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Ethno-ECLIPSE learning model: The bridge between collaboration and critical thinking skills

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ABSTRACT

Collaboration skills and critical thinking skills are two real-life competencies in the 21st century. These two skills are believed to be related to one another. However, research on the magnitude of the correlation between the two skills is rarely investigated. Empowerment of these two skills cannot be separated from the learning model. This study analyzes the relationship between collaboration and critical thinking skills through the ethno-ECLIPSE learning model and conventional learning. This correlation study involved 240 biology students from various universities in Special Region of Yogyakarta and Central Java Provinces, Indonesia. Collaboration skills data was obtained through peer-to-peer rating scales, while critical thinking skills data was collected through essay tests. Data was analyzed by using simple linear regression. The research results showed collaboration skills significantly correlate with students' critical thinking skills. The contribution of collaboration to critical thinking skills is higher when applying the ethno-ECLIPSE learning model (86.9%) than in conventional learning (48.2%). Then, the regression equation formed from both learning is parallel but not coincident. The ethno-ECLIPSE learning model can be the right choice and is highly recommended for achieving learning goals, especially increasing collaboration and critical thinking skills of pre-service teacher.

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1. INTRODUCTION

Collaboration and critical thinking skills are the two main skills needed in the 21st century. Collaboration refers to cooperative activities involving several individuals to construct knowledge and solve problems [1]. Collaboration is related to cooperative interactions between individuals based on understanding each other's orientations, preferences, and perspectives [2]. Collaboration is a coordinated effort to solve problems effectively and efficiently [3], [4]. Collaboration skills are interpreted as the ability to work effectively and be responsible for shared commitments to achieve common goals [5]. Collaboration skills are group cooperation skills based on the division of tasks and roles that are coordinated effectively and are responsible for achieving common goals.

Collaboration skills are also one of the essential skills that pre-service teacher must possess. Collaboration skills support individual academic achievement or success [6] while supporting teacher professionalism [7]. Collaboration skills also make it easier for teachers to discuss various theories and practices of learning innovation [8]. Individuals with good collaboration skills tend to be more confident,

creative, independent [9], tolerant, responsible, respectful, and at the same time, wiser in dealing with complex problems [4]. Collaboration skills enable teachers to build effective collaboration within academic units' internal and external spheres to strive for continuity, progress, and innovation in learning practices and personal career development. However, many countries, such as Thailand, Singapore, Vietnam, and Indonesia, find it difficult to create challenging assignments that encourage the development of collaboration skills [10].

Mastery of collaboration skills allegedly supports better critical thinking skills. Several types of small group discussion skills, such as asking, listening, responding, and explaining skills, can facilitate thinking skills, such as understanding, reasoning, and decision-making skills, as well as critical and creative thinking skills in order to solve problems [11]. Collaboration through processes of discussion as well as clarification and evaluation of ideas, can effectively bridge the improvement of students' critical thinking skills [12]. Collaboration allows students to develop feedback for others, negotiate, integrate different points of view, and evaluate and reflect on themselves and others [13] to solve problems more effectively and efficiently [4]. Collaboration can raise socio-cognitive and socio-emotional challenges to encourage cognitive interaction to regulate and evaluate group performance or find and implement solutions [14]. Collaboration allows students to interact with each other to build conceptual knowledge, practice self-regulation, formulate solutions to real-world problems [1], and develop critical thinking skills [15]. Mastery of collaboration skills involves creating a group social system that encourages deeper and simultaneous thinking activities to solve common problems. Critical thinking skills themselves are related to a series of thought processes in order to make the best decisions to solve complex problems. Critical thinking is an attempt to reflect logically and rationally to make the best decision regarding a matter [16]–[18]. Critical thinking involves mental or high-level cognitive abilities in synthesizing ideas, answers, concepts, conclusions, information, decisions, or models [19], [20]. Critical thinking is related to the skills of analyzing, evaluating, and establishing justification for information [21], reconstructing problems [22], as well as drawing conclusions, formulating arguments, and reflecting [23].

Critical thinking skills are high-level thinking skills in determining the best (most appropriate) decisions based on certain alternatives or representations to solve complex problems. Critical thinking skills facilitate teachers in creating meaningful learning [24] or studying the complexity of biological systems and materials [25]. Critical thinking skills are also reported to correlate with the development of teacher professionalism, including didactic and pedagogic abilities and mastery of the material [26]. Critical thinking skills are considered more important in supporting decision-making processes than intelligence factors [17]. Critical thinking experience facilitates student teacher candidates to gain different perspectives, make judgments based on considerations from various sides and points of view, and become critical thinkers [27]. Teachers need to understand the nature of critical thinking and, at the same time, be able to make critical thinkers so that later they can produce critical students [27], [28]. However, empowering critical thinking skills is still challenging for several countries, such as Thailand, Vietnam, UK, Canada [29], Korea, Turkey, the United States [30], and Indonesia [31].

Collaboration skills are closely related to the mastery of critical thinking skills in the context of a particular social environment. Collaboration and critical thinking skills are the basis for individuals to work together non-competitively (mutually support each other) in solving problems or achieving common goals [32]. Great teamwork can impact critical thinking skills [33]. Collaborative activities can significantly affect critical thinking skills [21], [34]. However, only one study has been found that examines the correlation between collaboration skills and critical thinking skills in particular. The study results show a positive correlation between collaboration skills and critical thinking skills through the adapting, searching, interpreting, creating, and communicating (ASICC) learning model. However, research has not disclosed the amount of the contribution and the regression equation formed [4]. The results of this study also show that the application of a learning model can be a variable that influences the correlation between collaboration skills and critical thinking skills.

A new learning model, the ethno-ECLIPSE, is believed to bridge the relationship between pre-service teachers' collaboration skills and critical thinking skills. The term 'ethno-ECLIPSE' represents the name of the overall learning model, namely the ethnoecological issue-based ECLIPSE learning model. The ethno-ECLIPSE learning model has been developed based on the principles of project-based learning (PjBL), inquiry learning (IL), and ethno-based learning (EBL). These elements seek to improve collaboration skills and, at the same time, students' critical thinking skills. PjBL encourages student involvement in collaborative activities, field observations, field visits, and learning processes through contextual experiences [35]. PjBL is proven to be able to improve collaboration skills [36]–[40] and students' critical thinking skills [39]. On the other hand, the application of IL can improve students' critical thinking skills [41], [42]. Research in groups facilitates the formation of social interaction among students to improve the quality of learning experiences, understanding of concepts, intellectual challenges, and analytical skills [43].

Meanwhile, using EBL elements is oriented towards creating a contextual learning climate [44] based on natural and cultural values [45]. Ethnoecological issue-based learning aims to form environmentally-oriented attitudes and personalities through investigative activities about the culture within an ecological framework [46]. In its application, students in each group are assigned to investigate indigenous ecological knowledge or IEK of ethnic communities and then analyze it in the context of ecosystems & problems material through an ecology course. The scope and learning outcomes in the material have been previously formulated by the researcher and embodied in the material book. Students then use the conclusions from the results of the investigation to make products that will be widely published. The term 'ECLIPSE' stands for the syntax of the learning model, which includes: i) Exploring (exploring the topic of the problem and designing the investigation design); ii) Compiling (collecting IEK data); iii) Linking (analyzing IEK data); iv) Imagining (drawing conclusions, formulating explanations, and designing products); v) Producing (making products); vi) Sharing (presenting and publishing products); and vii) Evaluating (evaluating and reflecting on learning). The learning stages facilitate collaboration activities, from research planning to product publication. Studies on the relationship between collaboration skills and critical thinking skills through the ethno-ECLIPSE learning model have never been conducted.

Based on the description above, the following research questions were formulated for the study: i) Is there a correlation between pre-service teachers' collaboration skills and critical thinking skills in learning with the ethno-ECLIPSE learning model and conventional learning? and ii) Is there a difference in the regression equation between pre-service teachers' collaboration and critical thinking skills in learning with the ethno-ECLIPSE learning model and conventional learning? The results of this study are expected to reveal the regression equation and, at the same time, the contribution of collaboration skills to critical thinking skills. In addition, the results of this study are also expected to be a reference in training students' collaboration and critical thinking skills through contextual learning. Contextual learning is highly relevant to the challenges of living in the 21st century.

2. RESEARCH METHOD

This research is a type of correlational study. This correlational study aims to examine the correlation between collaboration skills and critical thinking skills through learning with the ethno-ECLIPSE learning model and conventional learning. Collaboration skills are a predictor variable in this study, while critical thinking skills are a criterion variable. The research subjects included 240 students in the biology education study program from various universities in the Special Region of Yogyakarta and Central Java Provinces, Indonesia. The research subjects were spread over six classes, which were randomly divided into an experimental class and a control class. Students in the experimental class were taught with the ethno-ECLIPSE learning model, while students in the control class were taught with conventional learning. Profiles of respondents are presented in Table 1.

Table 1. Profile of research respondents

No	Catagory	Details	Person	Proportion (%)	Total
1	Gender	Male	29	12.08 %	240
		Female	211	87.92 %	

Data on student collaboration skills were collected by filling out an assessment scale between peers. The collaboration skills data that has been obtained is then converted into an interval scale using the method of successive interval (MSI). Meanwhile, data on students' critical thinking skills was collected by completing an essay test. Eight experts have previously validated the peer-to-peer rating scale and essay test. Data on collaboration and critical thinking skills were then analyzed using simple linear regression to reveal the correlation between collaboration skills and critical thinking skills of pre-service teacher. The data analysis process was also continued with a different regression equation test to reveal whether there were differences in the correlation of collaboration skills and critical thinking skills of pre-service teacher in the application of the ethno-ECLIPSE learning model and conventional learning. In addition, the different assessment tests also aim to reveal the form or learning design that shows the highest correlation between collaboration skills and critical thinking skills. The assumption test applied to the research data includes the normality and homogeneity tests. The data analysis process was carried out using SPSS 26 for Windows.

3. RESULTS AND DISCUSSION

3.1. The correlation between pre-service teachers' collaboration skills and critical thinking skills at the implementation of ethno-ECLIPSE learning model and conventional learning

3.1.1. Ethno-ECLIPSE learning model

The regression analysis results related to the correlation between collaboration skills and critical thinking skills of pre-service teacher in learning with the ethno-ECLIPSE learning model are presented in Tables 2-4. Based on Table 2, the value of Sig. is 0.000<α 0.05. These results indicate that there is an influence of collaboration skills on critical thinking skills in the application of the ethno-ECLIPSE learning model. Based on Table 3, the value of Sig. is 0.000<α 0.05. These results indicate that there is a significant effect of collaboration skills on critical thinking skills. The regression equation that can be formulated from Table 3 is Y=2.743X–10.686. This finding is relevant to the research results of Santoso *et al*. [4] who reported a correlation between collaboration and critical thinking skills. Other researchers [21], [34] also revealed that collaborative activities designed by educators could stimulate and simultaneously strengthen students' critical thinking skills. However, some of these studies have yet to reveal the magnitude of the correlation and the contribution of collaboration skills to critical thinking skills. The correlation between collaboration skills and critical thinking skills is inseparable from the learning design applied. Applying a particular learning model or strategy can be a means for educators to coordinate the efforts of each individual student while monitoring the effectiveness of collaboration during learning [47].

Table 2. Summary of anova test results related to the correlation of collaboration skills and critical thinking skills in the ethno-ECLIPSE learning model

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	14679.739	1	14679.739	797.527	.000[b]
	Residual	2208.788	120	18.407		
	Total	16888.526	121			

a. Dependent variable: critical thinking skills
b. Predictors: (constant), collaboration skills

Table 3. Regression coefficients related to correlation of collaboration skills and critical thinking skills in the ethno-ECLIPSE learning model

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	std. error	Betas		
1	(Constant)	-10.686	2.760		-3.872	.000
	Collaboration skills	2.743	.097	.932	28.241	.000

a. Dependent variable: critical thinking skills

Table 4. Regression summary regarding the correlation of collaborative skills and critical thinking skills in the ethno-ECLIPSE learning model

Model	R	R square	Adjusted R square	std. error of the estimate
1	.932 [a]	.869	.868	4.290287

a. Predictors: (constant), collaboration skills
b. Dependent variable: critical thinking skills

Collaboration skills support and facilitate pre-service teacher mastery of critical thinking skills. Collaboration skills enable a person to be tolerant, responsible, respectful, and wise in dealing with complex problems so that they can solve them more effectively and efficiently [4]. Peer support can be a tool for developing intellectual functions because it can help learners internalize various external knowledge and practice critical thinking skills [48]. Collaborative activities encourage students to carry out processes of discussion and metacognition while being responsible for their own learning [49]. Critical thinking skills can be trained and improved through collaborative experimental or scientific investigation activities [50]. Social interaction among students can support cognitive abilities in building knowledge independently [51]–[53].

Based on Table 4, the reliability value (R square) is 0.869. These results indicate that collaboration skills affect critical thinking skills by 86.9%, while the other 13.1% are influenced by other factors not examined in this study. This condition is possible because the ethno-ECLIPSE learning model directs each student to actively collaborate at every stage of learning in order to complete the challenging assignments given. Collaborative activities will have an impact on improving student collaboration skills so that, in the

end, it will have a greater influence on improving their critical thinking skills. Details regarding the syntax of the ethno-ECLIPSE learning model are shown in Table 5.

The exploring stage begins learning activities and focuses on apperception activities, exploration of problem topics and introductory materials, and planning investigations. Collaborative activities carried out by students at this stage include collaboration in formulating investigative questions, formulating investigative hypotheses, determining products to be made, and designing investigation designs. Formulation of questions is a thinking tool that supports the development of students' critical thinking and social skills [54]. Formulating or answering questions can generate initial knowledge, which in turn triggers student involvement in learning [55]. Orientation activities are related to curiosity in the context of formulating questions and research hypotheses [56], [57]. Formulating a hypothesis involves students' thoughts regarding the determination and arrangement of investigative variables based on the identified causal relationships [58]. Meanwhile, curiosity is needed in the disposition of critical thinking skills [59], [60]. These processes will not be carried out or resolved effectively without student collaboration. Collaboration and dialogue among students are needed to identify problems, formulate questions, and formulate hypotheses that impact argumentation and critical thinking skills [61].

Table 5. Syntax details of the ethno-ECLIPSE learning model

Learning model syntax ethno-ECLIPSE	Sub-stages learning activities
Exploring	Apperception
	Exploration of the topic of the problem: ecosystem problems in the modern era
	Introductory theoretical exploration: ecology and ethnoecology
	Formation of a research group and product determination
	Investigation design planning: formulation of investigative questions, formulation of investigative hypotheses, and designing investigation designs
Compiling	Preparation of data collection
	Collecting IEK data at conservation sites
	Collecting IEK data at non-conserved sites
Linking	Theoretical concept analysis
	IEK data analysis part I: translation of IEK data into scientific contexts (ecosystems and problems)
	IEK data analysis part II: translation of IEK data in the context of ecosystem productivity
Imagining	Evaluation of IEK data and drawing conclusions
	Explanation formulation
	Product design planning
Producing	Product manufacture
Sharing	Product presentation and discussion
	Product repair and improvement
	Product assessment and publication
Evaluating	Learning evaluation
	Reflection on learning outcomes

Compiling stage assigns students to identify and collect IEK data from conservation and non-conservation sites. The data was collected through in-depth interview techniques with the respondents. The interview process uses a semi-structured interview guide to allow students to develop questions as needed in the field. Student activity in exploring questions or formulating solutions will stimulate the expansion or development of questions based on new data or information [54]. Collaborative processes in collecting data play a role in training collaboration skills [62] and students' critical thinking skills [63]. In practice, each inquiry group will assign one member as the main interviewer. Several other members will often help by asking additional questions as a form of feedback, which will confirm or further explore the answers from the respondent. On several occasions, several other group members also asked questions based on different perspectives. Thus, collecting data through this collaboration will produce data and information from various perspectives. Collaboration in collecting and sharing information, designing learning activities, and discussing can facilitate students' critical thinking [64].

The IEK data obtained from the compiling stage is then analyzed in the linking stage. The process of analyzing the IEK data was carried out in the context of the material 'ecosystems & their problems', which had been prepared by the researcher. Analyzing IEK data must also be based on relevant theories from various credible reference sources. The results of the IEK data analysis are then used as a reference for evaluating the IEK data, drawing conclusions, and formulating explanations at the Imagining stage. This stage also includes student collaboration in designing products that will be made to represent the investigation results obtained.

Student collaboration activities in the linking and imagining stages can facilitate collaboration skills so that they increase critical thinking skills. Collaborative inquiry activities encourage social and cultural

interaction and communication among participants to share ideas and knowledge [65]. Collaborative activities in conducting investigations, forming links between investigative results and scientific knowledge, and testing hypotheses facilitate communication skills, critical thinking, and decision-making [66]. The principle of interaction in a collaborative activity includes cognitive interaction, such as interactions in thinking, reasoning, and analyzing, as well as interactions between students in elaborating on the material [34]. The collaborative climate opens opportunities for students to discuss, argue, present, or even listen to different points of view from one another to support critical mastery of concepts [67].

Collaborative activities during the linking and imagining stages open opportunities for each student to share their understandings and perspectives, which helps the process of analyzing and evaluating data better. Brainstorming and reflection activities during collaborative activities in small groups allow students to analyze various perspectives to train in more critical and systematic ways of thinking [68]. Collaboration encourages the involvement of participants in the same activities and goals, creates opportunities for critical dialogue, conducts investigations, creates systems or social support to solve various challenging problems, reflects [69], and makes decisions [70], [71]. Thus, the success of a series of student collaboration activities during analyzing and evaluating data, drawing conclusions, and formulating explanations will encourage the development of more optimal critical thinking skills.

The results of the investigation conclusions and explanations are then used to design and simultaneously manufacture authentic products. The product manufacturing process is allocated as an independent assignment for one month in the producing stage. Students in each group collaborate to make products according to the investigation results, accompanied by regular monitoring and evaluation from the lecturer. Students are challenged to transform the knowledge they have acquired into various forms of feasible products [72]. This process also allows students to brainstorm in groups to formulate concrete solutions to their contextual problems [73]. Student collaboration in planning and making products can improve collaboration skills to develop various innovative ideas and creative solutions [74] and simultaneously stimulate the development of critical thinking skills [73]. Making these products also really need unified performance management among group members. While the variety of student collaboration activities, such as modifying work plans, analyzing group strengths and weaknesses, formulating and proposing alternative solutions to improve group performance, and listening to opinions and ideas from others, can facilitate the improvement of critical thinking skills [39]. Making products can also help students integrate and reconstruct knowledge, improve professional skills, increase interest in the discipline or field of study, and improve skills in working with others [75].

Products that each student group has completed are then presented and discussed in class through the sharing stage. The feedback that each group has obtained is then used to improve and perfect the product. The lecturer then assesses the perfect final product and publishes it in various ways. A series of collaborative activities in this learning is finally closed with an evaluating stage which contains learning evaluation activities and reflection on learning outcomes. Class presentation and evaluation activities facilitate students' collaborative skills in small groups by encouraging planning processes and negotiating their respective tasks or roles [76]. The demands for presentation and comparison of products in class encourage students to analyze and determine the best solutions to strive for the success of project activities [77]. These needs require discussion processes among students to complement each other's work so that a proper product is obtained. Students are involved in discussion processes to evaluate the strengths and weaknesses of the products to be presented. In addition, students will also have discussions to share assignments and roles during the presentation. Discussion activities can encourage reflection processes and thinking activities to understand ideas and provide opportunities to build arguments or responses to ideas from other people [11].

The assessment techniques applied in the ethno-ECLIPSE learning model include self-assessment, peer assessment, product assessment, and written tests. Applying several assessment techniques is also considered capable of stimulating the performance and achievement of student learning outcomes. Self-assessment and peer assessment provide opportunities for students to develop teamwork skills [78] self-regulation, critical thinking skills, and decision-making [79]. Product assessment can also assist educators in evaluating their students' progress and providing feedback regarding the level of achievement in their understanding [80]. Product evaluation is one of the factors that can encourage students to pay more attention and seek to achieve the criteria set by the lecturer in the assessment rubric. Thus, the application of product assessment will stimulate student performance in order to produce products that are feasible and even better than other groups. In practice, student representatives from each group actively communicate project progress and difficulties experienced to lecturers. In fact, some of them also asked about the achievements of other groups in order to measure their own group's achievements and harmonize the process.

Process and outcome-based assessment in the context of project learning essentially targets the responsibilities and motivation of students individually and in groups [81] as well as cognitive and social skills [82]. The application of the written test itself is also considered important because it can encourage

student involvement in collaborative activities and group management and measure student mastery of the theory underlying product development and its application [83]. Legal and formal publication activities of various produced products also play an important role in generating student enthusiasm and motivation. Product publication activities through mass media or exhibitions support the pursuit of work originality and fighting spirit [84], motivation, and student satisfaction [85].

3.1.2. Conventional learning

The regression analysis results related to the correlation between collaboration skills and critical thinking skills of pre-service teacher in learning with conventional learning are presented in Tables 6-8. Based on Table 6, the value of Sig. is 0.000<α (0.05). These results indicate that there is an influence of collaboration skills on critical thinking skills in the application of conventional learning. Based on Table 7, the value of Sig. is (0.000)<α (0.05). These results indicate that there is a significant effect of collaboration skills on critical thinking skills, with regression equation is Y=2.750X–33.454. Based on Table 8, the reliability value (R square) is 0.482. These results indicate that collaboration skills affect critical thinking skills by 48.2%, while the other 51.8% are influenced by other factors not examined in this study.

Table 6. Summary of anova test results related to correlation of collaboration skills and critical thinking skills in conventional learning

	Model	Sum of squares	df	Mean square	F	Sig.
1	Regression	16467.986	1	16467.986	107.952	.000 [b]
	residual	17695.751	116	152.550		
	Total	34163.737	117			

a. Dependent variable: critical thinking skills
b. Predictors: (constant), collaboration skills

Table 7. Regression coefficients related to collaboration skills and critical thinking skills in conventional learning

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	std. error	Betas		
1	(Constant)	-33.454	7.962		-4.202	.000
	Collaboration	2.750	.265	.694	10.390	.000

a. Dependent variable: critical thinking skills

Table 8. Regression summary related to correlation of collaboration skills and critical thinking skills in conventional learning

Model	R	R square	Adjusted R square	std. error of the estimate
1	.694 [a]	.482	.478	12.351096

a. Predictors: (constant), collaboration skills
b. Dependent variable: critical thinking skills

Even though it correlates significantly with collaboration skills and critical thinking skills, conventional learning is not recommended to be applied. This conventional learning design does not allow students to practice collaborative scientific inquiry activities in real situations, especially in studying and analyzing ethnoecological issues. Collaboration in scientific inquiry supports knowledge reconstruction processes [86], [87] and student learning success [88]. This activity also has the potential to develop students' knowledge, motivation, and social skills (including collaboration) in order to formulate solutions to authentic problems [75]. Although smaller than in the ethno-ECLIPSE learning model, the correlation between collaboration skills and critical thinking skills formed in conventional learning is possible due to the influence of other factors not examined in this study. Some factors can affect the effectiveness of student learning, including prior knowledge [89], [90], motivation, learning preferences [90], personal conditions, study habits, household factors, school factors, lecturer (educator) factors [91], school and family environments [92], and familiarity with colleagues learning [93], [94].

3.2. Differences in the regression equations of the correlation between pre-service teachers' collaboration skills and critical thinking skills at the implementation of ethno-ECLIPSE learning model and conventional learning

The results of different tests of the regression equation line between collaboration skills and critical thinking in applying the ethno-ECLIPSE learning model and conventional learning are presented in Table 9. Based on the results of the different tests in Table 9, the value of Sig. parameter, which is the slope of the regression line (0.001)<(0.05). These results indicate that the increase in critical thinking skills of pre-service teacher as a result of collaboration skills in applying the ethno-ECLIPSE learning model and conventional learning is significantly different.

Table 9. Summary of difference test results related to regression equations regarding the relationship between collaboration skills and critical thinking skills

Regression	Sum of squares	df	Mean square	F	Sig.
Between groups	1403.882	1	1403.882	10.765	.001
Within groups	30908.072	237	130.414		
Total	32311.954	238			

The graph of the regression equation regarding the relationship between collaboration skills and critical thinking skills of pre-service teacher in the application of the ethno-ECLIPSE learning model and conventional learning is shown in Figure 1. The graph shows that the regression line formed in ethno-ECLIPSE learning and conventional learning is parallel and does not coincide. This means that the rate of increase in critical thinking skills due to the influence of collaboration skills with the ethno-ECLIPSE learning model is the same as conventional learning, but the amount of increase is different.

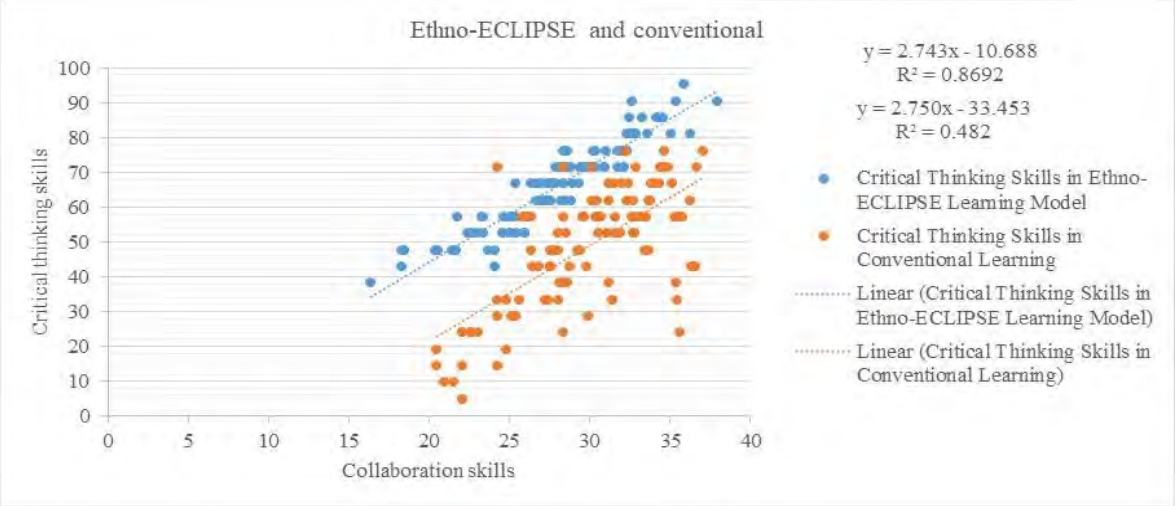

Figure 1. The graph of the regression equation in learning with the ethno-ECLIPSE learning model and conventional learning

Student collaboration activities in implementing the ethno-ECLIPSE learning model start with interpreting problems, analyzing and evaluating IEK data, drawing conclusions, formulating explanations, and creating products based on the findings directly related to developing aspects of critical thinking skills. Critical thinking skills involve synthesizing concepts, conclusions, or decisions regarding a complex problem appropriately [19], [20]. Critical thinking skills include building arguments, assessing statements, drawing and concurrently interpreting conclusions, evaluating reasoning, and reflecting in depth [95]. Critical thinking skills include interpreting, analyzing, evaluating, drawing conclusions, explaining [60], and self-regulation [19], [32], [95]. Student activities such as determining study topics, planning investigations, carrying out investigations in real situations, writing and presenting investigation results, discussing problems, and formulating solutions to problems found can improve collaboration skills [62] and critical thinking skills [96]. The demands for collaborative activities at each stage of the ethno-ECLIPSE learning

model facilitate improving students' critical thinking skills. This condition is relevant to the findings of [21], [50], [97]–[103] who show that collaboration in learning can facilitate the improvement of students' critical thinking skills. Challenges in learning require communication, negotiation, and collaboration skills among students to support evaluation and decision-making processes [68]. Collaborative activities critically support the formulation of problems, analysis, synthesis, and rigorous conclusion to achieve quality and meaningful learning outcomes for students [104]. Silva *et al*. [105] have also proven that social interaction can significantly improve students' critical thinking skills in the experimental class compared to the control class, which uses traditional learning.

Students' success in collaborating during learning indicates the mastery of collaboration skills. Meanwhile, the mastery of collaboration skills further supports critical thinking skills better. The significant relationship between collaboration skills and students' critical thinking skills in the experimental class represents the principles of Vygotsky's theory of social constructivism. The application of social constructivism theory allows students to discuss with each other and, at the same time, reflect on their learning so that it has an impact on the development of critical thinking skills [99]. The theory of social constructivism holds that the social environment provides great influence and support for learners' cognitive development. According to Vygotsky [106], a concept referred to as the zone of proximal development represents the distance or difference between the actual level of development and the level of potential development experienced by students. Actual development represents the potential for problem-solving abilities that a person can acquire independently.

Meanwhile, potential development represents the potential for one's problem-solving abilities under guidance or interaction with other experienced people. In other words, a learner who actively collaborates and at the same time gets guidance from other people who are more experienced tends to experience more optimal cognitive development [107]. The forms of guidance or social support should also be dynamic, flexible, open, and not just one-way [108]. Social constructivism theory emphasizes how learners can acquire and build meaningful knowledge in a social context [109].

The principles of Vygotsky's theory of social constructivism are accommodated primarily through using PjBL elements in the design of the ethno-ECLIPSE learning model. The PjBL paradigm represents Vygotsky's theory of social constructivism [110], [111]. PjBL is an alternative to transforming teacher-centred learning designs that are less contextual toward learning practices that encourage relationally and emotionally student engagement [112]. Scientific research projects in groups as the core of the design of the ethno- ECLIPSE learning model allow the creation of social relations among students, students and lecturers, or even between lecturers and students and ethnic communities outside the campus. Student independence in setting the IEK study theme, determining the location and respondents during data collection, and designing and manufacturing products have presented various forms of positive social interaction among students. To complete the project, various ideas and knowledge are shared and exchanged. Thus, collaborative inquiry activities in a natural and challenging environment are suggested to facilitate students' critical thinking skills.

4. CONCLUSION

This research departs from the belief that there is a correlation between collaboration skills and critical thinking facilitated by the learning model. Based on the research that has been done, it is proven that there is a positive correlation between collaboration and students' critical thinking skills, both students who are taught with the ethno-ECLIPSE learning model and conventional learning. However, the results of the determination test show that the contribution given by collaboration skills to critical thinking skills in the application of the ethno-ECLIPSE learning model is 86.9%, while in the application of conventional learning, it is only 48.2%. The results of further analysis related to the different regression equation tests of the two studies indicate that they are parallel but not coincide. The parallels and not coincide of these lines mean that there are similarities in the rate of improvement of critical thinking skills due to the influence of collaboration skills in both the application of ethno-ECLIPSE learning models and conventional learning. However, the magnitude of the increase differs from one another. Thus, the ethno-ECLIPSE learning model proved superior in bridging the correlation between collaboration and students' critical thinking skills. Therefore, it is suggested to lecturers or pre-service teacher education programs to be able to choose and use learning models, especially ethno-ECLIPSE, to improve collaboration skills and students' critical thinking skills.

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