Instructional technique questions in the searching phase of project based learning to increase concept map scores

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Abstract. The research aims to increase the student’s Concept Map (CM) score through the application of instructional technique questions in the stages of searching for the theoretical background of the driving question in Project Based Learning. Research is a Class Action Research with 3 Cycles, procedure of the research are: planning the lesson plan, implementation of actions, observation, reflection, and construct of expert CM. The research subjects consisted of 32 high school students. Percentage of students’s CM score calculated based Novak & Gowin. Validation test uses triangulation method: verification of CM scores suitability and documentation based on CM experts and interviews. Data analyzed as qualitative descriptive by reducing, presenting data and drawing conclusions based on complete CM data. The results shown that the instructional technique of teacher's questions increased the CM scores of students, but variation presented in component CM.

Keywords: questions, project based learning, concept map

1. Introduction
Searching for the theoretical background of the driving question is one of the stages of learning in PjBL [1]. The stage of searching for the theoretical background of the driving question is the process of searching for theoretical studies based on a list of problem questions that are used as the basis for planning the investigation [2]. Planning the investigation in PjBL aims to solve the problems presented in the form of cognitive products at the end of learning [3]. Cognitive learning products represent student’s understanding, knowledge, and attitude towards the problem being investigated [4], so it can be used as an assessment [5], one of them is Concept Map (CM) [6].

CM is a graphic that visualizes the knowledge structure of students [7]; [8]. CM visualizes student’s concepts by being arranged hierarchically and connected by labeled arrows [9]. CM consists of several components, that is: Valid Relationship (VR), Crosslink (C), Hierarchy (H), Pattern (P), Branching (B), and Example (E) [10]. Each component can be quantitatively calculated with a score [11];[12];[13]. Score calculation refers to Novak & Gowin (1984). The results of the average percentage of CM scores on PjBL to show 6.44%, thus PjBL has not optimally constructed the CM scores.

CM scores is optimized by improving communication between teacher and students that can occur at all stages of PjBL [14], no exception at the stage of searching for the theoretical background of the driving question. One form of communication is question [15]. Questions at the stages of searching for the theoretical background of the driving question are used as a systematic guide to help students improve their performance during learning. [16], making it easier for students to find answers based on the problems [17]. The answers found by students are organized in the form of a list of answers to...
facilitate students in understanding the material [18] and focus students on learning concepts [19]. The concept is constructed by students as a thought process [20], which is represented in CM scores. Questions from teachers are one form of instructional techniques [21]. Instructional techniques are the help of teachers in the form of communication containing detailed guidance [22]. The assumption is by adding instructional techniques question in the stage of searching for the theoretical background of the driving question in PjBL able to increase CM scores, thus the aim of the study is to increase CM scores through the application of instructional techniques questions in the stage of searching for the theoretical background of the driving question at PjBL.

2. Research Method
The study is a classroom action research with 3 cycles consisting of the stages of planning, implementing actions, reflection, and construct expert CM (Kemmis dan Mc Taggart in Darmawati, (2016)). Problems found from observation activities during the learning process with PjBL, thus the research subject is student’s CM score. PjBL learning uses material Musci, Anthocerophyta, and Marchantiophyta in the Pre-cycle, Cycle I, and Cycle II activities. At the end of learning student construct CM which is then calculated to get the CM score. The calculation of CM scores on PjBL is is data for Pre-cycle activities, while the calculation of CM scores PjBL with additional instructional techniques questions in searching for the theoretical background of the driving question obtained data for Cycle I and Cycle II activities.

Calculation of CM scores in refer to Novak & Gowin (1984). CM scores are obtained from calculations in each CM component, that is: VR, C, H, B, E, and P. VR is the relationship of one concept to another concept that is shown using a connecting line to get a score of 1 point. C is the relationship between concepts but different hierarchies get a score of 10 points. H is a vertical CM arrangement that gets a score of 5 points in each segment. B is the branching between the hierarchies gets 1 point in the first branch and then gets 3 points for next branch. E is an example of every concept found in the lowest hierarchy to get 1 point. P is a CM pattern that explains concepts from general to specific and detailed so that it gets a maximum score of 5 points. All scores for each component are summed to get the total CM score. Expert CM that has been prepared in advance has a different total score on each material. The total expert CM scores in the Musci, Anthocerophyta, and Marchantiophyta material were 2395, 641, and 1359 respectively. The percentage of total CM scores obtained from the calculation of the total score of all components divided by the total expert CM multiplied by one hundred percent.

CM score data is validated using data triangulation techniques (William Wiersma in Bachri, 2010). CM score that has been validated is then analyzed using qualitative descriptive analysis techniques consisting of data reduction, data presentation and conclusion drawing based on complete CM scores (Miles dan Huberman (1994) in Gumilang (2016)). Analysis of CM score in accordance with CM experts that have been prepared in advance.

3. Result And Discussion
3.1 Result
The results of the action on the Pre-cycle, Cycle I, and Cycle II generally show an increase in the average CM score. The average score of each CM component of students has increased which varies from Pre-cycle, Cycle I, and Cycle II. The average CM score in the three cycles is shown in Figure 1 as follows:
Figure 1 shows the average score on each CM component experiencing fluctuating changes, because each individual has specific advantages and disadvantages. The strengths and weaknesses of each individual are seen from the scores obtained by each student. Component C and V scores increased from Pre-cycle activities to Cycle I, but decreased in Cycle II. Score of components H, P, B, and E increased from Pre-cycle to Cycle I, but decreased in Cycle II. The acquisition of CM scores for each student is obtained based on evaluation in Pre-cycle learning until Cycle II. The scores on each component of each student are classified into two parts, below the average score and above the average score. Comparison of the number of students with the score of each CM component below the average score is shown in Figure 2.

Figure 2 generally shows a decrease in the number of students who have scores below the average for each CM component. 21.875% of students have scores below the average in Component C in Pre-cycle, then decrease to 12.5% in Cycle I, but have increased to 31.25% in Cycle II. VR component contained 21.875% in Pre-cycle, decreased to 6.25% in Cycle I, then increased in Cycle II to 31.25%. Component H has decreased from 46.875%, in Pre-cycle, to 31.25% in Cycle I, and 15.625% in Cycle II. 46.875% of students had a low score on P component in Pre-cycle, then decreased to 9.375% in Cycle I, afterward increased to 15,625% in Cycle II. Component B has decreased from 46.875% in Pre-cycle, 31.25% in Cycle I, and 15.625% in Cycle II. Component E has decreased by 9.375% in Pre-cycle, 6.25% in Cycle I, and 0% in Cycle II. 25% of students had below average scores on the total score in the Pre-
cycle, then decreased to 12.5% in Cycle I, then increased to 31.25% in Cycle II, thus in general the number of students who scored below the average in each CM component has decreased, but also an increase from Cycle I to Cycle II on some components. Comparison of the number of students with the score of each CM component above the average score is shown in Figure 3.

Figure 3. Comparison of Total Students with CM Component Scores above Average Score on Each Cycle

Figure 3 generally shows a significant increase from Pre-cycle to Cycle I, but has decreased from Cycle I to Cycle II. 9.375% of students had high scores on Component C in Pre-cycle, then increased to 28.125% in Cycle I, afterward decreased to 12.5% in Cycle II. 25% had a high score on VR components in the Pre-cycle, then decreased to 12.5% in Cycle I, thereafter increased to 15.625%. Components H, P, and B in the Pre-cycle there were no students who had a high score, subsequently experienced a drastic increase to 43.75% in Cycle I, then decreased to 12.5% in Cycle II. Components E in the Pre-cycle there were no students who had a high score, then experienced a significant increase to 37.5% in Cycle I, then decreased to 12.5% in Cycle II. 18.75% of students have a high score on the total score in Pre-cycle, 18.75% in Cycle I, then decreased to 15.625% in Cycle II.

3.2 Discussion
CM is a graph that represents various forms of relationships between concepts [26]. CM visualizes student’s concepts by being arranged hierarchically and connected by labeled arrows [9]. CM preparation involves students to identify concepts that are found and connect between concepts with one another [27], so that the knowledge structure possessed by students is represented in the total CM score (%).

The total CM score in the Pre-cycle, Cycle I, and Cycle II generally increased, but specifically on each component showed fluctuating changes. Components P, H, and B have increased from Pre-cycle to Cycle I. The increase in P, H, and B components in CM is due to the addition of instructional techniques questions that are applied in the searching phase for the theoretical background of the driving question on PjBL learning. Instructional techniques questions in the stages of searching for the theoretical background of the driving question is a guide for students to find information on the correct topic, so there is no misconception [28]. Learning that does not occur misconception aims to make students achieve cognitive processes that are more meaningful, not just discovering but also constructing information that is not yet known to students into more meaningful knowledge [29].

Meaningful knowledge possessed by students is seen from the results of observations on performance assessment in formulating hypotheses, which show an increase from Pre-cycle, Cycle I, and Cycle II by 40.56%, 56.87%, and 66.79%. Increasing the ability of students in formulating hypotheses is influenced by the addition of instructional techniques to questions used by the teacher [16]. Instructional techniques questions aim to focus students to find information that is not yet known to students that is constructed with knowledge that students already know, so that it becomes meaningful knowledge [30].
The information constructed by students is described in the form of P component in the calculation of CM. P component is a combination of the concept structure of knowledge which is described by the most common concepts at the top and decreasing to be more specific [31]. The description of the P component automatically forms a hierarchical arrangement structure in the CM [32]. The hierarchical structure in CM shows the relationship between knowledge that is already known and unknown to students [33], meaning that during the learning process there is a change in knowledge experienced by students [34]. Changes in knowledge between unknown and known knowledge of students indicates an increase in the concepts that students have, thus describing B component in CM [10].

The concept of increasing learners is related to knowledge structures that become more complex [32]. The complex knowledge structure obtained by students from the additional information obtained from the results of the discussion, which was carried out during PjBL learning with additional instructional questions in the searching phase for the theoretical background of the driving question [29]. Performance assessment data regarding group work and planning skills show improvement from Pre-Cycle, Cycle I and Cycle II. Performance assessment data scores on group work from Pre-cycle, Cycle I, and Cycle II were 37.65%, 55.23%, and 62.78% and performance assessment data scores regarding planning skills from Pre-cycle, Cycle I, and Cycle II were 40.12%, 58.76%, and 70.26%. The increase in performance assessment regarding group work and planning skills is due to the addition of instructional questions in the search phase for the theoretical background of the driving question on PjBL learning. [35]. Instructional techniques question make students focus when conducting discussions, so students are more maximal in building knowledge [36] to get a concrete structure of knowledge.

Components P, H, and B are interrelated to show the structure of knowledge [37] and understanding of students [38], thus the addition of question instructional techniques in the searching phase for the theoretical background of the driving question in PjBL learning is able to increase the CM score seen from components P, H, and B.

Components C, VR, and E decreased from Pre-cycle to Cycle I and the increase from Cycle I to Cycle II was caused by components C, VR, and E were not components that represented student’s understanding. Component C shows the relevance of points in different hierarchies [39]. The VR component shows the relationship between all the points in CM [40]. Component E shows the ability of students to mention examples that clarify the meaning of a concept [41], thus instructional techniques questions in the searching stage for the theoretical background of the driving question do not affect scores on components C, VR, and E.

The decline in components P, H, B, and E in the calculation of CM from Cycle I to Cycle II is due to the complexity of the material used in Cycle II, so that time management of students is not optimal [42]. Material that is too complex results in students’ motivation being low during learning [43], so that teachers need more time to motivate students. Time spent stimulating students’ motivation has an impact on time allocation that is not in accordance with lesson plan, and the lack of time to construct CM is shorter. Less optimal time allocation affects the results of the work done by students [44], so that a short time allocation causes the CM made by students not to be maximal.

A short time allocation when constructing CM has another impact, it is increasing scores on VR and C. The score increase in VR and C is because students are able to find points and connect them, but cannot form a maximum cognitive structure [45]. The maximum CM structure that is built by students is a structure that maps the general concept at the top, then goes down to be more specific [32].

Concept mapping is done by simplifying the concept and arranging it on paper to construct CM [46], so it takes a long time to construct CM in order to form a maximum CM structure. Short time causes the efficiency of students in making CM not optimal, resulting in a decrease in P, H, B, and E, but also increases C and VR.

Components P, H, and B are interrelated in showing the structure of knowledge [37] and understanding of students [38], thus the score increases only on P, H, and B indicating the application of instructional techniques questions in the searching stage for the theoretical background of the driving
question on PjBL is able to increase the CM score especially on components P, H, and B, but for other components requires further research.

4. Conclusion
The conclusion of the study is the application of instructional techniques in the searching phase for the theoretical background of the driving question on PjBL increases the CM scores of students, especially in components P, H, and B.

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