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Improving Student's Conceptual Understanding and Metacognitive Strategies through Quantum Learning Model with Concept Map Techniques

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Abstract

Nowadays, we commonly find students' low interest toward science learning, students' low understanding of science concept, and low impact of learning process toward students' thinking skills. This study aims to identify the improvement of students' conceptual understanding and metacognitive when applying quantum learning model with mind mapping at learning process. This study also describes the metacognitive strategies in quantum learning model using mind map. A mixed methodology was used in this study. The results show that students who studied using quantum learning model with mind mapping have higher conceptual understanding and metacognitive improvement. The steps in the quantum learning model can improve students' metacognitive strategies. The result provide suggestion to other teachers to alternatively use quantum learning model with mind mapping to improved students' conceptual understanding and metacognitive.

Keywords: conceptual understanding; mind mapping; quantum learning, metacognitive strategies

Introduction

The understanding of students' concepts in a Junior High School in Sragen Regency of science subjects is still weak. This is indicated by students' learning outcomes that have not been encouraging. According to Gardner as quoted by Santyasa (2014) understanding is a mental process of adaptation and transformation of knowledge. There are several reference indicators in the process of understanding concepts, namely: interpreting, giving examples, classifying, summarising, guessing, comparing, and explaining.

Low learning outcomes also indicate the ability of students to control the learning process is still low. According to Risnanosanti (2008) a person's ability to control the learning process is called metacognitive ability. According to Livingston (1997) metacognition includes a knowledge component and a strategy component. Metacognitive strategies include planning, monitoring, and evaluation. The application of metacognitive strategies will control one's learning process in order to make effective learning.

Responding to the abovementioned challenges, quantum learning model can be one of models implemented to improve learning process. Main principle of quantum learning is to bring students' world into our world and bring our world into students' (de Porter, et al, 2005). This principle requires the need for a teacher to enter the students' world as an early step of learning activity. In addition, quantum learning has two main concepts, namely accelerated learning and learning facilitation (de Porter, et al, 2005).

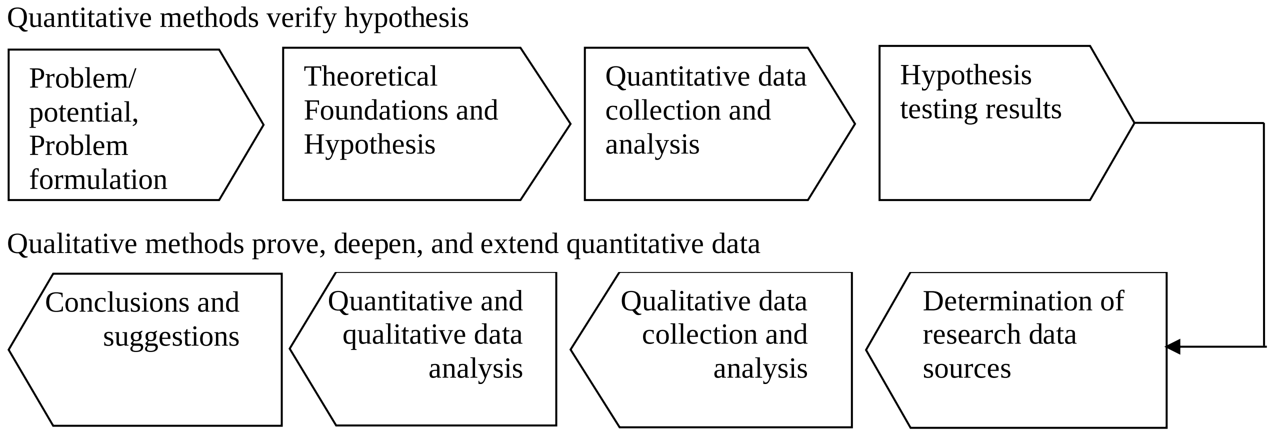
The quantum learning model can be implemented in various ways. One of suggestions in implementing quantum learning is to use a concept map. A concept map is a visual presentation of the connection of concepts and the hierarchical organization of concepts (Santrock, 2008). Concept maps provide an overview of the concepts in the subject matter to ensure students can understand the concept as a whole. Learning activity using quantum learning combined with concept maps is carried out through sequential learning steps (syntax). The syntax for learning the quantum learning model with a concept map is described in Table 1.

Table 1. *Syntax of quantum learning model with concept map*

No	Phase	Teacher activities	Student activities
1	Grow	Interact with students, motivate students by conveying AMBAK (what is the benefit for me).	Passionate about participating in learning activities.
2	Experience	Bring experience to students, invites investigations.	Experience yourself, conduct investigations, gather information.
3	Name	Give definitions and keywords, link, provide reinforcement using a concept map.	Define, understand information, relate information using concept maps
4	Demonstrate	Demonstrate, guide students.	Demonstrate, practice.
5	Repeat	Direct students to repeat the material.	Repeat the material learned, convey.
6	Celebrate	Give reward	Celebrate success.

Methodology

The research was conducted using mixed methods research. The design used is Explanatory Sequential Design. The steps in this study are illustrated in Picture 1 (Sugiyono, 2013)



Picture 1. *Chart of research development procedures.*

to the first step is to find that students' understanding of concepts and metacognitive strategies is low. Theoretical basis is determined in the form of conducting a literature review on quantum learning, concept maps, understanding concepts, and metacognitive strategies. The study proposed a hypothesis that there is a difference in improvement of concepts understanding and a difference in improvement of metacognitive strategies between quantum learning and concept maps compared to conventional learning. Conventional learning means learning process which do not use any specific learning model or syntax, method, and media. It only consists of opening, main session, and closing.

The collected data is students' understanding concepts based on test result and students' metacognitive strategies with questionnaires before and after treatment. The hypothesis test was carried out using a non-equivalent control group design by giving different treatment between the experimental group and the control group.

The source of qualitative data was determined by taking five students each from the experimental group and the control group. The qualitative data was collected through interviews. After the data was collected, quantitative and qualitative data analysis was carried out by confirming the results of quantitative data analysis with the results of qualitative data analysis. The data analysis result becomes reference for the study conclusion and suggestion provided for further improvement.

The subject of this study is students from class VIII B and VIII C of SMP Negeri 3 Sragen for the academic year of 2014/2015. There were 33 students from each class. Class VIII B students were the experimental group while class VIII C students were the control group. The variables used are independent variables and dependent variables. The independent variable is the use of a quantum learning model with a concept map technique and the dependent variable is an understanding of concepts and metacognitive strategies.

Data Collection Techniques and Instruments

Data was collected by using test, interview, and questionnaire techniques. Data collection instruments are divided into three stages, namely preliminary studies, expert validation, and implementation. The preliminary study used an interview guide instrument about learning support facilities and about barriers to learning activity. Expert validation uses validation sheets for learning tools, teaching materials, concept understanding tests, metacognitive strategy questionnaires, and interview guidelines for metacognitive strategies. The implementation uses a concept understanding test, a metacognitive strategy questionnaire, and a metacognitive strategy interview guide.

Instrument Validity and Reliability

Content validities were tested by asking for expert judgment (science education lecturers) and empirical method of validity. Based on both validity test, the valid concept understanding test instrument are 35 out of 45 items. For the metacognitive strategy questionnaire, 30 out of 35 statement items are valid. The reliability of the concept understanding test instrument was tested using the Kuder Richardson 20 formula. The reliability of the metacognitive strategy questionnaire was tested using the Cronbach's Alfa formula.

The validity test of qualitative data is carried out by triangulation method which uses different data collection techniques based on the same data source (Sugiyono, 2010). The data obtained from the questionnaire was compared with the data from the interviews.

Data analysis technique

Quantitative data in the form of data on increasing students' understanding of concepts and metacognitive strategies were analysed by inferential statistics using

Microsoft Excel For Windows 2007. The analytical techniques used are as follows.

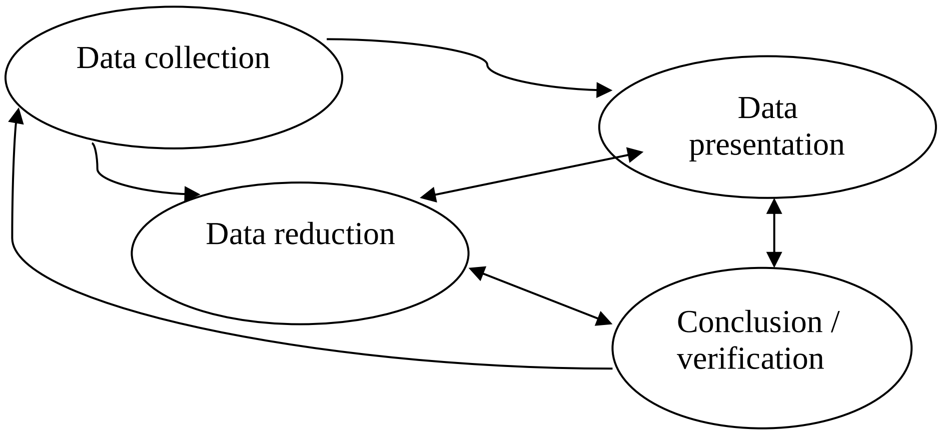
Normality test

The normality test was carried out because the use of parametric inferential statistics required the data to be analysed to be normally distributed. For normality test used chi squared test (χ^2). If the value of χ^2count is smaller than χ^2 table, then the data is normally distributed. From the normality test results, it shows that the data is normally distributed. Afterwards, the t test was carried out.

Paired sample t test

The t test is used to test the alternative hypothesis (Ha) to prove that there is a difference in improvement of concepts understanding and a difference in improvement of metacognitive strategies between quantum learning and concept maps compared to conventional learning. Ha is accepted if the value of t count is greater than t table.

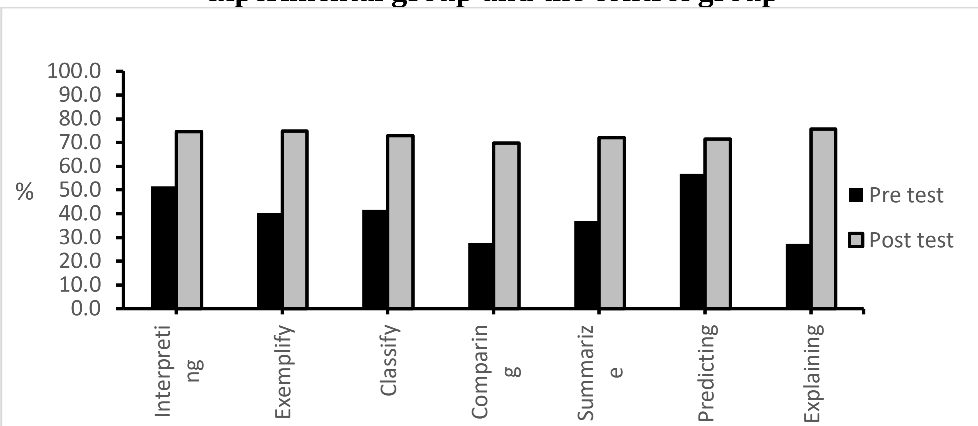
To analyse the qualitative data, an interactive model from Miles and Huberman is used as shown in Picture 2 (Sugiyono, 2010).



Picture 2. *Components of data analysis.*

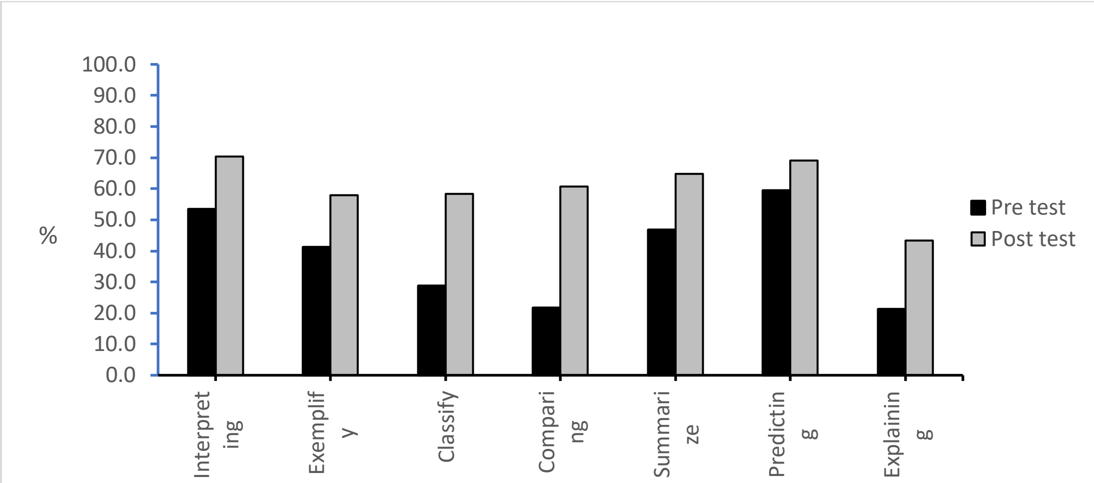
Qualitative data from this study is a description of students' metacognitive strategies consisting of planning, information management, monitoring understanding, minimising errors, and evaluating. The collected data was then reduced. Afterwards, the data was presented. The step after presenting the data was drawing conclusions and verification.

Findings and Discussion Comparison of increasing understanding of the concept of the experimental group and the control group



Picture 3. *Pre-test and post-test scores for understanding the concept of the experimental group*

In the pre-test experimental group, the average concept understanding result was 40.7%. Explaining had the lowest points with 27.3%, while the highest is predicting (57.0%). From the post test, the average concept understanding result was 72.9%. Comparing became the lowest indicator with 69.7%, while the highest indicator is explaining with 75.8%.



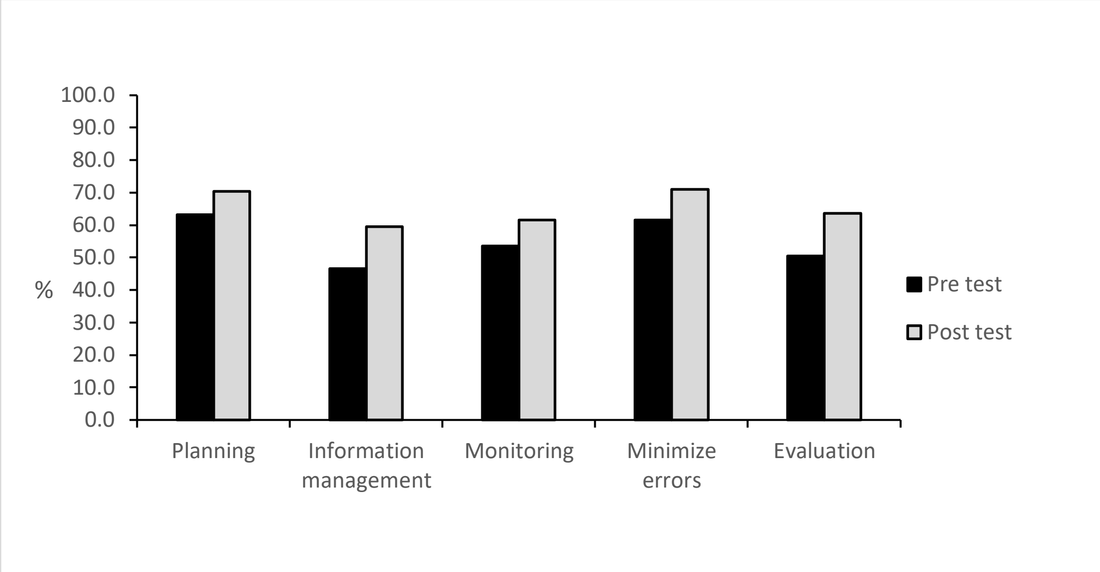
Picture 4. *Pre-test and post-test scores for understanding the concept of the control group*

For the control group, from the pre-test, the average concept understanding result was 39.8%. The lowest indicator was explaining with 21.2%, while the highest was interpreting with 53.3%. From the post test, the average concept understanding result was 61.6%. The lowest indicator was explaining with 33.3% while the highest is interpreting with 70.3%. Based on the t test, it was obtained that the t count = 4.51 and at dk = 32 with a significance level of 5%, it was obtained t table = 2.04. Since the t count > t table, Ho1 is rejected and Ha1 is accepted. It means there is a difference in improvement of concepts understanding and a difference in improvement of metacognitive strategies between quantum learning and concept maps compared to conventional learning.

The increase in understanding of concepts in the experimental group was generally higher than in the control group. In the experimental group, the students' conceptual understanding was better. Students were able to answer questions about the subject matter discussed. Students were able to explain the meaning of motion, give examples of motion, and classify the types of motion according to the group. Students explained motion through natural steps, gave examples of motion through demonstration steps, and classified motion accordance with concept maps.

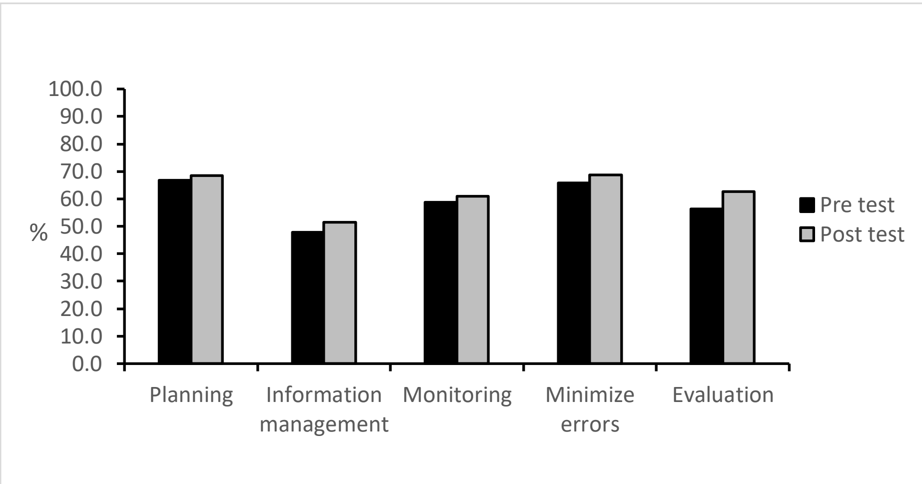
The difference in improvement of concept understanding that occurs was relevant to Kusno’s and Purwanto’s finding (2011) which states that quantum learning is effective and provides better learning outcomes compared to conventional learning. Increased understanding of concepts in the experimental group was also relevant to the findings of Suryani, et al (2014) which states that students' knowledge, attitudes, and preparatory actions for earthquakes can be increased through learning the quantum teaching model. In addition, increased understanding of concepts was also relevant to the findings of Riswanto and Putra (2012), which identify the use of effective mind mapping strategies to improve students' writing skills.

Comparison of the improvement of metacognitive strategies in the experimental group and the control group.



Picture 5. *Pre-test and post-test scores of the experimental group's metacognitive strategies*

In the experimental group, from the pre-test, the average metacognitive strategy result was 54.7%. The lowest aspect was information management with 46.7%, while the highest was planning with 63.3%. From the post-test, the average metacognitive strategy result was 64.6%. The lowest aspect was information management, which is 59.6%, while the highest was minimising errors with 71.0%.



Picture 6. *Pre-test and post-test scores of the control group's metacognitive strategies*

In the control group, from the pre-test, the average metacognitive strategy result was 58.3%. The lowest aspect was information management with 47.9%, while the highest was planning with 66.7%. From the post test, the average metacognitive strategy result was 61.4%. The lowest aspect was information management with 51.5%, while the highest was minimising errors with 68.8%. Based on the t test, it was obtained that the t count = 3.28 and at dk = 32 with a significance level of 5%, it was obtained t table = 2.04. Since t count > t table, Ho2 is rejected and Ha2 is accepted. It means there is a difference in the improvement of students' metacognitive strategies between those produced by quantum learning models and concept maps compared to conventional learning.

The improvement in metacognitive strategies in the experimental group was generally higher than that in the control group, despite there were aspects with small improvement difference. The small difference is due to the relatively short study time. The result shows that the students have carried out planning, monitoring, and correcting errors. Students prepared what is needed to learn, tried to understand the learning objectives, and sought help when they found difficulties with the subject matter. Students sought help if they found difficulties when they asked questions to the teacher or other students about the subject matter of motion that was not understood.

The improvement of metacognitive strategies was relevant to idea of Rosenzweig, et al (2011) which states that teaching students' metacognitive strategies that can help them succeed in doing assignments is something important. Sastrawati (2011) states that teachers need to pay attention to the metacognitive strategy factors that students have, along with the components that influence their emergence. Students with low metacognitive strategies need more attention in order to have higher metacognitive strategies.

Toit and Kotze (2009) states that metacognitive strategies can provide guidance in effective teaching and help students to learn effectively. For this reason, students' metacognitive strategies need to be improved effective learning activities and optimal results.

Description of the experimental group's metacognitive strategy

For the planning aspect, some excerpts of an interview obtained were as follows.

X : Do you try yourself to have enough time to study? Why?

Y : Yes I do, because if there is not enough time, I will not be able to complete the study.

X : Do you think about what it needs to learn before you start studying? Why?

Y : Yes I think, because if I do not prepare to study, I will not focus.

X : Do you set any specific goals before starting to study? Why?

Y : Yes I do, because if I don't know the purpose, I don't know the learning objectives.

From the interview, it is found that the student has some plans. The emergence of the planning aspect can be seen in the behaviour of students who spent time to study, tried to understand the learning objectives, and prepared what is needed to learn. Students spent time to study in order to learn about the information that has been delivered or will be delivered by the teacher thoroughly, understand the learning material, and can ask some questions well. Students tried to understand the learning objectives in order to understand the direction, purpose, and the results to be achieved from the learning activity. Students prepared what is needed to learn to be focused, comfortable, and perfect.

For the information management aspect, some excerpts of an interview with a subject was obtained as follows.

X : Do you pay more attention when you face important information? Why?

Y : Yes I do, in order it is to understand the important information conveyed.

X : Do you make your own examples to make the information more understandable? Why?

Y : Yes I do, because it is easier to understand example made by myself.

X: Do you ask yourself if what you read relates to what you have already known? Why?

Y : Yes I do, in order to understand the lesson, and help study.

Aspects of information management have grown in students. Students read slowly when encountering important information, elaborate on information by making their own examples, and relate new information to prior knowledge they already have. Students read slowly when they encounter important information in order to better know and understand the information presented. Students elaborate with make their own examples so that it is easy to understand and associate with making new things their selves. Students associate new information with their prior knowledge in order to deepen their understanding of new lessons, not to forget, and to learn more easily and quickly.

The monitoring aspect can be seen from some excerpts of an interview with a subject as follows:

X : Do you ask yourself periodically if you reach your goal, why?

Y : Yes I do, in order it is to know if I can do it or not, so I can study more.

X : Do you consider other ways to solve a problem before you answer, why?

Y : Yes I do, in order it is to implement the right strategy.

X : Do you review periodically to help understand important relationships, why?

Y : Yes I do, it is in order to forget, understand more that there is a relationship.

From the interview, it explains that the students carried out the monitoring aspect. Students were able to ask themselves whether they have achieved learning objectives, reviewed subject matter periodically, and considered various alternatives to solve a problem. Students asked themselves whether they have achieved the learning objectives in order to know if they have understood the lesson or not. It also shows that they were responsible for their learning. Students reviewed the subject matter periodically to make it easy to understand, easy to remember, and clearer. Monitoring aims to measure students' learning progress and improve the learning process carried out.

The aspect of minimising errors is shown by excerpts of an interview with a subject as follows.

X : Do you ask other students' help when you don't understand something? Why?

Y : Yes I do, if I don't understand, I have to ask, if I don't ask, I won't understand.

X : Do you change your strategy when you fail to understand? Why?

Y : Yes I do, because by using another method, I can understand.

X : Do you stop and go back through new information that is not clear? Why?

Y : Yes I do, because if I don't repeat it, I don't know, so that the information is clearer.

The interview shows that students made effort to reduce error. Students tried to ask for help from other students to understand the subject matter, change the strategies used, and repeat unclear subject matters. Students asked for help from other students to understand the subject matter to avoid mistakes and become faster to understand it. Students changed the strategies used to do the work faster and understand in other ways. Students repeated material that is not clear in order to quickly understand the knowledge and information.

The evaluation aspect is described by excerpts of an interview with a subject as follows.

X : After completing the test, do you know how well you did?

Y : Yes I do. I can be more enthusiastic for learning, and I can identify my own abilities.

X : Do you summarise what you have learned? Why?

Y : Yes I do, because I can understand what I have written. It is easier to work on it, and it is faster to learn.

X : Do you ask yourself if you have studied as much as you get immediately after completing the assignment? Why?

Y : Yes I do. It makes easier to learn and express opinions.

The evaluation aspect has grown in students. Students tried to find out the success of their learning, made a summary of the material studied, and assessed themselves against the learning activities that have been carried out. Students tried to find out the success of learning in order to get good grades, understand the lesson, and know their abilities. Students made a summary of the material studied in order to find out important things and save learning time. Through evaluation the progress achieved by a person in learning can be identified.

Conclusions and Suggestions

Based on the discussion of the results, from the research conducted, it is concluded that the increase in understanding of concepts produced by learning using the quantum learning model with concept maps is higher than the increase produced by conventional learning. Indicators in the process of understanding concepts that increased were interpreting, giving examples, classifying, summarising, guessing, comparing, and explaining.

The increase in metacognitive strategies produced by learning using the quantum learning model with concept maps is higher than the increase produced by conventional learning. The metacognitive strategies generated by implementing the quantum learning model with concept maps has emerged. It was depicted by students who have planned, managed information, minimised errors, monitored, and evaluated their learning.

Based on the conclusions, the suggestions that can be drawn is quantum learning models with concept maps can be used as an alternative for teachers to improve students' understanding of concepts and metacognitive strategies. In addition. Moreover, schools need to encourage teachers to carry out learning by applying a quantum learning model with concept maps.

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