D. S., Da Costa, A., Pincnheiro, A. R., & Alves, H. da C. (2024). Study on Schools Bullying for Adolescents. *KnE Social Sciences*, *2024*, 12–33.

Tomé, A. O., Ximenes, M. dos S., Da Costa, A., & Brito, M. (2024). Impact Factors of Student's Abandon Learning Activities: Case Study in Dili. *KnE Social Sciences*, *2024*, 34–47. https://doi.org/10.18502/kss.v9i31.17546

Udha, A. W., Mustaji, M., & Fatirul, A. N. (2022). Pengaruh Model Blended Learning Dan Motivasi Belajar Terhadap Kemampuan Berpikir Kreatif Siswa SMK. *JIPI (Jurnal Ilmiah Penelitian Dan Pembelajaran Informatika)*, *7*(1), 147–154. https://doi.org/https://doi.org/10.29100/jipi.v7i1.251

Vera-Monroy, S. P., Rodriguez, S., & Figueredo, M. A. (2024). Evaluating the effect of a blended collaborative/game-based learning strategy for skill reinforcement on undergraduate engineering. *International Journal of Mathematical Education in Science and Technology*. https://doi.org/10.1080/0020739X.2023.2295892

Sunita,W.,N., Parmithi, N., & Putu Wahyuni Risma Yanti, N. (2020). Pengaruh Model Pembelajaran Kolaboratif Dan Motivasi Belajar Terhadap Hasil Belajar Matematika Peserta Didik Kelas X IPS SMA Negeri 1 Abiansemal. *Jurnal Emasains: Jurnal Edukasi Matematika Dan Sains*, *9*(1), 45–55.

Widiyono, I. P., Effendi, S., & Susanto, A. (2022). The Influence of Motivation on Futsal Playing Skills of Young Walet Futsal Academy U-16 Kebumen. *JOSEPHA: Journal of Sport Science And Physical Education*, *3*(1), 9.

Wilda, D. A., Nursyamsiyah, S., & Huda, H. (2023). Implementasi Metode Diskusi dalam Meningkatkan Motivasi Belajar Siswa dalam Pembelajaran Fiqih. *Jurnal Pendidikan Islam*, *1*(2), 1–10. https://doi.org/10.47134/pjpi.v1i2.45

Wulansari, T., Rani, R., Wahidin, D., & Firmansyah, E. (2023). Refleksi Pragmatisme terhadap Motivasi Belajar Matematika Siswa dalam Logika dan Cinta di Drama Korea. *Jurnal Pendidikan Dan Kewirausahaan*, *12*(1), 240–255.

Ximenes, M. S. da Costa, A. (2025). Pastoral counseling in Christian schools: A hidden force in shaping professional teachers' roles beyond the classroom. *Journal of Professional Teacher Education*, *3*(1), 33–45. https://doi.org/10.12928/jprotect.v3i1.1610

Xu, B., Stephens, J. M., & Lee, K. (2023). Assessing Student Engagement in Collaborative Learning: Development and Validation of New Measure in China. *Asia-Pacific Education Researcher*. https://doi.org/10.1007/s40299-023-00737-x.