The Effect of the Two Stay Two Stray Cooperative Learning Model (TSTS) Assisted by STEM-Based Interactive Media on Critical Thinking and Student Learning Outcomes on Sensory System Material

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Abstract: This study aims to determine the effect of the two-stay two stray cooperative learning model (TSTS) assisted by STEM-based interactive media on critical thinking and student learning outcomes on sensory system material at SMA Negeri 2 Kerinci. This type of research is quasi-experimental research with a randomized control-group posttest-only design. The population of this study came from class XI students of SMA Negeri 2 Kerinci for the 2021/2022 Academic Year. The sampling technique used is a purposive sampling technique, namely that the determination of the sample takes into account certain criteria that have been made for the subject according to the research objectives. Data analysis techniques used the normality test, homogeneity test, and hypothesis test. Based on the research that has been done, it can be concluded that the STEM-based two stay two stray learning model has an effect on critical thinking and student learning outcomes on sensory system material at SMA Negeri 2 Kerinci.

Keywords: Critical thinking and biology learning outcomes; The two stay two stray (TSTS) model

Introduction

Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and the skills needed by themselves, society, nation and state (Wafi, 2017).

At this time, science and technology are developing very rapidly. This causes competition between countries and demands change and development in all fields, including in the world of education. The world of education is very important because education is an effort to improve human dignity. The role of education is very large in everyday life (Muthohar, 2022).

Developments in the field of technology have given birth to new challenges in the Industry 4.0 era, one of which is education, where education will create human resources with the development of technology, HR is required to have various skills to meet the needs of the education industry 4.0, namely a more cybergoth approach, creating a virtual learning environment student-centered, autonomous and collaborative. Education 4.0 is a phenomenon that responds to the needs of the Industrial Revolution 4.0 where humans and machines are accompanied to find solutions, solve problems and of course find innovation possibilities (Sudiyono, 2018).

Critical thinking is a life skill that needs to be developed by students at all levels of education during the learning process at school (Daryanto, 2015). Critical thinking skills need to be applied in learning so that students are accustomed to creating arguments, checking the credibility of sources, and making

decisions (Maulidia et al., 2019). Critical thinking skills are related to the ability to identify, analyze, and solve a problem creatively and logically to be able to obtain the right considerations and decisions in the learning process (Mudyaharjo, 2015).

In the learning process, creativity is one of the important skills that must be possessed and is the key to effective learning so that students get used to being open and responsive in finding or conveying new ideas, concepts, or opinions to others (Ngalimun, 2013). Student creativity in learning can also be stimulated through collaborative activities. Through collaboration in discussions with friends, students can work creatively with other people (Winkel, 2015). This can be achieved, one of the ways, by optimizing the use of technology as an educational tool which is expected to be able to produce output that can keep up with or change the times for the better (Makmun, 2018).

The latest learning models can be used and adapted in the development of learning, one of which is the two stay two strays (TSTS) learning model which is one of the cooperative learning models (Wardhani et al., 2021). The two stay two stray learning model is combined with STEM-based interactive media so that understanding the concepts in sensory system material will be more concrete and easy for students to understand. In this case, in the learning process, the teacher only acts as a conduit of information, facilitator, and mentor. With the collaboration between groups, students can discuss and find concepts about the concepts in the coordination system material and can solve problems that they do not understand. So that a pleasant learning atmosphere and interaction can also make students more active and enjoy learning so that students don't get bored easily when learning (Jones et al., 2022).

What is happening in elementary schools, according to the current trend of learning biology, is that students only study biology as a product, and memorize concepts, theories, and laws. Teachers are less creative in creating conditions that direct students to build their knowledge. Most of the teachers in the biology learning process still apply teacher-centered learning so that they are not able to teach students which can affect biology learning outcomes in the future (Handayani, 2020). Teachers very rarely give practicums to students, teachers only provide the material so that students become less active, get bored quickly, get bored and lack self-confidence. Various problems in the learning process in class will certainly influence student learning outcomes (Antika et al., 2019).

Based on the results of observations at Kerinci 2 Public High School from the results of interviews, it is known that based the results of the value collection data obtained from the biology study teacher at Kerinci 2

Public High School, it can be concluded that student learning outcomes are still low and some students still get grades below the minimum completeness criteria (KKM) is 64.5. So that it causes low students' understanding of the material being taught, and has an impact on student learning outcomes that have not reached the KKM, which can be seen from the average value of the results of the Daily Deuteronomy class XI MIPA students in biology subject matter of the sensory system.

Then this is by what was conveyed by the Kerinci 2 Public High School teacher, there are still many students who do not understand the learning conveyed by the teacher because students are less motivated by conventional learning methods, students do not play an active role in the teaching and learning process in the class indicated by the lack of students' curiosity about the subject matter and learning carried out by teachers in general still use conventional learning. To be able to actively involve students in the teaching and learning process in class and to be able to improve student learning outcomes, an appropriate learning model is needed, one of which is the cooperative learning model.

Based on this problem, one learning model that can improve 21st-century competence for students is the TSTS learning model. The two stay two stray cooperative learning model can trigger student activity in class. This two stay two stray cooperative learning model can attract students' attention, reduce boredom and drowsiness, can make students active and able to work together in groups, can provide a conducive and enjoyable learning atmosphere in the learning process. The application of the two stay two stray cooperative learning model can provide a direct influence to help create good interactions between teachers and students, increase students' courage in giving opinions, foster active student participation, and of course can improve student learning outcomes.

The media used as supporting material in the learning process is interactive media. The advantage of interactive media is that users can be given the ability to control existing elements, which is known as interactive multimedia (Interactive Multimedia). Sukarsana (2022) states that the use of interactive multimedia in learning can improve students' critical thinking skills, improve student learning outcomes, and challenge students to learn independently.

The use of the two stay two stray cooperative learning model has been proven to make student learning activities more interesting and enjoyable, increase student interest and motivation in learning, and make students interactive and communicative. Mutirdanili et al. (2021) The approach used in interactive media used is the STEM (science, technology,

engineering, and mathematics) approach. STEM is a learning approach that integrates four fields, namely science, technology, engineering, and biology into a holistic whole. The success of STEM can be seen in student learning outcomes, the type of school, and how it is applied (Rachmawan, 2020).

Based on the description above, a study was conducted on "The Influence of the Two Stay Two Stray Cooperative Learning Model (TSTS) Assisted by STEM-Based Interactive Media on Critical Thinking and Student Learning Outcomes on Sensory System Material in SMA Negeri 2 Kerinci".

Method

This research was conducted at SMA Negeri 2 Kerinci on 22 August to 22 September 2022. The population of this study came from class XI students at SMA Negeri 2 Kerinci for the 2021/2022 Academic Year. This research is included in quantitative experimental research. Experimental research is research that is intended to determine whether or not there are consequences of "something" imposed on the subject under investigation. In other words, experimental research tries to examine whether there is a causal relationship or not (Andriani, 2015).

The experimental quantitative research used is quantitative research with a quasi-experimental approach (Mahmud, 2011). According to Saifuddin (2021) Quasy Experiment is research that is proven by proving a hypothesis to see the influence of one independent variable on the dependent variable.

The sampling technique used was purposive sampling, namely the determination of the sample taking into account certain criteria that had been made for the subject according to the research objectives. This study consisted of two classes, namely the experimental class and the control class. The experimental class was given the treatment of the two stay two strays (TSTS) learning model assisted by STEM-based interactive media and the control class used conventional learning models (lectures), discussions, questions, and answers that were usually carried out at the school.

Data analysis techniques using normality test, homogeneity test, and hypothesis testing. This type of research is quasi-experimental research with a Randomized Control-Group Group Posttest Only Design. In summary, it can be seen in Table 1.

Table 1. Randommized Control-Group Posttest Only Design

Group	Pretest	Treatment	Posttest
Experiment	-	X	T2
Control	-	-	T2

Result and Discussion

Result
Description of Learning Outcome Data
Description of Student Learning Outcomes Data

The research was conducted in class XII SMA Negeri 2 Kerinci which was conducted in two sample classes, namely the MIPA 1 class as an experimental class or a class that used the two stay two strays (TSTS) cooperative learning model assisted by STEM interactive media and MIPA 2 class as the control class or class who do not use the two stay two strays (TSTS) cooperative learning model assisted by STEM interactive media. The value obtained by students is the result of the final test.

The final test serves to measure the level of student learning outcomes by applying the two stay two strays (TSTS) learning model assisted by STEM interactive media in biology subjects. This test was given to experimental class students as follows:

a) *Cognitive Aspect Learning Outcomes*

From the learning outcomes test, the scores obtained were processed to answer the proposed hypothesis. The distribution of test scores for the cognitive aspects of students in the experimental class and control class can be seen in Table 2.

Table 2. Distribution of Student Learning Outcomes Test Scores for Experiment Class and Cognitive Aspect Control Class

Test Score	Frequency	
	Experiment Class	Control Class
51 – 60	0	6
61 – 70	4	13
71 – 80	18	9
81 - 90	4	3
91 – 100	4	0
$\bar{X}$	81	72.5

Based on Table 2, in the experimental class, students obtained scores at high intervals of 91-100 for 4 people and at low intervals of 61-70 for 4 people. While students in the control class scored at intervals of 81-90 for 3 people and scores at intervals of 51-60 for 6 people. Based on the KKM for biology subjects on sensory system material at SMA Negeri 2 Kerinci, which is 75, students in the experimental class score on the average student learning achievement test have reached the KKM, which is 81 and for the control class, the average student achievement test score is still not KKM is 72.5.

b) *Affective Aspect Learning Outcomes*

From the learning outcomes test, the scores obtained were processed to answer the proposed

hypothesis. The distribution of test scores on the affective aspects of students in the experimental class and control class can be seen in Table 3.

Table 3. Distribution of Test Scores for Student Learning Outcomes in the Experimental Class and the Affective Aspect Control Class

Test Score	Frequency	
	Experiment Class	Control Class
51 – 60	0	0
61 – 70	0	0
71 – 80	4	20
81 - 90	18	8
91 – 100	8	2
$\bar{X}$	9.1	8.443

From Table 3, it can be concluded that the student learning outcomes score data on the affective aspect of students in the experimental class obtained scores at high intervals of 91-100 for 8 people and at low intervals of 71-80 for 4 people. While students in the control class scored at intervals of 91-100 for 2 people and scores at intervals of 71-80 for 20 people.

c) Psychomotor Aspect Learning Outcomes

From the learning outcomes test, the scores obtained were processed to answer the proposed hypothesis. The distribution of test scores for the psychomotor aspects of the experimental class and control class students can be seen in Table 4.

Table 4. Distribution of Student Learning Outcomes Test Scores for Experiment Class and Control Class for Psychomotor Aspects

Test Score	Frequency	
	Experiment Class	Control Class
51 – 60	0	0
61 – 70	0	3
71 – 80	2	18
81 - 90	22	6
91 – 100	6	3
$\bar{X}$	8.973	4.55

From Table 4 it can be concluded that the data on student learning outcomes scores on the psychomotor aspects of students in the experimental class obtained scores at high intervals of 91-100 for 6 people and at low intervals of 71-80 for 2 people. While students in the control class scored at intervals of 91-100 for 3 people and scored at intervals of 61-70 for 3 people.

Description of Students' Critical Thinking Data

Before testing the hypothesis, it is necessary to first describe the state of the data from each measuring variable. In this study, indicators of critical thinking skills are formulating problems, analyzing, evaluating,

being open to possibilities, and expressing something based on facts. This causes students to think more critically during learning in the experimental class than in the control class. The results of the percentage of critical thinking can be seen in Table 5.

Table 5. Critical Thinking Percentage Results

Critical Thinking Indicator	Experiment Class	Control Class
Formulate Problems	5.69	5.4
Analyze	2.39	2.27
Do Evaluation	5.59	6.77
Open To Possibility	5.33	2.29
Reveal Something Based on Facts	3.29	2.44
	4.10	3.23

Based on Table 5 students who think critically in the experimental class are generally higher than the results of critical thinking in the control class. Critical thinking skills on the indicator of formulating problems in the experimental class obtained a percentage of 5.69% and in the control class obtained a result of 5.4%. Critical thinking skills in analyzing indicators in the experimental class obtained a percentage of 2.39% and in the control class obtained a percentage of 2.27%. Critical thinking skills on the indicators of evaluating the experimental class are 5.59% while the control class is 6.77%. 29%. Then critical thinking on indicators reveals something based on facts in the experimental class the percentage results were 3.29% and in the control class, the results were 2.44%. The difference in the percentage of students' critical thinking in the experimental class and the control class, where the critical thinking of students in the experimental class showed a higher percentage interval and was described very well than the percentage interval of critical thinking in the control class which was described well.

Testing Requirements Analysis

Testing the analysis requirements of critical thinking tests and student learning outcomes includes tests for normality and similarity of variance or homogeneity of each group of data. This is intended to test that the data comes from a population with normal distribution and homogeneous variance.

Normality test

The normality test was carried out on the results of critical thinking on student learning outcomes score data for the experimental class and control class. The normality test was carried out using SPSS software. From the results of the normality test, it can be seen that the sig value > 0.05 (a predetermined level of significance) for all tests means that the data is normally

distributed. The description of normality test results for various data can be seen in Table 6.

Table 6. Data Normality Test Results

Data Group	Sig. Value	Conclusion
Experimental Class Critical Thinking Skills	0.598	Normal
Control Class Critical Thinking Skills	0.568	Normal
Experimental Class Learning Outcomes	0.899	Normal
Control Class Learning Outcomes	0.569	Normal

Homogeneity Test

The homogeneity test aims to determine whether the two groups of data have a homogeneous variance using SPSS software. From the results of the homogeneity test using SPSS, it can be seen that the sig value > 0.05 means that the data has a homogeneous variance. The results of the data homogeneity test can be seen in Table 7.

Table 7. Homogeneity Test Results of Critical Thinking Data and Student Learning Outcomes

Data Group	Sig. Value	Conclusion
Experimental Class Critical Thinking Skills	0.899	Homogeneous
Control Class Critical Thinking Skills		
Experimental Class Learning Outcomes	0.675	Homogeneous
Control Class Learning Outcomes		

Hypothesis Tester
Critical Thinking

After testing the normality and homogeneity of the data, then tested the critical thinking hypothesis using the T-test. It can be seen that the sig (2-tailed) value < 0.05, which is 0.040 means that the two stay two strays (TSTS) learning model assisted by STEM-based interactive media affects students' critical thinking skills.

Learning Outcomes
Cognitive Aspect

After testing the normality and homogeneity of the data, then tested the hypothesis of cognitive aspects of student learning outcomes using the T-test. The calculation for testing the hypothesis of student learning outcomes in the cognitive aspect can be seen by the sig (2-tailed) value <0.05, which is 0.000, meaning that the two stay two strays (TSTS) learning model assisted by STEM-based interactive media influences student learning outcomes in the cognitive aspect.

Affective Aspect

For testing the hypothesis of affective aspects of learning outcomes using the U-test. The calculation for testing the hypothesis of student learning outcomes in the affective aspect is sig (2-tailed) <0.05, namely 0.003, meaning that the two stay two strays (TSTS) learning model assisted by STEM-based interactive media affects student learning outcomes in the affective aspect.

Psychomotor Aspect

To test the hypothesis of psychomotor aspects of learning outcomes using the U-test. Calculations to test the hypothesis of student learning outcomes in the psychomotor aspect can be seen that the sig (2-tailed) value <0.05, namely 0.003 means that the two stay two strays (TSTS) learning model assisted by STEM-based interactive media affects student learning outcomes in the psychomotor aspect.

Discussion
The Effect of STEM-Based Interactive Media-Assisted TSTS Learning Model on Critical Thinking of Students of SMA Negeri 2 Kerinci

The results showed that the effect of the TSTS learning model assisted by STEM-based interactive media on the critical thinking of Kerinci 2 Public High School students that the sig (2-tailed) value < 0.05, namely 0.040 means the two stay two strays (TSTS) learning model assisted by STEM-based interactive media effect on students' critical thinking skills. The use of the two stay two strays (TSTS) learning model assisted by STEM-based interactive media has an influence on students' critical thinking skills because the stages in the TSTS learning model assisted by STEM-based interactive media can provide great benefits to students during the learning process. The stages of the TSTS learning model are assisted by STEM-based interactive media.

The results of research conducted by Riska et al. (2019) concluded that the TSTS-type cooperative learning model can increase student activity in the learning process. If students participate actively in teaching and learning activities, there will be positive interactions between students and between teachers and students, so that the learning climate in the classroom becomes conducive. This is the opinion of Jones et al. (2022), which states that in cooperative learning there is a belief among group members that group success depends on the contribution, inclusion, and success of each individual in the group. Irhas et al. (2021) state that this learning model can improve the five elements of the cooperative learning process which consist of positive interdependence, individual responsibility, face-to-face, inter-group communication, and evaluation of group processes.

The advantages of the TSTS learning model According to Mesah et al. (2020) the TSTS type cooperative learning model has a good contribution in increasing student learning activities. The learning process is formed through an activity in which a teacher conveys the material to his students. These learning activities are very dependent on the main components in them, for example, teachers, students, learning media, and materials. The teacher in this study acts as a facilitator. The teacher guides and directs students so that the learning process goes well, such as conveying material through easy-to-understand learning media. In delivering this material students are very interested in listening to any information conveyed by the teacher. Clarity of information provided by the teacher can be achieved through planning and organizing good learning (Mauliana, 2021). Through TSTS learning, it can increase student activity and create a pleasant learning atmosphere (Zunita, 2022).

Testing the hypothesis shows that the TSTS learning model assisted by STEM-based interactive media affects students' critical thinking. Management of learning using the TSTS learning model assisted by STEM-based interactive media makes students actively participate during learning activities. This can be seen from the enthusiasm of students to take lessons, the activeness of students in learning both in question and answer and group work, as well as students' creative ideas in solving problems, in line with Daulay's research (2021) the TSTS learning model can create a fun learning atmosphere, this model involving students directly to be actively involved in the learning process, this makes students' attention centered on learning and motivated and makes it easier for students to solve problems independently or in collaboration with groups.

The two stay two stray learning model can train students to interact actively with other students (Darmawan et al., 2020). This is in line with the opinion of Pratiwi et al. (2016) who states that through sharing information or knowledge in group work, positive reciprocal relationships can be created between one student and another. Direct interactions in positive reciprocal relationships can influence learning outcomes.

In contrast to learning in the control class with conventional learning models, students only listen and pay close attention, record teacher explanations, and ask questions and answers about the material being taught. It is not all students get the opportunity to think so the ability of students to explore critical thinking skills is still lacking. In addition, students also lack the initiative to solve a problem.

In addition, there are also differences in learning in the control class where there is no discussion, making the learning process in the control class only occur in one direction between the teacher and students. Thus there is no activity in exchanging opinions or information with friends. This makes students participate less in learning so students are less able to develop critical thinking skills in the learning process. There is no mutual exchange of opinions and sharing with their friends, so the courage of students in giving opinions is also still lacking which affects students' self-confidence in answering.

The Influence of TSTS Learning Model Assisted by STEM-Based Interactive Media on Student Learning Outcomes at SMA Negeri 2 Kerinci

Judging from student learning outcomes, the TSTS learning model assisted by STEM-based interactive media provides an increase in student learning outcomes compared to conventional learning models. This can be seen from the average value of student learning outcomes in the experimental class is higher than in the control class. The results showed that the TSTS learning model assisted by STEM-based interactive media affected the learning outcomes of the experimental class students compared to the learning outcomes of students in the control class with conventional learning. The higher learning outcomes obtained by students in the experimental class were due to the TSTS learning model assisted by STEM-based interactive media which made students more active and easy to understand the material being studied.

In the control class, students are taught with a conventional/lecture learning model. The teacher explains the material to students, and during the learning process, there is a discussion related to the material being studied. With learning like this students receive more material from the teacher. This shows that the use of the cooperative learning model two stay two strays (TSTS) assisted by STEM interactive media in learning Biology on the subject matter of sensory systems in humans can increase student effectiveness while biology student learning outcomes without applying the assisted two-stay two strays (TSTS) cooperative learning model STEM interactive media in Class XII SMA Negeri 2 Kerinci obtained an average score of 60.5. The value obtained by students in the Control class or classes that do not use the two stay two strays (TSTS) cooperative learning model assisted by STEM Interactive Media is still below the KKM that has been set.

Based on the hypothesis test obtained count 3.0763 > Table 1.68. This shows that there is a comparison of learning outcomes using and not using means that there are differences in learning outcomes of students who are taught using the two stay two strays (TSTS) cooperative learning model assisted by STEM interactive media with

the learning outcomes of students who are taught using conventional learning.

The implementation of learning at each meeting shows positive student responses to the application of the two stay two strays (TSTS) cooperative learning model assisted by STEM interactive media during the learning process takes place. Students feel happy and interested in learning so students are more enthusiastic and motivated in learning biology. With group discussions, students can exchange opinions with their group mates and be more courageous in expressing ideas or opinions. These activities include group discussions about the material being studied so that students can interact with each other and build cooperation between students so that smarter students can help less intelligent students. Then the activity of visiting each other aims that students can obtain information not only from their group but also from other groups. This allows students to gain a deeper understanding of the material being studied so that it becomes easier for students to understand the concept of the material being taught.

According to Hamdani (2018) also states that the two stay two strays (TSTS) type cooperative learning model in Physics learning can improve students' cognitive learning outcomes and is reinforced by the results of research conducted by Handayani (2020) that every student feels responsible for doing their best for the group. This can be seen from how they meet face to face or discuss with their group members. These interaction activities will form a synergy that benefits all members.

Ismawati et al. (2018), also stated that the Type Two Stay Two Stray (TSTS) cooperative learning model in Physics learning can improve students' cognitive learning outcomes and is reinforced by the results of research conducted by Handayani (2020) that each student feels responsible for do what's best for the group. This can be seen from how they conduct face-to-face discussions with group members. These interactive activities will form a synergy that benefits all members. The results of the thoughts of several heads will be richer than the results of only one head (Fathurrohman et al., 2019).

Silberman (2015) this cooperation can be seen through the submission of ideas from each group member. The ideas that have been collected are discussed to produce an agreement. After that, there is a division of tasks to exchange information between one group and another, where two students seek information in another group and two students stay in their group to provide information to the visiting group members. Then the results of obtaining the information were discussed by the original group to compare with

the results of their previous work so that the final results obtained were maximized.

Contrary to the situation of students who are taught by conventional learning, most of the students are not enthusiastic. Students just sit quietly and pay attention to the explanation, then students transfer it to their respective notebooks, resulting in less interaction between students. If there are questions given to students, only certain students can answer the questions given, while other students who don't understand just stay silent waiting for answers from other students or waiting to write answers on the blackboard then proceed with giving assignments to students, as a result learning become less effective. According to Lufri (2006) that the cooperative learning model is strengthened by the two stay two stray types assisted by STEM interactive media which can avoid boredom caused by the formation of permanent groups and provide opportunities for students to interact with other groups, to spur the formation of new ideas and enrich intellectually. Students, helping students understand difficult concepts, helping students grow cooperative skills, critical thinking, and the ability to help friends.

Testing the hypothesis shows that the two stay two strays (TSTS) learning model assisted by STEM-based interactive media affects student learning outcomes. In addition, seen from the results of the affective aspect of student learning outcomes good predicate in the experimental class, and moderate predicate in the control class. Whereas in the psychomotor aspect, the experimental class is also categorized as a good predicate, and the control class is categorized as a moderate predicate. From the results of the hypothesis test of affective and psychomotor aspects of learning outcomes, it was found that the two stay two strays (TSTS) learning model assisted by STEM-based interactive media affected student learning outcomes both from cognitive, affective, and psychomotor aspects.

This is in line with the research of Wardhani et al. (2021) entitled "Differences in Science Learning Outcomes of Students Who Are Taught Using the Two Stay Two Stray Cooperative Learning Model (TSTS) assisted by STEM and Conventional Interactive Media in Class XI of SMP Negeri 8 Medan" that the science learning outcomes of students who were taught with the TSTS cooperative learning model were higher and better than the conventional learning model.

However, the application of the two stay two strays (TSTS) learning model requires a long time, causing the teacher to have difficulties in managing the class. The existence of the two stay two strays (TSTS) learning model, in addition to increasing learning outcomes, can also develop students' mindsets to think critically in solving a problem and can also establish a collaboration

with friends through group assignments. The implications of this research are expected to assist teachers in managing classes to be more effective and to increase student learning activities, to improve student learning outcomes.

Conclusion

Based on the research that has been done, it can be concluded that the STEM-based two-stay two-strays (TSTS) learning model influences critical thinking and student learning outcomes on sensory system material at SMA Negeri 2 Kerinci.

Conflicts of Interest
The authors declare no conflict of interest.

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