12-2009

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Recommended Citation

Speicher, T., & Kehrhahn, M. (2009). Analogical Reasoning: A Process for Fostering Learning Transfer from the Classroom to Clinical Practice. *International Forum Of Teaching & Studies, 5*(2), 52-58.

Analogical Reasoning: A Process for Fostering Learning Transfer from the Classroom to Clinical Practice

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[Abstract] In 2001, the Institute of Medicine (IOM), a committee of physicians and health policy experts charged to improve the health of the United States by the National Academy of Science, identified a gap in the area of education of health care practitioners as one of the reasons for medical error. However, one of the most common instructional methods in medical education to promote transfer and problem solving is examination of a single patient case (Shine, 2002), a pedagogical practice shown to be ineffective (Gentner, Loewenstein & Thompson, 2003; Norman et al., 2007).

Therefore, adult learners in health care may be ill-equipped through traditional classroom instructional strategies to not only transfer what they have learned in the classroom (Norman, et al., 2007; Weeks, Lyne & Torrance, 2001), but may also lack problem solving skills needed to address novel clinical problems (Battles & Shea, 2001; Shine, 2002). To address the transfer gap between the classroom and clinical environment, a literature review was undertaken. A key finding was use of multiple case examples with instructor cueing (prompting or provision of hints) was superior to use of single case examples alone for fostering transfer of learning. Based on empirical evidence and literature review findings, the authors propose a theoretical model, propositions, and implications for clinical practice for use by educators to foster transfer of learning from the classroom to the clinical practice setting.

[Keywords] Cueing; analogical reasoning; schema; applicability

Introduction

In 1999, 44,000 to 98,000 deaths occurred in the United States because of medical error, more than the number of deaths caused by breast cancer, AIDS, or vehicular accidents (Kohn, Corrigan & Donaldson, 1999). From 1999-2003, one-fourth of adults experienced a medical error (Sage, 2003). In 2001, the Institute of Medicine (IOM), a committee of physicians and health policy experts charged to improve the health of the Nation by the National Academy of Science, identified a gap in the area of education of health care practitioners as one of the reasons for medical error. The identified gap by the IOM prompted the need to overhaul clinical education at all levels. Moreover, public recognition of medical errors crystallized concerns that health care students are not effectively transferring their classroom learning to clinical practice (Battles & Shea, 2001; Shine, 2002). Traditional instructional strategies are insufficient to enable students to transfer what they have learned in the classroom (Weeks, Lyne & Torrance, 2001), or to address novel clinical problems they will face as future health care professionals (Shine, 2002).

Problem Statement

Lecture-based teaching has been one of the traditional teaching methods attributed to poor problem solving ability among health care students (Shine, 2002; Weeks, Lyne, Mosely & Torrance, 2000). For example, Weeks et al., (2000) found a failure of traditional lecture to promote transfer of critical life-saving knowledge among United Kingdom student nursing cohorts (N=392). In this study 58.5% of students made drug dosage calculation errors and after three remedial trials reached only 78% proficiency. The authors identified traditional lecture-based practices as a primary barrier for transfer of problem solving skills needed for calculation of drug dosages.

Additionally, one of the most common instructional methods in medical education to promote problem solving with novices who possess limited real-world clinical experience is examination of a patient case (Shine, 2002). However, researchers (Gentner, Loewenstein & Thompson, 2003; Norman et al., 2007) have demonstrated that use of multiple case examples with instructor cueing (prompting or

provision of hints) is superior to a single case example and essential for fostering transfer of learning to enable novel problem solving. Traditional instructional practices such as singular case examination may result in a lack of problem solving skill and mental flexibility, impeding transfer of classroom learning to clinical practice, and promulgating medical error (Shine, 2002).

Eliminating medical error is not possible because human error is inevitable, but it can be limited (Al-Assaf, Bumpus, Carter & Dixon, 2003). One way to limit error identified by the IOM (2001), researchers, and educators (Norman, et al., 2007; Weeks, et al., 2000; 2001) is effective education of health care students and professionals. Al-Assaf, et al., (2003) advocated addressing medical error directly with those who provide care. However, to move closer to addressing one of the roots of the medical error phenomenon, starting with those who educate our health care students is a priority.

The predominant mode of continuing education of health care practitioners once they enter the workforce is through classroom-based instruction (Shine, 2002). Health care practitioners must have the ability to solve novel clinical problems. However, adult learners in health care may be ill-equipped through traditional classroom instructional strategies to not only transfer what they have learned in the classroom (Norman, et al., 2007; Weeks, Lyne & Torrance, 2001), but may also lack problem solving skills needed to address novel clinical problems through traditional pedagogical approaches (Battles & Shea, 2001; Shine, 2002). An instructional approach such as case-based analogical reasoning with cueing is an alternative pedagogical approach that has been advocated to bridge the learning transfer gap from the classroom to clinical practice setting (Norman, et al., 2007) and to promote the mental flexibility practitioners need today for solving novel clinical problems (Shine, 2002).

The challenge for health care educators is to *foster* learners' transfer of a classroom learning experience to clinical practice in order to curb the incidence of medical error. As a first step to address this challenge, this paper examines the effectiveness of cueing on the case-based analogical reasoning process and proposes a theoretical model to improve transfer of learning.

Conceptual Framework

After conducting a review of transfer of learning and analogical reasoning literature, a model that nested the concepts together with the instructional intervention of cueing was not present. Therefore, to fill this gap in the literature, the Perception of Applicability Model (Figure 1.) was constructed to represent the role of cueing on promoting learning transfer.

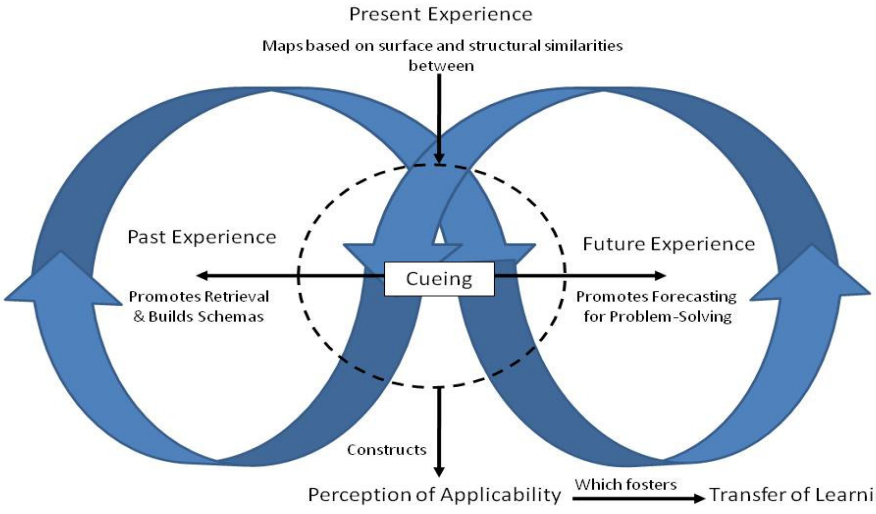

Figure 1. Perception of Applicability Model.

However, the Trio Model of Adult Learning (Sheckley, Kehrhahn, Bell, & Grenier, 2007) served as the foundation and impetus for the conceptualization of the model in its early stages, particularly Trio's emphasis on key experiences to promote cognitive processes involved in analogical reasoning (see Figure 2).

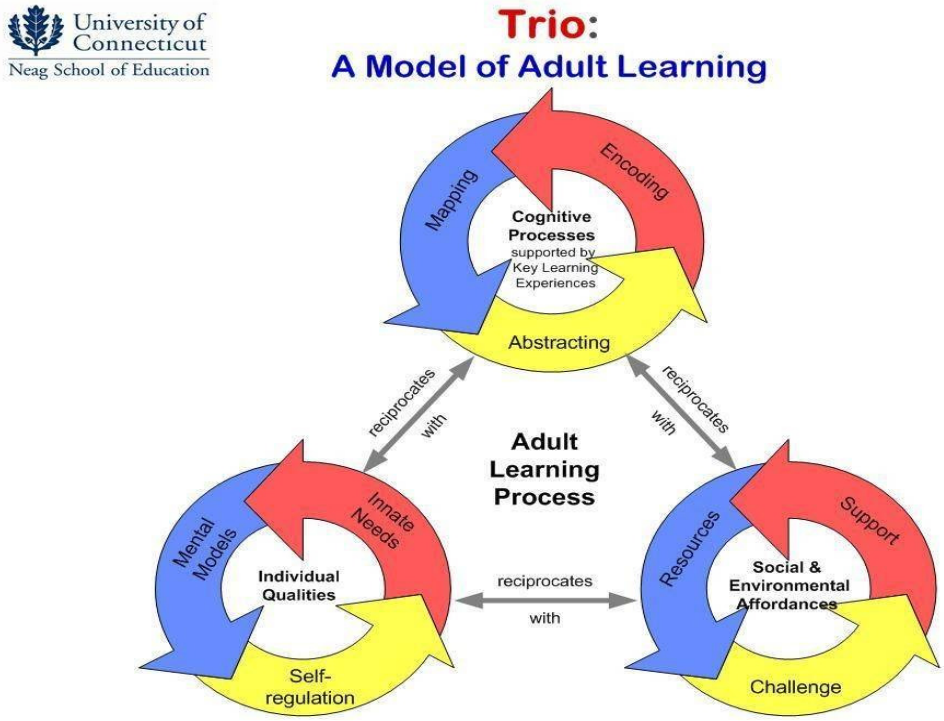

Figure 2. TRIO Model of Adult Learning.

Cueing by the instructor during case-based analogical reasoning is a key experience for learners because it helps them recall and map past experiences to their present. Cueing can also promote students' forecasting of the match between past and present experiences for problem solving and goal attainment, thereby, constructing a perception of applicability of their learning experiences for meaningful application and transfer. Following are three propositions, which evolved from empirical evidence to support the intervention of cueing during the case-based analogical reasoning process.

Proposition 1: Learning Transfer is fostered when quality schemas are developed

A schema is an abstract representation of a concept or experience and its associated properties; it is a bundle of knowledge about an experience, the more connections made, the higher quality the schema (Reed, 1996). An essential method in promoting analogical transfer is to provide the learner with key experiences (schema), which build their mental models to foster problem solving skills (LeGrow, Sheckley, & Kehrhahn, 2002). When we have an experience, we make sense of the experience by searching our relevant prior experiences to contrast and compare them to the present based on their surface and structural features (mapping)—if a problem exists, we extend the mapping to the problem (target) to be solved (Holyoak & Koh, 1987). Findings in health care and non-health care disciplines suggest when novices lack robust schemas; novel problem solving is limited (Norman et al., 2007; Novick, 1988), but can be overcome by using multiple sample cases to serve as base exemplars for novel problem solving (Norman et al., 2007; Novick & Holyoak, 1991; Shayo & Olfman, 2000).

The use of multiple case examples demonstrates the power for developing a novice's schema quality to solve novel problems, but also the necessity of the learner to perceive them as applicable for

successful analogical reasoning and learning transfer to occur. Shayo and Olfman (2000) demonstrated use of multiple examples among novices enhanced schema quality to solve novel problems. The authors examined undergraduate seniors (N=44) who had previous database and processing experience to determine to what extent two versus one database training case example in either a relevant or generic context would affect schema quality and use of a novel database. Large to moderate effect sizes[1] for improved schema quality were found among subjects who received training with two database examples over subjects who received one in either a generic (ES_r =.85) or relevant context (ES_r = .40). Moreover, a large effect size (ES_r = .86) for an ability to successfully use a novel database was observed between subjects who received relevant examples over those who did not. This study showed the value of multiple case examples in successful analogical reasoning and transfer of learning and the necessity of learners to perceive that the cases are applicable.

In traditional medical education, acquiring knowledge often precedes understanding its application, thus leaving individuals unsure if they really need to learn and transfer their learning. Yelon, Sheppard, Reznich and Sleight (2004) conducted a qualitative study on how teaching fellows (N = 73) formed the intention to transfer their fellowship training. A rich base of prior experience from which to compare proposed teaching ideas not only promoted their intention to transfer an idea, but also enabled fellows to see the applicability or fit between the idea and their experiences for attainment of future goals or solution of a problem. As illustrated in Figure 1. and articulated in proposition one, the ability of learners' to optimally compare their past and present learning experience and its applicability for solving problems is dependent upon rich past learning experiences. In sum, provision of relevant multiple case examples can assist in the development of quality schema, which serve an essential role in fostering learning transfer because they serve as a base from which individuals compare and contrast past and present experiences in order to assess applicability to problem solving and future experiences.

Proposition 2: Learning Transfer is fostered when the learner is prompted to identify shared structural relations between a base and target analog

Empirical studies have shown the effectiveness of using analogical reasoning to solve novel problems relies on learners' ability to identify the common structural relationship between base and target analogs (Gentner, Lowenstein & Thompson, 2003; Novick, 1988). According to Gentner's Structure Mapping Theory (1983), drawing an analogy between two examples leads to a structural alignment between them promoting abstraction of schemas, thereby, facilitating improved recall and transfer of learning. Gentner, et al., (2003, Experiment 1) found the ability of undergraduates (N = 48) to transfer an optimal negotiation principle for solution of a novel negotiation problem hinged on whether case examples examined shared a structural relationship. Subjects guided to compare cases containing a structural relationship proposed the optimal structural negotiation principle more than subjects not prompted to compare cases (ES_r = .57).

As observed with Gentner et al., (2003, Experiment 1) findings, earlier work by Holyoak and Koh (1987, Experiment 2) on structural relationships also demonstrated undergraduate students (N = 63) problem solved more effectively when asked to compare two structurally similar examples, particularly, when provided guidance in finding the structural principle between the examples. Subjects compared story analogs containing either high or low structural and surface similarity. Transfer of the principle for solution of the target was significantly compromised if either surface or structural similarity was reduced (ES_r = .38 & .44, respectively). However, once a hint was given only structural dissimilarity in the base analogues decreased transfer (ES_r = .26). "Detection of an analogy based solely on abstract structural features may be a rare event for novice problem solvers" (p. 338), therefore, necessitating deliberate cueing (Holyoak & Koh, 1987). Learners' map experiences based on their surface or structural characteristics as seen in Figure 1., however, as discussed in proposition two, problem solving and learning transfer is improved when learners' are prompted to examine the structural relationship they share, which requires cueing.

Proposition 3: Learning transfer is fostered when cueing is utilized to facilitate base analogue retrieval and mapping

Cueing the learner to search for either surface or relational connections between current and past experiences promotes identification of correspondences between base and target analogues, promoting both retrieval and mapping for successful analogical transfer and problem solving (Gentner, et al., 2003; Novick & Holyoak, 1991). However, identification of structural similarities serve the primary role in the analogical transfer process *after* relevance of the base and target analogues have been recognized via the provision of a hint as observed by the medium effect size found in experiment 2 by Holyoak and Koh (1987), discussed earlier. Cueing is critical when prompting individuals to identify structural relationships between analogues because it cues the learner to pay attention to the relationship among analogues for solution (Holyoak & Koh, 1987). Cueing learners to identify the relationship between analogues facilitate dissociation of the surface and structural relationship of the examples—the structural relationship serving a more powerful tool for problem solving (Gentner & Markman, 1997; Norman, et al., 2007).

Use of multiple case comparison and instructor cueing can compensate for a lack of relational experience in novices. Norman, et al., (2007) demonstrated extremely large effect sizes for improved transfer by prompting health science undergraduates (N= 35) to examine the relational structure among multiple case examples rather than utilizing one example alone to solve a target problem. When subjects were prompted to compare multiple examples, they transferred their underlying concepts to solve new clinical problems significantly better than those presented with multiple examples with no cueing (ES_r = 1.36). The group which received only one example and no prompting did worse in comparison to the prompted group which received multiple examples (ES_r = 1.74).

As depicted in the Perception of Applicability Model (Figure 1.) and discussed in proposition three, cueing serves the central role in assisting learners' to identify, recall and map their experiences to determine how they can be utilized for problem solving. Moreover, cueing facilitates identification of the structural relationship between case examples, enhancing problem solving and learning transfer (Gentner, Loewenstein & Thompson, 2003; Norman et al., 2007).

Conclusion and Implications for Practice

Educational preparation of health care practitioners requires reexamination. The traditional measure of providing singular patient case examples is ineffective in comparison to having learners' compare structurally similar cases with instructor cueing (Norman et al., 2007). If health care educators understand the factors which impact the formation of a perception of applicability of a learning experience and methods by which to facilitate it when using case examples, they can assist the learner to transfer their learning from the classroom to the clinical environment, thereby, possibly reducing the rate of medical error.

Implications for Practice

1. Educators' should identify the learner's level of experience with the instructional or case content. Identification of experience level will assist the educator to determine the extent of cueing needed to assist the learner in the case-based analogical reasoning process.
2. Novices' will require deliberate cueing during the case comparison process in order to foster their identification of the structural principle inherent in the cases for problem-solving application and future use in the clinical setting.
3. Use of relevant comparison cases with instructor cueing should occur in the education of health care practitioners. This practice will help learners' identify the applicability of the inherent structural principle for potential application and will build context specific schema of learners' for future problem solving.

The challenge for educators of health care students and practitioners is to construct and facilitate learning experiences that capitalize on identification of structurally relevant case comparison examples for solution of future clinical problems. The Perception of Applicability Model is a first step towards

establishing a foundation from which to examine to what extent and in what ways multiple case-based examinations with cueing can improve transfer of learning and problem solving to reduce the incidence of medical error rampant in the health care system.

Acknowledgement

I would like to acknowledge the contributions of my doctoral advisors, mentors and friends, Drs. Marijke Kehrhahn, Sandy Bell, Barry Sheckley, Robin Grenier and Doug Casa for their contributions to this manuscript and my continual development as an Adult Learning Practitioner.

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