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Group investigation inquiry online learning model for empowering students' metacognitive abilities and creative thinking

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Abstract

Numerous educational models have been developed to enhance students' aptitudes in online learning. Therefore, this study aimed to analyse the effect of the group investigation inquiry online learning model (GINO) on the metacognitive and creative thinking abilities of students in Senior High Schools (SHS) in Ambon, Indonesia. The method employed a pretest-posttest control group design, with a sample comprising 116 students from Senior High Schools 1, 4, and 12 Ambon. Validity and reliability tests were also conducted to measure metacognitive abilities and creative thinking. Furthermore, the data analysis encompassed descriptive and inferential approaches, employing ANCOVA. The results showed that the GINO learning model effectively enhances the metacognitive abilities and creative thinking of SHS students in Ambon ($p=0.000<\alpha=0.05$). To foster a distinct online learning environment, the model was subjected to modifications in its learning stages through the integration of the group investigation learning model and inquiry strategies, providing valuable variations in the learning process. This research contributes to showing how varied learning is very important in providing a more interesting learning climate compared to conventional learning carried out by teachers and this learning model can be applied to other concepts in learning.

Abstrak. *Berbagai model pembelajaran telah dikembangkan untuk meningkatkan kemampuan siswa dalam pembelajaran daring. Oleh karena itu, penelitian ini bertujuan untuk menganalisis pengaruh model pembelajaran group investigation inquiry online (GINO) terhadap kemampuan berpikir metakognitif dan kreatif siswa pada Sekolah Menengah Atas (SMA) di Ambon, Indonesia. Metode penelitian ini menggunakan desain kelompok kontrol pretest-posttest, dengan sampel yang terdiri dari 116 siswa dari SMA 1, 4, dan 12 Ambon. Uji validitas dan reliabilitas juga dilakukan untuk mengukur kemampuan metakognitif dan berpikir kreatif. Selanjutnya, analisis data menggunakan statistik deskriptif dan inferensial, dengan menggunakan ANCOVA. Hasil penelitian menunjukkan bahwa model pembelajaran GINO secara efektif meningkatkan kemampuan metakognitif dan berpikir kreatif siswa SMA di Ambon ($p=0.000<\alpha=0.05$). Untuk menumbuhkan lingkungan belajar online yang berbeda, model ini mengalami modifikasi dalam tahapan pembelajarannya melalui integrasi model pembelajaran investigasi kelompok dan strategi inkuiri, sehingga memberikan variasi yang berharga dalam proses pembelajaran. Penelitian ini berkontribusi untuk menunjukkan bagaimana pembelajaran yang bervariasi sangat penting dalam memberikan iklim pembelajaran yang lebih menarik dibandingkan dengan pembelajaran konvensional yang dilakukan oleh guru dan model pembelajaran ini dapat diterapkan pada konsep-konsep lain dalam pembelajaran.*

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A. Introduction

The COVID-19 pandemic has transformed the national education system from face-to-face classrooms to online learning. However, online learning also benefits from delivering knowledge, developing technology skills, providing access to a wide range of learning resources (Paudel, 2021; Greenhow et al., 2022), and offering convenience and flexibility (Dhawan, 2020; Cai et al., 2022). In addition, Tate et al. (2022) added that physical, human, and social resources are needed for effective online learning.

Physical resources encompass devices such as computers, laptops, tablets, and smartphones, whereas human resources include educators (teachers and lecturers) and students. In the context of online learning, the role of teachers remains crucial in facilitating the smooth implementation and mastery of learning objectives. In the design process, teachers have the option to select models that empower cognitive, psychomotor, and affective abilities, despite the setting. One particular design that can effectively empower these three domains is the group investigation (GI) and inquiry learning.

The group investigation learning model has been successfully implemented online in several studies. The group investigation e-task in activities (GIETAL) learning model focuses on group investigation activities for online discussions and collaboration among students (Ningsih et al., 2022). Moreover, the GI learning model supported by online PhET media can increase the scientific working skills of students (Arinda et al., 2019). Online flipped classroom GI learning can foster teamwork and collaboration skills in conducting investigations (Sojayapan & Khlaisang, 2018). The efficacy of inquiry-based e-learning has been explored in several studies. Suartama et al. (2020) investigated this learning model and highlighted its ability to foster feedback exchanges between lecturers and students, as well as peer-to-peer feedback. In a study by Mamun et al. (2020), the development of modules significantly improved students' skills in prediction, observation, explanation, and evaluation. Chou et al. (2022) conducted a study that demonstrated differences in the competencies of students studying physics when inquiry strategies were combined with online simulations. Furthermore, Suwono et al. (2017) reported that guided inquiry, implemented through blended learning, effectively enhanced the metacognitive abilities of students in learning about the human circulatory system compared with a control group. In line with this study, Antonio and Prudente (2021) developed an instrument using the metacognitive argument-driven inquiry (MADI) approach. The results highlighted the utility of the MADI in inquiry-based biology learning, particularly in enhancing conceptual abilities of students.

A previous study provided a basis for integrating GI and inquiry learning models implemented online. Therefore, the combination becomes the group investigation inquiry online, abbreviated as the GINO learning model. A previous study has shown that models implemented offline can improve the critical thinking, cognitive learning outcomes, and scientific attitudes of high school students in the West Seram Regency, Indonesia (Pattipeilohy et al., 2022). Baharom et al. (2020) also explained that the inquiry process involves stages of investigation, such as fact-finding, relationship, controlled, general relationship, and solving scientific problem investigations at Levels I, II, III, IV, and V. The opinions indicate a connection between group investigation and inquiry, allowing integration into a relevant and unified learning sequence conducted online. Inquiry-based learning has been shown to facilitate active student participation in the learning process while also improving students' metacognitive abilities (Divrik et al., 2020). This approach encourages students to express themselves and exercise their creative thinking skills (Michalopoulou, 2014). Moreover, the development of metacognitive abilities is instrumental in enabling students to effectively engage in the inquiry process and navigate the various stages of the scientific process (Li & Yuan, 2022; Bruckermann et al., 2017; Omarchevska et al., 2022). Several studies have reported that the investigation stages in the stimulation, investigation, review, and inference (SIRI) learning model play a role in enhancing students' creative thinking in the study of biology (Jamaluddin et al., 2023). There are differences in the variables before and after the implementation of the group investigation learning model (Maspupah et al., 2021). The stages in the complex instruction team product (CITP) also empower metacognitive abilities to increase awareness in designing investigations about ecosystems and become independent learners (Rumahlatu et al., 2020).

Therefore, the group learning model is highly suitable for combination with GINO to enhance the metacognitive abilities and creative thinking of senior high school students in learning the human circulatory system. Collaborative learning, which combines multiple learning models or strategies, can improve higher-order thinking skills such as metacognition and creativity (Ramdani et al., 2022; Hamzah et al., 2022; Alharbi et al., 2022). Teaching the human circulatory system online during the COVID-19 pandemic is a challenge. However, the collaboration of the GINO learning model empowers metacognitive abilities and creative thinking is essential to be conducted.

Group investigations focus on investigations for problem solving while inquiry strategies focus on how to carry out scientific discoveries through inquiry activities. According to Morris (2024), the inquiry strategy trains students to ask questions, investigate,

analyse data, and make conclusions. Meanwhile, Yun (2024) state the stages of group investigation are exploration, analysis, and problem solving.

This research aims to analyse the influence of the GINO learning model on the metacognitive and creative thinking abilities of SHS students in Ambon, Indonesia. It is hoped that the results of this research can be a basis for implementing online-based learning models to measure other thinking abilities.

B. Materials and methods

The study aimed to empower the metacognitive abilities and creative thinking of students in Ambon. This study was conducted on the basis of a quasi-experimental design with pretest-posttest control as shown in Table 1.

The population consisted of Grade XI students from SHS 1, 4, and 12 Ambon. The sample included students from two classes: XI Science$_4$ and Science$_6$ from SHS 1 Ambon; XI Science$_4$ and Science$_5$ from SHS 4 Ambon; XI Science$_2$ and Science$_3$ from SHS 12 Ambon, with a total of 116 selected as the sample. Moreover, the class selection was based on random sampling via a lottery technique, and the study was conducted in the odd semester of the 2020-2021 academic year, with a focus on the concept of the human circulatory system.

The study stages were (1) conducting the initial test, (2) implementing the GINO learning model in classes XI_1 and XI_2 (Table 2), and (3) conducting the final test. The instrument used was an essay test to measure the metacognitive and creative thinking abilities of Grade XI students. The instrument was tested and deemed valid and reliable for measuring metacognitive and creative thinking abilities (Table 3). The metacognitive and creative thinking assessment instruments used a rating scale ranging from 0-7 and 0-3, as shown in Tables 4 and 5.

Table 1 Research design for the GINO and GIO classes

Pretest	Group	Posttest
O_1	XI_1	O_2
O_1	XI_2	O_2

Description:
O_1 = Pretest conducted on the GINO and GIO classes
O_2 = Posttest conducted on the GINO and GIO classes
XI_1 = Class using the GINO learning model
XI_2 = Class using the GIO learning model

Table 2 GIO and GINO learning stages

Group investigation online (GIO)	Strategi inquiry	GINO learning model collaboration
1. Identifying the topic collaboratively by teachers and students online using the Teams/Zoom application 2. Planning learning tasks collaboratively by teachers and students online using the Teams/Zoom application 3. Investigating by students offline with control through the WhatsApp group 4. Compiling the report by students offline 5. Presenting the report collaboratively by teachers and students online using the Teams/Zoom application 6. Evaluation collaboratively by teachers and students online using the Teams/Zoom application	1. Orientation 2. Conceptualization 3. Investigation 4. Discussion 5. Conclusion	1. Orientation: Organizing students into study groups, identifying topics, and formulating titles (collaboratively by teachers and students online using the teams/zoom application) 2. Conceptualization: Formulating questions and hypotheses, searching for information, and outlining the stages of investigation (collaboratively by teachers and students online using the teams/zoom application) 3. Conducting the investigation (performed by students offline with supervision and control through the WhatsApp group) 4. Compiling the final report (performed by students offline) 5. Discussion: Collaboratively with teachers and students online using the teams/zoom application 6. Evaluation collaboratively by teachers and students online using the teams/zoom application

(Source: Modified from Pattipeilohy et al., 2022)

Table 3 Validity and reliability analysis of the questions

Creative thinking indicator	Question number	Validity		Reliability	
		Significant	Interpretation	Significant	Interpretation
Fluency	1	.543 (*)	Valid	.845 (*)	Excellent
Flexibility	2	.075 (*)			
Originality	3	.098 (*)			
Development	4a	.183 (*)			
	4b	.120 (*)			
Evaluation	5a	.079 (*)			
	5b	.776 (*)			
	5c	.887 (*)			
	5d	.055 (*)			

*) Significance at $p \geq 0.05$

Table 4 The instrument for measuring students' metacognitive abilities

Score	Rubric criteria
7	Answers about the concept of the circulatory system in one's sentences, with a clear and systematic presentation, logical, correct grammar (language), supported by reasoning (analysis/evaluation/creation), and accurate answers according to the concept of the circulatory system.
6	Answers about the concept of the circulatory system in one's sentences, with a somewhat accurate and systematic presentation, somewhat logical, with less accurate grammar (language), supported by reasoning (analysis/evaluation/creation), and accurate answers according to the concept of the circulatory system.
5	Answers about the concept of the circulatory system in one's sentences, with a less/not systematic and orderly presentation, less/not logical, with less accurate grammar (language), supported by reasoning (analysis/evaluation/creation), and accurate answers according to the concept of the circulatory system.
4	Answers about the concept of the circulatory system are not in one's sentences, with a systematic and orderly presentation, logical, correct grammar (language), supported by reasoning (analysis/evaluation/creation), and accurate answers according to the concept of the circulatory system.
3	Answers about the concept of the circulatory system not in one's sentences, with a less/not systematic and orderly presentation of answers, less/not logical, with less accurate grammar (language), supported by reasoning (analysis/evaluation/creation), and accurate answers according to the concept of the circulatory system.
2	Answers about the concept of the circulatory system not in one's sentences, with a less/not systematic and orderly presentation, less/not logical, with less accurate grammar (language), less supported by reasoning (analysis/evaluation/creation), and less accurate answers according to the concept of the circulatory system.
1	Answers about the concept of the circulatory system not in one's sentences, with a less/not systematic and orderly presentation of answers, less/not logical, incorrect grammar (language), not supported by reasoning (analysis/evaluation/creation), and answers not under the concept of the circulatory system
0	No answer at all.

(Source: Adapted from Corebima, 2008)

Table 5 The instrument for measuring students' creative thinking

Indicator	Descriptor	Criteria	Score
Fluency	Able to link blood type, antigen, and red blood cells into a unified concept of the human circulatory system	Using the three words in a unified concept	3
		Using two words to form a unified concept	2
		Use one word to describe a concept	1
		No answer	0
Flexibility	Provides a variety of different ways to solve problems in the human circulatory system disorders	Relevant, 3 correct answers	3
		Relevant, 2 correct answers	2
		Relevant, 1 correct answer	1
		Irrelevant or unanswered	0
Originality	Provide solutions using your language	If the answer is different from the language of the book	3
		If the answer is the same as the language of the book	2
		If there is an answer but the answer is wrong	1
		If not answer	0
Development	Trying or testing the results of blood transfusions from various blood types	Relevant, all stages of the test are correct	3
		Relevant, multiple test stages are correct	2
		Relevant, only 1 test stage is correct	1
		Irrelevant or unanswered	0
Evaluation	State the reasons for the correctness of the answer to a case regarding Dengue Hemorrhagic Fever	The correct answer, correct reason	3
		Incorrect answer, but the correct reason	2
		The correct answer, incorrect reason	1
		No answer	0

(Source: Adapted from Yildiz & Yildiz, 2021)

Data on metacognitive abilities and creative thinking collected from the GIO and GINO classes at three schools in Ambon city were analysed via descriptive and inferential statistics. A descriptive analysis of the metacognitive data was performed via the Formula 1 by Corebima (2009).

$$y_{2=}\frac{y_1+2x}{3} \text{.....Formula 1}$$

Description:
y1 = Score obtained from understanding the concept
y2 = Combined score between conceptual understanding and metacognitive abilities
x = Metacognitive abilities score

The description results are explained through categories according to Asy'ari et al. (2019) in Table 6. Descriptive analysis for creative thinking data was performed through the average score of each indicator on fluency, flexibility, originality, development, and evaluation. The average score was subsequently categorised on the basis of Wijayati et al. (2019) in Table 7. ANCOVA inferential statistics were used to analyse the effect of the learning model on the variables but were previously tested for normality and homogeneity of the data. The use of ANCOVA test to analyse the average difference

between groups using initial test as covariate. The data homogeneity and normality analyses used the Levene and Shapiro-Wilk tests, as shown in Table 8 and 9. Furthermore, the ANCOVA test was continued with a confidence level of p=0.05 via the SPSS 18 for Windows application.

Table 6 Metacognitive category

Score	Category
85-100	Super
68-84	Ok
51-67	Development
34-50	Cannot truly
17-33	Risk
0-16	Not yet

Table 7 Creative thinking category

Creative thinking indicator	Category
Fluency Flexibility Originality Development Evaluation	High: ≥2.2 Medium: ≥1.4 – 2.2 Low: 1.00 – 1.4

Table 8 Normality analysis

Dependent variable	Shapiro-Wilk			Description
	Statistic	df	Sig.	
Metacognitive	.737	64	.170 (*)	Normal
	.910	52	.201 (*)	
Creative thinking	.956	64	.082 (*)	
	.965	52	.127 (*)	

Table 9 Homogeneity analysis

Dependent variable	Levene statistic			Description
	Statistic	df	Sig.	
Metacognitive	.482	64	.226 (*)	Homogeneous
	.179	52	.673 (*)	
Creative thinking	.125	64	.724 (*)	
	.010	52	.058 (*)	

C. Results and discussion

The effect of the learning model on metacognitive abilities

The metacognitive abilities of students in the GIO and GINO classes are in different categories (Table 10). The use of a different learning model can also empower different metacognitive abilities. The metacognitive scores in schools implementing the GIO learning model are in the development category, namely, SHS 1 Ambon with 27 students with scores of 60-67, SHS 4 Ambon with 17 students with scores of 52-60, and SHS 12 Ambon with 20 students with scores of 61-64.

Table 10 Description of senior high school students' metacognitive abilities

Schools	GIO class			GINO class		
	Metacognitive score	Number	Description	Metacognitive score	Number	Description
SHS 1 Ambon	60-67	27	Development	68-71	18	OK
SHS 4 Ambon	52-60	17	Development	68-73	11	OK
				65-67	6	Development
SHS 12 Ambon	61-64	20	Development	70-72	3	OK
				60-67	14	Development
Total		64			52	

The metacognitive scores in schools implementing the GINO learning model are in the "OK" and development categories, namely, SHS 1 Ambon with 18 students with a score of 68-71 in the "OK" category, SHS 4 Ambon with 11 students with a score of 68-73 in the "OK" category and 6 students with a score of 65-67 in the development category, and SHS 12 Ambon with 3 students with 70-72 in the "OK" category and 14 students with a score of 60-67 in the development category (Table 10). Learning that prompts students to engage in activities and manage their thinking dynamically can enhance their metacognitive abilities (Li et al., 2022; Rashwan et al., 2021). Adiansyah et al. (2022) stated that metacognitive abilities can be empowered through various creative and innovative learning methods that focus on students. Therefore, GINO can be considered a varied learning model in Grade XI for learning the human circulatory system. Moreover, GIO does not use variations in its learning stages.

The ANCOVA test results show that the learning model has a significant value of 0.000<p=0.05 (Table 11). Therefore, the learning model affects the metacognitive abilities of Grade XI students in learning the human circulatory system online. The differences between the GIO and GINO learning models can be seen in the Least Significant Difference (LSD) post hoc test, as shown in Table 12.

Table 11 ANCOVA results for students' metacognitive abilities

Source	Type III sum of squares	df	Mean square	F	Sig.
Corrected model	878.772[a]	2	439.386	17.292	000
Intercept	29389.499	1	29389.499	1156.597	000
Initial metacognitive	46.571	1	46.571	1.833	179
Learning model variations	828.671	1	828.671	32.612	000
Error	2871.366	113	25.410		
Total	375182.000	116			
Corrected total	3750.138	115			

Table 12 LSD test of students' metacognitive abilities

Learning class	Mean	Notation
GIO	54.1719	a
GINO	59.5577	b

The LSD results (Table 12) show that there are differences in metacognitive abilities between students taught via the GIO and GINO learning models in terms of the concept of the human circulatory system. Metacognition is useful in improving students' ability to learn independently, examine and analyse the information received, and provide feedback in the learning process (Bozorgian et al., 2022; Kuklick et al., 2023; Capobianco & Nordahl, 2023). Some of these opinions indicate that the ability to support higher-level thinking during learning is very important. Furthermore, it can be defined as the process of managing, monitoring, and evaluating thoughts and understanding the mastery of the learned concept. Kralik et al. (2018) proposed that the formation of metacognition involves an interrelated process of perception, decision, and action. This process can be understood as perception leading to action and influencing decision-making, as well as decisions resulting in subsequent actions. This theory posits that the development of metacognitive abilities occurs through the sequential stages of GINO learning. Students' perceptions are initially shaped by the identification of topics and the formulation of titles, questions, and hypotheses. They subsequently engage in information retrieval and the formulation of investigation strategies. The stage of action entails conducting investigations, and the decision-making process involves producing final reports and engaging in collaborative discussions.

By integrating these three distinct processes within the GINO learning stages, students have the opportunity to cultivate well-rounded metacognitive abilities. Proficient metacognition enables individuals to regulate their emotions, cognition, attention, reasoning, and memory effectively (Pearman et al., 2020). According to Bae and Kwon (2021) and Antonio and Prudente (2021) students who demonstrate strong planning and reflective skills are likely to possess a high level of metacognitive ability. Additionally, working on tasks independently promotes good metacognitive regulation. Whereas when GINO learning is separated into an online investigation group without an inquiry strategy, the planning for enquiry is skipped. This is in accordance with the opinion of (Lu et al., 2021) related to the inquiry strategy, where the inquiry strategy emphasises the collaboration of students to develop scientific stages and conduct better investigations so that it affects students' metacognitive abilities.

The effect of the learning model on creative thinking

The creative thinking abilities of students in the GIO and GINO classes are in different and similar categories, as shown in Table 13. Creative thinking

scores in schools implementing the GIO learning model, namely, the SHS 1 Ambon for the indicators of fluency, originality, and evaluation are categorised as high with student creative thinking scores of 2.30, 2.70, and 2.60, respectively. The SHS 4 Ambon indicators of fluency and originality are categorised as high with student creative thinking scores of 2.40 and 3.00, respectively. The SHS 12 Ambon for the indicators of fluency and flexibility are categorised as high with student creative thinking scores of 3.00 and 2.85, respectively. For schools implementing the GINO learning model, students' creative thinking ability scores for all indicators (fluency, flexibility, originality, development, and evaluation) are categorised as high with a score range of 2.50-3.00 (Table 13). The benefit of students having the ability to think creatively is to train them to overcome problems in life (Ritter et al., 2020; Perdana et al., 2020). According to Dewi & Mashami (2019), inquiry-based learning can improve aspects of fluency, flexibility, originality, development, and evaluation. Tegeh et al. (2022) also reported that investigative groups combined with flipped learning can increase empower creative thinking abilities. Therefore, the combination of the GINO model is more successful in empowering creative thinking because the concept is supported by inquiry-based learning and investigative group stages. According to Daud (2017), the learning process that can develop students' creative thinking occurs through the stages of discovery, presentation, and application of concepts to think divergently.

The ANCOVA results show that the learning model has a significant value of 0.000<p=0.05 (Table 14). Therefore, the learning model affects the creative thinking abilities of Grade XI students in studying the human circulatory system online (Table 15).

Table 13 Description of the results of students' creative thinking abilities

Indicator	SHS 1 Ambon				SHS 4 Ambon				SHS 12 Ambon			
	GIO class		GINO class		GIO class		GINO class		GIO class		GINO class	
Fluency	2.30	High	3.00		3.00	High	3.00		3.00	High	3.00	
Flexibility	2.10	Medium	3.00		2.40		3.00		2.85		3.00	
Originality	2.70	High	2.60	High	2.10		2.60	High	1.85		2.90	High
Development	2.00	Medium	2.50		2.10	Medium	2.60		2.10	Medium	2.50	
Evaluation	2.60	High	2.80		2.10		2.60		2.20		2.50	

Table 14 ANCOVA of students' creative thinking ability

Source	Type III sum of squares	df	Mean square	F	Sig.
Corrected model	883.448[a]	2	441.724	91.183	.000
Intercept	4882.382	1	4882.382	1007.846	.000
Initial creative	43.801	1	43.801	9.042	.003
Variable code	852.346	1	852.346	175.946	.000
Error	547.414	113	4.844		
Total	65680.000	116			
Corrected total	1430.862	115			

Table 15 LSD test of students' creative thinking ability

Learning class	Mean	Notation
GIO	21.090	a
GINO	26.544	b

The LSD results show that there are differences in creative thinking between students taught via the GIO and GINO learning models in terms of the concept of the human circulatory system (Table 15). The role of the teacher is to design varied learning methods to increase the creative thinking abilities of students (Holzapfel et al., 2022; Kuo et al., 2019). Therefore, the various stages of the GINO learning model can improve creative thinking compared with GIO. According to Michalopoulou (2014), discovery-based learning experiences can train students through a series of scientific processes. (Heard et al., 2023) stated that the dimensions of the variables are problem definition, idea generation, and idea quality. The GINO learning stages have the potential to foster the development of creative thinking by operating across three dimensions. The orientation, conceptualization, and discussion stages serve as the dimensions of problem definition, the idea generation dimension, and the idea quality dimension. To cultivate creative thinking, a blend of convergent and divergent reasoning is employed in the initial stages, followed by the evaluation of the outcomes to generate ideas and reasoning (Runco & Jaeger, 2012) (Mekern et al., 2019). Students are trained to empower creative thinking through idea generation for formulating problems, titles, formulating hypotheses, investigating, and reporting writing through a series of GINO learning processes.

GIO collaboration stages with inquiry strategies can enrich the learning stages. According to (Liu et al., 2022), the inquiry strategy helps students find solutions to problems that have been successfully identified. Meanwhile, according to (Cairns & Areepattamannil, 2019), the role of the teacher in inquiry-based learning determines the evaluation results and student achievement.. These activities strongly support students in empowering their creative thinking abilities during final exams.

D. Conclusion

The GIO learning model and the GINO learning model, which combines the online investigation group and inquiry strategy learning stages, have the potential to enhance metacognitive abilities and foster creative thinking among students studying the human circulatory system in Ambon city. This is indicated by the metacognitive ability scores of students in the GIO and GINO classes being in different categories. The metacognitive scores in schools implementing the GIO learning model are in the development category, namely, SHS 1 Ambon with 27 students with scores of 60-67, SHS 4 Ambon with 17 students with scores of 52-60, and SHS 12 Ambon with 20 students with scores of 61-64. The metacognitive scores in schools implementing the GINO learning model are in the "OK" and development categories, namely SHS 1 Ambon with 18 students with a score of 68-71 in the "OK" category, SHS 4 Ambon with 11 students with a score of 68-73 in the "OK" category and 6 students with a score of 65-67 in the development category, and SHS 12 Ambon with 3 students with 70-72 in the "OK" category and 14 students with a score of 60-67 in the development category. The results of the ANCOVA test show that the learning model has an effect on students' metacognitive abilities with a significance value of 0.000<p=0.05. In addition, the results of the LSD post hoc follow-up test show that there is an average difference between the GIO and GINO learning models.

On the other hand, the creative thinking ability scores of students in the GIO and GINO classes are in different categories. The creative thinking scores at schools that implement the GIO learning model, namely, the SHS 1 Ambon for the fluency, originality, and evaluation indicators are categorised as high, with student creative thinking scores of 2.30, 2.70, and 2.60, respectively. The SHS 4 Ambon for the fluency and originality indicators are categorised as high with student creative thinking scores of 2.40 and 3.00, respectively. The SHS 12 Ambon for the fluency and flexibility indicators are categorised as high with student creative thinking scores of 3.00 and 2.85, respectively. For schools that implement the GINO learning model, the creative thinking ability scores of students for all indicators (fluency, flexibility, originality, development, and evaluation) are categorised as high, with a score range of 2.50-3.00. The results of the ANCOVA test show that the learning model has an effect on students' creative thinking ability, with a significance value of 0.000 <p = 0.05. In addition, the results of the LSD post hoc follow-up test revealed that there was an average difference between the GIO and GINO learning models. Therefore, incorporating diverse learning methods, such as the implementation of GINO, in online biology education is recommended. Future research can trial the GINO learning model with other learning models using technology-based learning media in accordance with the current 5.0 education era which is characterized by the rapid development of technologies, such as artificial intelligence, robotics, and the Internet of Things (IoT).

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