Analyzing the Structure of Student Sustainability Knowledge Using Traditional and Holistic Concept Map Scoring Methods

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Analyzing the Structure of Student Sustainability Knowledge using Traditional and Holistic Concept Map Scoring Methods

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ABSTRACT

To properly initiate educational reforms needed to train sustainability-conscious engineers, methods are needed to assess conceptual understanding of sustainability. Concept maps (cmaps) have been proposed as useful tools for capturing the complexity and interconnectedness of sustainability; however, difficulties in scoring cmaps have limited their application as assessment tools. The goal of this project was to examine effectiveness of traditional and holistic cmap scoring approaches for characterizing student understanding of sustainability. Cmaps were used to assess structure of student sustainability knowledge in a capstone design course and a graduate seminar in Civil and Environmental Engineering (CEE) at Georgia Tech. Judges applying traditional and holistic cmap scoring methods demonstrated at least substantial agreement (κCohen > 0.60). Convergent validity was also shown for the two scoring approaches. Results of traditional and holistic procedures suggested that graduate students possess more sophisticated semantic networks related to sustainability knowledge than undergraduates. Data on CEE student sustainability knowledge can be used to guide efforts to integrate sustainability into undergraduate curricula. More broadly, study results demonstrate that cmaps can be used as valid and reliable assessment tools.

INTRODUCTION

Sustainable Engineering: Although technology has contributed to current unsustainable practices, engineering is important for promoting future sustainable development. Sustainable engineering is a new field aimed at balancing economic, environmental, and social systems during development. To properly initiate educational reforms needed to train sustainability-conscious engineers, methods are needed to assess conceptual understanding of sustainability (Figure 1). Concept Maps (Cmaps): Cmaps, which are graphical tools for organizing knowledge, may be useful tools for capturing the complexity of sustainability. Difficulties in scoring cmaps have limited their wide-spread application as assessment tools. Two potential scoring procedures include the traditional and holistic methods(Figure 2).

OBJECTIVES

1. To determine the reliability and validity of traditional and holistic cmap scoring methods.
2. To analyze the ability of scoring approaches to discern differences in sustainability knowledge between undergraduates and graduates.
3. To provide insights into improving sustainability education in Civil and Environmental Engineering (CEE) at Georgia Tech using cmap data.

Theoretical Basis

Use of cmaps is supported by semantic memory theory, which posits that knowledge networks are formed by creating directed links between concepts. Since cmaps mimic internal semantic networks, they may be used to infer structure of student understanding[1].

RESULTS AND DISCUSSION (CONT.)

Holistic Method Outcomes: Holistic scores also revealed graduates’ sustainability knowledge networks to be more complex than those of undergraduates. Specifically, graduates’ total holistic scores were significantly higher (p = 0.027) than undergraduates (Figure 6). Thus, the holistic method was also able to capture differences in student sustainability knowledge.

Figure 1. Conceptual sustainability model.[2]

Figure 2. Traditional and holistic cmap scoring approaches.[2]

Figure 3. Methodology for scoring cmaps.

Figure 4. Intermacrelatedness of traditional and holistic scoring methods.

Table 1. Spearman correlations between traditional and holistic subscores.

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1. Cmaps can be reliably scored (κCohen > 0.60) using traditional or holistic approaches by trained judges.
2. Both scoring procedures show convergent validity for quantifying knowledge depth, breadth, and connectedness in cmaps.
3. Both traditional and holistic scoring methods can discern differences in sustainability knowledge between undergraduates and graduates.
4. Since undergraduates had statistically fewer cross-links than graduates, improvements to CEE curricula may be needed to teach students about the interrelated nature of sustainability.

REFERENCES