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Timothy E. Speicher  
*Weber State University*

Marijke T. Kehrham  
*University of Connecticut*

Alexandra Bell  
*University of Connecticut*

Douglas J. Casa  
*University of Connecticut*

*See next page for additional authors*

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**Author Information**

Timothy E. Speicher, Marijke T. Kehrham, Alexandra Bell, and Douglas J. Casa

# Effect of Cueing on Learning Transfer Among Pre-professional Undergraduate Healthcare Students Engaged in a Case-based Analogical Reasoning Exercise

Timothy E. Speicher  
Weber State University

Marijke T. Kehrhahn  
Alexandra Bell  
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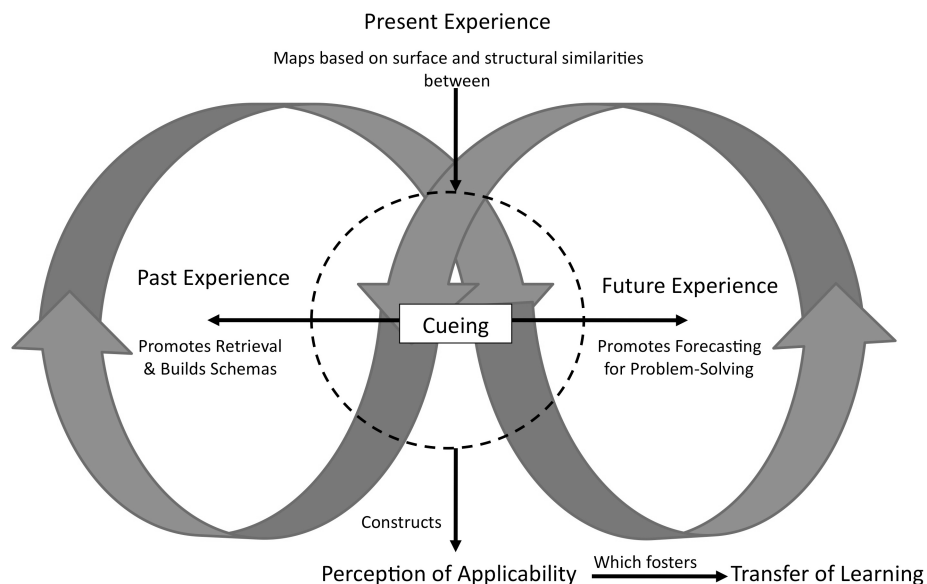
Key Words: cueing, transfer, analogical reasoning

**Abstract:** To examine the extent of transfer of cued versus non-cued pre-professional healthcare undergraduates engaged in a case-based analogical reasoning exercise. Independent *t*-test analysis and effect size was calculated to assess transfer between cued and non-cued participants ( $N = 192$ ). Cued participants ( $n = 98$ ,  $M = 2.30$ ,  $SD = .89$ ) demonstrated significantly more transfer ( $t(175.91) = 2.65$ ;  $p = .009$ ;  $CI_{95} = (.10, 0.68)$ ;  $d = .39$ ) than non-cued participants ( $n = 94$ ,  $M = 1.9$ ,  $SD = 1.14$ ). Learning transfer improves among pre-professional undergraduates when cued during a case-based analogical reasoning experience.

Transfer of learning has been characterized as the ability to use knowledge or skill obtained in one context to solve a problem in another, either similar in nature, known as near transfer, or dissimilar in context, termed far transfer (Barnett & Ceci, 2002). In allied health and medical education, instructors expect students will acquire the ability to transfer their classroom learning of patient cases to solve novel clinical problems in practice (Radtke, 2008; Shine, 2002). One of the most common instructional methods that has persisted to promote transfer and problem-solving has been the examination of a single patient case (Shine, 2002), a pedagogical practice shown to be ineffective (Gentner, Loewenstein & Thompson, 2003; Norman, Dore, Krebs & Neville, 2007). However, researchers have demonstrated that use of multiple case examples with instructor cueing (prompting or provision of hints) is superior for fostering transfer of learning to enable novel problem solving (Gentner, Loewenstein & Thompson, 2003; Norman et al., 2007).

Instructors serve a central role in the case-based analogical reasoning process because they not only cue the learner to identify structural relationships that exist between the cases being compared and the learner's past experiences, but also how these relationships may solve future problems (Shayo & Olfman, 2000; Speicher & Kehrhahn, 2009; Yelon, Sheppard, Sleight & Ford, 2004). Speicher and Kehrhahn (2009) proposed a model (Figure 1) that supports the intervention of cueing during the case-based analogical reasoning process to foster learning transfer. The cueing intervention helps learners retrieve and map their present learning

experience with their past experience. This mapping process helps to not only build an individual's schema but the match between both develops in the student a perception of being able to apply the learning experience to a current or future problem.



*Figure 1. Perception of applicability model*

Use of multiple case comparison and instructor cueing can also assist novices to focus on the structural rather than surface attributes of cases (Holyoak & Koh, 1987). Norman et al. (2007) demonstrated 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 participants were prompted to compare multiple examples, they transferred their underlying concepts to solve new clinical problems significantly better than those presented with multiple examples without cueing ( $d = 1.36$ ). The group that received only one example and no prompting did worse in comparison to the prompted group that received multiple examples ( $d = 1.74$ ). Holyoak and Koh (1987) asserted that providing the learner with prompting is a critical instructional technique for moving the student to identify structural relationships among multiple analogues or examples because it alerts the learner to look for the relationship that exists among analogues for solution. The findings of this study affirm the benefit of assisting students to dissociate surface from relational attributes among multiple-case examples.

The purpose of this study was to examine the extent of learning transfer of cued versus non-cued pre-professional healthcare undergraduates engaged in a case-based analogical reasoning exercise and to determine what factors, if any, explained variance in transfer outcomes.

## Method

A quasi-experimental randomized post-test design was utilized (Creswell, 2005). The experimental and control groups compared two worked cases (i.e., cases with solutions) involving patients who had experienced heat illness. The experimental group (cued) received written cues that guided participants to look for a solution common to both cases and to write down how each was similar. The instruction for the control group (non-cued) was to read and write down what was going on in each case separately. Cueing prompts and their presentation format were based on the work of Gentner et al. (2003) and Gick and Holyoak (1983). Additionally, based on procedures used by previous researchers (Gentner et al., 2003) to facilitate case comparison, patient cases for the experimental group appeared on the same sheet of paper with cases for the control group on separate sheets. After examining the cases, each group composed a solution for a third target case involving a hypothermic patient. Imbedded in the worked cases was an implicit shared structural principle (thermoregulation of core body temperature).

Dependent variables of the study were transfer of (a) the structural principle and (b) the optimal treatment method common to the worked cases, assessed from solution responses to the target case. Transfer was assessed on the basis of the extent of the structural similarity of the solutions provided to those embedded in the worked cases. The independent variable was the cueing intervention. Covariates analyzed were prior experience with case content and geographic location where subjects spent most of their lives.

### *Sample*

The sample consisted of ( $N= 192$ ) volunteer pre-professional undergraduate students seeking a career in allied health or medicine. Participants were randomized into either experimental ( $n = 98$ ; 40 males; 58 females) or control ( $n = 94$ ; 43 males; 51 females) conditions. Students were college-aged ( $M = 19$ ,  $SD = 1.73$ ), from the Northeast (92%) and primarily Caucasian (87%). The study occurred at four institutions of higher education in the State of Connecticut with Institutional Review Board approval.

A demographic and prior experience survey (DPES) was administered. No significant differences were found within or between groups revealing a sample homogenous in nature. Also, no significant differences in prior experience with case content between groups existed.

### *Data Collection*

Guided by the work of Gentner and Colhoun (2010), we also developed a learning transfer assessment instrument (LTAI) to determine the extent of transfer of the worked cases' structural principle (thermoregulation of core body temperature) and optimal treatment method (direct full- body treatment technique) to a third target case.

The LTAI utilized an ordinal scale from 0-3 to determine the extent of structural similarity in participant solutions. A score of 3 indicated a great extent of structural similarity and 0 represented none. Intraclass correlation coefficients (ICC) were utilized to assess inter- and intra-rater reliability of the LTAI outcomes. Inter-rater reliability of the structural principle and treatment method were .91 and .95, respectively. Intra-rater reliability ranged from .88 to .93 for the structural principle and from .95 to .96 for the treatment method.

Data collection occurred through the LTAI and DPES instruments in a one-time, 30-minute classroom environment. After worked cases were read and responses given, participants were provided the target case to be solved. In order to limit unintentional case comparison within

the control group, participants were not permitted to refer back to their worked cases or responses for solution of the third target case.

*Data Analysis*

Statistical analysis was performed with SPSS v. 16 with an alpha level of .05 (two-tailed) as the criterion for significance. An independent-samples *t*-test analysis of the mean difference was calculated to assess the extent of transfer of the structural principle and treatment method between groups. Additionally, effect sizes were calculated according to Cohen’s (1988) conventions. Correlational analysis was performed prior to ANCOVA testing to determine variance in transfer scores based on group assignment, level of prior experience and geographic location.

**Results**

Table 1 outlines the descriptive statistics for the study. A significant ( $t(175.91) = 2.65; p = .009; CI_{95} = (.10, 0.68)$ ), but small effect approaching the medium range ( $d = .39$ ) existed between the cued and non-cued groups for transfer of the structural principle.

In contrast, distribution of transfer scores for the optimal treatment method were relatively equivalent. However, no significant difference was found for cued and non-cued groups ( $t(190) = .874; p = .39; CI_{95} = (-0.14, 0.36)$ ) and an even smaller effect size ( $d = .13$ ) was present.

**Table 1.** Mean Difference of Transfer Scores

<b>Outcome Variable</b>	<b>Cued Participants</b>	<b>Non-Cued Participants</b>	<b><i>t</i> Value</b>	<b><i>P</i> Value</b>	<b>Effect Size (<i>d</i>)</b>
Structural Principle	M = 2.30 SD = .89	M = 2.14 SD = .86	(175.91) 2.65	.009	.39
Treatment Method	M = 1.9 SD = 1.14	M = 2.03 SD = .90	(190) .874	.380	.13

Correlational analysis of the dependent variables (structural principle and optimal treatment method) and covariates (prior experience and demographics) did not reveal any significant relationships ( $p = >.05$ ). Therefore, based on these findings, the covariates were assessed not to have had an impact on transfer outcomes, negating the need for ANCOVA analysis.

**Discussion**

Historically, students pursuing an allied health or medical degree have received the majority of their professional education and training based on the case method of instruction (Sage, 2003). However, findings of our current study, which are consistent with those in the cognitive literature (Gentner et al., 2003; Gentner & Colhoun, 2010; Novick & Holyoak, 1991; Shayo & Olfman, 2000), suggest multiple case examination with cueing to be a more effective pedagogical technique over singular or multiple case examination alone to improve learning transfer and problem solving among novice pre-professional healthcare undergraduates.

Additionally, our findings support the underpinnings of case-based analogical reasoning with cueing for novice healthcare students; cueing students to look for structural relationships across multiple patient cases assists in identification of the cases shared structural principle(s), (b) builds schema that result in more effective problem-solving and (c) fosters learning transfer. Moreover, the results of the study also suggest that cued students may form a perception of applicability of their learning experience, thereby, improving transfer because they are aware the learning experience will help them solve a future goal or problem.

Seel (2006) has argued though that solution of complex real-world problems may not be teachable at all through a mock analogical reasoning process. He contended problems must be “experienced and dealt with using general intelligence and world knowledge” (p. 47). Moreover, critics may also point out that novices not only need similar prior experience to engage in successful analogical reasoning and transfer, but must also possess proficiency in the respective domain: albeit; without experience, no opportunity exists to even develop proficiency, let alone recall the experience for application. However, Gentner et al. (2003) showed that prior experience with a source analogue or domain—although helpful to engender analogical reasoning—is not absolutely necessary because multiple case examination with cueing supplants lack of prior experience within the domain and serves to fill relational gaps in individuals’ experience, thereby, providing them a foundation upon which to compare and solve novel problems.

Our findings for transfer of the structural principle affirm the value of using a case-based analogical reasoning process with cueing to improve transfer in a pre-professional undergraduate novice population. Cued participants who demonstrated greater transfer of the structural principle likely did so because they were prompted to actively look for and compare the structural similarities between the heat-illness cases unlike non-cued participants who analyzed the cases separately.

Compared with the positive findings for transfer of the structural principle, the cueing intervention did not have a significant impact on transfer of the optimal treatment method to the target case. A simple explanation may exist for this finding. Novick (1988) has found when novices attempt to solve a problem they are likely to retrieve similar past experiences to form their solution procedure, even when cued to use a correct solution procedure that has been provided. Lacking a significant difference in our groups based on prior experience with the case content, the likelihood exists that the lack of a transfer effect of the optimal treatment method was the result of either how the cues or cases were constructed; cued participants may not have recognized the future utility of the optimal treatment method utilized in the heat-illness cases. That is, the written cue or solution of the hypothermic case may have been so simple and intuitive in nature (i.e., apply heat directly to the patient) that the cueing intervention had a negligible influence.

So, if the process of multiple case examination with cueing is such a powerful tool for facilitating learning transfer, then why was a larger effect for cued and non-cued participants not evident in this study? The authors attribute the lack of robustness in effect between groups to possible limitations associated with the cueing intervention. One such limitation may have been how the cueing intervention was delivered.

In order to control variance in our study, we chose to deliver the cueing intervention through written instruction instead of guided verbal instruction, which has been shown to be effective in promoting transfer. Gentner et al. (2003) found undergraduate business students who received guided instruction (probing participants with questions related to their understanding of

comparison cases for application to a test case) proposed more solutions and demonstrated better transfer of a business negotiation principle to solve a business problem than participants who received simple or no instruction. These results point to the value of providing students with real-time guidance and feedback to assist them in calibration of their thinking when engaged in a case-based analogical reasoning process. Even though paper-based cueing may ensure more consistent delivery of cases and their cues, the format does not provide learners' feedback on how the cases or the structural principle(s) might be interpreted or applied. The paper-based delivery format may have also caused cognitive overload of the participants.

When the capacity of working memory is limited or exceeded, cognitive overload occurs (Tuovinen & Sweller, 1999). The inability of our participants to reference the worked-cases and respective analyses when attempting to solve the target case may have unduly taxed their working memory, causing cognitive overload, which inhibited transfer and problem solving. Cognitive load theory suggests that individuals have a limited short-term working memory capacity that can be overwhelmed with complex task requirements (Tuovinen & Sweller, 1999). We believe that even though our participants were provided worked case examples with solutions and ample time to complete the problems, the lack of verbal explanation coupled with the need to remember the cases and analyses when attempting to solve the third case may have demanded a greater amount of working memory to process the structural attributes of the cases, thwarting a more positive transfer effect.

Regardless of the limitations in the present study, cued participants transferred the structural principle more than non-cued participants and solved the dissimilar patient case more effectively. Even though generalization of the study and its outcomes to other teaching methods (e.g., problem-based learning, web-based learning, etc.) and non-academic settings (e.g., workplace training) is limited because the study setting occurred in a traditional undergraduate academic classroom environment, clinically, the implications are significant.

### **Implications**

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 U.S. National Academy of Sciences, identified a gap in the area of education of healthcare practitioners as one of the reasons for medical error. We along with our other colleagues (Gentner & Colhoun, 2010; Hummel & Nadolski, 2002; Norman et al., 2007; Shine, 2002) believe that traditional instructional strategies such as single case examination are insufficient to enable students to transfer what they have learned in the classroom to address novel clinical problems they will face as future healthcare professionals (Shine, 2002; Weeks et al., 2001). The challenge for educators of health care students and adult learning practitioners is to construct and facilitate learning experiences that capitalize on identification of structurally relevant case comparison examples for solution of future clinical problems.

### **Conclusion**

The findings of our study are a first step towards addressing the medical error phenomenon and overall lack of transferability of classroom instruction to clinical practice. Two observations from our findings are particularly relevant based on the context of educating future healthcare practitioners. First, learning transfer and problem solving are improved with the use of a paper-based format that provides novel pre-professional healthcare students cues when examining



multiple worked cases, a potentially useful pedagogical tool to engender novice learning for large class sizes. Second, a paper-based format may not be as useful for teaching treatment approaches unless constructed in a manner that brings more depth to the application of their principle(s) or concept(s). Future research should explore how the pedagogical approach utilized in this study works over an extended period of time with allied health students, medical students and practicing clinicians. Additionally, studies should be conducted to determine what role and magnitude a perception of applicability of a case-based analogical reasoning learning experience plays in the motivation of individuals to transfer classroom learning to clinical practice.

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