JPPIPA 11(8) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

The Effect of Process Oriented Guided Inquiry Learning (POGIL) Model on Critical Thinking Skills and Collaboration Skills of Class XI Students of SMAN 14 Gowa Biology Teaching Material

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Received: May 13, 2025
Revised: July 11, 2025
Accepted: August 25, 2025
Published: August 31, 2025

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DOI: 10.29303/jppipa.v11i8.12123

Abstract: This study aims to determine the effect of the POGIL learning model on critical thinking skills and collaboration skills of students in class XI sman 14 Gowa. The research design is pretest-posttest control group design. The population in the study were all grade XI students in the 2024/2025 school year which were spread into 5 study groups. The sampling technique used purposive sampling. A total of 3 study groups used in this study, namely, study group XI. B3 as an experimental class 1 applied the POGIL learning model, study group XI. B1 as experimental class 2 applied discovery learning model, and study group XI.C1 as control class applied NHT model. The data collection techniques used were critical thinking skills test and collaboration skills questionnaire. The research instruments used were a critical thinking skills test in the form of an essay of 7 questions, and a collaboration skills questionnaire of 15 statement items. The data analysis technique used was Analysis of Covariance (Ancova) using SPSS with a significant level of 0.05. Based on the Ancova test results, the significance value of the critical thinking skills variable is 0.00 <0.05 and the significance value of the collaboration skills variable is 0.00 <0.05, so it can be concluded that the application of the POGIL learning model has a significant effect or a real effect on the collaboration skills variable.

Keywords: Critical thinking skills; Collaboration skills; POGIL

Introduction

The 21st century is marked as an era of openness or globalization, which has led to significant changes in various aspects of life. In this context, 21st-century education demands a learning process that can produce high-quality human resources and equip them with essential skills such as critical thinking, communication, collaboration, and creativity (OECD, 2019; Trilling et al., 2010). These four skills are not inherently possessed from birth but can be shaped and developed through proper educational processes (Redhana, 2019).

In the context of Indonesian education, five student character traits have become the primary focus of evaluation in learning and national assessments, namely critical thinking skills, creativity and innovation, communication skills, collaboration, and self-confidence (Adnan et al., 2021). The goal of learning that emphasizes 21st-century skills is to encourage students to think independently about the content they learn, seek solutions to problems, and be open to diverse perspectives (Hattie et al., 2015; Palennari et al., 2021).

Education in this era should no longer focus solely on subject mastery, but also on developing critical thinking and collaboration skills that align with the

How to Cite:
Fitriah, Daud, F., & Ali, A. (2025). The Effect of Process Oriented Guided Inquiry Learning (POGIL) Model on Critical Thinking Skills and Collaboration Skills of Class XI Students of SMAN 14 Gowa Biology Teaching Material. *Jurnal Penelitian Pendidikan IPA*, *11*(8), 651–660. https://doi.org/10.29303/jppipa.v11i8.12123

demands of the times. These skills are also key indicators in international assessments such as the Programme for International Student Assessment (PISA), which measures students' abilities to solve real-world problems, collaborate, and think reflectively and critically (Atmojo et al., 2024). However, the 2022 PISA results show that Indonesia still faces major challenges in mastering these skills. Out of 81 participating countries, Indonesia ranked 68th, with reading scores (359), mathematics (366), and science (383) categorized as low. One of the main contributing factors to this poor performance is students' underdeveloped critical thinking skills (Arda et al., 2024; Rosyida et al., 2024).

Two interrelated and complementary skills are critical thinking and creative thinking (Trilling et al., 2010). Critical thinking and collaboration skills are interrelated because critical thinking ability helps individuals analyze, evaluate, and solve problems effectively, while collaboration skills allow them to work together with others to achieve a common goal. In collaboration, critical thinking is required to contribute the right ideas, provide reasoned solutions, and evaluate opinions and inputs from team members. Good collaboration also facilitates critical thinking through discussion, exchange of ideas, and collective problem solving (Ariadila et al., 2023; Chen et al., 2018; Huda et al., 2024; Wardani, 2023).

The current condition of students' critical thinking skills is still a challenge in many schools. Several studies show that many students have not been able to develop critical thinking skills optimally, especially in evaluating information, analyzing data, and composing logical arguments (Haeruman et al., 2017). The contributing factors vary, ranging from teacher-centered teaching methods to the lack of use of learning models that encourage active participation and deep thinking. In addition, the focus of learning that often only emphasizes memorization of material also hinders the development of critical thinking skills. Therefore, innovation is needed in learning models that encourage students to explore and develop these skills, such as POGIL and problem-based learning (Rozali et al., 2022).

Learners' collaboration skills are still in need of improvement in many educational institutions. Although collaboration is one of the essential 21st century skills, many students are not used to working effectively in teams. Research shows that although students often work in groups, many do not fully understand how to share ideas, listen to others' opinions, or resolve conflicts in teams (Rosnaeni, 2021). One of the reasons is the learning approach that has not emphasized much on cooperation and interaction between students. Teachers often focus more on individual achievement rather than effective teamwork processes. For this reason, collaboration-oriented learning models, such as POGIL or cooperative learning, are increasingly relevant to use so that students can be more familiar and trained in building these skills (Indana, 2018).

Based on the results of observations and interviews with one of the biology educators at SMAN 14 Gowa, that he has applied the discovery learning model in recent years in the hope that students can be more active and independent in learning. However, although the discovery learning model has been used, he admits that the results have not been as expected. Where students tend to still memorize the material without really understanding the concept, students also rarely ask questions or explore new ideas presented during learning. In addition, interaction in groups is also less effective, where only a few learners are actively involved in the discussion, while others are passive and wait for answers from friends. This shows that learners' critical thinking skills and collaboration skills are still low and untrained even though the learning model in the school uses discovery learning.

The low critical thinking and collaboration skills of SMAN 14 Gowa also contributed to suboptimal learning outcomes. More innovative and participatory learning models, such as POGIL, are expected to improve learning outcomes through increased student engagement in the learning process independently and collaboratively (Irwanto et al., 2018). In addition, 21st century skills, such as critical thinking and collaboration, have a positive correlation with better academic achievement. Based on the problems described, a learning model that can effectively address and develop 21st century skills is needed. One learning model that is considered effective in developing these skills is the Process Oriented Guided Learning (POGIL) learning model (Pinasthi et al., 2024; Wijaya et al., 2021).

The Process Oriented Guided Inquiry Learning (POGIL) learning model is currently gaining popularity at various levels of education because it is considered effective in improving students' critical thinking and collaboration skills. POGIL encourages students to learn actively through structured, problem-based activities, where they work in groups to explore new concepts. Recent research shows that this model not only helps improve understanding of the material, but also develops higher-order thinking skills such as analysis and synthesis (Irwanto et al., 2018). POGIL is also considered relevant to be applied in various subjects, especially in science and mathematics, which demand in-depth understanding of concepts and active engagement of students.

Several studies have shown that the application of POGIL has a positive impact on students' critical thinking skills and collaboration skills (Oktaviana, 2019). Research conducted by Hein (2012) found that students

who learned using the POGIL model showed a significant increase in critical thinking skills compared to students who learned using conventional methods. In addition, the results of research by Yanti et al. (2023) also revealed that POGIL can improve students' collaboration skills, especially in terms of communicating and working together to achieve shared learning goals.

This model not only encourages students to think critically and creatively, but also improves their collaboration and communication skills, which are very important in facing the challenges of globalization. The Process Oriented Guided Inquiry Learning (POGIL) model is a refinement of guided inquiry that emphasizes the active learning process and content application, as well as engaging students in critical thinking (Annisa, 2017).

Previous studies have shown that the POGIL learning model can significantly improve students' critical thinking and collaboration skills. For example, research conducted by Sarifah et al. (2023) showed that the guided inquiry learning model was able to improve critical thinking skills and collaboration skills. In addition, research by Sudartik et al. (Sudartik et al., 2023) concluded that POGIL also proved to have a significant effect on learning outcomes and critical thinking skills.

This study aims to explore the effect of implementing the POGIL learning model on critical thinking skills and collaboration skills. Given the importance of 21st century skills in facing increasingly complex global challenges in education, the Process Oriented Guided Inquiry Learning (POGIL) learning model has been recognized as a method that emphasizes active learning through structured inquiry, which aims to train learners to think critically and work together effectively in teams (Hanson, 2006; Moog et al., 2008). Thus, this research is expected to provide a deeper understanding of how POGIL can overcome the weaknesses that exist in the learning process.

This research is important because the results of this study can be the basis for teachers to evaluate and update the learning strategies used in the classroom, in order to improve the overall quality of biology learning. The novelty of this research is not only measuring cognitive (critical thinking) but also affective (student collaboration) which is a more holistic approach to learning outcomes.

Method

The type of research used is quasi-experimental research. The research design used was pretest-posttest controlled group design in order to get a causal relationship through the existence of experimental group classes and control groups. The type of research used is quasi-experimental research. The research subjects were all study groups of class XI consisting of 5 classes with a total of 168 students at SMA Negeri 14 Gowa. The sampling technique used simple purposive sampling with a sample size of 111 people. The samples in the study included classes XI B2, XI B3 and C1, each class totaling 37 people. Data collection techniques used in this study were tests in terms of essay tests and questionnaires. Descriptive data analysis consists of mean, standard deviation, highest score and lowest score using IBM SPSS Statistic 23.

Result and Discussion

Result

The results of descriptive statistical analysis obtained are as follows: the results of the descriptive analysis of the critical thinking skills of students before and after the learning process using the POGIL, Discovery Learning, and NHT learning models can be seen in table 1.

Table 1. Descriptive Analysis of Thinking Skills Descriptive Analysis of Thinking Skills of Each Class Thinking of Each Class

Variable		Number of samples	Average	Standard Deviation	Lowest Score	Highest Score
POGIL	Pretest	37	55,88	8.25	42,86	67,86
	Posttest	37	75,67	8.57	57,14	96,43
Discovery Learning	Pretest	37	51.93	8.31	35.71	71.43
	Posttest	37	66.21	8.60	46,71	85.71
NHT	Pretest	37	49.22	9.60	35.71	75.00
	Posttest	37	61.48	6.94	50.00	78.57

The class taught with the POGIL model, during the pretest obtained an average score of 55.88 ± 8.25, with the highest score of 67.86 and the lowest score of 42.86. After learning (posttest), the average increased to 75.07 ± 8.57, with the highest score of 96.43 and the lowest score of 54.76. The class taught with the Discovery Learning model, the pretest results showed an average value of 51.93 ± 8.31, with the highest value of 71.43 and the lowest value of 35.71. The posttest results showed an average increase to 66.21 ± 8.60, with the highest score of

85.71 and the lowest score of 46.71. The class taught with the NHT (Numbered Heads Together) model, the pretest results obtained an average value of 49.22 ± 6.96, with the highest value of 75.00 and the lowest value of 35.71. After learning, the posttest results showed an increase with an average score of 61.48 ± 6.94, the highest score was 78.57, and the lowest score was 50.00.

Collaboration Skills (Self-Assessment) of Learners Taught with POGIL, Discovery Learning, and NHT Models

Classes taught with the POGIL model, during the pretest, the average value of collaboration skills was 45.72 ± 3.66, with the highest score of 51.67 and the lowest score of 38.33. After learning (posttest), there was an increase with an average value of 68.64 ± 5.96, the highest value was 76.67, and the lowest value was 51.67. The class using the Discovery Learning model showed pretest results with an average score of 44.46 ± 3.46, the highest score was 53.33, and the lowest score was 36.67. After learning, the posttest score increased to 64.86 ± 7.64, with the highest score of 85.00 and the lowest score of 48.33. Meanwhile, the class using the NHT (Numbered Heads Together) model obtained an average pretest score of 47.56 ± 3.80, with the highest score of 53.33 and the lowest score of 38.33. The posttest results showed an increase to 60.90 ± 7.25, with the highest score of 80.00 and the lowest score of 45.00.

Table 2. Descriptive Analysis of Collaboration Skills (Self-Assessment) Each Class

Variable		Number of samples	Average	Standard Deviation	Lowest Score	Highest Score
POGIL	Pretest	37	45.72	3.66	38.33	51.67
	Posttest	37	68.64	5.96	51.67	76.67
Discovery Learning	Pretest	37	44.46	3.46	36.67	53.33
	Posttest	37	64.86	7.64	48.33	85.00
NHT	Pretest	37	47.56	3.80	38.3	53.33
	Posttest	37	60.90	7.25	45.00	80.00

Collaboration Skills (Peer Assessment) of Learners taught with POGIL, Discovery Learning, and NHT Models

Based on the results of descriptive analysis of students' collaboration skills through peer assessment, it is known that the class taught using the POGIL model experienced an increase in the average score from 59.41 during the pretest to 68.15 during the posttest. The highest score increased from 68.33 to 83.33, and the lowest score also increased from 51.67 to 56.67. This shows an overall increase in collaboration skills in the class. In the class that used the Discovery Learning model, the average score increased from 57.29 to 65.31. The highest score increased from 66.67 to 75.00, and the lowest score increased from 46.67 to 55.00, which also showed an increase in collaboration skills after learning. Meanwhile, the class that applied the Numbered Heads Together (NHT) model experienced an increase in the average score from 55.58 to 62.43. The highest score increased from 68.33 to 80.00, and the lowest score increased from 48.33 to 51.67. This increase also indicates that the NHT model contributes positively to students' collaboration skills, although the increase is not as high as the POGIL class.

Table 3. Descriptive Analysis of Collaboration Skills (Peer Assessment) Each Class

Variable		Number of samples	Average	Standard Deviation	Lowest Score	Highest Score
POGIL	Pretest	37	59.41	4.08	51.67	68.33
	Posttest	37	68.15	6.24	56.67	83.33
Discovery Learning	Pretest	37	57.29	4.70	46.67	66.67
	Posttest	37	65.31	5.65	55.00	75.00
NHT	Pretest	37	55.58	4.81	48.33	68.33
	Posttest	37	62.43	6.02	51.67	80.00

Overall, the three learning models showed an increase in the value of students' collaboration skills based on the results of peer assessment, with the POGIL model having the most significant impact. The results of the normality test are shown in Table 4.

Table 4. Kolmogorov-Smirnov Normality Test Results Critical Thinking Skills, and Collaboration Skills of Learners

Variable	Class		Sig	Description
Critical Thinking Skills	POGIL	Pretest	0.200	Normal
	Discovery Learning		0.200	Normal
	NHT		0.200	Normal
	POGIL		0.052	Normal

Variable	Class		Sig	Description
Collaboration Skills (*Self Assesment)*	Discovery Learning		0.053	Normal
	NHT		0.117	Normal
Collaboration Skills *(Peer Assesment)*	POGIL		0.116	Normal
	Discovery Learning		0.175	Normal
	NHT		0.066	Normal
Critical Thinking Skills	POGIL		0.188	Normal
	Discovery Learning		0.139	Normal
	NHT		0.066	Normal
Collaboration Skills (*Self Assesment)*	POGIL		0.200	Normal
	Discovery Learning	Posttest	0.200	Normal
	NHT		0.200	Normal
Collaboration Skills *(Peer Assesment)*	POGIL		0.200	Normal
	Discovery Learning		0.164	Normal
	NHT		0.200	Normal

Table 4 shows the results of the Kolmogorov-Smirnov normality test on critical thinking skills data, and students' collaboration skills on pretest and posttest scores have sig. > 0.05 (significance value more than 0.05). So it can be concluded that the data on critical thinking skills and collaboration skills of students are normally distributed.

Data from the homogeneity test results of the effect of the POGIL learning model on critical thinking skills and collaboration skills of students in class XI SMAN 14 Makassar are shown in Table 5.

Table 5. Results of Homogentic Test of Critical Thinking Skills and Collaboration Skills of Students

Variable		Sig.	Description
Critical Thinking Skills		0.605	Homogeny
Collaboration Skills (*Self Assesment)*	Pretest	0.734	Homogeny
Collaboration Skills *(Peer Assesment)*		0.621	Homogeny
Critical Thinking Skills		0.535	Homogeny
Collaboration Skills (*Self Assesment)*	Posttest	0.308	Homogeny
Collaboration Skills *(Peer Assesment)*		0.984	Homogeny

Table 5 shows the results of the homogeneity test of the critical thinking skills variable data and the collaboration skills of students on the pretest and pottest have a sig value. > 0.05 (significance value is more than 0.05). So it can be concluded that the variable data of critical thinking skills and collaboration skills are homogeneous.

The Effect of Learning Models on Critical Thinking Skills of Class XI Students of SMAN 14 Gowa

The results of better classes in the application of POGIL, discovery learning and NHT learning models for critical thinking skills variables, can be seen based on the corrected average value. The corrected mean value for the critical thinking skills variable can be seen in Table 6.

Table 6. Corrected Average Value of the Effect of the POGIL Learning Model on Critical Thinking Skills

Model	Average
POGIL	75.454[a]
Discovery Learning	66.242[a]
NHT	61.681[a]

Table 6 shows significant differences between the three classes. These differences can be seen in the average scores, indicating a difference in the influence of infographics on critical thinking skills in each class. The POGIL learning model appears to have the most optimal impact on science process skills, followed by discovery learning and NHT.

The Influence of Learning Models on Collaboration Skills (Self-Assessment) of Class XI Students of SMAN 14 Gowa

Improved class outcomes in the implementation of the POGIL, discovery learning, and NHT learning models for collaboration skills (self-assessment) can be seen based on the corrected mean scores. The corrected mean scores for critical thinking skills are shown in Table 7.

Table 7. Corrected Mean Score: Effect of the POGIL Learning Model on Critical Thinking Skills

Model	Average
POGIL	68.646[a]
Discovery Learning	64.836[a]
NHT	60.933[a]

Table 7 shows significant differences between the three classes. These differences can be seen in the average scores, which indicate the differences in the influence of learning models on collaboration skills (self-assessment) in each class. The POGIL learning model appears to have the most optimal impact on

collaboration skills (self-assessment), followed by discovery learning and NHT.

The Effect of Learning Models on Collaboration Skills (Peer Assessment) of Grade XI Students at SMAN 14 Gowa

The improved results of the classes implementing the POGIL, discovery learning, and NHT learning models for collaboration skills (peer assessment) are evident based on the corrected average scores. The corrected average scores for collaboration skills (peer assessment) are shown in Table 8.

Table 8. Corrected Average Scores for the Effect of Learning Models on Collaboration Skills (Peer Assessment)

Model	Average
POGIL	68.341[a]
Discovery Learning	65.302[a]
NHT	62.258[a]

Table 8 shows similarities between the three classes taught using the learning models. These differences can be seen in the average, which indicates a significant difference in the influence of the learning model on collaboration skills (peer assessment) in each class. The POGIL learning model has a more optimal effect on collaboration skills (peer assessment), followed by the discovery learning and NHT learning models.

Discussion

The Effect of Learning Models on Critical Thinking Skills of Grade XI Students at SMAN 14 Gowa

The highest average critical thinking skill score was found in the POGIL learning model at 75.454, followed by Discovery Learning at 66.242, and NHT at 61.681. Thus, the POGIL learning model provides a more optimal impact on improving students' critical thinking skills compared to the other two models.

The use of the POGIL (Process-Oriented Guided Inquiry Learning) learning model in the learning process has proven effective in improving critical thinking skills. According to Devi et al (2019), the POGIL model encourages students to learn actively and construct knowledge through investigation and small group collaboration, which aligns with the characteristics of critical thinking. Similarly, Walker et al. (2017) stated that POGIL significantly increases students' chances of success in completing learning and encourages analytical thinking through active learning. Similar research by Sugiarti et al. (2024) also showed that implementing the POGIL model significantly improved high school students' critical thinking skills in science learning. This finding is supported by a meta-analysis conducted by Walker et al. (2017), which concluded that cooperative-based approaches like POGIL have a statistically significant impact on learning achievement and higher-order thinking skills.

Meanwhile, the Discovery Learning model also demonstrated a significant impact, although not as optimal as POGIL. This is supported by research conducted by Fatmawati et al. (2025), which stated that Discovery Learning encourages students to discover learning concepts on their own, resulting in a better understanding of the material and the ability to think critically. However, this process requires more intensive guidance to prevent students from becoming confused during the exploration phase.

The NHT model, while capable of improving social skills and group work, remains less effective than the other two models on critical thinking skills. This aligns with the research findings of Handayani (2011), which concluded that the NHT model is more effective in increasing overall student engagement in discussions, but less effective in stimulating in-depth analytical thinking. Therefore, selecting the right learning model is crucial for developing students' critical thinking skills. Constructivist-based learning models like POGIL provide more space for students to develop analytical, evaluation, and reflection skills, which are core to critical thinking skills.

The Influence of Learning Models on Students' Collaborative Skills (Self-Assessment)

The highest average collaborative skills score was found in the POGIL learning model at 68.646, followed by Discovery Learning at 64.836, and NHT at 60.933. Thus, the POGIL learning model provided a more optimal impact on improving students' collaboration skills compared to the other two models.

The use of the POGIL (Process-Oriented Guided Inquiry Learning) learning model in the learning process has proven effective in improving collaboration skills. According to research by Aini et al. (2025), the POGIL model encourages students to work together in small groups with clear roles and responsibilities. Rodriguez et al. (2020) confirmed that POGIL facilitates interdependence and communication among small group members, which supports collaborative problem-solving and shared accountability.

Meanwhile, the Discovery Learning model also demonstrated a significant impact on improving collaboration skills, although not as optimal as POGIL. Research by Ningkaula et al. (2021) shows that the STEM-based Discovery Learning model helps students understand the material independently while interacting actively in groups, although teacher support is still needed for effective collaboration.

The NHT model tends to focus more on equitable student participation within groups, but lacks depth in encouraging reflection or self-evaluation as part of self-

assessment. This is supported by research by Bulu et al. (2019), which shows that although the NHT model increases active discussion, the development of complex collaborative skills is more effectively achieved through an inquiry-based approach like POGIL.

It can be concluded that selecting the right learning model is crucial for developing students' collaborative skills. The POGIL model, which is based on a constructivist approach and cooperative learning, provides more space for students to interact, contribute, and evaluate the group work process independently, allowing for optimal development of collaborative skills (self-assessment).

The Influence of Learning Models on Collaboration Skills (Peer Assessment)

The highest average collaborative skills score (peer assessment) was found in the POGIL learning model at 68.341, followed by Discovery Learning at 65.302, and NHT at 62.258. Thus, the POGIL learning model provided a more optimal impact on improving students' collaborative skills compared to the other two models.

The POGIL learning model again demonstrated its effectiveness in fostering students' collaborative skills, not only from a self-evaluation perspective but also from peer assessment. This is supported by research by Syarafibi et al. (2024), which explained that collaborative activities in the POGIL model encourage students to mutually evaluate the group work process, increase self-confidence, and foster collective responsibility. Soltis et al. (2015) showed that students in POGIL groups more frequently reflected on the contributions of their peers and developed interpersonal responsibility not seen in lecture-based learning.

Discovery Learning also has a significant impact on collaboration skills based on peer assessment. Research by Oktaviani et al. (2021), indicates that Discovery Learning encourages students to actively construct knowledge within groups, thereby strengthening interaction and cooperation—key foundations in peer assessment. However, this process still requires guidance to ensure that all group members are equally involved. Vincent-Ruz et al. (2020) noted that even in large classrooms, the structure of POGIL helps students more accurately recognize and evaluate their peers' contributions, thus reinforcing a sense of responsibility and mutual respect.

As for the NHT model, although it contributes to the improvement of collaboration skills, its impact is relatively lower compared to the other two models. NHT tends to emphasize equal participation through random numbering and group presentations but does not sufficiently explore the process of evaluating individual performance through peer feedback. This aligns with findings from Mardiana et al. (2024), which show that while NHT facilitates group communication, the evaluative aspect of teamwork remains underdeveloped. Idul et al. (2022) stated that collaborative science learning within the POGIL framework enhances both individual and peer feedback processes, which are essential in reflective teamwork.

Therefore, it can be concluded that selecting a learning model based on active cooperative approaches such as POGIL is highly effective in developing collaboration skills through peer assessment. This model not only promotes social interaction but also fosters evaluative attitudes and responsibility among students in a collaborative learning environment.

Conclusion

The results showed that the learning model positively influenced the critical thinking and collaboration skills of students of class XI SMAN 14 Gowa. The POGIL model had the greatest effect compared to Discovery Learning and NHT, both in critical thinking and collaboration aspects (self-assessment and peer assessment). It is suggested to future researchers to add forms of assessment such as direct observation or portfolios to obtain a more comprehensive picture, as well as implement these three models at other levels or schools for more general results.

Acknowledgments
Thank you to all parties who have helped in this research so that this article can be published.

Author Contributions
All authors contributed to writing this article.

Funding
No external funding.

Conflicts of Interest
No conflict interest.

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