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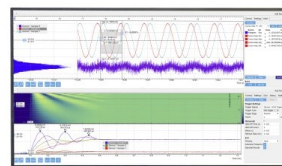
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Quantum Teaching and Learning Model Using Mind Mapping and Its Effect on Creative Thinking Skills and Establishment of Senior High School Student Characters in Biology Subject

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Abstract. The purpose of this study is to examine the effect of quantum teaching and learning model assisted by mind mapping on creative thinking skills and student character development. The research method was quasi-experimental design with pretest-posttest nonequivalent control group design. The research population is all student in grade XI IPA (Science) SMA 7 Malang with XI IPA-2 as research sample for the experimental class. The experimental class was given treatment through learning with mind mapping assisted quantum teaching model. For the control class is class XI IPA-4, and this class was for Biology learning using the quantum teaching model only. Data analysis used ANAKOVA with a significance level of 0.05, which was previously tested for data normality and data homogeneity. The results showed that the quantum teaching model assisted with mind mapping could improve: 1) creative thinking skills, and 2) the formation of student characters.

INTRODUCTION

The progress of a nation is determined by its human resources. One way to prepare human resources is through education (1). This is in accordance with the objectives of national education, which prepare students to become smart, independent, and dignified generations as described in the National Education System Law No. 20 of 2003. Partnership for 21st-century skills (P21, 2009) identifies 21st-century skills, including basic skills that are widely known, one of which is creative thinking skills, which are included in higher-order thinking skills (HOTS), which are also one of the 21st century intelligence components. need to be further developed in the face of future

challenges. In addition, these skills are essential for preparing students for a more complex life and work environment. In line with Lamb (2) that in addition to high knowledge in various disciplines, students will need various skills and capabilities including creative, critical, and problem-solving thinking to develop in the future.

Based on data from the global creativity index, Florida (3) referring to the fields of technology, talent, and tolerance, Indonesia is ranked 115 out of a total of 139 countries. These data indicate that the creative thinking skills of students in Indonesia are still low. The results of interviews with biology teachers at SMA Negeri 7 Malang in October 2019 obtained data that teachers need to further develop students' creative thinking skills in learning objectives. Students' creative thinking skills have not been empowered during learning and there is no proper test to measure the level of students' creative thinking skills. This shows that creative thinking skills need to be empowered properly and correctly. In addition, the results of research by Kadir & Masi (4) concluded that the level of creativity of students was still low, namely 41.19%.

In addition to creative thinking skills, Fullan (5) identifies 21st-century competencies, one of which is character education. This is in accordance with what is stated in Government Regulation no. 87 of 2017 concerning strengthening character education. Character is a way of thinking and behaving that characterizes each individual to live and work together, both within the sphere of family, society, nation and state (6). Lepiyanto (7) states that character education really needs to be instilled as early as possible to anticipate future problems that are increasingly complex such as children's attention and concern for the surrounding environment, lack of responsibility, and low self-confidence.

The implementation of character education in schools will be more effective if it is integrated with various subjects, not excluded into a single subject (8). The Ministry of National Education states that character development can be integrated into subjects. One of the subjects that play a role in developing student character education is Biology. However, the facts in the field, according to the research results of Puji, et al. show that the integration of character education through learning biology has not been widely implemented by teachers. This result is in line with the results of an interview with a biology teacher at SMA Negeri 7 Malang which was conducted in October 2019, that the teacher has not integrated the element of character education in Biology learning, only the cooperative and communicative character is often applied because the teacher often uses the cooperative learning model.

Based on the description above, the learning strategy with the quantum teaching model assisted by mind mapping is attempted to overcome problems related to creative thinking skills and character building of students. The quantum teaching learning model is directed learning that takes into account the learning objectives and student achievement by turning all obstacles into benefits to create a comfortable and enjoyable learning atmosphere. The main principle in quantum teaching is "Bring Their World to Our World, and Deliver Our World to Their World" (9) which means it is to remind educators that entering the world of students is a very important first step to make the starting material for teaching. This learning model is known for its design framework, namely TANDUR (Tumbuhkan (*Grow*), Alami (*Experience*), Namai (*Name*), Demonstrasikan (*Demonstrate*) Ulangi (*Repeat*), dan Rayakan (*Celebrate*) (9) Meanwhile, mind mapping is a creative thinking tool that reflects the natural workings of the brain (10). According to Silaban and Napitupulu, mind mapping can help students and teachers in the learning process in class by summarizing subject matter into sheets that are much easier for students to learn and remember.

The results of research on mind mapping are presented as follows. The results of research conducted by (11) and (12) show that the use of the mind mapping method can improve students' creative thinking skills. Tirtawati's research results (13) that the application of quantum learning with mind mapping techniques can improve creative thinking skills. Research conducted by (14) in relation to character education, the implementation of mind mapping in learning activities is considered capable of instilling character. Meanwhile, the results of research conducted by (15,16), and (17) show that the application of the quantum teaching model can shape the character of students. Based on the problems described, a study entitled "The Influence of Mind Mapping-assisted Quantum Teaching Models on Creative Thinking Skills and Student Character Building in Biology Learning" was conducted. The purpose of this study was to explain the effect of the quantum teaching model assisted by mind mapping on creative thinking skills and character building of students.

METHOD

This type of research is a quasi-experimental research design with a pretest-posttest non-equivalent control group design. This research was conducted at SMA Negeri 7 Malang with the research population being all students of class XI IPA in the even semester of the 2018/2019 academic year. The classes used in the study were class XI IPA 2 as an experimental class that was taught using the quantum teaching model assisted by mind mapping, and class

XI IPA 4 as a control class that was taught using the quantum teaching model only. The two classes were selected as samples based on the results of the equivalence test.

The learning tools in this study include a syllabus, a Learning Implementation Plan (RPP), an Independent Learning Activity Unit (UKBM), syntax implementation observation sheets, and test kits. The materials used in this research are the coordination/regulation system and psychotropic substances. The research instruments used include instruments of creative thinking skills in the form of essay questions with rubric assessments, and instruments for character building students in the form of questionnaires. Data collection was carried out by: 1) making observations, 2) collecting students' initial data through pretest, 3) conducting research, and 4) retrieving students' final data through post-test.

The research data were analyzed using inferential statistics to test the hypothesis. Before testing the hypothesis, first the prerequisite test is carried out, namely the data normality test using the One Sample Kolmogorof-Smirnof test, and the homogeneity test using the Levene Test. After that, it was continued with the analysis of covariance test (ANAKOVA) with the help of SPSS 16.0 for Windows with a significance level of 0.05 ($P < 0.05$).

RESULTS

Students' Creative Thinking Skills Based on Pretest and Posttest Results

In Table 1, it can be seen that the average score of early creative thinking skills in the experimental class is 50 and the final creative thinking skills score is 81, there is an increase in the average score of 62%. In the control class, the average score of initial creative thinking skills is 50 and the final score is 63, there is an average increase of 26%.

TABLE 1. Creative thinking skills data description

Class	Score average		Increasing (%)
	<i>Pretest</i>	<i>Posttest</i>	
Experimen	50	81	62
Control	50	63	26

Student Character Building Based on Pretest and Posttest Results

In Table 2, it can be seen that the average score for students' character building for the early program in the experimental class was 75 and the value for students' character building for the final program was 88, there was an increase in the average score of 17%. In the control class, the average score for students' character building for the early program was 75 and the score for character building for the final program was 79, an average increase of 5%.

TABLE 2. Description of Student Character Formation Data

Class	Score average		Increasing (%)
	<i>Pretest</i>	<i>Posttest</i>	
Experimen	75	88	17
Control	75	79	5

Results of Data Analysis of Students' Creative Thinking Skills Based on Pretest and Posttest Values

Data on students' creative thinking skills were obtained based on the results of the pretest and post test which were then analyzed using Anacova (a summary of the anacova test can be seen in Table 3). In Table 3, it can be seen that F counted at 221.778 with a significance of 0.00. The significance value is less than 0.05, it is concluded that

there are differences in the creative thinking skills of students who are taught using the quantum teaching model assisted by mind mapping with students who are taught through the quantum teaching-learning model alone.

TABLE 3. Summary of hypothesis testing for creative thinking skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	145.983 ^a	2	72.992	111.265	.000
Intercept	59.637	1	59.637	90.909	.000
Kelas	145.489	1	145.489	221.778	.000
Pre_KBK	1.983	1	1.983	3.023	.087
Error	40.017	61	.656		
Total	8650.000	64			
Corrected Total	186.000	63			

a. R Squared = .787 (Adjusted R Squared = .780)

Results of Data Analysis on Student Character Formation Based on Pretest and Posttest Values

Student character formation data were obtained based on the results of the pretest and posttest which were then analyzed using Anacova (a summary of the Anacova test can be seen in Table 4). Based on Table 4, it can be seen that F counted at 169.527 with a significance of 0.00. The significance value is less than 0.05, it is concluded that there are differences in the formation of the character of students who are taught using the quantum teaching model assisted by mind mapping with students who are taught through the quantum teaching-learning model only.

TABLE 4. Summary of Student Character Building Hypothesis Testing

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2262.670 ^a	2	1131.335	133.082	.000
Intercept	389.229	1	389.229	45.786	.000
Kelas	1441.156	1	1441.156	169.527	.000
Pre_KBK	790.029	1	790.029	92.933	.000
Error	518.564	61	8.501		
Total	482857.000	64			
Corrected Total	2781.234	63			

a. R Squared = .814 (Adjusted R Squared = .807)

DISCUSSION

The Effect of Mind Mapping Assisted Quantum Teaching-Learning Model on Creative Thinking Skills

The results of the covariance analysis test of students' creative thinking skills showed that there was a significant difference between the experimental class and the control class. It was further explained that there was an effect of quantum teaching learning assisted by mind mapping in the experimental class. Based on the descriptive analysis, the average posttest of creative thinking skills in the class using quantum teaching assisted by mind mapping is the highest compared to the class using quantum teaching only, with an increase of 62%. These results are in line with

Tirtawati (13) research results that mind mapping assisted quantum learning is better at measuring creative thinking skills and the application of quantum learning with mind mapping techniques can improve creative thinking skills.

Student activities in learning quantum teaching assisted by mind mapping can facilitate them to develop creative thinking skills. In line with what was stated by Tirtawati (13), to develop creative thinking skills, quantum learning can be integrated with mind mapping. According to Yosefa (18), learning quantum teaching using mind mapping will spur students to be active and students' reasoning abilities about the lessons being taught can be seen from their active, creative, and innovative attitudes in facing lessons. Quantum learning with TANDUR syntax can make students more creative and productive (19).

At the growth stage, the teacher displays a phenomenon or problem in the form of pictures, videos, or current issues or short stories about someone's experiences related to the material to be studied. In this case, students carry out observing activities which is the first stage of the scientific approach. After observing a phenomenon or problem, students are given the opportunity to present arguments or ask questions about this phenomenon, so that the second stage of the scientific approach appears, namely asking questions. In this case it can help students to develop creative thinking skills, as stated by (20) to be able to think creatively, a stimulus is needed to trigger students to think. The stimulus can be in the form of providing a challenging phenomenon or problem at the beginning of the lesson. Indicators of creative thinking skills that can be developed are fluency, where students fluently express their ideas related to a given phenomenon or problem.

The next stage is natural. The teacher brings about experiences that all students can understand. Students get the opportunity to develop their initial knowledge, such as doing practicum or experiments related to the material or students discussing with their groups to solve a problem. In this case students carry out activities to collect data, in accordance with the third stage of the scientific approach. At this stage it means that the learning process will be more meaningful if students experience directly the material to be taught. It can be said that student-centered learning. (21) argues that creative thinking as a positive action is an important factor in stimulating brain function that can demonstrate and create a good learning style, student-centered learning is needed. In line with one of the principles of quantum teaching using the TANDUR principle, it can be stated that this learning model allows students to learn comfortably and happily with direct student participation in the learning process (22). The natural stage facilitates students to develop indicators of creative thinking skills, namely flexibility, where students can provide answers, varying opinions obtained from different points of view, namely discussion partners in one group, thinking of various ways to solve problems.

The next stage is the naming stage, which can also facilitate students to develop indicators of creative thinking skills of flexibility. At this stage, students try to find the concept of the experience that has been passed. Students carry out activities to draw conclusions on what they have passed or found. If it is related to the scientific approach, students are at the associate stage, (23) states that the learning environment is a necessary resource for creative thinking. One of the efforts to develop creative thinking skills is to create a learning environment that involves students' real experiences in learning (24). This is in accordance with one of the advantages of the quantum teaching model proposed by (25), in which the student learning process is more focused on the material being studied because it is linked to the experiences of students' daily lives. At this stage students can write down the results of the experiment, the results of problem identification, and the results of the discussion with the group

The fourth stage, namely demonstration, students are given the opportunity to show that they know what they have learned to others and relate it to new experiences and knowledge. Students can display the results of group work, discuss in large groups. Students carry out communicating activities, according to the fifth stage of the scientific approach. This stage can facilitate students to develop indicators of creative thinking skills, namely elaboration. Through large group discussions, students can enrich and develop an idea. In line with what was stated by (26), that creative people will look for new things, discover and develop new things. During large discussions, the teacher helps direct students to correct misconceptions, assisting in understanding difficult concepts. This is one that can be developed in training creative thinking skills.

The next step is to repeat the mind mapping. At this stage, they will strengthen their memory of the material that has been studied, by summarizing the material in the form of mind mapping. Mind mapping is a creative thinking tool that reflects the natural workings of the brain (10). According to (14) the implementation of mind mapping in learning activities can foster various positive characters, one of which is creative. Indicators of creative thinking skills that can be developed are originality. Students make mind mapping individually, which will try to find unique combinations so that the results will be different from their friends. Research results by (11) (2015), and (12) show that mind mapping can improve creative thinking skills.

The Effect of Mind Mapping Assisted Quantum Teaching Learning Model on Student Character Building

The results of the descriptive analysis of the character building of the experimental class students increased by 17%, higher than the control class, which was 5%. Based on the results of the analysis of the hypothesis test, it states that there is a significant difference between the experimental class and the control class, meaning that there is an effect on the character building of students who are taught using the quantum teaching model assisted by mind mapping in the experimental class. This increase is because quantum teaching learning can increase student participation through adjusting students' environmental conditions, increasing motivation and interest in learning, increasing memory and increasing a sense of togetherness, increasing hearing power, and increasing refinement of behaviour (27). (28) in her research states that the application of a quantum learning model with character education can increase student involvement in the learning process and instill a self-concept that cannot be separated from the character values of the nation. The results of research by (15), (16), and (17) also showed that the application of the quantum teaching model can shape the character of students.

Using mind mapping in learning activities, students will summarize the material that has been studied in the form of short notes so that they will map their thoughts individually (10). According to (29) using mind mapping will make students active in learning, so that they can optimize children's brain abilities, train them to think critically and innovatively, and develop positive character values in a child. The activeness of these students can improve student learning outcomes, so that educational goals can be achieved, namely to give birth to intelligent and characterful individuals. Research results (14), (6), and (29) show that mind mapping can instill character in students.

The character building developed in this study is curiosity, independence, tolerance, and communication. At the **growth** stage, the teacher displays a phenomenon related to everyday life related to the material, so that it will bring out the character of student curiosity. Associated with the scientific approach, at this stage students carry out observing activities. Students observe the phenomena displayed by the teacher through videos, photos related to learning. Students' curiosity will increase when the teacher displays what is in the video or photo in 3D, so that students can get a more real experience. This will make students ask a question to answer their curiosity, so that there is a relationship with the scientific approach to the questioning stage.

At the **experience** stage, students gain experience to develop a sense of curiosity, such as doing lab work or experiments related to the material or students discussing with their groups to solve a problem. When conducting experiments, identifying problems, discussing with groups, students' thinking skills will emerge, innovation is added to their initial knowledge which occurs at the naming stage (30). These two stages (**experience and name**) can develop a communicative character, because when discussing with groups of students are required to work together and provide opinions.

Demonstration stage, students are given the opportunity to convey what they have learned, receive new information from discussions in large groups. At this stage, the character of tolerance can be developed, because during presentations or large group discussions there will be more and more different opinions. According to (9) quantum learning includes all related interactions and differences that maximize learning moments. In this case, students are best not to criticize friends who are having an opinion, give friends the opportunity to submit their opinions, respect or respect the opinions of different friends. (31) stated that the main principles of good character are respect, truth, fairness, and responsibility.

The **repeat** step is assisted by mind mapping, students can strengthen their memory of the material that has been studied, by summarizing the material in the form of mind mapping. Mind mapping is a creative note-taking method that makes it easy for us to remember a lot of information. At the repeat stage assisted by the character mind mapping method that can be developed, namely independent. Students individually make mind mapping, so that students are able to develop independent character.

Mustari (32) explains that independence is all attitudes and behavior that are carried out by individuals and are not dependent on others. Independence is needed by someone so as not to become a burden to others, to train someone to be able to do everything by themselves according to their abilities. With independence, students will become confident individuals, can wisely make their own decisions, can maximize the abilities they have which are useful for their survival in the future.

CONCLUSIONS

Based on the results of data analysis and discussion, it is concluded that 1) the quantum teaching model assisted by mind mapping has an effect on improving students' creative thinking skills, and 2) the quantum teaching model assisted by mind mapping has an effect in improving the character formation of students.

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