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Analogy co-construction as a learning strategy in life-span development classes

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Abstract

Analogies are commonplace heuristic tools in classrooms across all educational levels and content areas. In the present investigation, analogy-enhanced learning was examined in relation to conceptual applications of major developmental theories in undergraduate life-span development classes. To this end, systematic comparisons were undertaken between a learning condition in which individual students created their own analogies and a learning condition involving analogy co-construction as generated by small groups of students working cooperatively. On all quantitative and qualitative measures, results favored group co-construction of analogies over self-generated analogy creation. Findings are discussed in terms of social-constructivist and transformative-learning principles.

As famed Greek philosopher Aristotle wrote centuries ago, analogies imply an intuitive understanding of the similarities in dissimilar ideas (Else, 1957). Applied to teaching and learning, analogies allow students to compare topics with which they are already familiar to new topics so that they can gain a better understanding of this new information. In this sense, analogies serve a conduit function in facilitating transfer of learning between old and new understandings (Reddy, 1993). Throughout this cognitive-bridging process, learners are able to come to terms with both similarity and dissimilarity relationships between conceptualizations that are being compared. Like a camera, for example, the human eye can discriminate shades of color, judge size, register depth perception, and see movement. Unlike the camera, however, the human eye can capture a three-dimensional image, has blind spots, and does have a set focal length in relation to its lens (Amit, 2009).

Literature Review

Analogies have a long history as explanatory tools in making classroom learning more active and applied. In fact, early reports in the teaching literature show that educators have relied on analogies in the classroom for more than half a century (Heese, 1966; Oppenheimer, 1956). By prefacing their explanations with analogous expressions, such as "Likewise," "Similarly," and "Just as," teachers have incorporated analogies into their teaching repertoire (Glynn, Law, & Doster, 1998).

Across all educational levels and content areas, teachers have used analogies to present both tangible principles and abstract models and to bridge the gap between novel information and knowledge already entrenched in long-term memory (see Vendetti, Matlen, Richland, & Bunge, 2015). Most of the research on the pedagogical impact of analogical reasoning involves analogies created by teachers and textbook authors to introduce new concepts to their

students (Mayo, 2001). In science education, the literature offers examples of teacher-generated analogies that relate successfully to students' life experiences. For instance, Pinto (1998) used relative size of balls from different sports to model variation of atomic sizes. Though considerably less extensive than the literature in the natural and physical sciences, reports within the social and behavioral sciences also describe the use of analogies for conceptualizing abstract theories and models. As an illustration, Wegner (1995) proposed a computer network model of human transactive memory that compares the formation of computer networks to the manner in which individual human memory systems are linked into group memory systems.

Providing students with opportunities to make comparisons between newly and previously learned concepts supports the processes involved in analogical reasoning (Richland & Simms, 2015). When presented with more than one concept, students who engage in analogical comparison have been shown to discover the principles that are common to both ideas (Genter, 2010; Holyoak, 2012) and to transfer these shared relationships from unfamiliar examples (Orton, Anggoro, & Jee, 2012). Analogical comparisons can be used not only to uncover similarities between concepts, but also to reveal differences between them (Mayo, 2019; Sagi, Gentner, & Lovett, 2012). In classroom practice, however, teacher-generated analogies sometimes fall short in identifying similarity and difference relationships between familiar (*source*) and unfamiliar (*target*) concepts. In addition to the fact that students may not comprehend the source concept properly, they may be unable to compare features of the source and target successfully (Mayo, 2010). As a possible remedy to these problems, students may be asked to generate and apply their own analogies, which can permit a deeper and more personalized understanding of the connections between source and target when students possess sufficient entry-level understanding of the underlying principle shared by both (Mayo, 2001).

Analogies can facilitate transitions between progressively sophisticated mental constructs once students have a clear sense of what they already know (Kaufman, Patel, & Magder, 1996). However, students whose background knowledge is incomplete or inaccurate cannot be counted on to create appropriate analogies on their own. In the absence of well-defined prior knowledge of the subject matter, Wong (1993b) measured the capacity of undergraduate students to advance their conceptual understanding of scientific phenomena through the process of individually creating, applying, and modifying their own analogies. He viewed the new inferences and insights gained by these students as *generative*, "where conceptual growth emerges from continual refinement and synthesis of fragmented, incomplete knowledge" (Wong, 1993b, pp. 1259-1260). In a related experiment, Wong (1993a) also assessed conceptual change in undergraduates who not only developed, but also evaluated and modified a series of self-generated analogies for explaining scientific phenomena. Once again, he observed "nontrivial changes in explanation … [that] ranged from the emergence of new explanations to the raising of important questions about the nature of the phenomena" (Wong, 1993a, p. 367). Taken together, Wong's (1993a, 1993b) investigations demonstrate that individually conceived, generative analogies foster evolving, dynamic representations throughout the process of understanding concepts.

In order to foster analogy-enhanced learning in the field of developmental

psychology, analogies have been used to depict the nature of human development. In a widely adopted text for teaching life-span development, Santrock (1999) discussed the prevalence of three competing developmental analogies: (1) a staircase; (2) a seedling in a greenhouse; and (3) a strand of ivy in a forest. The staircase analogy (Case, 1992) symbolizes the component processes evident in the stage theories proposed by Sigmund Freud (1940/1970), Erik Erikson (1968), Jean Piaget (1926/1959), and others. From these stage perspectives, human development is represented as a discontinuous process of qualitative change that takes place over alternating developmental peaks and plateaus. In contrast, the seedling-in-the-greenhouse analogy (Kagan, 1992) embodies John B. Watson's (1930/1967) and B. F. Skinner's (1953) behavioral viewpoint in which developmental changes are learned as individuals are acted upon by their environments. Lastly, the strand-of-ivy-in-a-forest analogy (Kagan, 1992) invokes Urie Bronfenbrenner's (1979) ecological theory that stresses the importance of sociocultural and contextual factors in human development. In accordance with this approach, the ever-widening systems that support individual development occur at interconnected environmental levels that proceed from familial and community structures (*microsystem*) to overarching patterns of broader cultural variables (*macrosystem*).

Present Study's Background and Purpose

In a prior two-experiment report, the effect of analogical reasoning was examined in teaching undergraduates the conceptual applications of leading developmental theories in the context of life-span development classes (Mayo, 2001). In the first experiment, analogies were formulated to illustrate each theory as a means of comparing teacher-generated analogy learning to a control condition in which students wrote 200-word synopses pertaining to the major features of each theory. To demonstrate one of these teacher-generated analogies, "The core of personality development is like a dark and murky cavern full of sinister shadows" was used to portray Freud's (1940/1970) perspective that personality development is governed chiefly by the unconscious. The teacher-experimenter intended the dark and sinister implications to characterize Freud's largely pessimistic view of human nature that underscores the controlling influence of lower-level instincts. Students were asked to relate each teacher-generated analogy to one or more developmental theories that it best fit, offering a well-conceived written rationale for each of their choices.

In the second study of this two-part report (Mayo, 2001), systematic comparisons were undertaken between learning conditions based on teacher- versus student-generated analogies. As a parallel student-composed comparison to the teacher-experimenter's previous Freudian analogy, one student wrote that "Freud's view of the structures and functions of human personality is similar to the multilayered earth of an inactive volcanic mountain." In this analogy, the student compared the layering of volcanic rock to the positioning of the unconscious deeply beneath the surface of the conscious mind. Just as an inactive volcano may erupt after a period of dormancy, the same occurs in the human subconscious when repressed traumatic issues rise to the forefront of the conscious mind.

Overall findings from these aforementioned experiments (Mayo, 2001) showed that students experiencing analogy-enhanced learning (either teacher- or self-

generated in nature) were better able to apply these developmental theories when compared to learning without analogical components. Also, students in the teacher-generated-analogy learning condition were academically outperformed by students who individually generated and recorded their own analogies in a cumulative record of similarities and differences between source and target concepts. The dependent measure associated with these findings derived from students' scores on comparable, 50-item, multiple-choice tests administered in respective learning conditions, each emphasizing conceptual-application questions that represented major developmental theories.

Based on the results of the previous investigation (Mayo, 2001), it is known that conceptual understanding is encouraged through analogy-enhanced learning, particularly when students work individually to generate their own analogies. This report was the first to draw systematic comparisons between teacher- and student-generated analogies as part of the same study. The research literature has been subsequently absent of other empirical investigations with an emphasis on comparing varying conditions of analogy-enhanced learning. The present study was intended to help fill this gap in the literature. More specifically, the focus of the current experiment was to explore the pedagogical efficacy of group-based analogy co-construction in terms of conceptual applications of major developmental theories. It was predicted that students who experienced analogy co-construction would demonstrate greater mastery of these developmental theories than students who work on their own to construct self-generated analogies.

Methods

Participants

Participants were 113 college freshmen and sophomores (i.e., 74 females and 39 males) completing one of four sections of an introductory course in life-span development. Their ages ranged from 17 to 46 years (M = 24.83). Approximately 93% of participants were nursing or other allied-health majors. The remaining participants were spread among psychology, sociology, and teacher education majors.

Design

An independent two-group quasi-experimental design was used to compare participants' academic performance in two learning conditions. In the self-generated analogy (SGA) condition, individual students formulated their own analogies. In the analogy co-construction (ACC) condition, students worked together in small groups to co-create their analogies. Over two consecutive semesters, intact classes were assigned randomly to either the SGA (n = 55) or ACC (n = 58) condition. There were no appreciable differences between conditions based on age, gender, college GPA, and SAT and/or ACT performance.

Procedures

At the start of the semester, all participants received preliminary lecture-based instruction on conceptual foundations of the following seven, prominent developmental theories: ethological, contextual, psychodynamic, learning, cognitive, humanistic, and sociocultural. The experimenter served as the instructor in both learning conditions. Moreover, all investigation-related assignments were completed in class with an equal amount of

time allotted to assignment completion between conditions. Except for differing exposures to analogy-enhanced learning, every effort was taken to keep course content and other pertinent learning variables constant between conditions.

In the SGA condition, individual students created and recorded their own analogies and accompanying justifications to represent each of the seven developmental theories previously discussed. In contrast, students in the ACC condition worked in instructor-preassigned groups of three or four individuals to formulate and record analogies and associated justifications to portray these same developmental theories. Once assigned to their corresponding groups, students were asked to select individuals to serve in flexible and rotating capacities of facilitator, recorder, and other defined roles. As opposed to the SGA learning condition in which each student worked individually and was graded accordingly, all students working together within a given group in the ACC condition were assigned the same grade for completing the required assignment. In both learning conditions, the submission date for corresponding written assignments took place during the week prior to a follow-up exam that counted as 10% of the final-grade average. In each instance, respective written assignments also constituted 10% of the final grade.

Results and Discussion

The dependent measure was similar to the measure that was used in the preceding report (Mayo, 2001). As an objective measure of learning gains in each condition, an exam was administered that consisted of 50 scenario-based, conceptually applied, multiple-choice questions tied to the targeted developmental theories. Using procedures that were followed in the prior report (Mayo, 2001), questions were selected from test-bank items to minimize the possibility of experimenter effects during exam creation. In the dual interest of test security and alternate-form test reliability, appropriate care was exercised in matching questions on content and level of difficulty in the process of selecting items for random inclusion on two different-but-equivalent exam versions (one for each condition). The results of an independent-groups *t*-test showed that students in the ACC condition (M = 85.79; SD = 7.97) significantly outperformed students in the SGA condition (M = 82.33; SD = 9.46), $t(111) = 2.11$, $p < .05$.

A brief questionnaire was used to assess students' perceptions of completing corresponding assignments in the SGA and ACC learning conditions. Within this survey instrument, each of the following five items was linked to a five-point Likert-type scale with anchors at 1 (*not helpful*) and 5 (*very helpful*): (1) stimulating engagement in learning; (2) facilitating understanding of course content; (3) increasing motivation to learn; (4) promoting intellectual challenge; and (5) fostering interest in the subject matter. Across all measures, students in the ACC condition rated more positively the experience of completing their analogy-based learning assignment. Students' numerical ratings are shown in Table 1.

Viewed as a whole, the present findings concerning analogy co-construction are consistent with the basic tenet of social constructivism that casts learners as social beings who create knowledge in dialogue with others (Perkins, 1999). Building on the fundamental underpinnings of social constructivist theory, Bruner (1996) used the term *community of learners* to describe a classroom milieu where students work together to encourage learning. This stance favors the pedagogical efficacy of classroom

Table 1

Students' Numerical Ratings of Analogy-Based Assignments in the Self-Generated Analogy (SGA) and Analogy Co-construction (ACC) Learning Conditions

Questionnaire Item	SGA (n = 55)		ACC (n = 58)	
	M	*SD*	*M*	*SD*
Stimulating engagement in learning	3.41	0.68	4.52	0.77
Facilitating understanding of course content	3.89	0.82	4.74	0.53
Increasing motivation to learn	3.24	1.04	4.16	0.91
Promoting intellectual challenge	3.55	0.46	4.43	0.63
Fostering interest in the subject matter	3.68	0.85	4.31	0.49

environments designed for students to create shared knowledge as a means of "socially shaping, modifying, and broadening the perspectives of individual learners" (Clark, 1998, p. 93). In such classroom settings, knowledge construction may result more from social processes occurring among individuals than from personal processes occurring within individuals (Mascolo, Craig-Bray, & Neimeyer, 1997). The classroom workings of a community of undergraduate learners were observed in the present investigation. Relying on anecdotal classroom evidence (i.e., students' critical reflections) with a graduate student audience, comparable results also were found. More specifically, when a group of six graduate students in the interdisciplinary field of capacity development co-created metaphor as a means of co-discovering knowledge, a collective and learner-driven process emerged that promoted deep and long-lasting learning and knowledge acquisition (Willox et al., 2010).

Current findings indicated that cognitive advancement unfolds through interactions among students involving their arrival at shared understandings. These findings, in turn, relate to *co-regulated coordination* (Raeff & Mascolo, 1996) as a social constructivist conception that helps to explain how learners progress together through joint activity. In the words of Mascolo et al. (1997), "Co-regulated coordination occurs at the intersection of personal and social processes ... [where] individuals transform jointly produced meanings in terms of their existing skills and meanings" (p. 21).

On a theoretical level, the present results on analogy co-construction coincide with transformative learning paradigms (Mezirow, 1991; O'Sullivan, Morrell, & O'Connor, 2002) that point to the efficacy of active knowledge co-creation. Considering the findings of the current investigation, these learning models can be broadened in practice to include a formally structured process of group interaction among students that culminates in shared understandings. Because arriving at an optimal number of students to assign to classroom work groups is crucial to the success of any cooperative learning assignment (Mayo, 2013), future research might focus on systematically varying the number of students assigned to analogy co-construction groups [e.g., two versus three or four as used in the present investigation versus five or more as employed by Willox et al. (2010)] to determine whether comparative performance differences might emerge.

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