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Research Article

Biology reading literacy: measurement and empowerment through CIRC learning model

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Abstract

Reading literacy in biology learning is related to the ability to understand the meaning of organism and its processes as well as behavior and attitude in supporting reading activities. The research aims to find out the influence of the Cooperative Integrated Reading and Composition (CIRC) learning model on students' reading literacy in Biology context. The research method used includes a quasi-experiment using a pretest-posttest non-equivalent control group design. The independent variable is a learning model that consists of two types, namely: CIRC learning model and the conventional model. The research is conducted in 8th Grade of MAH Islamic Schools, Bogor, Indonesia, by involving 66 students as the sample by random sampling. The dependent variable is reading literacy in a Biology context, which is in the subject of plant structure and its utilization in technology. Reading literacy instruments are developed by adapting from PISA that has been stated as valid and reliable. The research results indicate that CIRC learning influenced the achievement of students' reading literacy in a Biology context. The result of sig proves it. value of 0.002<0.005. CIRC was proven to be superior compared to conventional learning in plant structure and its utilization in technology learning. CIRC learning could be applied in biology learning to empower students' reading literacy.

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Introduction

Biology learning at various levels is closely related to the reading activity (Djamahar, Ristanto, Sartono, Ichsan & Muhlisin, 2018; Ristanto, Zubaidah, Amin, & Rohman, 2018a). Reading is a skill that allows readers to obtain information from a text (Mudra, 2018; Ristanto, Djamahar, Heryanti & Ichsan, 2020). One is that reading skill is associated with literacy the ability (Ristanto, Zubaidah, Amin & Rohman, 2017). Literacy ability is an essential capital for students' self-development; therefore, it should be built from an early age (Basyiroh, 2017; Kusmana, 2017; Qumillaila, Susanti & Zulfiani, 2017). Literacy is generally defined as the ability to read and write (Baer, Baldi, Ayotte & Green, Patricia, 2007). Literacy ability becomes one of the essential factors in students' learning process; thus, it is used as one of the learning achievement indicators (Ristanto et al. 2017). Confidence in one's literacy and application of appropriate learning models could become important factors in improving students' literacy ability at school (Genlott & Grönlund, 2013; Ristanto et al. 2018a).

Reading literacy is not only related to the ability to develop the meaning of various texts but also behavior and attitude in supporting the reading activity (Bacanak & Gökdere, 2009; Ristanto et al. 2017; Suwono, Pratiwi, Susanto & Susilo, 2017). The reading activity could last a lifetime, including biology learning (Lestari, Ristanto & Miarsyah, 2019; Ristanto et al., 2018a). The behavior and attitude are expected to play a role in achieving potential development by each person in literate and learned communities (Cavas, Ozdem & Cavas, 2013). Study results indicate that students' reading literacy ability in Indonesia is still low (Klymkowsky, Garvin-Doxas & Zeilik, 2003; Ristanto et al. 2017;

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Suwono et al. 2017). Based on student reading rank released by PISA in 2018, according to its study result, Indonesian students are in the rank of 72 of 76 countries. It supports statistics from UNESCO in 2012, stating that the reading interest index in Indonesia is very low, which is 1 of 1000 residents. It puts Indonesia in the second-lowest ranking of the country members.

Several definitions related to reading literacy stated that it is a skill owned by someone to be able to understand, use, reflect, and involve in reading and is associated with situations that are encountered every day. Besides, it aims to add and develop knowledge and self-potential as well as to participate in the communities (Geske & Ozola, 2008; Leino, 2014). The International Reading Literacy Study (PIRLS) explains reading literacy as one's ability to understand and use reading needed by communities and individuals. Readers could construct themselves from the meanings contained in various texts. Someone reads to learn and to participate in reading community at school and in daily life as well as for fun (Baer, Baldi, Ayotte, Green & Mcgrath, 2009; Ismirawati, Corebima, Zubaidah, Ristanto & Nuddin, 2020; Martin, Mullis, & Kennedy, 2007)

Reading literacy is an essential skill for almost all learning processes, and students require it not only for language and reference but also for learning other subjects (Geske & Ozola, 2008). Based on a paradigm, reading literacy could be categorized into four approaches, namely: 1) cognitive that considers literacy as a thinking skill and reading literacy that emphasizes on text content understanding, 2) socio-cognitive that is the same as an approach but also reading context: reading process consists of readers, reading and cognitive context, 3) functional and 4) socio-culture (Baer et al. 2009; Leino, 2014).

Reading literacy concept in PISA is limited by three dimensions, namely: reading material format, type of reading assignment, or reading aspect and situation when the reading to be used. The first dimension is a text format that is divided into continuous text, which is compact-sentence texts that are arranged in a paragraph and could be in a bigger structure form, such as a chapter or a book with the following format: narration, exposition, description, argumentation, instruction, documents or records, and hypertexts. Non-continuous texts, which are non-compact sentences or in a non-text format that requires different approaches or reading methods, such as a graph, table, diagram, map, form, information sheet, calls, and advertisement and vouchers. The second dimension is the reading assignment that is divided into three aspects, namely: 1) assignment to find information. 2) Assignment to integrate and interpret texts, which is an ability to build meaning and integrate or conclude various information. 3) Assignment to reflect and evaluate texts, which is to connect written information with knowledge, idea, and prior experiments. The third dimension is situation or context, which is a text categorization based on the objectives of writing the text, the relationship between the text and other person and general context that consists of a person, education, work and public (Baer et al. 2007; Leino, 2014).

Factors influencing one's literacy consist of gender, use of language at home, reading habit given by educators, school location (Ristanto et al. 2017) race or ethnic, parents' education and student's family structure (Smith, Worker, Ambrose & Schmitt-McQuitty, 2015). Therefore, parents and educators play an essential role in building literacy from an early age (Artelt, Schiefele & Schneider, 2001; Klymkowsky et al. 2003; Rahmah, 2015; Schiffl, 2020). The literacy ability is one factor that influences students' scientific ability (Haug, 2014; Holbrook & Rannikmae, 2009; Laius, Rannikmäe, Rannikmäe & Rannikmäe, 2010; Suwono et al. 2017). Hence, students are expected to have a sound reading ability to achieve scientific learning objectives (Cavas et al. 2013; Ozdem, Cavas, Cavas, Cakiroglu & Ertepinar, 2010). One main step taken by the teacher to develop the competence is by strengthening reading activity in biology learning (Ristanto et al. 2018a). Cooperative Integrated Reading and Composition (CIRC) is a learning model emphasizing reading and writing (Djamahar et al. 2019, 2018; Ristanto et al. 2018a; Ristanto, Zubaidah, Amin, & Rohman, 2018b).

Biology learning in *madrasah* (Islamic school) or school should not be merely teacher-center (Djamahar, Ristanto, Sartono & Darmawan, 2020). However, it must focus on students to play an active role in the learning process to improve their understanding of science (Darmawan, Brasilita, Zubaidah & Saptasari, 2018; Hidayati, Pangestuti & Prayitno, 2018; Miharja, Hindun & Fauzi, 2019). The expectation, however, it could also build students' reading literacy in Biology science context. Cooperative learning has proven practical and acceptable by students in biology learning (Bustami, Riyati & Julung, 2019; Darmawan et al. 2019; Djamahar et al. 2019). In learning, students could help each other (Harahap, Ristanto & Komala, 2020; Kazemi & Khalili-Sabet, 2012; Loes, An, Saichaie & Pascarella, 2017).

Various studies have been conducted regarding scientific literacy, including biology (Djamahar et al. 2018; Haug, 2014; Lehrer & Schauble, 2007; Prasetyo, Sukaesih & Hadiyanti, 2016; Ristanto et al. 2017; Suwono et al., 2017) and reading literacy (Artelt et al. 2001; Becker, McElvany & Kortenbruck, 2010). There are, however, no studies that

develop reading literacy in biology learning. The research aims to analyze the influence of CIRC learning applications on reading literacy in a Biology context.

Research Problem

The low level of literacy reading in Indonesia and the absence of research on an increase in literacy reading through biology lessons is the background of this research. Students at the secondary school level should already have literacy skills. This research focuses on measuring the reading biology literacy and implementing the CIRC learning model in junior high school students at MAH Islamic School. These skills are needed in order to support the achievement of learning biology.

Based on the preliminary study, the formulation of the problem in this research is whether CIRC learning can improve students' reading biology literacy?

Method

Research Model

The research used a quasi-experiment research design using the non-equivalent control group pretest-posttest design (Sugiyono, 2012). The independent research variables included the CIRC learning model and conventional learning, whereas the dependent variable was reading literacy ability. The research design is indicated in Table 1.

Table 1.

The Non-equivalent Control Group Pretest-Posttest Design

Pretest	Treatment	Posttest
T_1	X_0	T_2
T_3	X_1	T_4

Note: $T_{1,3}$ = Pretest, $T_{2,4}$= Posttest, X_1 = CIRC Leaning Model, X_0 = Control

Participants

The research population consisted of all 8th Grade students of MAH Islamic Schools, in Citaringgul Bogor, Indonesia and sampling was conducted randomly. Classes involved in the research process comprised one class for the experimental group that learned through CIRC learning and one class for control class that learned through conventional learning. The number of samples involved in the research was 66 students.

Instruments

Instruments used in the research included student worksheets developed by referring to CIRC learning syntax. The reading literacy instruments in the biology context in the form of multiple-choice tests, checkpoints, and essays developed by referring to PISA. The reading literacy indicators consisted of retrieve information, form a broad understanding, develop an interpretation, reflect on and, evaluate the content of the text, and reflect on and evaluate the form of text. The instrument of this study was developed, validated, and used to assess students' reading literacy. Meanwhile, the reliability of the instrument biology reading literacy in each construct was established by acceptable Cronbach alpha values. 17 questions on reading literacy used in the research (Appendix 1). In the implementation process, students were given one set of reading literacy questions to be solved in 60 minutes.

Data Collection

The research process was conducted at the first meeting of plant structure and its utilization in technology subjects. Before the meeting, students had received an explanation of the learning contract and learning process activities to be conducted with CIRC learning as well as assignments that must be done. The activities aimed to make students and teachers understand and had an adequate understanding of the research variables and scope. The experimental research was conducted for two months on the main content of plant structures and its implementation in technology that consisted of explaining the correlation between plant tissues and its function as well as its various utilization in technology, conducting article analysis activity on plant tissue structures and producing simple technological ideas inspired by structures in plant tissues. The learning was planned for one month; however, since there were other academic activities in ninth grade, the learning lasted for two months.

The CIRC learning model refers to the modified CIRC learning model by Ristanto et al. (2018b). Stages of CIRC learning include forming heterogeneous groups, reading and discussing articles on plant tissue topics from books and articles from the internet, and presenting the discussions' results. The CIRC learning design scheme is presented in Figure 1.

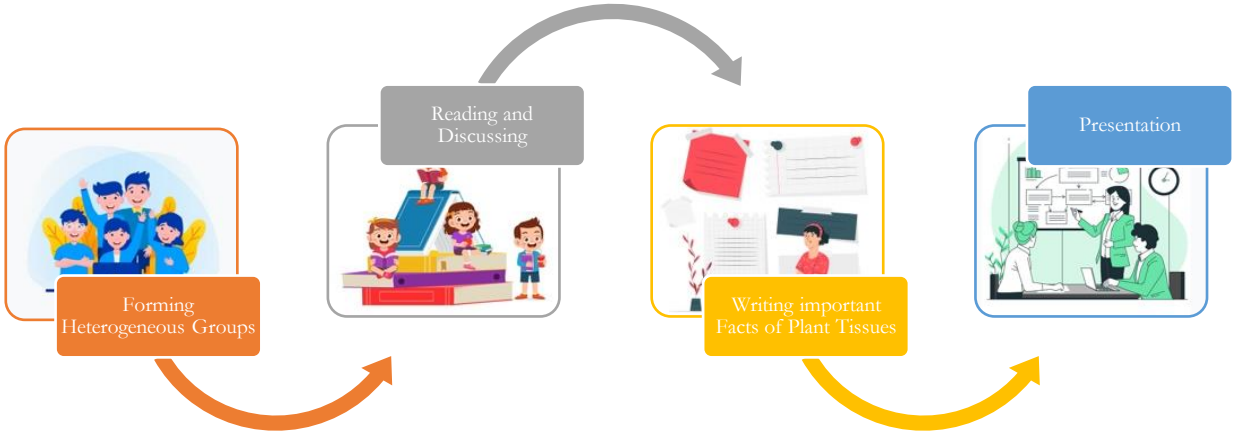

Figure 1.

CIRC Learning Stages Adaptation Ristanto et al. (2018b), Pictures Source: https://www.freepik.com

The group division of heterogeneous groups consists of 4 students with criteria based on high, medium, and low academic ability. Articles or readings used are electronic books from the Indonesian Ministry of Education and culture and readings related to the latest information about plant tissue. The group discussion results are then written back on the student worksheet, and the results are presented and followed by a discussion by the class students. Control class learning is applied to conventional learning. Conventional learning is learning that is usually applied by teachers before conducting research. Biology teachers usually apply lecture learning and continue with question and answer and discussion.

Data Analysis

The research data were analyzed using descriptive statistics in the form of an average score of reading literacy in a Biology context. Hypothesis testing was conducted using the ANCOVA test. The ANCOVA assumption prerequisite tests were previously conducted that consisted of data normality test and variance homogeneity test. The normality test used One-Sample Kolmogorov-Smirnov, whereas the homogeneity test used Levene's Test of Equality of Error Variances. The tests were conducted using the statistical analysis program of SPSS 22.0 for Windows with a significance level of 0.5%.

Results

The main research purpose was to find out the influence of CIRC learning model application on reading literacy in biology context in 8th-grade students of MAH, Citaringgul Bogor. The results of data normality and homogeneity tests in biology reading literacy scores indicated that all data had probability values (Sig.) greater than the alpha of 0.05. It could be inferred that the reading literacy ability data had normal and homogeneous data distribution. The instrument used in this study was 17 questions developed by referring to indicators from PISA. The instrument has been tested and has a valid category and a very high-reliability category. The results of testing the research hypothesis are shown in Table 2.

Table 2.

ANCOVA Test of the Influence of Learning Model on Reading Literacy Ability.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4078.994[a]	2	2039.497	111.459	.000
Intercept	1283.233	1	1283.233	70.129	.000
Pretest	2860.717	1	2860.717	156.338	.000
Learning	183.641	1	183.641	10.036	.002
Error	1152.790	63	18.298		
Total	359224.141	66			
Corrected Total	5231.783	65			

The results of the ANCOVA test in Table 2 suggested that there was an influence of the learning model on reading literacy with sig. value = 0.002, which was less than alpha of 0.005 (<0.005). It implied that Ha stating that the CIRC learning model did not influence students' reading literacy, was rejected. Thus, the research Ho stating that the CIRC learning model influenced students' reading literacy was accepted. It could be inferred that there was an influence of

the learning model on reading literacy ability. Next, a post hoc test was performed using the LSD test, as presented in Table 3.

Table 3.
The Result of LSD Test on The Influence of Learning Models Application on Biology Reading Literacy Ability

Class	Mean		Corrected Mean	Increase
	Pretest	Posttest		
Conventional	51	69	68,94	26 %
CIRC	57	78	77,53	27 %

According to the LSD test results in Table 3, it can be seen that the achievement of students' reading literacy ability in the Biology context in the experimental class was higher than those in the control class. Class taught with the CIRC learning model had higher reading literacy ability improvement than those in the conventional class. Differences in the reading literacy results are descriptively presented in Table 4.

Table 4.
Average Scores of Pretest and Posttest of Biology Reading Literacy Ability

Learning Variable	Mean and Category			
	Pretest	Category	Posttest	Category
CIRC Model	56.87	Less	77,53	Good
Conventional Learning	50.69	Less	68,94	Less

Table 4 suggested that students who were taught using CIRC had higher posttest scores than those in the control class, which was 77.53 with good category and 68.94 with less category, respectively. It can be concluded that CIRC learning has proven to be more effective in achieving students' reading literacy ability in biology context than conventional learning.

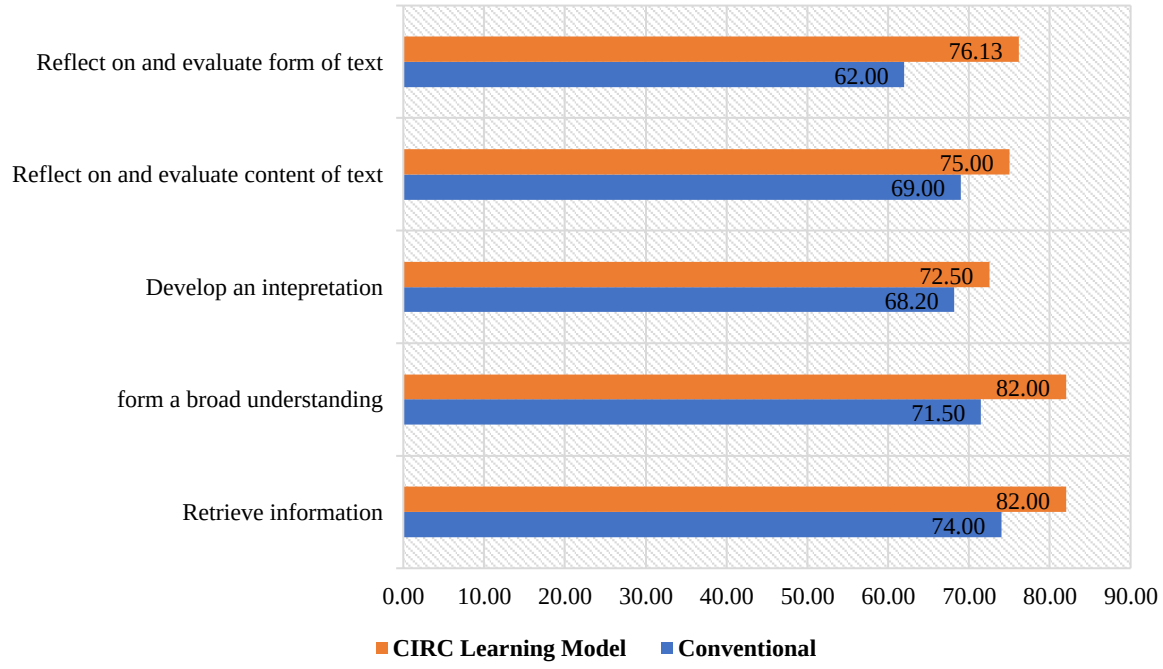

Figure 2.
Differences in Biology Reading Literacy Dimension Scores

Discussion

Based on Figure 2, the highest literacy dimension differences with the application of CIRC compared to the conventional class was in the ability to retrieve information and form a broad understanding. The lowest score from students was in skill to develop an interpretation. The research result was in line with findings on CIRC learning potential (Ekawati, Susetyarini, Pantiwati & Husamah, 2015; Gupta & Ahuja, 2015; Ristanto, Zubaidah, Amin & Rohman, 2018b; Ristanto et al. 2018a). The ability of students who were taught using CIRC was better than those in

the conventional class in terms of reflecting retention in reading. The most different ability was in students' ability to reveal information. By following the learning model syntax, the students were able to receive a significantly different score compared to those in conventional class (Ristanto et al. 2020; Rittle-Johnson, Fyfe & Loehr, 2016).

The main purpose of the research was to find out the influence of CIRC learning model application on reading literacy in biology context in 8th-grade students of MAH Islamic Schools, Citaringgul Bogor. The covariance analysis results (Table 2) indicated that there was an influence of the CIRC learning model on reading literacy. Moreover, the descriptive statistic test result (Table 4 and Figure 2) also suggested that the CIRC learning model had higher biology reading literacy scores than conventional learning. The research results proved that students' reading literacy ability in biology context was in the same category before the application of CIRC learning. The posttest results, however, indicated that students' achievement in biology reading literacy was significantly different (Table 3).

Differences in the reading literacy achievement in biology context could be examined through the CIRC learning model characteristics that supported the strengthening of students' reading literacy competence. Steps in learning and CIRC learning instruments referred to the results of development in biology learning (Ristanto et al. 2018b). The implemented CIRC learning helped students to train themselves to learn to build their knowledge in a heterogeneous group. Each group member had responsibility in achieving the learning objectives. The learning activities were conducted with discussion to solve problems through a scientific reading (Baloche & Brody, 2017; Loes et al. 2017; Loes & Pascarella, 2017), to train students' skill to develop collaboration skill, to cooperate with their peers and to share an opinion and socialize (Gupta & Ahuja, 2015; Lestari et al. 2019) that were implemented through reading and writing activities (Darmawan et al. 2018; Genlott & Grönlund, 2013; Stacey, 2010). Worksheets developed and done by the students in the CIRC learning were relevant in supporting the second dimension of reading literacy, which is reading assignment. Students were faced with activities to analyze and determine the main topic related to plant tissues contained in the reading.

Student worksheet in biology learning activities through CIRC helped students in analyzing articles. Students, along with their group were not only worked together to find important concepts contained in the articles but also rewrote it along with scientific reasons that supported opinion to achieve the learning objectives (Djamahar et al. 2019). These activities were following the reading literacy aspect of finding information. Articles used were those articles that supported biology learning activity in plant structures and their utilization in technology subjects. The articles were contained in the textbook as well as from various sources, including the internet that contains essential information from plant structures issues and its development with biotechnology. The activity aimed to help students in mastering the biology content learned.

The CIRC learning application in plant structure and its utilization in technology subject directed students to be actively involved in the learning process. Reading activity would foster cognitive expansion process through the thinking ability (Cromley, 2009; Kazemi, 2012; Wright, Franks, Kuo, McTigue & Serrano, 2016). Students who were familiarized with reading activity would improve their understanding of the subject being studied (Becker et al. 2010; Darmawan et al. 2019). Once students completed their reading and discussing articles and cases related to plant structures and their utilization in technology, they would discuss with their group to compile a complete conclusion in a short sentence. This activity was an aspect developed in reading literacy dimension, which is integrating and interpreting texts. The expected abilities included building meaning and integrating or concluding some information (Leino, 2014; Ristanto et al. 2020).

The third aspect of the reading assignment dimension has the assignment to reflect and evaluate text (Artelt et al. 2001). The dimension is built through CIRC learning by connecting written information with knowledge, idea, and prior experiences. In CIRC learning, after reading activity, students discuss and compile a worksheet by giving responses and selecting relevant content components. The activities are believed to be able to train students to analyze articles' advantages and disadvantages and reflect them in the form of responses to the article that have been studied (Ekawati et al. 2015; Gupta & Ahuja, 2015; Ristanto et al. 2018b). Another advantage of CIRC learning, aside from emphasizing reading activity, was related to the opportunity given for students to build responsibility in a group. The attitude helps students to have challenges and abilities to master the content studied. The activity includes discussion to determine important matters from the reading, raise further questions, and reflect on the activities.

The plant structure and its utilization in technology studied through CIRC had difficulty characteristic in mastery the content and concept with extensive study (Loertscher, Lewis, Mercer & Minderhout, 2018; Suwono et al. 2017) and it must be correlated to the daily life (Bustami, Syafruddin & Afriani, 2018; Dani, 2009). CIRC application made students be able to find the main concept of the plant structure subject, and by reading content-integrated articles, it

was expected that students could connect the content to its utilization in technology based on the reading result (Harahap et al. 2020). CIRC could facilitate other sub-contents such as connecting plant tissue structures and its function and various utilizations in technology by conducting article analysis activity on plant tissue structure and resulting simple technological ideas inspired by the structure in plant tissues.

The advantages of the CIRC learning model were not empowered to students who studied using conventional learning. The learning was explained as a biology learning design commonly applied in biology learning at the MAH. In conventional learning, biology learning had not activated students to be actively involved in building their knowledge through reading study and analysis. Students were only provided with opportunities to listen more to the teacher's lecture and write it in notebooks. However, discussion in some cases sometimes took place in biology learning through questions and answers. Additionally, the learning process was teacher-centered, and it had the potential to hinder students' thinking processes and activities (Bruehl, Pan & Ferrer-Vinent, 2015; Kinay & Bagceci, 2016; Tsai, Shen & Lin, 2014). A learning process that provides fewer students' involvement in reading and discussion activities in biology learning results in less meaningful learning; therefore, content received would easily forget, and the strengthening of biology learning literacy is not maximally empowered (Inayah, Ristanto, Sigit & Miarsyah, 2020; Miarsyah et al. 2020).

The research findings are important to continue to reveal the influence of each indicator and to indicate that students who learn with a focus on reading analysis and train the writing skills through CIRC learning could help them to empower their reading literacy. The research had several limitations, among others: students are still weak in developing broader interpretations based on reading. Next, it is expected that learning could be designed that could improve the skill

Conclusion and Recommendations

The CIRC learning model had a significant influence on biology reading literacy in students of MAH Islamic Schools in Citaringgul, Bogor, Indonesia. It is expected that CIRC learning could be applied in biology learning in empowering students' reading literacy. Biology learning is related to reading and laboratory practices so that it is easier for students to achieve the learning objectives. Learning design needs to be developed further that combined both biology learning principles. This study's results provide recommendations for biology teachers in junior high schools to pay attention to reading literacy skills in biology education. Research needs to be done to uncover the relationship between reading biology literacy with student achievement, including scientific literacy and specifically biological literacy.

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References

Artelt, C., Schiefele, U., & Schneider, W. (2001). Predictors of reading literacy. *European Journal of Psychology of Education*, *16*, 363–383. https://doi.org/10.1007/BF03173188

Bacanak, A., & Gökdere, M. (2009). Investigating level of the scientific literacy of primary school teacher candidates. *Asia-Pacific Forum on Science Learning and Teaching*, *10*(1), 1–10. Retrieved from https://www.eduhk.hk/apfslt/v10_issue1/gokdere/index.htm#con

Baer, J., Baldi, S., Ayotte, K., & Green, Patricia, J. (2007). *The Reading Literacy of U.S. Fourth-Grade Students in an International Context Results From the 2001 and 2006 Progress in International Reading Literacy Study (PIRLS). U. S. Department of Education*. https://doi.org/http://nces.ed.gov/pubs2008/2008016.pdf

Baer, J., Baldi, S., Ayotte, K., Green, P. J., & Mcgrath, D. (2009). *The reading literacy of U.S. fourth-grade students in an international context. The Reading Literacy of U.S. Fourth-Grade Students in an International Context*.

Baloche, L., & Brody, C. M. (2017). Cooperative learning: exploring challenges, crafting innovations. *Journal of Education for Teaching*, *43*(3), 274–283. https://doi.org/10.1080/02607476.2017.1319513

Basyiroh, I. (2017). Program pengembangan kemampuan literasi anak usia dini (studi kasus best practice pembelajaran literasi di tk negeri centeh kota bandung). *Tunas Siliwangi*, *3*(2), 120–134. Retrieved from http://e-journal.stkipsiliwangi.ac.id/index.php/tunas-siliwangi/article/viewFile/646/476

Becker, M., McElvany, N., & Kortenbruck, M. (2010). Intrinsic and extrinsic reading Motivation as predictors of reading literacy: A longitudinal study. *Journal of Educational Psychology*, *102*(4), 773–785. https://doi.org/10.1037/a0020084

Bruehl, M., Pan, D., & Ferrer-Vinent, I. J. (2015). Demystifying the chemistry literature: Building information literacy in first-year chemistry students through student-centered learning and experiment design. *Journal of Chemical Education*, *92*(1), 52–57. https://doi.org/10.1021/ed500412z

Bustami, Y., Riyati, Y., & Julung, H. (2019). Think talk write with pictured cards on human digestive system: impact of critical thinking skills. *Biosfer: Jurnal Pendidikan Biologi*, *12*(1), 13–23. https://doi.org/https://doi.org/10.21009/biosferjpb.v12n1.13-23

Bustami, Y., Syafruddin, D., & Afriani, R. (2018). The implementation of contextual learning to enhance biology students' critical thinking skills. *Jurnal Pendidikan IPA Indonesia*, *7*(4), 451–457. https://doi.org/10.15294/jpii.v7i4.11721

Cavas, P. H., Ozdem, Y., & Cavas, B. (2013). Turkish pre-service elementary science teachers ' scientific literacy level and attitudes toward science. *Science Education International*, *24*(4), 383–401. Retrieved from https://files.eric.ed.gov/fulltext/EJ1022326.pdf

Cromley, J. G. (2009). Reading achievement and science proficiency: International comparisons from the programme on international student assessment. *Reading Psychology*, *30*(2), 89–118. https://doi.org/10.1080/02702710802274903

Dani, D. (2009). Scientific literacy and purposes for teaching science: A case study of lebanese private school teachers. *International Journal of Environmental & Science Education*, *4*(3), 289–299. Retrieved from http://www.ijese.com/IJESE_v4n3_Special_Issue_Dani.pdf

Darmawan, E., Alamsyah, M. R. N., Permadani, K. G., Pamungkas, S. J., Prajoko, S., Sukmawati, I., … Zamzami, M. R. A. (2019). Integration of Simas eric with google classroom: enhancing biology students motivation and scientific writing. *Biosfer: Jurnal Pendidikan Biologi*, *12*(1), 1–12. https://doi.org/10.21009/biosferjpb.v12n1.1-12

Darmawan, E., Brasilita, Y., Zubaidah, S., & Saptasari, M. (2018). Enhancing metacognitive skills of students with different gender using simas eric learning model at state senior high school 6 Malang. *Biosfer*, *11*(1), 48–57. https://doi.org/10.21009/biosferjpb.11-1.5

Djamahar, R., Ristanto, R. H., Sartono, N., & Darmawan, E. (2020). Approaches to Respiratory and Excretion Systems Teaching: An Innovative Learning through Cirsa. *Universal Journal of Educational Research*, *8*(6), 2204–2210. https://doi.org/10.13189/ujer.2020.080602

Djamahar, R., Ristanto, R. H., Sartono, N., Ichsan, I. Z., Darmawan, E., & Muhlisin, A. (2019). Empowering Student's Metacognitive Skill Through Cirsa Learning. *Journal of Physics: Conference Series*, *1227*(1), 012034. https://doi.org/10.1088/1742-6596/1227/1/012034

Djamahar, R., Ristanto, R. H., Sartono, N., Ichsan, I. Z., & Muhlisin, A. (2018). Cirsa: designing instructional kits to empower 21st century skill. *Educational Process: International Journal*, *7*(3), 200–208. https://doi.org/10.22521/edupij.2018.73.4

Ekawati, R., Susetyarini, E., Pantiwati, Y., & Husamah, H. (2015). Peningkatan hasil belajar dan kemampuan berpikir kritis dengan model pembelajaran cooperative integrated reading and composition (CIRC). *Jurnal Pendidikan Biologi Indonesia*, *1*(3), 298–306. https://doi.org/https://doi.org/10.22219/jpbi.v1i3.2662

Genlott, A. A., & Grönlund, Å. (2013). Improving literacy skills through learning reading by writing: The iWTR method presented and tested. *Computers & Education*, *67*, 98–104. https://doi.org/10.1016/j.compedu.2013.03.007

Geske, A., & Ozola, A. (2008). Factors influencing reading literacy at the primary school Level. *Problems of Education in the 21st Century*, *6*(1), 71–77. Retrieved from http://www.scientiasocialis.lt/pec/node/112

Gupta, M., & Ahuja, J. (2015). Cooperative integrated reading composition (circ): improving achievement in english writing composition among seventh graders. *Issues and Ideas in Education*, *3*(1), 41–53. https://doi.org/10.15415/iie.2015.31004

Harahap, L. J., Ristanto, R. H., & Komala, R. (2020). Getting critical thinking about ecosystem: How impact and responses of students about the CirGi learning model? *Biosfer: Jurnal Pendidikan Biologi*, *13*(1), 86–100. https://doi.org/10.21009/biosferjpb.v13n1.86-100

Haug, B. S. (2014). Inquiry-based science: Turning Ttachable moments into learnable moments. *Journal of Science Teacher Education*, *25*(1), 79–96. https://doi.org/10.1007/s10972-013-9375-7

Hidayati, N., Pangestuti, A. A., & Prayitno, T. A. (2018). Edmodo mobile: developing e-module on biology cell for online learning community. *Biosfer: Jurnal Pendidikan Biologi*, *11*(2), 94–108. https://doi.org/10.21009/biosferjpb.v11n2.90-100

Holbrook, J., & Rannikmae, M. (2009). The meaning of scientific literacy. *International Journal of Environmental & Science Education*, *4*(3), 275–288. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/6779241

Inayah, A. D., Ristanto, R. H., Sigit, D. V., & Miarsyah, M. (2020). Analysis of science process skills in senior high school students. *Universal Journal of Educational Research*, *8*(4A), 15–22. https://doi.org/10.13189/ujer.2020.081803

Ismirawati, N., Corebima, A. D., Zubaidah, S., Ristanto, R. H., & Nuddin, A. (2020). Implementing ERCoRe in learning : will metacognitive skills correlate to cognitive learning result ? *Universal Journal of Educational Research*, *8*(4A), 51–58. https://doi.org/10.13189/ujer.2020.081808

Kazemi, M. (2012). The effect of jigsaw technique on the learners' reading achievement: the case of english as L2. *Mjal*, *4*(3), 170–184. Retrieved from https://www.mjal.org/removedprofiles/2013/14.pdf

Kazemi, M., & Khalili-Sabet, M. (2012). Exploring the Iranian EFL learners' reading performance: The effect of teaching method. *International Journal of Applied Linguistics & English Literature*, *1*(6), 256–263. https://doi.org/10.7575/ijalel.v.1n.6p.256

Kinay, I., & Bagceci, B. (2016). The investigation of the effects of authentic assessment approach on prospective teachers' problem-solving skills. *International Education Studies*, *9*(8), 51–59. https://doi.org/10.5539/ies.v9n8p51

Klymkowsky, M. W., Garvin-Doxas, K., & Zeilik, M. (2003). Bioliteracy and Teaching Efficacy: What Biologists Can Learn from Physicists. *Cell Biology Education*. https://doi.org/10.1187/cbe.03-03-0014

Kusmana, S. (2017). Pengembangan literasi dalam kurikulum pendidikan dasar dan menengah. *Diglosia*, *1*(1), 151–164. Retrieved from http://jurnal.unma.ac.id/index.php/dl/article/view/520

Laius, A., Rannikmäe, M., Rannikmäe, M., & Rannikmäe, M. (2010). Impact on student change in scientific creativity and socio-scientific reasoning skills from teacher collaboration and gains from professional in-service. *Journal of Baltic Science Education*, *10*(2), 127–137. Retrieved from http://www.scientiasocialis.lt/jbse/?q=node/222

Lehrer, R., & Schauble, L. (2007). Scientific Thinking and Science Literacy. In *Handbook of Child Psychology* (pp. 153–196). Hoboken, NJ, USA: John Wiley & Sons, Inc. https://doi.org/10.1002/9780470147658.chpsy0405

Leino, K. (2014). *The relationship between ICT use and reading literacy : focus on 15-year-old Finnish students in PISA studies*. *Jyväskylä University Press*. Jyväskylä. Retrieved from https://jyx.jyu.fi/bitstream/handle/123456789/44930/1/978-951-39-5828-2.pdf

Lestari, P., Ristanto, R., & Miarsyah, M. (2019). Analysis of conceptual understanding of botany and metacognitive skill in pre-service biology teacher in Jakarta, Indonesia. *Journal for the Education of Gifted Young Scientists*, *7*(2), 199–214. https://doi.org/10.17478/jegys.515978

Loertscher, J., Lewis, J. E., Mercer, A. M., & Minderhout, V. (2018). Development and use of a construct map framework to support teaching and assessment of noncovalent interactions in a biochemical context. *Chemistry Education Research and Practice*, *19*(4), 1151–1165. https://doi.org/10.1039/C8RP00029H

Loes, C. N., An, B. P., Saichaie, K., & Pascarella, E. T. (2017). Does collaborative learning influence persistence to the second year of college? *Journal of Higher Education*, *88*(1), 62–84. https://doi.org/10.1080/00221546.2016.1243942

Loes, C. N., & Pascarella, E. T. (2017). Collaborative learning and critical thinking: testing the link. *Journal of Higher Education*, *88*(5), 726–753. https://doi.org/10.1080/00221546.2017.1291257

Martin, M. O., Mullis, I. V. S., & Kennedy, A. M. (2007). *PIRLS 2006 Technical Report*. *TIMMS & PIRLS International Study Center*.

Miarsyah, M., Ristanto, R. H., Nurhayati, Mufida, S. N., Suparini, & Zharroh, A. E. (2020). Development of adobe flash media integrated into HOTS on circulation system (AF-HOTS bicycle media). *International Journal of Advanced Trends in Computer Science and Engineering*, *9*(1), 896–903. https://doi.org/10.30534/ijatcse/2020/128912020

Miharja, F. J., Hindun, I., & Fauzi, A. (2019). Critical thinking, metacognitive skills, and cognitive learning outcomes: a correlation study in genetic studies. *Biosfer: Jurnal Pendidikan Biologi*, *12*(2), 135–143. https://doi.org/10.21009/biosferjpb.v12n2.135-143

Mudra, H. (2018). Metacognitive Online Reading Strategies among Pre-Service EFL Teachers in Indonesia. *Educational Process International Journal*, *7*(2), 151–164. https://doi.org/10.22521/edupij.2018.72.5

Ozdem, Y., Cavas, P., Cavas, B., Cakiroglu, J., & Ertepinar, H. (2010). An investigation of elementary students scientific literacy levels. *Jouranl of Baltic Science Education*, *9*(1), 6–19. Retrieved from http://www.scientiasocialis.lt/jbse/files/pdf/vol9/06-19.Ozdem_Vol.9_No.1.pdf

Prasetyo, A. P. B., Sukaesih, S., & Hadiyanti, L. N. (2016). Pendampingan guru biologi kota semarang dalam mengembangkan instrumen penilaian otentik pada kurikulum berbasis kompetensi. *Unnes Science Education Journal*, *5*(1), 1182–1190. https://doi.org/http://dx.doi.org/10.15294/usej.v3i2.3349

Qumillaila, Q., Susanti, B. H., & Zulfiani, Z. (2017). Pengembangan augmented reality versi android sebagai media pembelajaran sistem ekskresi manusia. *Jurnal Cakrawala Pendidikan*, *36*(1), 57–69. https://doi.org/10.21831/cp.v36i1.9786

Rahmah, A. (2015). Digital literacy learning system for indonesian citizen. *Procedia Computer Science*, *72*, 94–101. https://doi.org/10.1016/j.procs.2015.12.109

Ristanto, R. H., Djamahar, R., Heryanti, E., & Ichsan, I. Z. (2020). Enhancing students ' biology-critical thinking skill through CIRC-Based scientific approach (Cirsa). *Universal Journal of Educational Research*, *8*(4A), 1–8. https://doi.org/10.13189/ujer.2020.081801

Ristanto, R. H., Miarsyah, M., Muharomah, D. R., Astuti, T. A., Aini, S., & Prihatin, A. I. (2020). Light-board: Simple media to learn photosynthesis concepts. *International Journal of Advanced Trends in Computer Science and Engineering*, *9*(1), 299–303.

https://doi.org/https://doi.org/10.30534/ijatcse/2020/45912020

Ristanto, R. H., Zubaidah, S., Amin, M., & Rohman, F. (2017). Scientific literacy of students learned through guided inquiry. *International Journal of Research & Review*, *234*(5), 23–30. Retrieved from https://www.ijrrjournal.com/IJRR_Vol.4_Issue.5_May2017/IJRR004.pdf

Ristanto, R. H., Zubaidah, S., Amin, M., & Rohman, F. (2018a). From a reader to a scientist: developing cirgi learning to empower scientific literacy and mastery of biology concept. *Biosfer: Jurnal Pendidikan Biologi*, *11*(2), 90–100. https://doi.org/10.21009/biosferjpb.v11n2.90-100

Ristanto, R. H., Zubaidah, S., Amin, M., & Rohman, F. (2018b). The potential of cooperative integrated reading and composition in biology learning at higher education. *International Journal of Educational Research Review*, *3*(2), 50–56. https://doi.org/10.24331/ijere.376727

Rittle-Johnson, B., Fyfe, E. R., & Loehr, A. M. (2016). Improving conceptual and procedural knowledge: The impact of instructional content within a mathematics lesson. *British Journal of Educational Psychology*, *86*(4), 576–591. https://doi.org/10.1111/bjep.12124

Schiffl, I. (2020). How information literate are junior and senior class biology students? *Research in Science Education*, *50*(2), 773–789. https://doi.org/10.1007/s11165-018-9710-2

Smith, M. H., Worker, S. M., Ambrose, A. P., & Schmitt-McQuitty, L. (2015). Scientific literacy: California 4-H defines it from citizens' perspective. *California Agriculture*, *69*(2), 92–97. https://doi.org/10.3733/ca.v069n02p92

Stacey, K. (2010). Mathematical and scientific literacy around the world. *Journal of Science and Mathematics Education in Southeast Asia*, *33*(1), 1–16. Retrieved from https://pdfs.semanticscholar.org/c48a/333b0dc6f336e41508443b15d9e5d9761be9.pdf

Sugiyono. (2012). *Metode penelitian kuantitatif kualitatif dan R&D*. Bandung: Alfabeta.

Suwono, H., Pratiwi, H. E., Susanto, H., & Susilo, H. (2017). Enhancement of students' biological literacy and critical thinking of biology through socio-biological case-based learning. *Jurnal Pendidikan IPA Indonesia*, *6*(2), 213–222. https://doi.org/10.15294/jpii.v6i2.9622

Tsai, C.-W., Shen, P.-D., & Lin, R.-A. (2014). Exploring the Effects of Student-Centered Project-Based Learning with Initiation on Students' Computing Skills. *International Journal of Information and Communication Technology Education*, *11*(1), 27–43. https://doi.org/10.4018/ijicte.2015010102

Wright, K. L., Franks, A. D., Kuo, L.-J., McTigue, E. M., & Serrano, J. (2016). Both theory and practice: Science literacy instruction and theories of reading. *International Journal of Science and Mathematics Education*, *14*(7), 1275–1292. https://doi.org/10.1007/s10763-015-9661-2

Appendix 1.
Instruments of Biology Reading Literacy Test on Plant Tissue Topic

Text 1 for question No. 1 - 6

Researchers Utilize Spinach Leaves to Create Human Heart Tissue

REPUBLIKA.CO.ID, researchers are succeeded in utilizing spinach leaves to create heart tissue including its blood vessels. In resolving issue of lack of organ donor, researchers try to develop various types of tissue.

"Plants and animals have fundamental differences in terms of liquid, chemical, and macromolecules transport process. There is a surprising similarity, however, in their vascular tissue structure", stated by a research team from *Worcester Polytechnic Institute* (WPI) as quoted by *Science Alert*.

The researchers remove green materials of the spinach leaves leaving the cellulose structure that support the leaves. Plant cellulose is a widely studied material and spinach is a common vegetable even the researchers could get one from the local market.

Heart tissue transplantation is applied for patients with incurable heart tissue damages. It could happen after a heart attack.

The study to date still examines its application in living human heart tissue. "We are convinced that the structure has a capability of curing patients. We have plenty works to do but this is very promising," explained the WPI Glenn Gaudette biomedical researchers.

Source: http://trendtek.republika.co.id/

1. Which of the following statements matches with a text entitled "*researches utilize spinach leaves to create human heart tissue*"?
   a. Researchers utilize spinach stem to create heart tissue
   b. Plants and animals have fundamental differences in terms of liquid, chemical, and macromolecules transport process
   c. Celluloses from plant is material that seldom to study
   d. Heart tissue transplantation by utilizing cellulose structure of spinach leaves
2. Pay attention on the following statements!
   Answer with **"Yes/No"** on the answer sheet of statements that match the contents of the text!

No.	Question	Answer
1.	Spinach leaves are utilized to create tissue due to lack of organ donor.	Yes/No
2.	Spinach leaves are dissected and its cellulose structures are utilized	Yes/No
3.	Heart transplantation is carried out when a patient has heart damage.	Yes/No
4.	Vascular tissue in plants and animals has similarity	Yes/No

3. Which of the following statements that contains main idea can be found in the text?
   a. Researchers utilize spinach leaves to deal with heart tissue damage
   b. Animals and plants have fundamental differences in vascular tissue
   c. Researchers still examine the application of spinach tissue in living human heart
   d. Researchers believe that the spinach leaf tissue could be utilized for heart transplantation
4. State important facts could be found in text 1?

5. that the structure has a capability of curing patients. **We have plenty works to do but this is very promising**" State your opinion why the researchers use the terms of "we have plenty works to do" in the sentence!

6. Is the title used in the text suitable to the text description and is there anything that needs to be clarified from the text? Explain!

Text 2 for No. 7-11

Could a Plant have a Cancer?

Jakarta, In medical definition, cancer is a body cell that turns ferocious and continuously grows wild due to genetic mutations. It becomes a dangerous disease due to its invasive nature that damages the surrounding tissue.

In human, cancer becomes one of dreaded diseases as it could cause death. It is similar to animal, such as Tasmanian Devil that vulnerable to facial cancer.

What about plant? We may rarely or even never hear of a cancer problem in a plant.

To answer the question, an anchor of a science show, *SciShow,* Hank Green, states that it is the same case for a plant, although cancer in plants is more difficult to spread.

"Have you ever seen a tree with a part that grows like a large circular knot? Do you know what that is? It is an example of plant cancer," explained Hank as quoted from *SciShow*, Thursday (18/5/2017)

Cancer in plants could grow due to such factors as infection or structural damages. Since plants have no blood circulatory system the cancer cells are not easy to spread.

"In animals, cancer cells spread to other tissues by circulating in bloodstream. Plants, however, do not have the circulatory system. Plants transport their nutrient liquids such as sap without cells in it," said Hank.

"Moreover, another factor is related to plant cell walls that have strong structure. The walls protect the cells from moving easily; thus, cancer cells will have difficulty to separate," Hank continued.

Due to those factors, plants can indeed be more resistant to cancer.

Source: https://health.detik.com/

7. Which of the following statements that contains main idea found in the text?
   a. Cancer is a body cell that turns ferocious and continuously grows wild due to genetic mutation
   b. Cancer is one of deadly diseases
   c. Cancer in plants is caused by infection factor or structural damage
   d. Cell walls in plants serves to protect cells from moving easily thus cancer cells will have difficulty to separate

8. State the scientific facts found in the text 2 on cancerous plants!

9. State your opinion on cancerous plants around your house!

10. Which of the following statements that matches with the text entitled "*could a plant have cancer*"?
    a. Cancer is caused by genetic mutations in living organism that develop wildly
    b. Plants are rare to have cancer
    c. Cancer in plants occurred due to infection factors or structural damages
    d. Cell walls could ward off cancer in plants
11. Is there anything that needs to be clarified or added from the text 2, explain!

Text for No. 12-17

Why Don't the Coconut Trees Fall Down Against a Storm?

Jakarta, CNN Indonesia – Trees could break, fall down, or the branches could break if hit by strong winds. It is not the case, however, for palm trees such as coconut trees. Coconut trees will stand still in the strong wind. Why? You need to know that palm tree stems are not from wood. "Inside the palm stem are spongy tissues that are scattered irregularly," said Hope Jahren, a geochemist in her book *Lab Girl*, as quoted by Live Science recently.
Most trees place rings when they grow each year, except palm trees. Some of its cells are easily formed and folded but then return to its original position.

Without conventional internal structure, palm trees are flexible and adaptive in a gentle breeze to a violent storm conditions.

There are 188 genera and 2,585 species of palm trees identified, stated Professor Judy Jernsdedt, a botanist at the University of California.

Not all palm trees, however, are that strong. Plant trees planted in non-native areas usually could not grow as good and strong as those planted in its native areas.

If soil in its growing area is very wet, the palm trees will easily uprooted by strong winds as the roots are not firmly planted.

Although palm trees are technically a tree, its family is closer to grass, corn, and paddy instead of other tree family. Palm is a member of *Arecaceae* family and it appears since 100 million years ago in the *Cretaceous* era. **(ded/ded)**

Source: https://student.cnnindonesia.com/

12. Read the following statements thoroughly and then sort according to the text 3!
    1. Palm trees and coconut trees are plants resistant to strong winds
    2. Inside the palm and coconut stem are spongy tissues
    3. There are 188 genera and 2,585 species of palm trees
    4. Palm trees will be easily uprooted by strong winds if they grow on wet soil

13. Based on the reading, in very wet growing areas palm trees will be easily uprooted by strong winds as the roots are not firmly planted. Please state your action on how a palm tree could grow well and strong!

14. What information should be added in the online news article entitled "why don't the coconut trees fall down against a storm? So that readers have clearer picture on the news article?

15. Palm trees and coconut trees are plant that is tough against strong winds. It is because….
    a. the stem roots have spongy tissues that irregularly scattered
    b. the stem has spongy tissues
    c. palm trees are planted in its native habitat
    d. palm trees are planted on wet soil
16. Pay attention on the following statements!
    Answer with "**Yes/No**" on the answer sheet of statements that match the contents of the text!

No.	Statement	Answer
1.	Palm trees and coconut trees have strong stem	Yes/No
2.	Cells in palm tree are easily formed yet hard to fold	Yes/No
3.	There are 188 genera and 2,585 species of palm trees	Yes/No
4.	Palm tree have a closer kinship to grass, corn, and paddy	Yes/No

17. Write important facts and scientific reflection after reading an article entitled "why don't the coconut trees fall down against a storm"

Thanks