Exploring Students’ Cognitive Structures Through Flow Maps: Ecological Cycles

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SYNOPSIS

Introduction

Exploring learners’ cognitive structures has always been an important issue in educational research, especially in the field of science education. Cognitive structure is a hypothetical construction showing the organization and relationship between concepts in a learner’s long-term memory (Shavelson, 1974). The benefits of exploring one’s cognitive structure for education were explained by Tsai and Huang (2002) as; prior knowledge, assessment and metacognition. Before instruction, the exploration of cognitive structure can help teachers to know what their students have already assembled in their memories. If teachers know students’ prior knowledge, they can design appropriate teaching strategies and assist students to connect previous experience and new incoming information for enhancing meaningful learning. In addition, through probing students’ cognitive structures, educators can be able to understand what students learn and how their knowledge may change during the learning process. The analysis of cognitive structures can enhance metacognition and more reflective analysis of how to improve one’s own learning. Learners can retrospectively reflect on their specific concepts and compare existing structures in memory with previous knowledge. This type of reflection can enhance conceptual development.

For representing knowledge structure a variety of methods have been used including concept maps and semantic network diagrams. When showing learner’s cognitive structure they are major issues how to use quantitative terms for a valid description and how to display the cognitive structure information through visual formats. Recently, a new and particularly useful method in representing cognitive structure has been developed by Anderson and Demetrius (1993) known as “flow map method”. The flow map procedure is based on eliciting students’ narrative describing phenomena that they are observing, have observed or have represented in memory. The flow map provides a figural representation of the flow of information and identifies links and focal ideas in transcribed oral or written narratives. Flow maps are useful in identifying the knowledge framework and ultimately control the rate, linearity and complexity of recalled scientific information stored in memory (Bischoff, 2002).
The purpose of this study was to identify 30 pre-service biology teachers’ cognitive structure on carbon cycle. For this purpose, ideational networks were assessed based on written narratives of students. The amounts of ideational network linkages in narratives were analyzed through flow map method. Written narrative of students were analyzed individually, then together and transformed as a flow map by authors.

The results suggest that all the students’ narratives show a sequential pattern beginning with the events between photosynthesis and respiration. The student’s flow map that has the least ideational network contained 5 statement and 3 recurrent linkages. The student’s flow map that has the most ideational network contained 12 statement and 6 recurrent linkages. Moreover none of the students have explained all the steps in carbon cycle. The illustrative data show that students’ number of ideas contained in their cognitive structure and the connection of these ideas are inadequate on carbon cycle.

For teaching to be effective, teachers have to know their students’ pre-existing knowledge structure. Flow maps can provide important clues about students’ knowledge frameworks. Through analyzing students’ cognitive structures by using flow maps, teachers can identify students’ misconceptions, strengths and weaknesses on various scientific topics. This will guide teachers and students to identify and remove failures in students’ cognitive structures.