Instructional techniques’ teacher’s questions in the presenting stage of project-based learning to improve students’ concept map scores

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Abstract. The study aims to improve students' concept maps scores through the implementation of instructional techniques' teacher's questions in the presenting stage of project-based learning (PjBL). The research is Classroom Action Research with 3 cycles, procedures of the research are: lesson plan, implementation of action activities, observation, reflection and construct of expert concept map. The participants were 35 students of class X high school. Percentage of students' concept map scores calculated based on Novak and Gowin. Validation test use triangulation method, includes: verification of concept map scores suitability and documentation based on concept map expert and interview. Data analysis with qualitative descriptive by reducing, presenting data and drawing conclusions based on complete concept map data. The results showed that the teacher's questions as instructional techniques' in the presenting stage of project-based learning commonly improve scores of students' concept map, but each component of the concept map has a variation percentage.

Keywords: question, presenting, PjBL, concept map

1. Introduction

One of the stages in project-based learning (PjBL) is presenting that accommodates students to communicate concepts from the results of information analysis [1]. Presentation is part of oral communication that encourages students to collect, organize and construct knowledge, and communicate the concept [2]. Concepts can be communicated and visualized through cognitive learning products, such as concept map [3].

Concept map (CM) is a representation of knowledge in graphical form, which consists of nodes (concepts) and links [4]. The link between concepts is arranged hierarchically with concepts that are more generally placed in the top followed by more specific concepts [5]. Component of concept map consists valid relationship (VR), hierarchy (H), crosslink (C), branching (B), pattern (P) and example (E), which are calculated qualitatively to obtain the concept map score [6]. The average result of the concept map score in project-based learning is 7.69%, thus project-based learning has not optimally constructed the concept map.

Concept map scores in project-based learning is optimized by communication between teacher and student that can occur at all stage of project-based learning, no exception at the presenting stage [7]. Weaknesses in the presenting stage are students have difficulty understanding all the material so that there is a concept that is not communicated [8]. To overcome those by implementing questions as instructional techniques’ [9].
Instructional techniques are instructions, both in the form of statements, orders, and questions [10], which can accommodate students to make lists based on the content to be organized and constructed into concept maps [11], which is the answer to the teacher's question. Teacher's questions facilitate students to find concepts based on facts, practice communicating concepts [10], organize and summarize content, identify understanding [11], and assess students' thinking ability in finding and linking concepts that have not yet been known [12]. The relationship between concepts is represented in the concept map score [6]. The assumption with the implementation of instructional techniques in the form of teacher questions in the presenting stage on project-based learning is able to increase the concept map score.

2. Research Method
The research is a classroom action research with 3 cycles, according to Kemmis & Mc Taggart consists of planning, implementing actions and reflection [13]. Problems were identified from observation activities on pre-cycle, while cycle I was carried out by applying question as instructional techniques in presenting phase of project-based learning, and cycle II was carried out by making an improvement to cycle I. Learning topic on pre-cycle, cycle I, and cycle II is Musci, Anthocerophyta, and Marchantiophyta. The research participants were 36 students of class X high school, consisting of 24 female students and 12 male students. At the end of learning process is measurement by using the students' concept map scores is used as research data. The research data is the concept map score supported by the data performance assessment.

Analysis of the calculation of the concept map score according to the expert concept map consisting of 6 indicators, namely valid relationship, level hierarchy, branching, pattern, crosslink, and specific example. Valid relationship which shows the relationship of two concepts obtains 1 point, while the hierarchy of levels shows the superordinate relationship and subordinate concepts at different levels get 5 points for each level. Branching shows the branching from each level of the hierarchy with 1 point at the first level and 3 points for branching at the next level, while the pattern shows the concept compiled from the general to the specific gain 5 points. Crosslink shows the relationship of two concepts at different hierarchical levels to get 10 points, while specific example showing valid object specifics gets 1 point.

An example of calculating the concept map score according to Novak & Gowin (1984) is shown in Figure 1. Figure 1 shows an example of the concept map consisting of 13 valid relationships, 4 hierarchies, 3 level of branching, perfect pattern, 2 cross-links, and 1 example. The concept map score assessment rubric according to Novak & Gowin (1984) is presented in Table 1. Score of expert concept map Musci, Anthocerophyta, Marchantiophyta is 2395, 641 and 1359. The score of each component concept map is shown in Table 2. Research data analysis was carried out with qualitative descriptive analysis techniques, according to Miles & Huberman (1994) consists of data reduction, data presentation and conclusions [14]. Test the validity of research data by William Wiersma using triangulation techniques [15].

![Figure 1. Example of concept map according to Novak & Gowin (1984)](image)
Table 1. Concept map scores according to Novak & Gowin (1984)

| Indicator      | Score | Expert Concept Map Score |
|----------------|-------|--------------------------|
| Valid relationship | 1 poin | 1x13 = 13 poin          |
| Hierarchy level  | 5 poin | 5x4 = 20 poin            |
| Branchings      |        |                          |
| • 1st level     | 1 poin | 1 poin                   |
| • 2nd level     | 3 poin | 3 poin                   |
| • 3rd level     | 3 poin | 3 poin                   |
| Pattern         | Maks. 5 poin | 5 poin                  |
| Cross-link      | 10 poin | 10x2 = 20 poin          |
| Specific example| 1 poin | 1x2 = 2 poin             |
| Score Total     | 67 poin |                        |

Table 2. Expert concept map scores on pre-cycle, cycle I, and cycle II according to Novak & Gowin (1984)

| Indicator       | Pre-cycle | Cycle I | Cycle II |
|------------------|-----------|---------|----------|
| Valid relationship| 307 poin  | 65 poin | 199 poin |
| Hierarchy level  | 25 poin   | 30 poin | 25 poin  |
| Branching        | 10 poin   | 13 poin | 10 poin  |
| Pattern          | 5 poin    | 5 poin  | 5 poin   |
| Cross-link       | 1970 poin | 520 poin| 1040 poin|
| Specific example | 78 poin   | 8 poin  | 80 poin  |
| Score Total      | 2395 poin | 641 poin| 1359 poin|

3. Result and Discussion

3.1 Result
The results of the study for the concept map (CM) scores of students in pre-cycle, cycle I and cycle II generally showed an increase in the average score, but a fluctuating increase and decrease of CM component scores shown in Figure 2. Students with a score below the average are shown in Figure 3, while the above average score is shown in Figure 4.

Figure 2. Comparison of Average Score of Concept Map Components and Total Score (%) in Pre-Cycle, Cycle I and Cycle II

Figure 2 shows that the average score of VR in the pre-cycle is 27.61, then decreased to 15.28 in the cycle I and the cycle II increased by 46.89. The average score of H in pre-cycle, cycle I and cycle
II is 13.89, 25.14 and 22.43. Component C in pre-cycle has obtained an average of 211.39, while cycle I decreased to 102.57 and increased by 282.86 in cycle II. 3.47 shows the average score of component B in pre-cycle, cycle I becomes 10.09 and cycle II is 8.46. The average score of P in pre-cycle is 2.78, then increased to 4.14 in cycle I and 4.48 in cycle II. Component E shows an average of 5.83, decreased to 3.34 in cycle I and increased in cycle II by 11.26. The average percentage of total scores in pre-cycle, cycle I and cycle II was 11.38, 25.05 and 27.70.

![Figure 3. Comparison Number of Students with Component Score of Concept Map below Low Standard in Pre-cycle, Cycle I and Cycle II](image3.png)

The number of students with below the low standard scores for VR in pre-cycle and cycle I was 5.71% and increased by 22.86% in cycle II. Different results are seen in component H, which is 25.71% in pre-cycle, then decreases to 11.43% in cycle I and 0% in cycle II. Component C shows the same pattern as VR, which is constant at pre-cycle and cycle I of 8.57% and has increased to 22.86%. Students who score below the low standard for component B are 25.71%, while in cycle I and II decreased to 11.43% and 0%.

Component P has the same pattern as components H and B, in pre-cycle obtained 25.71%, while in cycle I and cycle II decreased to 17.14% and 0%. Different results seen in component E obtained 2.86% in pre-cycle, while the cycle I decreased to 0%, but in the cycle II increased to 11.43%. Students who obtain a total score below the low standard in pre-cycle and cycle I are 8.57%, while in cycle II increased by 25.71%.

![Figure 4. Comparison Number of Students with Component Score of Concept Map above High Standard in Pre-cycle, Cycle I and Cycle II](image4.png)
Figure 4 shows students who scored above the high standard for the VR was 17.14% in the pre-cycle, then increased to 22.86% in the cycle I, while the cycle II dropped to 11.43%. Components H, B and P have other variations, in pre-cycle obtained 11.43% of the total students, while in cycle I decreased to 0% and an increased to 48.57% in cycle II. Students get a score above the high standard for component C by 25.71%, while increased by 28.57% in cycle I but decreases to 11.43% in cycle II. Component E obtained 2.86% of the total students in pre-cycle, while cycle I increased to 14.29%, but decreased to 0% in cycle II. Students who get a total score above the high standard in pre-cycle is 20%, while cycle I increased to 25.71% and decreased to 14.29% in cycle II.

3.2 Discussion

Component scores of CM represent the ability to find and connect concepts [16], which consists of VR, H, C, B, P and E [17]. CM total score in pre-cycle, cycle I and cycle II generally showed an increase seen from the average total score of 11.38%, 25.05%, and 27.69%, but the component score of CM had a varied decrease and increase in each cycle. The detailed review of all CM components in pre-cycles for below-low standard, average and above high standard shows a fluctuating increase and decrease.

The fluctuating changes in each CM component show a specific pattern, but the patterns of component H, B and P show an increase from pre-cycle to cycle I. The increase in the number of students for components H and B is due to the application of instructional techniques’ teacher’s questions in the presenting stage of project-based learning. Questions facilitate students to understand the knowledge (concept) that are being studied [18]. Organizing understanding of the concept being studied represents the subsumption [19] so that students are able to classify the conceptual relations in a superordinate and subordinate structurally to forming H [20].

Questions as instructional techniques in the presenting stage increasing component H, also increase component B. A good question is able to accommodate students to think at various levels of cognitive domains, one of which is analysis [9]. Component B indicates analysis ability in the whole concept (progressive differentiation) [19] so that students are able to describe branching of superordinate and subordinate at different hierarchical levels [21]. The application of instructional techniques’ teacher’s questions facilitates students to explore and remember concepts and find concepts [22], so that concepts in the presenting stage the concepts collected, organized and constructed can be communicated which are facilitated with questions [23]. Clear communication improves understanding of the concept [23] [24] so that the CM arranged by students becomes better.

The CM component shows an increase in the number of students from pre-cycle to cycle I besides H and B, namely P. The increase in the number of students for component P is due to the application of instructional techniques teachers’ questions in the presenting stage of project-based learning. Component P shows concepts that are arranged from general to specific [6], which describes the structure of students’ knowledge and represents overall conceptual understanding [25]. Understanding of concepts is stimulated through teacher questions [26]. Teacher questions accommodate students to collect, organize and construct knowledge so that understanding of concepts increases [12]. A good question is able to encourage students to master the concepts learned [11], making it easier for students to compile P.

In-depth study of the fluctuations in component scores of CM: VR, C and E showed a decrease from pre-cycle to cycle I. The decrease in the number of students for the component VR is caused by the application of instructional techniques teachers’ questions in the presenting stage of project-based learning is not optimal, so it has not been able to increase the VR score. The VR shows the relationship between two meaningful concepts connected through a line. The construct of VR components represents students' understanding of linking concepts [6], which is stimulated through questions [21]. Questions used by teachers in the first cycle include C1, C2, and C4 so that they are less able to improve the ability to find and connect concepts, especially in VR components. Inaccurate questions can lead to misconceptions and difficulties in accepting concepts [22] consequently students in compiling VR are not optimal.

Component C shows the decreased number of students from pre-cycle to cycle I. The decrease in the number of students for component C is caused by the application of instructional techniques
teachers’ questions in the presenting stage is not optimal, so it has not been able to improve all components C. Component C which represents synthesizing ability (integrative reconciliation) [19]. The ability to synthesize can be accommodated through questions [27]. Questions used by teachers in cycle I are less able to improve the role of students in synthesizing information. Inaccurate questions can lead to misinterpretation of information [11], consequently the ability to find and connect concepts is not optimal, especially in component C, so that students in constructing C are not optimal.

The patterns of component E show a decrease in the number of students from pre-cycle to cycle I. Decreasing the number of students for component E due to the application of instructional techniques teacher’s questions in the presenting stage is not optimal. Component E shows a specific valid object [6]. The ability to mention specific objects helps students to clarify the meaning of the concept [28]. Questions stimulate students to find the information (content) [12], but the questions in cycle I lack the facilitating students to find concepts especially for component E, thus students in compiling E are less than optimal.

The component CM: VR, H, C, P and E increase from cycle I to cycle II is due to: 1) the application of instructional techniques’ teacher’s questions in presenting stage of project-based learning; 2) presenting activities maximizing students in communicating concepts; 3) the ability to store information on students; 4) student performance. Questions stimulates to recall knowledge that is already known and accommodates students to relate it to unknown concepts [29]. Minimizing misconceptions about unknown concepts by focusing students’ attention on important concepts [11], thus maximizing the level of understanding [26]. Understanding of concepts is also accommodated through presenting activities that aim to communicate concepts that have been organized so that listeners receive easily [24]. The acceptance and storage of concepts for each individual are different [30], thus affecting the construction of CM. The increase in CM scores is also influenced by student performance, namely group work. Group work stimulates students to submit ideas and questions. Students' questions accommodate critical and analytical thinking skills and communication skills [31]

The construction of CM, especially in component B shows a decrease from cycle I to cycle II. The decrease in the number of students in component B is caused by the learning material used in cycle II is more complex and student's time management is not well organized, so that in the preparation of the CM is not optimal. Learning material is related to the content that is expected to be learned, remembered and understood by students [32], but complex material causes learners to become bored and unmotivated in the learning process [33]. Students who are not motivated to have difficulty in developing information so that they are unable to collect new information and connect it to information that is already known, thus difficult to understanding and mastering concepts [34]. Understanding and mastering concepts are one aspect of students' success in learning [35]. Learning success is influenced by the ability of students to organize time [36]. Less structured time organizing to carry out activities or complete prioritized tasks results in activities and tasks not being resolved efficiently [37], thus the CM arrangement is less than optimal.

Components of CM: VR, H, C, P, and E have increased, while component B is the only component that has decreased from cycle I to cycle II, so further research is needed. The results of the analysis of the application of instructional techniques teachers’ questions in the presenting stage of project-based learning able to improve the ability to find and connect the concepts of students with CM.

4. Conclusion
The results of the implementation of instructional techniques’ teacher's questions in the presenting stage of project-based learning generally increase the students’ concept maps score, but each component of the concept map has varied increased and decreased.

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Acknowledgment
The researcher would like to thank the Principal, Biology Teacher, all students of class X MIPA at 
Sukoharjo High School and all participants who involved in the research. Researchers hope that the 
research results useful for readers and further research.