FACILITATING MALAYSIAN STUDENT TEACHERS' UNDERSTANDING OF THE BIOLOGY SYLLABUS THROUGH CONCEPT MAPPING

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This article describes the outcome of an exercise carried out with one hundred undergraduate student teachers (preservice teachers) enrolled in a Biology Teaching Methods course, a third year course in a four-year Teacher Education Programme. The students, working in groups of three to four, were assigned to construct a concept map showing their understanding of a part of the Form Four (grade ten) biology syllabus/curriculum offered in the Malaysian Secondary School System. The concept maps were derived from materials taken from the syllabus, and consisted of scientific concepts as well as the scientific skills and values associated with the chapters and their relationships. The purpose of this assignment was to familiarize the students with the syllabus and to make them understand the scope of the syllabus itself so that these preservice teachers would know what to focus on when they actually teach in the classroom. Through this exercise, not only the students' understanding of the syllabus was revealed but misconceptions among the students on the syllabus and the concept of scientific skills and values were also detected.

INTRODUCTION

Concept mapping is a type of knowledge representation and has been devised on the basis of Ausubel's learning theory (Novak, 1981). A concept map is structured by building up together small pieces of units of interacting concepts/ideas and their propositional frameworks. In order to be able to build a concept map, students will have to understand the relationship or the connection between concepts and even among concepts. The use of concept mapping as an instructional tool requires the learner to operate at all six levels of Bloom's educational objectives (Novak & Gowin, 1984). The concept map developed by the students will show their overall understanding of the topic/ theme. Students show some of their best thinking when they try to represent something graphically, and thinking is a necessary condition for learning. A concept map helps the presenter to convey his/her idea /message across to others making communication simpler because a concept map provides the 'overall view' or what some call 'the big picture' of the knowledge/ideas concerned.

A concept map has a variety of usage not only in education but in other fields as well. The use of concept map extend to a wide span of age group ranging from elementary/primary school children to scientists (Leake, Maguitman, Reichherzer, Canas, Carvalho, Arguuedas, Brenes & Eskridge, 2003). Canas, Carnot, Coffey, Feltovich and Novak (2003) described the use of concept mapping in business and government as a tool in capturing knowledge, support of group processes like brainstorming and also to serve as a tool in achieving consensus. This is due to the nature of the concept map itself that contain the ideas/concept to be discussed in orderly manner fashioned /arranged by the people involved.

Concept mapping can be used for several purposes such as to generate ideas or brainstorming; design complex structures;

communicate complex ideas; aid learning by explicitly integrating new and old knowledge (Chmeilewski & Dansereau,1998); and assess understanding or diagnose misunderstanding (Aidman & Eggan, 1998; Rice, Ryan & Samson, 1998). Concept mapping can be used in curriculum planning for showing the topics/contents of a course/ programme or used by educator at the beginning of a lesson in introducing a topic to the students. As a learning tool, students' concept maps can be used as a study guide. Novak & Wandersee (1991) stated that concept map facilitates meaningful learning, permitting application of the new knowledge in new situations and also in retaining knowledge for long periods of time. Concept maps drawn by students express their conceptions or misconceptions and can help the teacher diagnose the misconceptions that make the instruction ineffective (Ross & Munby, 1991).

Concept maps, as assessment tools, can be thought of as a set of procedures used to measure the structure of a student's declarative knowledge. Concept map measures can be characterized by: (a) a task that invites students to provide evidence bearing on their knowledge structure in a domain; (b) a format for the students' response; and (c) a scoring system by which the students' concept map can be substantively evaluated accurately and consistently. Without these three components, a concept map cannot be considered as a measurement tool (Ruiz-Primo & Shavelson, 1996). The task is the demand requiring students to provide evidence of their knowledge in a content area.

Concept mapping tasks varied in three ways: (a) demands made on the students in generating concept maps (tasks demands), (b) constraints placed on the task (task constraints), and (c) the intersection of task demands and constraints with the structure of the subject domain to be mapped (content structure). The format for students' responses can be paper-and-pencil response (Wallace & Mintzes,1990; Markham, Mintzes & Jones, 1994) where students drew the concept map on a blank page; oral response (Nakhleh &

Krajcik,1991) or computer response (Fisher, 1990) or even filling in the prestructured skeleton map (Anderson & Huang,1989).

There are no 'right'or 'wrong' concept maps and concept maps will definitely vary from individual to individual. Hence, it is useful to be able to evaluate or assess different maps. Three general scoring strategies have been used with maps: (a) score the components of the students' maps (e.g., number of links); (b) compare the students' maps with a criterion map (e.g., a map constructed by an expert); and (c) a combination of both strategies. Cronin, Dekkers and Dunn (1982) for instance developed an evaluation scheme based on Ausubelian learning principles. Wallace & Mintzes (1990) devised a scoring system whereby scoring is made based on the components involved.

METHODOLOGY

The purpose of this study was to investigate the use of concept map as an assessment tool in a collaborative setting for assessing students' understanding of biology syllabus for Malaysian schools. The syllabus concerned is the form four / grade ten biology syllabus. The sample consisted of one hundred undergraduates student teachers (preservice teachers) enrolled in a Biology Teaching Methods course, a third year course in a four-year Teacher Education Programme.

Prior to the task set, these students were given four hours of lectures on the components of the Malaysian secondary school Biology syllabus for form four (grade ten). They were also given three hours of lecture on concept mapping and futher guidance by the lecturer involved during their construction of the concept map. Students worked in groups of three or four. There were 28 groups of students involved in this exercise (16 groups of four students and 12 groups of three students).

The task was to construct a concept map on the Malaysian Secondary School Biology syllabus for Form Four. Topics required to be included in the map were the themes, the scientific skills and the values suitable for each theme involved. The format for student's response was paper-and-pencil response as used by Markham, Mintzes & Jones (1994) and Wallace & Mintzes (1990). Students were encouraged to include other graphics such as symbols or pictures in their concept map. Time given to complete the task was eight weeks. The concept maps represent one possible way of understanding the material of groups of students at the time the map was constructed.

Table 1
Content of the concept map and weightage

Weightage	Items	Sub items
5%	Inclusion of the topics	Four themes: 1. Introduction to Biology (1 chapter). 2. Investigating cell as a basic unit of life (5 chapters). 3. Investigating physiology (2 chapters). 4. Investigating the interrelationship of life and it's environment (2 chapters).
5%	Proposition on the link	Correct proposition between the concepts
30%	Levels of hierarchy	Each of the chapters in the themes arranged according to the different level of hierarchy in terms of the cellular approach in

		biology content (the simple/less complex topics to a more complex topics)
30%	Scientific skills	observation, classification, measure and using numbers, making inference, predicting, using of time and spatial skill, interpreting data, control the variables, making hypothesis, experimenting and communicating
30%	Values	Appreciate balance in nature, rational, objective, cooperative, responsible, critical & analytic, showing interests in science, honest, hard working & resilient, flexible, loving, confident & independent.

The scoring system used was an adaptation based on scoring system used by Wallace & Mintzes (1990) based on the components involved. Scoring is made based on the criteria set for each of the components: 30% is alloted to the levels of hierarchy of the chapters in the theme of the concept map, 5% for the complete inclusion of the topics, 5% for the correct proposition, 30% for the correct/appropriate science process skills in each theme and 30% for the correct/appropriate scientific and noble values associated with the topic. The content of the concept map is summarized in Table 1. The scores of the map are presented as a total value.

Table 2

The score of each group in each components in the concept map

Group	Inclusion of the topics 5%	Levels of hierarchy 30%	Scientific skills 30%	Values 30%	Prepo-sition 5%	Total
1	5	20	28	29	5	87
2	5	25	29	28	4	91
3	5	20	15*	28	3	71
4	5	15	10*	28	2	60
5	5	27	30	28	4	94
6	5	17	20	25	1	68
7	5	28	26	26	4	89
8	5	28	15*	25	3	76
9	4	10	20*	20	1	55
10	5	20	20*	25	1	71
11	5	20	15	28	1	74
12	5	29	15*	15	4	68
13	5	20	29	27	2	83
14	5	20	30	30	3	88
15	5	15	20	25	3	68
16	5	26	05	10	4	50
17	5	15	25	15	1	61
18	5	25	27	28	5	90
19	5	25	25	25	1	81
20	5	20	15	15	4	59
21	5	28	16*	20	5	74
22	5	25	16	16	2	64
23	5	15	10	10	4	44
24	5	18	26	25	2	76
25	5	28	15	15	5	68
26	5	25	15	15	5	65
27	5	20	15	05	3	48
28	5	15	28	15	5	68

* denotes misconception

RESULTS AND DISCUSSION

An example of the concept maps produced by one group of students is shown in Figure 1. The results from the analysis of all the concept maps produced by the students is summarized in Table 2. The results showed that the lowest total score is 44 and the highest total score is 94. The mean (average) total score is 71.11 indicating that on the overall, group performance is good as the score is above 50%. Even the lowest score is above 30% .

The focus on this exercise was on the understanding of the content of the syllabus. Table 3 states the average and the achievement in each compenents on this concept map. The results (Table 3) shows that students knew all the topics involved in the syllabus as the achivement percentage (mean score ÷ weightage) for the inclusion of topics is 99.2%. Students' understanding of the arrangement order of the topics involved in all the chapters is less than the first component (the inclusion of topics) but still high (71.30%). This is followed by their knowledge on science skills (66.66%), the preposition used that showed students' understanding of the relationship of the concepts (65.60%) and the values appropriate for the topics/concepts involved (63.43%). It was noted that groups that scored less in this component (values) not only list just a few values but also stated the value generally without giving specific example. For example, in the topic of Balanced Ecosystem, one of the values that could be imparted through the teaching of the topic is that students should appreciate the balance in nature; not just to appreciate God's gift to humankind.

Table 3
Mean Score and Achievement Percentage in each components of the concept map

Aspects	Inclusion of topics	Hierarchy	Science skills	Values	Preposition
Mean score	4.96	21.39	20.00	19.03	3.28
Achieve-ment percentage	99.2	71.30	66.66	63.43	65.60

Misconceptions were detected in the area of science skills. Seven groups showed some misconceptions on science skills. Thinking skills was stated the same as science skills. Examples of this misconception is classifying (science skill) which was stated to be the same as compare and contrast (which is a thinking skill), interpreting data became interpreting concepts, defining operationally was confused as memorizing a set of definitions and observing (a science skill) is confused as visualizing. Groups that showed misconceptions in the science process skills also did not state the specific science skills associated with the topics/concepts but only stated the science skill in general. For example, in the topic of mitosis, the specific science skill is observing the cells under a microscope but the science skill that was stated was only 'observation.'

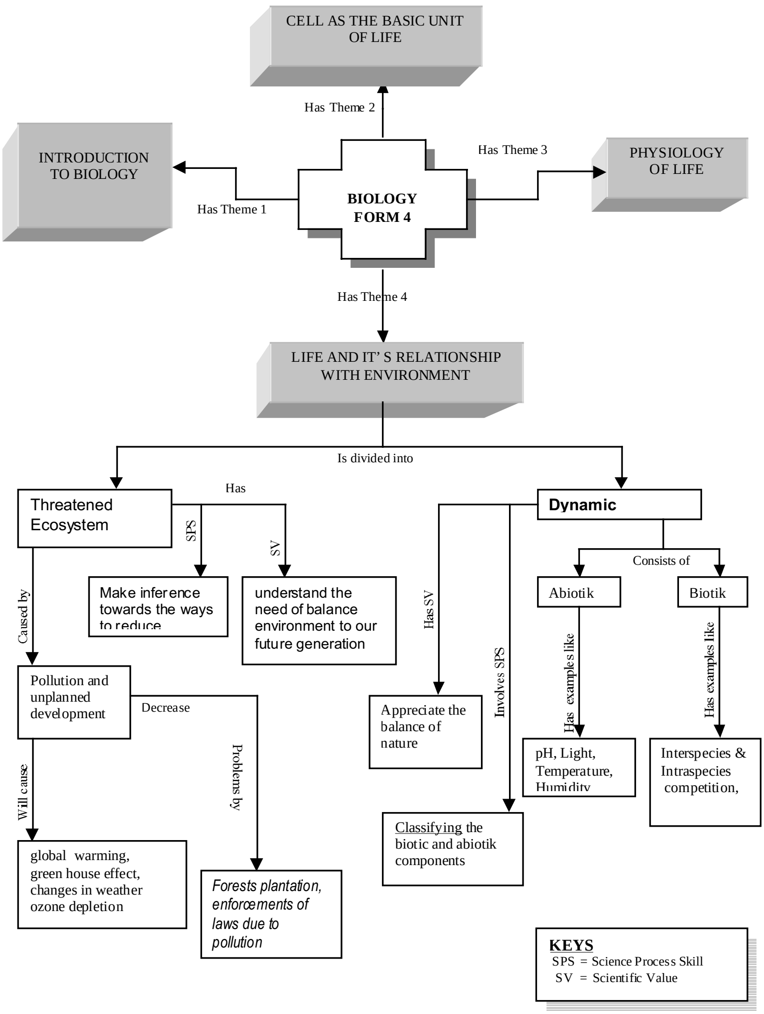

Figure 1: Caption of the concept map of Biology Syllabus for Form Four

CONCLUSION

This study showed how concept mapping can be used to assess the student teachers' understanding of Biology syllabus. In constructing the concept map, students had to evaluate their own understanding and synthesize the knowledge when they arrange the hierarchy of the topics involved, assigned the preposition on the links and synthesize the specific examples of science skills and values associated with the specific concept/topic. These activities require a high level cognitive performance as identified by Bloom (1956). Through this exercise, students were more familiar with the scope of the biology syllabus and aware of the related scintific skills and values that needed to be integrated in the teaching of Biology in the classrooms. It is hoped that once these student teachers have undergone this concept mapping exercise, they will appreciate and apply concept mapping with their students so that biology is presented in a connected manner and biology learning becomes more meaningful.

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