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The Efficacy of Concept Mapping as a Learning Tool in Life-Span Development Classes

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Abstract

The effectiveness of concept mapping on learning has been reported in research across a number of undergraduate disciplines. The purpose of the present investigation was to add to the existing literature on concept mapping in the teaching of psychology through systematic comparisons of learning in undergraduate life-span development classes. In one group, students completed concept-mapping assignments. In another group, they completed written assignments with features of relationship-identification shared with concept mapping. The combined results of quantitative and qualitative comparisons favored concept mapping over the more traditional learning assignments. Implications for future classroom research are discussed.

Over a 12-year span beginning in the late 1970s, Joseph D. Novak led a group of researchers at Cornell University who pioneered concept mapping as a graphic organizational and meta-learning strategy that assists in knowledge configuration (see Novak, 1990). He borrowed from Ausubel's (1963, 1968) meaningful theory of learning in which knowledge acquisition occurs through assimilation of new concepts into existing conceptual frameworks. With concept mapping, the learner organizes networks of concepts in a diagram resembling a hierarchical flow chart that proceeds from the most-inclusive general concept to more-specific subordinate ones (Novak, 2010). In a concept map, nodes represent concepts by means of labels containing a keyword or short phrase; links are directional lines indicating temporal or causal relationships between concepts; propositions are two or more concepts connected with descriptive words to form meaningful statements; hierarchies are row-arranged levels within the map that flow from most abstract to increasingly more specific; and cross-links are connections between initially discrete concepts in distant parts of the map that illustrate recognition of broad linkages within a topic (Mayo, 2010; Novak & Cañas, 2008). The one- or two-way directional links between subordinate concepts, along with the descriptive connecting words, depict an understanding of semantic or ideational relationships between concepts in a learner's knowledge set (Novak, 1998).

In the context of higher education, Hay, Kinchin, and Lygo-Baker (2008) discussed ways in which concept mapping can be used to "transform abstract knowledge and understanding into concrete visual representations that are amenable to comparison and measurement" (p. 295). The efficacy of concept mapping in teaching applied concepts has a longstanding history in the research literature within the natural and physical sciences (e.g., Arnaudin, Mintzes, Dunn, & Shafer, 1984; Cilburn,

1990; Wallace, Mintzes, & Markhan, 1992), including more recent applications to college-level chemistry (Singh & Moono, 2015), biology (Bramwell-Lalor & Rainford, 2013), geology (Englebrecht, Mintzes, Brown, & Kelso, 2005), and physics (Martinez, Perez, Suero, & Pardo, 2013). Dating back to the early 1990s, undergraduate nursing is another academic discipline in which the benefits of concept mapping have been widely reported (see Daley, Morgan, & Black, 2016, for a historical literature review). Although to a comparatively lesser degree, the pedagogical utility of concept mapping has also been shown within undergraduate classes in other academic disciplines, including accounting (Simon, 2007), management (Gray, 2007), technology (Alhomaidan, 2015), and teacher education (Buldu & Buldu, 2010).

In my own teaching discipline, researchers have explored the use of concept mapping in the undergraduate psychology curriculum. However, the incidence of this research has been relatively sparse. To my best knowledge, there have been no empirical or anecdotal reports in the research literature for more than a decade. In the framework of teaching introductory psychology, Jacobs-Lawson and Hershey (2002) compared students' concept maps at the beginning (pretest) and end (posttest) of the semester, concluding that concept mapping is effective at assessing students' knowledge. Similarly, in examining concept mapping in a sophomore-level personality theories course, Anthis (2005) found a significant increase in the number of quantitative items in students' concept maps from pretest to posttest. More recently, Carnot and Stewart (2006) used concept mapping in both a sophomore-level cognitive psychology class (as advance organizers for class lectures and discussions) and a senior-level culture and psychology class (as graphic organizers for each textbook-based chapter). Although they did not implement formal measurement of students' responses to concept mapping, they did find overall indications that students responded favorably when maps were targeted for a future assignment or possessed applicability to other learning scenarios.

Purpose

In the early 2000s, I had co-conducted a collaborative pilot investigation that examined concept mapping of the human nervous system as a learning assignment in multiple sections of both introductory psychology and biology classes. Visual inspection of students' work from this cross-disciplinary study showed that concept mapping provided students in all class sections with an organizational platform from which to comprehend the basic structures and functions of the human nervous system (Mayo & Salata, 2002). Following my involvement in this investigation, I have applied concept mapping more extensively throughout my own introductory psychology and several other undergraduate psychology classes. Although I have continued to observe anecdotal confirmation of the teaching and learning benefits associated with concept mapping, I have become increasingly interested in determining whether I might uncover empirical evidence in my own classes to support my more informal classroom observations. I designed the present investigation to satiate this growing personal interest, and at the same time, to add to the existing research literature on concept mapping within the teaching of psychology. More specifically, in the current study I will undertake a systematic comparison between a learning condition where one group of undergraduate life-span development students completes concept-mapping

assignments and another condition in which a different group of these students completes more traditional written assignments with elements of relationship-identification shared with concept mapping. Consistent with previous research findings on the favorable impact of concept mapping on learning, I predict that those students in the concept-mapping learning condition will demonstrate greater learning gains than those in the comparison condition.

Methods

Participants

Participants were 126 college freshmen and sophomores (79 women and 47 men) enrolled in one of four sections of a life-span developmental psychology course. Their ages ranged from 17 to 56 years (M = 25.84).

Design

As part of an independent two-group quasi-experimental design, I compared student performance in two course sections receiving concept-mapping assignments (Mapping condition) with similar performance in a Control condition consisting of two other course sections in which I gave no such assignments. Over two consecutive semesters, I randomly assigned intact classes to either the Mapping (n = 67) or Control (n = 59) condition. There were no appreciable differences between conditions on the basis of age, gender, GPA, and SAT and/or ACT scores. Except for the presence or absence of the concept-mapping assignments, I held the course content, testing format, and other pertinent instructional variables constant between conditions, including the fact that I served as instructor for all class sections.

Procedure

In both the Mapping and the Control conditions, I chose the same 10 developmental theorists as the focal points of 5 total hours of classroom instruction. I selected these theorists as leading representatives of these major developmental perspectives: ethological (Konrad Lorenz); contextual (Urie Bronfenbrenner); psychodynamic (Sigmund Freud, Erik Erikson); learning (B. F. Skinner, Albert Bandura); humanistic (Abraham Maslow); cognitive (Jean Piaget, Lawrence Kohlberg); and sociocultural (Lev Vygotsky).

In the Mapping condition, I conducted 30 minutes of preliminary training on how to properly construct a concept map based on a pre-existing, concept-mapping training module (Mayo, 2010). Following this training and the aforementioned classroom instruction on the targeted developmental theorists, I asked students to generate concept maps to portray their comprehension of the work of each theorist. Completed maps were due in class on an exam day one week after completion of the classroom instruction. In grading the maps, I followed an established grading scheme (Mayo, 2010) in which I assigned specified point values to accurate nodes, links, hierarchies, and cross-links.

Students individually completed the concept maps—each worth 1% of the final course grade—outside of class as hand-drawn assignments. I elected for a hand-drawn over a computer-generated mode of completion so as to avoid the need for additional student training on constructing concept maps electronically. As an illustrative example, Figure 1 shows a student-generated concept map for Bronbrenner's (1979) bioecological

(contextual) theory. Although this map was originally hand-drawn, for optimum presentation clarity I have re-constructed it electronically through CmapTools (Florida Institute for Human and Machine Cognition, 2018), which is a cost-free, downloadable, online software toolkit that allows users to construct, navigate, share, and critique concept maps.

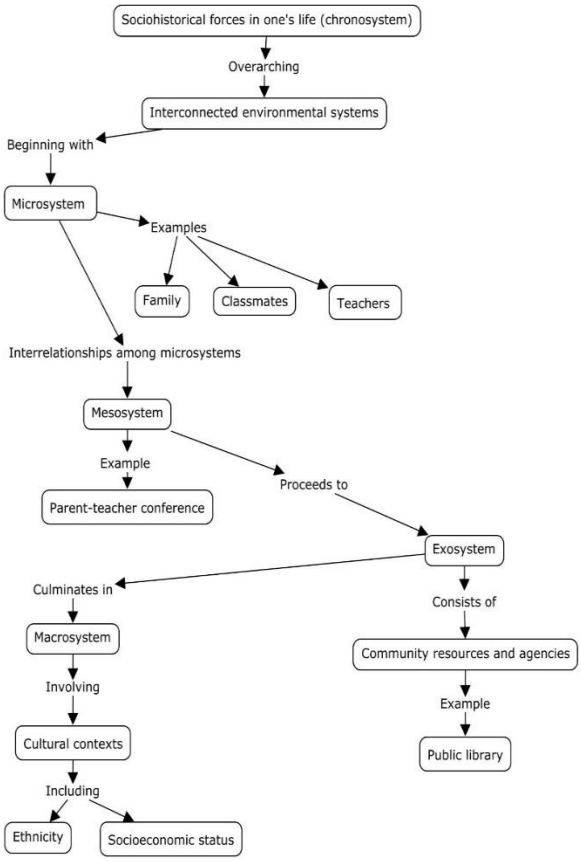

Figure 1. Computer-Generated Version of an Originally Hand-drawn, Student-Composed Concept Map of Bronfenbrenner's Bioecological Theory

In order to establish equivalency between conditions, in place of the concept-mapping assignments, I assigned students in the Control condition written assignments pertaining to the work of the same developmental theorists addressed in the Mapping condition. At the root of concept mapping is the depiction of conceptual connections. Consequently, the written assignments in the Control condition were aimed at addressing conceptual relationships between core features of the work of each selected theorist. Each assignment consisted of a maximum 350-word synopsis associated with each chosen theorist. Parallel to the procedures followed in the Mapping condition, students in the Control condition individually completed the synopses outside of class after receiving an equal amount of classroom instruction on the work of the developmental theorists in question. Moreover, each synopsis was worth 1% of the final course grade, with all synopses due in class on an exam day 1 week following classroom instruction.

Results and Discussion

As the dependent measure for use in comparative statistical testing, I used academic performance on an exam that representatively canvassed the work of the targeted developmental theorists. In both conditions, this exam was administered one week after completion of classroom instruction on the developmental theorists. In order to minimize the possibility of experimenter effects in composing and grading this exam, I selected 50 multiple-choice questions from conceptually based, test-bank items. In the dual interest of test security and alternate-form test reliability, I matched questions on content and level of difficulty in the process of selecting items for random inclusion on four different-but-equivalent exam versions (one for each of the four participating class sections). The results of an independent-groups *t*-test showed that students exposed to concept mapping (M = 83.16, SD = 8.61) significantly outperformed those students who did not receive this

Table 1

Students' Numerical Ratings of the Assignments in the Mapping and Control Conditions

	Control		Mapping	
Item	M	SD	M	SD
1. Organizing course content	3.04	0.77	4.62	0.53
2. Improving overall conceptual understanding	2.76	0.93	4.46	0.81
3. Clarifying conceptual relationships	2.89	1.01	4.33	0.65
4. Stimulating engagement in learning	2.93	0.68	4.01	0.96

educational intervention (M = 78.94, SD = 10.29), $t(124) = 2.51$, $p < .01$.

I used a brief questionnaire to assess students' perceptions of completing respective assignments in the Mapping and Control conditions. Within this survey instrument, I linked each of the following four items to a 5-point Likert-type scale with anchors at 1 (*not helpful*) and 5 (*very helpful*): (1) organizing course content; (2) improving overall conceptual understanding; (3) clarifying conceptual relationships; and (4) stimulating engagement in learning. Across all attitudinal measures, students in the Mapping condition rated far more positively the experience of completing the concept-mapping assignments than students in the Control condition rated the synopses assignments. Students' numerical ratings appear in Table 1.

At the conclusion of the survey, I invited students in both conditions to write open-ended comments about their corresponding assignments. With nearly 75% of participants in the Mapping condition responding, slightly over half voiced that the visual nature of concept maps helped them to recognize and better understand the *big picture* of interrelationships among related ideas. In contrast, only about 20% of participants in the Control condition offered comments about the synopses assignments, with the vast majority being critical insofar as conceptual comprehension and interconnections are concerned.

Viewed as a whole, the present findings suggest that concept mapping is an effective student learning tool in the context of teaching life-span developmental psychology. As predicted, the results of comparative statistical testing lend empirical support to the conclusion that concept mapping improves learning when compared to a more traditional learning task. In addition, student attitudinal data indicated that concept mapping not only possesses organizational value in learning but also serves as a graphic organizer that both encourages and facilitates students' visual understanding of concepts and their component interrelationships. These results corroborate previously discussed findings on the successful use of concept mapping as a meta-learning technique in other undergraduate classes in psychology (Anthis, 2005; Carnot & Stewart, 2006; Jacobs-Lawson & Hershey, 2002) and other academic disciplines (e.g., Alhomaidan, 2015; Buldu & Buldu, 2010; Martinez et al., 2013).

In the present investigation, students in the Mapping condition created their maps

individually. Future research on concept mapping might examine whether learning differences arise between conditions where students create concepts maps on their own and those conditions in which they rely on group processes to construct the maps. Additionally, subsequent research might focus on systematic comparisons between concept mapping and other types of graphic organizers (e.g., Venn diagrams, analogy organizers, knowledge grids) to determine if learning differences are found within these comparisons.

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