



The Effectiveness of Problem Based Learning Model Aided with Concept Mapping on the Analysis of Senior High School Students' Ability in Learning Material of Immune System

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Abstract

Problem-based learning is learning model suitable for 21st Century's educational purpose. Concepts of learning material can be built using concept mapping. The objective of this research is to analyze the effectiveness of problem-based learning model aided with concept mapping on the analysis of Senior High School students' ability (differentiating, organizing, and attributing aspect) in learning material of Immune System. The subject of this research is eleven grade students of SMA Negeri 12 Semarang and SMA Kesatrian 1 Semarang, each of these senior high schools provided two experimental classes. The design of this research is pre-experimental, with one group pretest-posttest design. The method of gathering data was used in this research is test and observation. Instruments that were analyzed in this research are multiple choice, students discussion's worksheet, a product of learning outcomes, and learning implementation. The analysis ability of students from SMA Negeri 12 Semarang showed an average of 80% with classical content mastering for XI-MIPA 4 and XI-MIPA 5 are 84,2% and 76,4% respectively. Average of N-gain is 0,4706 which categorized in medium criteria. The analysis ability of students from SMA Kesatrian 1 Semarang showed an average of 73% with classical content mastering for XI-MIPA 1 and XI-MIPA 2 are 76,4% and 81% respectively. Average of N-gain is 0,4426 which categorized in medium criteria. Based on the research result can be drawn a conclusion that implementation of the problem-based learning aided with concept mapping is effective for increasing students' analysis ability in SMA Negeri 12 Semarang and SMA Kesatrian 1 Semarang.

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INTRODUCTION

Problems in education in Indonesia so diverse that affect the quality of human resources. One of them is the low quality of education at every level because of the weakness of the learning process. The learning process requires a new paradigm by a teacher, originally from teacher-centered learning towards an innovative and student-centered. The changes started in terms of curriculum, instructional models, and how to teach so as to improve the quality of the output (Shoimin, 2014). Changes made aiming to support the realization of the goals of education.

Efforts to realize educational goals can be done with the innovation of the learning model. 21st-century learning model can be a reference to the teachers as professional educators in an effort to improve student learning outcomes. Meanwhile, teaching and learning in the context of 21st-century learning, especially on the Curriculum 2013 is the students learning the material through examples, implementation, and real-world experience both inside and outside the school (Joseph et al., 2015). Anderson (2000) stated that the 21st-century science learning should ideally be directed at four components: (1) communication, (2) collaboration, (3) critical thinking and problem-solving, and (4) creativity and innovation. On Curriculum 2013 stated explicitly to use the method or the constructivist-based model involving scientific approaches such as Problem Based Learning (PBL), Project Based Learning (PjBL), Discovery Learning and Inquiry (Sudarisman, 2015). PBL is a learning model that is ideally suited to meet the goal of education for the 21st Century includes four components.

PBL is an instructional model that is done by presenting a problem, ask questions, facilitate the investigation, and open dialogue. Problems to be solved by applying some of the concepts and principles that simultaneously studied and included in the curriculum subjects (Sani, 2014). PBL implementation consists of five syntaxes of onboarding issues, organize the students, independent investigation and groups, develop and present the work, and to analyze and evaluate the problem-solving process (Anders, 2012). On the biology of learning, problem-solving takes the concepts of biology are correct. The concepts of learning materials can be built through the concept mapping.

Concept Mapping is an effective learning strategy because it can present the structure of the concept and identifies misconceptions or misconceptions materials by students (Hui-Chun et al., 2014). Concept maps can be used to help students in solving problems and knowing the concepts that have been owned by the students. The opinion was strengthened by the results of research Simatupang & Simatupang (2015) that the model PBL-aided concept mapping has a significant impact on learning outcomes (activities) students.

Student learning outcomes covering three aspects: cognitive, psychomotor and affective. According to the revised Bloom's taxonomy of cognitive aspects are divided into low-level thinking skills or LOTS (Lower Order Thinking Skills) and high-level thinking skills or HOTS (Higher Order Thinking Skills). LOTS of capabilities including the ability to remember, understand and apply, while HOTS includes the ability to analyze, evaluate, and create (Krathwohl & Anderson, 2001).

In 2013 most of the competency curriculum require students to analyze so that students need to develop analytical skills in the learning process. Analysis skills required to resolve the problem, both in itself, the surrounding environment, and particularly the school environment (Purwito et al., 2013). Analyzing include or differentiate the process of sorting, organizing, and attribute (Anderson & Krathwohl, 2010).

Based on research Kholifah et al. (2015) one of the materials that require a high school biology and analysis skills are still many misconceptions is the material of the immune system. In the study, Kholifah used concept maps to develop students' understanding of the concept.

RESEARCH METHOD

Research conducted at SMAN 12 Semarang and SMA Kesatrian 1 Semarang. The study used a quasi-experiment *one-group pretest-posttest design*, Samples were students of class XI-MIPA 4 and XI-MIPA 5 SMA N 12 Semarang and XI-MIPA 1 and XI-MIPA 2 in SMA Kesatrian 1 Semarang an experimental class of all. Determination of the sample using purposive sampling techniques. The independent variable of the application of assisted PBL concept mapping on learning the material in the class XI immune system. The dependent variable in the form of analysis skills. The control variables of teachers of biology, biological materials, the number of lessons as well as about the pre-test and post-test. The research data covers primary data in the form of analysis skills with the analysis of the percentage value analysis capabilities, N-gain and completeness of classical study and secondary data sheets discussion of students, the product of student learning outcomes (concept mapping and posters) and adherence to study with descriptive analysis of the percentage (Guttman scale).

RESULTS AND DISCUSSION

Based on research the effectiveness of the model problem based learning aided concept mapping on the analysis skills of students material immune system that has been done in SMA Negeri 12 Semarang and SMA Kesatrian 1 Semarang, data which includes primary data in the form of pre-test and post-test analysis capabilities (to distinguish, organize and attribute) and secondary data (sheet student discussions, student learning activities, the product of student learning outcomes, and enforceability of learning).

Students Analysis Capabilities

The primary data analysis capabilities of students obtained from the pre-test and post-test. The percentage of students analysis skills in SMA Negeri 12 Semarang and Kesatrian 1 Semarang is presented in Figure 1.

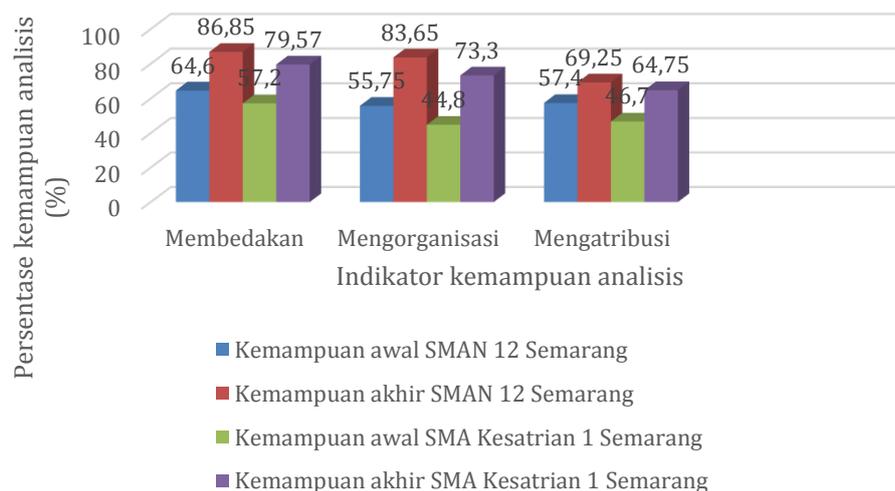


Figure 1 The results of the analytical skills of students after learning problem-based learning model with concept mapping aided immune system materials

In the initial analysis capabilities in SMAN 12 Semarang the percentage of class analysis capabilities XI-MIPA 5 is higher than grade XI-MIPA 4 as well as in the classical completeness. However, for final analysis capabilities percentage analysis capabilities, XI-MIPA 4 is higher than the class XI-MIPA 5 as well as in the classical completeness. Implementation of the pre-test in class XI-

MIPA 5 takes place in accordance with properly, while in pre-test in class XI-MIPA 4 slightly reduced working time about 10 minutes due to the reduction of teaching hours during the first meeting. In this case, the time effect on students' ability to analyze problems for a given problem also requires enough time to analyze it well.

From Table 4.1 it can be seen that the increase in learning outcomes (*N-gain*) Class XI-MIPA 4 of 0.5295 with moderate criteria. These results indicate a considerable increase compared outcomes study before obtaining treatment. Students' activities during independent investigation and also quite active group for students interested in the issue or the case presented. These results are consistent with research Simatupang & Simatupang (2015) that the problem-based learning models aided concept mapping has a significant impact on student activity. Based on the value of learning outcome (*N-gain*) on both classes of 0.4706 with moderate criteria and classical learning completeness well above 75%, it can be said to be a model of the problem-based learning concept mapping aided effectively applied in SMA Negeri 12 Semarang.

In SMA Kesatrian 1 Semarang research done in class XI- MIPA 1 and XI-MIPA 2. Ability preliminary analysis of class XI-MIPA 2 is superior because the student has been informed in advance pre-test will be carried out before the learning material while the immune system of class XI-MIPA 1 has not received the information because the teacher forgot to deliver it. The factors that influence differences in the results preliminary analysis capabilities in both classes. During the learning process, in class XI- MIPA 1 and XI- MIPA 2 there are many obstacles that interfere with the learning process. Based on interviews with teachers and a number of students at the time of observation, although already implemented Curriculum 2013 learning methods used in biology still use the lecture method and learning is still centered on the teacher or teacher-centered. The statement was proven during the learning process aided model of the problem-based learning concept mapping. In addition, students are also less trained to discuss in groups so that cooperation within the group has not gone well. Once applied to the model problem-based learning concept mapping aided participation of students to analyze issues that served to increase. Although the results *pre-test* and post-test class XI-MIPA 2 is higher than the XI-MIPA 1 the increase of learning outcomes (*N-gain*) is higher grade Mathematics XI-1 that is equal to 0.4800 with moderate criteria. That is increase in learning outcomes and analysis skills higher student in the class. Overall, in the classical learning completeness in both classes is already $\geq 75\%$ and *N-gain* is also included in the criteria being that it can be said that the model of problem-based learning aided concept mapping effectively applied in SMA Kesatrian 1 Semarang.

Ability Students in Differentiating

The results of students' ability to distinguish between before and after the application of problem-based learning models aided concept mapping is presented in Table 4.2.

Table 4.2 Results of the analysis of students' ability to distinguish

result	SMA Negeri 12 Semarang		SMA Kesatrian 1 Semarang	
	XI- MIPA 4	XI- MIPA 5	XI- MIPA 1	XI- MIPA 2
The ability to distinguish early	62.5%	66.7%	55.9%	58.5%
The ability to distinguish the end	85.5%	88.2%	81.35%	77,8%
classical completeness	89.4%	94,4%	91.15	70.9%
<i>N-gain</i>	0.6140	0.6458	0.5750	0.4660
Criteria <i>N-gain</i>	moderate	moderate	moderate	moderate
<i>N-gain</i> each school		0.6299		0.5205
Criteria <i>N-gain</i> every school		moderate		moderate

The ability to distinguish is the ability to determine which parts of relevant information (Anderson & Krathwohl, 2010). Based on Table 4.2 it can be seen the student's ability XI-MIPA 4 in differentiating early learning of 62.5% after application of problem-based learning models aided concept mapping students' ability to distinguish increased to 85.5%. These results are obtained due to the student's ability to distinguish between active and passive immunization was higher than the results of a wide differentiate immunity in the immune system. In class XI-MIPA 4 sub immunization materials more attractive as directly related to events or problems that exist in society. It is also supported by the work of students on worksheet student discussion. Students assume that sub immunization material more attractive and easy to understand.

Meanwhile, in class XI-MIPA 5 students better understand the material sub-sorts of immunity in the immune system because students are more aware of the concept mapping described by the teacher and made with his group. Improvement in both classes are included in the criteria of being, it shows that an increase is in high enough on learning outcomes during the learning process. The average increase (*N-gain*) The ability to distinguish high school students in Kesatrian 1 Semarang at 0.5205 with moderate criteria. In class XI- MIPA 1 and XI-MIPA 2 students' ability to distinguish two kinds of immunity in the immune system is higher than the student's ability to distinguish active immunization and passive immunization. The results showed that the students' ability to distinguish between types of immunization must be further improved. Students are not accustomed to discussing in the group so it took a long time when students are grouped for complete sheet student discussion.

Ability Students in Organizing

The ability of students to organize high school SMA Negeri 12 Semarang and SMA Kesatrian 1 Semarang are presented in Table 1.

Table 1 Results of the analysis of students' ability to organize

Result	SMA Negeri 12 Semarang		SMA Kesatrian 1 Semarang	
	XI-MIPA 4	XI-MIPA 5	XI-MIPA 1	XI-MIPA 2
The ability to organize early	55%	56,5%	44.1%	45.5%
The ability to organize final	88.3%	79%	73.5%	73.1%
classical completeness	94.7%	66.6%	61.7%	51.6%
<i>N-gain</i>	0.7403	0.5177	0.5263	0.5065
Criteria	High	moderate	moderate	moderate
<i>N-gain</i> each school		0.6290		0.5164
Criteria		moderate		moderate

The ability to organize is the ability to build parts in a systematic and coherent information. On the ability to organize when the students were given a description of a situation or problem orientation, students are able to identify relationships systematic and coherent among the elements that are relevant (Anderson & Krathwohl, 2010). Based on Table 4.3 it can be seen that the average *N-gain* the ability to organize in S SMAN 12 Semarang at 0.6290 with moderate criteria. This increase is showing a rapid increase, evidenced by the increase in the student's ability to organize the results of early and late. In class XI-MIPA 4 classical completeness pre-test for the ability to organize at 23.6% and class XI-MIPA 5 of 16.6%. The percentage is very low due to the previous study, the ability of students are less trained so that the student's ability in organizing low.

Once applied to the model *problem based learning* aided concept mapping, classical completeness ability to organize in both classes has increased. In class XI-MIPA 4 classical completeness increased to 94.7%, while the grade XI-MIPA 5 increased to 66.6%. The ability to

organize can be improved when students learn to create a concept map sub-material component and an immune response in the immune system. These results are supported by research Saptono *et al.* (2013). Kassab and Hussain (2010) also explained in his research that the students are able to develop a better concept map as they progress in problem-based learning curriculum.

The ability to organize in SMA Kesatrian 1 Semarang increased (*N-gain*) Of 0.5164 with moderate criteria. Increased ability to organize class XI- MIPA 1 and XI- MIPA 2 at the beginning and the end result is almost the same or equivalent as presented in Table 4.3. The ability of students to organize influenced by the students' ability to map the existing concept is based on prior knowledge and new knowledge obtained after the learning process. Although the students' ability to organize has increased for completeness in the classical result is still below 75%. That means the ability of students to be developed further through meaningful learning.

Students ability to attribute

The percentage attribute capabilities, classical completeness, and improvement of results (*N-gain*) In the SMAN 12 Semarang and SMA Kesatrian 1 Semarang presented more in Table 4.4.

Table 2 Results of the analysis of students' ability to attribute

Result	SMAN 12 Semarang		SMA Kesatrian 1 Semarang	
	XI-MIPA 4	XI-MIPA 5	XI-MIPA 1	XI-MIPA 2
Ability attribute the beginning	57.2%	57,6%	43.4%	50%
Ability attribute the end	68.4%	70.1%	61.4%	68.1%
classical completeness	50%	58%	32.3%	48.3%
<i>N-gain</i>	0.2615	0.295	0.3181	0.3629
Criteria	Low	Low	moderate	moderate
<i>N-gain</i> each school	0.2783		0.3405	
Criteria	Low		moderate	

Attribute ability is the ability to determine the destination of the information. Attribute occurs when students are able to determine the angle of view, opinions, values, or purpose behind a problem. The attribute also involves the process of marking a part of a component or another part. The ability to attribute involves the deconstruction process in which students determine the purpose of the author of a paper or problem given by the teacher. Table 4.4 is based on students' ability to attribute the price at SMAN 12 Semarang included in low criteria. Enhancement (*N-gain*) of class XI-MIPA 4 and XI-MIPA 5 at 0.2783. These results indicate that a slight increase in the students' ability to distinguish at the beginning and at the end after application of problem-based learning models aided concept mapping.

These results are due to the ability to attribute level is more difficult than the ability to differentiate and organize. Attribute the learning ability in problem-based learning is presented by analyzing the immune response and the kinds of disorders of the immune system. But in the learning process of students are still difficulties in describing it through a concept map. Concept Mapping on indicators presented by the teachers attributes the more influential than that made by the students. More training is needed so that students are able to apply concept maps to improve attribution skills. Judging from the results of classical completeness, classical completeness in both classes is still around 50%, which means that there are still many students whose ability to attribute is still low.

Meanwhile, SMA Kesatrian 1 Semarang ability to attribute included in the criteria for being with an average increase of 0,3405. However, if viewed from the classical completeness attribute the students' skills in still lacking and below 50%. It shows that the students' ability to attribute is lower

than the ability to distinguish and organize. These results are also supported by the lack of results of students in mapping the concepts and analysis of the material sub humoral immune response and cell-mediated immunity. Attribute the ability of students should be increased by extending the exercises and creating concept maps.

Secondary Data

Secondary data research-aided model of the problem-based learning concept mapping consists of pieces of student discussions, student learning activities, concept mapping, poster and enforceability of learning. The results of the student discussion sheets, concept mapping, and posters were analyzed in groups while learning implementation was analyzed based on observations by observers at each meeting of the immune system learning material. The percentage of secondary data in the SMAN 12 Semarang and SMA Kesatrian 1 Semarang are presented in Table 4.5.

Table 3 Percentage of secondary data in the SMAN 12 Semarang and SMA Kesatrian 1 Semarang

Average	SMAN 12 Semarang		SMA Kesatrian 1 Semarang	
	XI-MIPA 4	XI-MIPA 5	XI-MIPA 1	XI-MIPA 2
LDS	75	81	76	72
<i>Concept mapping</i>	64	75	66	67
Poster	76	76	72	74
keterlaksanaan learning	92%	94%	95%	97%

SMA Negeri 12 Semarang average value of LDS in class XI-MIPA 4 is lower than the class XI-MIPA 5. The average value of LDS in class XI-MIPA 4 is lower than the value of the post-test. Meanwhile, the average value of LDS in class XI-MIPA 5 is higher than the average post-test score. It shows that the analysis ability of class XI-MIPA 4 higher individually than as a group. Based on observations by researchers during the learning process, during the discussion of students are less active and less well cooperate with each other in the group. According to students, the discussions on the biological learning also still rarely done in the classroom. Teachers often use the lecture method so that learning is more often centered on the teacher. It is certainly not in line with the 21st-century education that requires students to be the center of learning. In addition, it is also not in line with the characteristics of the problem-based learning.

In SMA Kesatrian 1 Semarang average value of LDS XI-MIPA 1 is higher than the average post-test score, while the average value of LDS XI-MIPA 2 lower than the average post-test score. Based on observations by researchers and interviews with students, learning biology is very rare group discussions. Learning in the classroom using a passive lecture and students to ask and respond. Student interest in learning is also low so that needs to be built so they are motivated. Based on these factors, it can be concluded that most of the learning process is still teacher-centered it is inversely proportional to the characteristics of the problem-based learning models. The learning process in the PBL is more focused on the students as people learn (Wijnen *et. Al.*, 2017). Student-centered learning means that the learning process should be directed to the active students independent in solving a problem that is contextual.

The results of student learning product which analyzed research on problem-based learning models aided concept mapping in the form of posters and concept mapping. KD indicators of achievement of competence at 4.14 are to collect data about the importance of immunization and abnormalities in the immune system and make the media about the importance of community participation in the program and the type of immunization as well as abnormalities in the immune

system. The results of student learning product are part of the assessment of learning outcomes psychomotor aspects. Result product learning helps students to improve their skills in applying the material that has been acquired during the learning process. Analyzed a concept mapping created by students in groups of students in conjunction with a discussion sheet. Concept mapping consists of three kinds of questions the concept of the body's defense system components in LDS I, a map concept on the body's defense mechanism and concept mapping LDS II disorders of the immune system in the LDS IV.

From the data presented it can be seen that the students' abilities to analyze and describe the map concept on the different sub material. Despite an increase in students analysis skills with the help of the concept mapping but the result of making maps concept by students is still less than the expectations of researchers. Students are still experiencing difficulties in linking concepts with one another. Students are also less creative in formulating a map concept. That is because the students were not used to the concept maps for learning. Concept mapping in the textbook and handbook still not maximized benefits.

Making the concept mapping in the learning process aims to train students to map the concept is based on concepts that have been acquired during the learning process. In addition, concept mapping also enhances students' analysis skills to the problems presented. The statement was supported by research Saptono *et al.* (2013) that charting concepts can have positive effects on the development of reasoning skills. A good maps concept that will provide benefits in learning in order to achieve meaningful learning. Based on the results Hartley (2014) show that understanding and learning can be supported and improved through the process of maps concept.

Product further student learning outcomes are making posters. The poster is one form of media information that can steer the importance of community participation in the program and the type of immunization as well as abnormalities in the immune system. Poster assessment criteria assessed include images conformity with the objectives, suitability of the image with the slogan, suitability image with the message to be conveyed, the suitability of the language with the goal of posters, text content, identity, the appeal of reading, and writing with images proportionally. Differences in scores poster at both schools can conclude that the learning outcomes of students psychomotor every student is different because it is influenced by internal and external factors. Based on observations by researchers, internal factors influencing that student interest, student creativity, innovation, and enthusiasm. While external factors influencing that a group of friends, the attitude of responsibility and duties of subjects other than biology.

Implementation learning in problem-based learning model application-aided concept mapping in SMAN 12 Semarang and SMA Kesatrian 1 Semarang there are several obstacles that cause the learning carried out does not reach 100%. This requires the application of learning activity of students during the learning process in order to achieve the steps of the problem-based learning that is integrated with the concept mapping. In addition, a reduction in time spent on learning in several meetings that affect the enforceability of learning.

CONCLUSION

Based on research data analysis and discussion, it can be concluded that the application of the model problem based learning concept mapping aided effectively improve students' analysis skills in differentiating, organizing and learning material attribute on the immune system in SMA Negeri 12 Semarang and SMA Kesatrian 1 Semarang. Analysis skills in public schools namely SMAN 12 Semarang and private high school that SMA Kesatrian 1 Semarang increased visits from N-gain value. Values of N-gain SMA N 12 Semarang is at 0.4706, while SMA Kesatrian 1 Semarang at 0.4426 in the medium category.

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