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Reading, Mind Mapping, Sharing (RMS) And Reading, Questioning, Answering (RQA): Their Effect on the Higher-Order Thinking Skills (HOTS)

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Abstract

The respiratory system is one of the topics in Biology that requires students' Higher Order Thinking Skills (HOTS). In respiratory system learning, teachers can implement constructivism-oriented learning models, such as Reading, Mind Mapping, Sharing (RMS), Reading, Questioning, and Answering (RQA). This study aims to measure students' HOTS and analyze differences in implementing RMS and RQA learning models for students' HOTS in the respiratory system topic. The research method is a quasi-experiment with pretest-posttest control group design as the research design. The research employs two experimental classes for the RMS and RQA model and one control class. The research population is the SMAN students in DKI Jakarta Province. The research sample consists of 81 students selected using a multistage sampling. The percentage results of HOTS categorization indicate an improvement in the percentage of students in the high HOTS category in each class. The hypothetical testing conducted using One Way Inova at α=0.05 gains a significance value of 0.139. The research results suggest no significant differences between RMS and RMQ learning models for HOTS in the respiratory system topic.

Introduction

The implementation of the Curriculum 2013 learning encourages the existence of higher-order thinking skills (HOTS) that reinforce students to think critically, creatively, and innovatively (Fitriani & Sari, 2019). HOTS is crucial to be implemented and improved in learning at schools (Rahmi et al., 2021). Moreover, the characteristic of biology learning is to involve students actively and requires cooperation among them. Biology learning aims to help students to improve their HOTS and to express opinions (Nurhayani, 2018).

Biology learning at school faces some challenges due to one of the characteristics of its topics (Lestari & Susanti, 2016). Respiratory system is one of the biology topics that requires students' HOTS. The topic contains numerous terms and mechanism concepts that are deemed difficult by some students since they require analysis skills (Sara et al., 2020). Results to be achieved in the essential competencies (KD) 3.8 of the Curriculum 2013 on respiratory system emphasizes students' ability to analyze, evaluate, and be creative; therefore, it requires HOTS (Afrita & Darussyamsu, 2020). Teachers must consider effective learning models to support HOTS (Fitriani & Sari, 2019). Respiratory system learning is better conducted using a constructivist approach, mainly involving students with the learned content (Djamahar et al., 2020). Moreover, implementing constructivism-oriented learning models is assumed to be appropriate for improving HOTS (Putra et al., 2019).

Constructivism is a learning approach where students are active in searching for information and developing their knowledge; hence, they can construct their thinking and train their thinking skills (Diani et al., 2018). The constructivism-oriented learning models include reading, mind mapping, sharing (RMS) (Diani et al., 2018; Muhlisin, 2019) and reading, questioning, answering (RQA) (Corebima & Bahri, 2011; Haerullah & Usman, 2013).

Learning implementation in the RMS model is adjusted to the concept of constructivism. The RMS model effectively improves students' HOTS (Diani et al., 2018). The reading activity will train students' HOTS, especially in developing analysis skills (Bahri, 2016). Collaboration of mind mapping and sharing activities facilitates discussion, exchange of ideas, analysis, evaluation, and creation that stimulates the thinking process and improves students' HOTS (Diani et al., 2018).

In addition to the RMS model, students' HOTS can be improved through the RQA model (Sumampouw, 2011; Mulyadi et al., 2014). The RQA model is constructivism. Thus, it can increase student activeness in constructing their thoughts (Maulida et al., 2017). The reading activity stimulates students' thinking process to find the essential parts of the topic (Muhlisin, 2016). The questioning and answering activity is one of the methods to stimulate the thinking process and improve students' HOTS (Sumampouw, 2011; Bahri & Idris, 2017).

An adequate selection of learning models is crucial to improving students' HOTS in the respiratory system topic. Through differences in syntax in the implementation of RMS and RQA, students are expected to be active in constructing their thoughts to address their difficulties in the respiratory system topic that requires HOTS; thus, the biology learning objectives in improving HOTS can be achieved. The RMS and RQA are also expected to reference learning models for teachers to train and improve students' HOTS.

The results of previous RMS and RQA studies show that the RMS model is efficacious in improving students' HOTS (Diani et al., 2018), the RQA model can empower students' HOTS (Mulyadi et al., 2014), both RMS and RQA models are proven to be able to improve students' HOTS. The previous studies, however, have yet to compare both learning models to measure students' HOTS in the respiratory system topic. Therefore, there is a need to study the differences in the RMS and RQA model for the HOTS in the respiratory system topic.

Methods

a. Research Design

The research method used a quasi-experiment, and the pretest-posttest control group design was chosen as the research type (Sugiyono, 2017). Table 1 explains the research design.

Table 1. Pretest-posttest control group design

Group	Pretest	Treatment	Posttest
RMS Class	O_1	X_1	O_3
RQA Class	O_2	X_2	O_4
Control Class	O_5	X_3	O_6

Description:

O_1: The HOTS pretest score of the RMS experimental class
O_3: The HOTS posttest score of the RMS experimental class
O_2: The HOTS pretest score of the RQA experimental class
O_4: The HOTS posttest score of the RQA experimental class
O_5: The HOTS pretest score of the control class
O_6: The HOTS posttest score of the control class
X_1: RMS learning treatment
X_2: RQA learning treatment
X_3: Conventional learning treatment

b. Population and Sample

The research population was SMA students in DKI Jakarta Province. The sampling technique used was a multi-stage sampling that consisted of several stages. The first stage was a cluster random sampling to select a city and East Jakarta was chosen. The second stage was a cluster random sampling to select a sub-district which resulted in the Pulo Gadung sub-district. SMA Negeri 36 Jakarta was selected as the sample in the third stage of cluster random sampling. The fourth stage was a purposive sampling technique that selected Grade XI of IPA since the class is related to the topic to be tested in the research. The fifth stage was a cluster random sampling that selected three classes from the Grade XI of IPA, namely Class XI MIPA 1, Class XI MIPA 2, and Class XI MIPA 3. The last stage was selecting a sample through a simple random sampling technique by determining the minimum number of samples using the Slavin formula, which resulted in 80 out of the 100 students.

c. Instrument

The research used HOTS test instruments of the respiratory system that consisted of 25 multiple-choice questions on the cognitive aspects C4 to C6 of the revised Bloom Taxonomy with five answer options, student questionnaire responses, and learning implementation sheets. The validity test of the HOTS instrument tests of the respiratory system used a point biserial formula. The number of questions to be tested was 25 question items, and 20 of them were valid. The reliability test employed the KR-20 formula. The instrument reliability value after the test was 0.97, indicating that the instruments were reliable.

d. Procedure

The learning was implemented online using Google Meet and WhatsApp Group in the RMS, RQA, and control classes that consisted of three meetings in the academic year of 2020/2021. Students in the experimental and control classes worked on the pretest outside the learning hour before the topic learning began. The RMS learning syntax referred to Diani, et al. (2018) is illustrated in Figure 1 and the RQA learning syntax referred to Mulyadi, et al. (2014) is indicated in Figure 2. The posttest of the HOTS mastery of the respiratory system was given to the experimental and control classes outside their learning hour after completing the topic. Students in the RMS and RQA classes then filled out the response questionnaires about the learning.

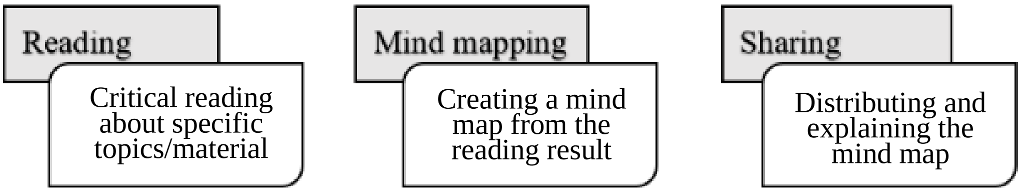

Figure 1. RMS Learning Syntax

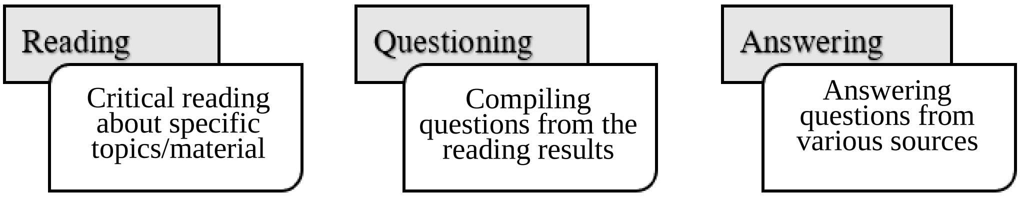

Figure 2. RQA Learning Syntax

e. Data Analysis Technique

The data analysis technique used a statistic descriptive analysis, analysis prerequisite tests, hypothetical testing, and a further test. The analysis prerequisite tests consisted of normality and homogeneity tests. The hypothesis testing used a One Way Anova test to determine whether differences existed between the learning models for HOTS of the respiratory system. The further test used the Turkey test to identify differences between groups.

Results and Discussion

a. Description of HOTS Score Data

The research resulted in the students' HOTS values of the respiratory system. The values were generated from the pretest and posttest of the experimental and control classes. The data analysis gained the lowest, highest, average, and gain values, as presented in Table 2.

Table 2. Description of HOTS Value Data

Description	RMS Class		RQA Class		Control Class	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
N	27,00	27,00	27,00	27,00	27,00	27,00
The lowest score	30,00	55,00	30,00	50,00	30,00	50,00
The highest score	55,00	85,00	50,00	70,00	55,00	75,00
Average	43,52	67,78	40,19	60,74	42,04	62,78
Average Gain	**24,26**		**20,55**		**20,74**	

Table 2 indicates that the average pretest and the highest posttest were in the RMS class and the lowest was in the RQA class. The gain value is the difference between the posttest and pretest scores. The highest improvement of HOTS was in the RMS class and the lowest was in the RQA class.

1) Percentage of HOTS Categorization

HOTS can be divided into 3 categories: high, moderate, and low, which are calculated using standard deviation adapted into categories (Azwar, 2012). The results of the categorization of students' HOTS can be seen in Appendix 15. The percentage of HOTS categorization is indicated in Table 3.

Table 3. Percentage of HOTS Categorization

HOTS Category	Percentage of HOTS (%)					
	RMS Class		RQA Class		Control Class	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Low	3,70	-	7,40	-	11,11	-
Moderate	96,29	51,85	92,59	85,18	88,88	74,07
High	-	48,14	-	14,81	-	25,92

Based on Table 3, the percentage of the pretest for each class indicates no students were included in the high HOTS category; yet, there was an improvement in the percentage of the high HOTS category for each class in the posttest results. The highest posttest percentage from the high HOTS category was in the RMS class of 48.14%. Students included in the low percentage of the HOTS pretest category in the RMS class was 3.70%, RQA was 7.40%, and control was 11.11%. There was a decrease in percentage in each class with no students included in the low HOTS category in the posttest result.

2) Improvement in the HOTS Cognitive Dimension

There are three indicators of HOTS cognitive dimensions, namely analyzing (C4), evaluating (C5), and creating (C6). Improvement from the average pretest to posttest based on the HOTS cognitive dimension is indicated in Figure 3.

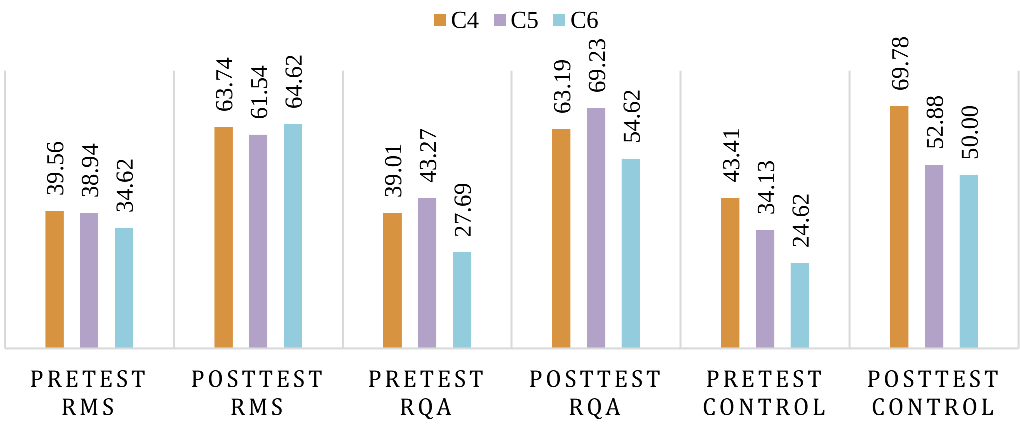

Figure 3. Improvement from *pretest* to *posttest* in the HOTS cognitive dimensions

Figure 3 shows that each class experienced an improvement in the average pretest to posttest in the HOTS cognitive dimensions. The most significant improvement was in the indicator of creating (C6) in the RMS class, evaluating (C5) in the RQA class, and analyzing (C4) in the control class.

b. Observation of Learning Implementation

The activities of teachers and students in the experimental and control classes were observed in three meetings. The first meeting discussed the sub-topic of structures and functions of respiratory organs; the second meeting discussed the sub-topic of respiratory mechanisms and gas exchange; and the third meeting discussed the sub-topic of respiratory air and respiratory system disorders. The percentage of the learning implementation by teachers and students is presented in Table 4.

Table 4. Percentage of Learning Implementation

Topic Learned	Learning Implementation (%)		
	RMS Class	RQA Class	Control Class
Structures and functions of respiratory organs	89,00	94,00	86,00
Respiratory mechanisms and gas exchange.	89,00	94,00	94,00
Respiratory air and respiratory system disorders	94,00	89,00	89,00
Average	**90,00**	**92,00**	**90,00**
Criteria	**Excellent**	**Excellent**	**Excellent**

Based on the percentage of the learning implementation in Table 4, the learning implementation in RQA, RMS, and Control classes was 81%-100%, which is an excellent criterion (Riduwan, 2009).

c. Questionnaire of Student Responses to Learning Models

The questionnaires of the response to learning models were distributed to the students in the RMS and RQA experimental classes. Students in the RMS class gave the highest positive responses to each indicator. The percentage of the questionnaire of student responses in the RMS and RQA classes is indicated in Figure 4.

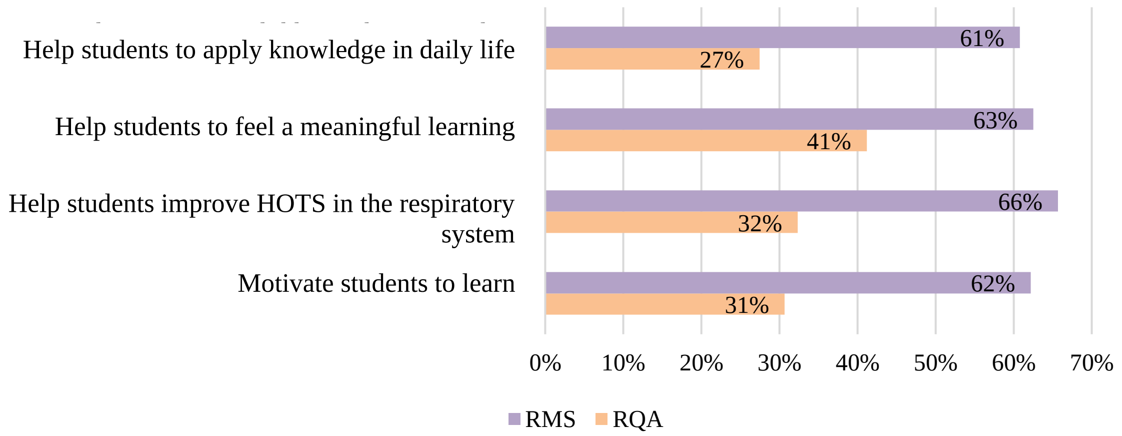

Figure 4. Percentage of response questionnaire of students in RMS and RQA classes

d. Analysis Prerequisite Tests

1) Normality Test

The normality test employed the Kolmogorov-Smirnov at α =0,05. The theses results are indicated in Table 5.

Table 5. Normality Test

Class	*Pretest*	*Posttest*	Gain Value	α	Description
RMS	0,123	0,072	0,103	0,05	Normal
RQA	0,071	0,064	0,083	0,05	Normal
Control	0,071	0,099	0,129	0,05	Normal

Based on Table 5, all pretest, posttest, and gain value data have a significance value of >0,05 indicating that data in the experimental and control classes were normally distributed.

2) Homogeneity Test

The homogeneity test used the Levene test at α = 0,05. The results are presented in Table 6.

Table 6. Homogeneity Test

Pretest	Posttest	Gain Value	α	Description
0.222	0.446	0.872	0,05	Homogeneous

Table 6 shows that all pretest, posttest, and gain values have a significance value of >0,05, indicating that data in the experimental and control classes came from a homogeneous population.

e. Hypothesis Testing

The hypothesis testing used a One-Way ANOVA at α =0,05. The values used in the test were the gain values. The hypothesis testing results are indicated in Table 7.

Table 7. Hypothesis Testing

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	235,185	2	117,593	2,022	0,139
Within Groups	4537,037	78	58,167		
Total	4772,222	80			

Table 7 shows that F statistics (2,022) < F table (3,114) and the significance value was 0,139 > 0,05; therefore, H0 was accepted, indicating that there were no significant differences between the learning models for the HOTS in the respiratory system topic. Due to the result, the Turkey test was not conducted.

The implementation of online learning followed the learning syntax and the RPP of each learning model. The RMS learning syntax consists of reading, mind mapping, and sharing. In the first syntax, students were directed to critically read the respiratory system topic to locate the essential parts of the topic. The reading activity allowed students to prepare for the respiratory system learning and improve their critical thinking skills. Muhlisin (2016) explains that students are facilitated to self-prepare in learning activities by reading the topic critically, aiming at locating the crucial ideas and improving critical thinking skills. Critical thinking is part of HOTS in biology learning, and it plays a crucial role (Noviyanti et al., 2019; Harahap et al., 2020).

The next step was to direct students to mind mapping in a group. The mind mapping activity helped students to organize knowledge and construct thoughts in the respiratory system learning. Muhlisin et al., (2016) clarify that mind mapping plays a role in organizing knowledge or constructing thoughts well; thus, it facilitates students to map the incoming information after reading the topic into a creative visual form. Knowledge gained by the students from the reading process can be measured from the results of the mind map compiled.

The mind map compiled by the students in the LKPD was analyzed following the assessment rubric that consisted of four indicators, namely the depth of the topic, keywords, and the use of colours and images. The results of the mind map from the students indicate that in the first meeting, in the indicator of the depth of the topic, almost all groups received a fair category. Students included a sub-chapter of the topic and tried to develop several concepts. Additionally, there were no groups that received poor and excellent categories. In the colour indicator, most groups received a good category using more than one colour. The closely related concepts had the same colour. Some groups, however, received a fair category with the use of more than one colour but incorrect implementation. In the image indicator, none received an excellent category.

The results of the students' mind maps in the second and third meetings indicate the depth of the topic. Most groups received a good category; students included the sub-chapter of the topic and developed numerous concepts. None of the groups received an excellent category in the image indicator In the colour indicator, most of the groups received good categories by using more than one colour. The closely related concepts had the same colour. Several groups received excellent categories. The different implementations of colour in each branch will facilitate association (Anggraini, 2017). Most of the mind maps produced by the groups had different colors and the groups used images indicating that mind mapping activity can hone creativity and support students' creative thinking process. Anggraini (2017 states that mind mapping hones creativity since the process involves pattern, colour, and image; therefore, it supports creative thinking. In the keyword indicator, all groups received good categories; namely, groups wrote concepts in the form of keywords or phrases. Mind mapping is better if it uses a single keyword since it makes the mind map stronger and more flexible. Using sentences as a keyword can reduce the generation of new thoughts. Anggraini (2017) expresses that a single word makes it easier to generate new thoughts.

Mind mapping improves students' HOTS (Diani et al., 2018). A mind map that can improve HOTS contains the depth of the topic, the use of the same colour in the related concepts, the use of colour and image, and the use of a single keyword (Diani et al., 2018). The prepared mind map showed that most groups experienced development based on each indicator, suggesting that mind mapping activity could improve HOTS since several assessment indicators were well achieved.

Further, the groups were directed to share, present, and discuss the prepared mind map with other groups. The sharing activity can help improve HOTS in the respiratory system learning since social interaction, exchange of ideas, and problem-solving occur. The sharing syntax referred to the Vigotsky development theory, namely, social interaction can develop critical thinking skills, confidence, and problem-solving (Muhlisin, 2019). Students in the group could present the mind map with good explanations and enthusiasm. This aligns with their positive responses in the indicator questionnaire of motivating students in learning where the RMS class were higher. Motivation is essential in learning; students without learning motivation will not be able to learn (Ningsih et al., 2019).

The weakness of RMS learning in the current research is that group mind mapping over a long period gives insufficient time for the teachers to clarify and explain incomprehensible topics. This can be addressed by assigning students to read the topics at home so that the mind mapping is on time and students can evaluate their knowledge before the learning starts. Additionally, teachers have more time to explain the topics that students do not understand.

The RQA learning syntax consists of reading, questioning, and answering. In the first syntax, students were directed to critically read the respiratory system topic. The reading activity made students to be active in constructing their thoughts in the respiratory system learning. Mulyadi, et al., (2014) explain that through critical reading, students can find important parts of the topic and actively construct thoughts.

Next, students were directed to make a group where they could discuss questions and answers to be composed. The questioning activity facilitates students to analyze information and evaluate knowledge actively; hence, it can stimulate HOTS. Hariyadi et al., (2017) state that questioning activity can stimulate students' thinking process to evaluate incomprehensible knowledge. The answering activity would encourage students to think critically and solve problems and provide an opportunity for students to learn from various sources to answer questions in the respiratory system learning. Nuzulah, (2018) opines that answering skills urges students' critical thinking and problem-solving. Skills in composing questions from the topic read can be used to assess thinking skills (Mulyadi, et al., 2014; Ramdiah & Adawiah, 2018). Questions and answers compiled by students in the LKPD were analyzed according to the assessment rubric. The quality of the questions was measured according to the LOTS and HOTS question categories (Hariyadi et al., 2017).

Based on the results of LKPD, questions prepared by all groups in the first meeting were in the LOTS category. The LOTS question category includes a rhetorical question, C1-C3 (Guspatni, 2017). The results indicate that students' cognitive dimension was low; thus, they felt less challenged to create HOTS questions. Mulyadi, et al., (2014) explain that a low level of cognitive dimension causes students to create LOTS-type questions. In the second and third meetings, some groups still created LOTS questions, and some were in the HOTS category. The HOTS question category includes a hypothetical question, C4-C6 (Hariyadi et al., 2017). This indicates a development in the student's cognitive dimension. Hariyadi et al., (2017) state that the more reading experiences, the higher the cognitive dimension of the students; thus, the more quality the questions compiled.

Referring to the answers made, most groups could answer the compiled questions. However, in the first meeting, most answers were not accompanied by further explanations about what was asked, and they mostly can be found directly in the books. This is related to the LOTS questions made by the students. In the second and third meetings, most answers had further explanation. According to Hariyadi et al. (2017), students answer questions based on their cognitive dimension. Next was presenting and discussing the results of questions and answer to other group. Students in the group could present the answers and questions, but other groups responded less enthusiastically.

The weakness of the RQA learning in the current research is that students needed to be directed to underline or summarize the topic while reading. Corebima (2010) explains that students must read critically and summarize the topic to find a substantial meaning about a certain topic. Based on the substantial meaning, students can create more quality questions and answers (Hariyadi et al., 2017).

The descriptive of the HOTS data suggests that the average pretest and posttest in the three classes were improved. The improvement was indicated in the gain values where the RMS class was higher. In Table 5, the pretest and posttest scores that were categorized as high, moderate, and low HOTS, show an improvement in the percentage of students in the high HOTS category and a decrease in the percentage of the low HOTS category where none of the students were in the category as indicated in the posttest results of each class. The highest percentage of the posttest in the high HOTS category was in the RMS class of 48.14%. The calculation results suggest that the RMS class was higher in improving HOTS. This was due to the RMS model that allows students to be more motivated and assisted in improving the HOTS. The questionnaire results indicate that the percentage of positive responses in the RMS class in the indicator of helping students to improve HOTS was higher than those in the RQA class.

Based on the improvement results in the HOTS cognitive dimensions, the RMS class generated the highest HOTS improvement in the cognitive dimension in the creating indicator (C6). This was due to the RMS syntax of mind mapping that hones the students' creativity to drive the creative thinking process. Anggraini (2017) states that mind mapping hones creativity since it involves pattern, colour, and image in its creation; therefore, it supports the creative thinking process. The RQA class received the highest improvement in HOTS in the evaluating (C5) indicator. This was due to the RQA syntax that supports students' thinking skills in evaluating their knowledge. Asking activity will stimulate students' thinking process to evaluate knowledge that is not understood (Hariyadi et al., 2017). The control class received the highest HOTS improvement in the cognitive dimension of analyzing (C4) indicator. This was due to the problem statement activity that trained students to develop skills in analyzing problems (Wulandari et al., 2018).

The improvement and positive results had no significant value in the results of hypothesis testing using One Way ANOVA. The test indicated that H0 was accepted, which means there were no differences in the learning models for HOTS in the respiratory system topic. The research was in contrast to research by Diani et al., (2018) stating that the RMS learning model is efficacious in improving students' HOTS, and Mulyadi et al., (2014) that students' HOTS can be empowered through the RQA learning model.

The finding can be related to a factor that the students who are not familiar with the learning model currently applied. Maulida et al. (2017) explain that the newly applied RQA learning model requires an adaptation process from the students. This can be seen in the results of LKPD RQA in the first meeting, where students created LOTS-type questions indicating that the student's cognitive dimension level in the groups was low. In the next meeting, however, some groups who could adapt showed development. Moreover, there were no trials of the learning models before their implementation in respiratory system learning as conducted by Muhlisin et al. (2016) to find out the obstacles; therefore, classes with the RMS model also required adaptation since it was observed that it took a long time for the groups to create a mind map.

Another factor was the meeting time and online platform that resulted in the implementation of learning was less than 100%. Teachers needed more time to clarify and explain incomprehensible topics. However, students needed more time to conclude. Sani (2016) explains that closing activity is crucial since it reduces misconceptions of incomprehensible topics when teachers explain them, and teachers can evaluate student thoughts from their conclusion. Teacher clarification related to the topic learned improved students' critical thinking skills (Muhlisin, 2016).

Conclusions and Recommendations

Based on the study's findings, it can be concluded that there were no significant differences between RMS and RQA learning for HOTS in the respiratory system topic. This study also has some limitations. Thus, further research can implement RMS and RQA learning to improve students' HOTS in the respiratory system using offline learning methods and researching other aspects besides hots. In the implementation of RQA learning, teachers could assign students to summarize the topic before learning, and in RMS learning, teachers could assign students to read the topic before learning. In addition, future researchers can use a larger sample.

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