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Learner-Centered Teaching: Postsecondary Strategies That Promote "Thinking Like A Professional"

The Learner-Centered Psychological Principles (LCPs) provide a holistic framework that integrates social constructivist and cognitive theories, as well as motivational and individual differences theories. We have used these to better align our own classroom practice with the rapidly expanding knowledge about how learning occurs. In an active and collaborative learning environment, we have used specific instructional techniques, identifying similarities and differences strategies, to enhance students' thinking and learning skills. Original research on the novice-expert continuum supports the domains of the LCPs and underscores the importance of strategies to engage students in identifying similarities and differences to enhance students' abilities to "think like a professional."

A CRITICAL PURPOSE OF postsecondary education is to prepare students for their future professional lives. Meeting this purpose requires supporting students in developing deep understandings of their disciplines and in honing their critical thinking abilities. Helping students "think like a professional" in the field is at the heart of learner- and learning-centered education at the college level.

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Learner- and Learning-Centered Practices

As indicated by McCombs (this issue), supporting changes in educational practice and educational systems so they operate more congruently with the growing body of knowledge about human learning was one impetus behind development of the Learner-Centered Psychological Principles (LCPs) (APA Work Group of the Board of Educational Affairs, 1997). A similar desire to make teaching practice at the college level consistent with learning theory has led to intentional changes in our own pedagogical approaches at the classroom level. Although our approach has been formed around an independent understanding of social constructivist theory and cognitive theory, the LCPs provide an overarching framework that integrates these as well as elements of motivational and individual differences theories (Lambert & McCombs, 1998).

In the work we do with college students, learner- and learning-centered principles merge in an active and collaborative learning environment. Learner-centered educational environments have been described as those in which the focus on individual learners is combined with a pedagogical approach that incorporates the best available knowledge about how learning occurs (Lambert & McCombs, 1998). Specifically, attention is given to creating a

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supportive context that addresses an array of individual students' prior knowledge, skills, attitudes, beliefs, and needs (Bransford, Brown, & Cocking, 2000; McCombs, 1997). Thus, the culture of the learner- and learning-centered classroom is cooperative, collaborative, and supportive, and the instructor and students learn together (Barr & Tagg, 1995; Huba & Freed, 2000; McCombs, this issue).

We have adopted the collaborative and active learning approach of Johnson and Johnson (1989) as a vehicle to create the social context for learner-centered education. The process of discovering what students are thinking, providing opportunities for them to examine and correct possible misconceptions, and providing situations that invite students to expand their thinking and build new knowledge is enhanced by students' active participation in guided and authentic collaborative exercises (e.g., Johnson & Johnson, 1989; Stage, Mullen, Kinzie, & Simmons, 1998; Thompson, Jungst, Colletti, Licklider, & Benna, in press). In addition to enhancing student learning, these approaches have also been shown to increase retention (Gardiner, 1994; Slavin, 1992; Svinicki, 1992).

This article includes a brief summary of the specific literature that supports instructional approaches we have used in the college classroom. We then describe strategies we have found to be effective, and link them to what, in practice, are overlapping domains of the LCPs.

"Thinking Like a Professional": What Does Novice-Expert Research Tell Us?

To meet the postsecondary education goal of developing students' professional-level expertise, teaching should be done in a manner consistent with findings on expert performance in domains that are relevant to a particular discipline (Niemi, 1997). Although there is no direct substitute for the kinds of life experiences that "make an expert an expert," Glaser (1992) has suggested that findings from novice-expert research can be used to structure learning experiences that move students farther and faster toward thinking like an expert in the discipline.

It is generally recognized that experts in some domains use frameworks for thinking so problem solving appears to occur without conscious effort. Key research identifying differences between novices and experts has been summarized by Glaser (1992) and Bransford et al. (2000). Very briefly, experts' proficiency is *highly specific*, and allows them to (a) discern meaningful patterns in information they encounter (e.g., the classic chess master study by deGroot, 1965); (b) effectively organize knowledge around major principles and concepts (e.g., Chi, Feltovich, & Glaser, 1981); (c) respond to context and access appropriate knowledge to address it (e.g., Glaser, 1992); (d) perform fluent or effortless retrieval of relevant knowledge (e.g., Spiro, Coulson, Feltovich, & Anderson, 1994); (e) self-regulate in terms of attention allocation and feedback recognition (e.g., Glaser, 1992; Wineburg, 1998); and (f) remain flexible in their application of knowledge (also referred to as *adaptive expertise*, Hatano & Inagaki, 1986). It is important to note, however, that expertise in some domains (for example, interpreting history) is not always characterized by "smooth and efficient" performance by experts (Wineburg, 1998). In any domain, a learner-centered approach to developing expertise requires purposeful and specific instruction that builds student capacity in these arenas.

Thinking About Thinking in a Learner-Centered Context

All of the aforementioned attributes of expertise are important, and teaching to enhance individual student performance in that regard will help all students begin to think like professionals. Some depend heavily on broad and deep content knowledge and major principles that can be used to organize that knowledge (e.g., items a-c above and the cognitive factors identified in the LCPs); others depend on self-awareness and context awareness (items d-f above, and the metacognitive factors identified in the LCPs). We believe that self-regulation (including metacognition—knowledge of what one does and does not know), as well as attention to "real-time" feedback while on task, is a frequently overlooked expert skill that can and should be intentionally developed through work with each student. In fact, the research of Wineburg (1998) suggests that arriving at an "expert" solution, even for an expert, can depend heavily on self-questioning and self-monitoring during a given task. This ties in particularly well with propositions that "it is less the doing than the thinking, reflecting on that doing, that counts" for learning (Leamnson, 2000). Such reflection can be intentionally structured into learner-centered experiences.

Effective Learner-Centered Practices That Contribute to Expertise

Effective learner-centered teaching strategies, then, should contribute to the breadth and depth of content knowledge, assist students in learning how to organize knowledge around major concepts and principles, enhance retention and retrieval, and contribute to student development of metacognitive abilities, among other things. One group of strategies that has many of these characteristics is "identifying similarities and differences."

Instructional strategies for identifying similarities and differences

In their meta-analysis of research studies on instructional strategies, Marzano, Pickering, and Pollack (2001) identify nine general strategies that have a high probability of enhancing individual student performance. Of those nine, the instructional strategies aimed at identifying similarities and differences had the largest effect sizes and percentile gains in student performance after exposure to the instruction. Although Marzano and colleagues were working with data generated in the K-12 setting, and making recommendations for the use of strategies specifically for K-12 educators, we have found applications in postsecondary settings.

We believe the effectiveness of these strategies relates directly to the innate tendencies of humans to search for meaning and make sense of experiences, and the natural inclination of our brains to seek recognizable patterns, including the motivational/affective and cognitive/metacognitive domains in the LCPs (see also Caine & Caine, 1997; Markman & Gentner, 1993). Students can be encouraged to further develop these innate tendencies, and to become more aware of when and how they are doing so. In this regard, identifying similarities and differences strategies lend themselves particularly well to developing students' abilities to think like professionals. In addition, use of these strategies in a supportive and collaborative context addresses the developmental/social and individual differences domains of the LCPs.

In terms of practical classroom application, Marzano et al. (2001) indicate that identifying similarities and differences strategies can include a variety of approaches, including comparing/contrasting, classifying/categorizing, as well as creating similes and analogies, and that they can be used effectively with either instructor-generated or student-generated structures. The following are three specific examples of identifying similarities and differences strategies we have used to accomplish learner-centered objectives in our own postsecondary classrooms.

Venn diagrams. While there are numerous ways to structure compare/contrast exercises, one that is relatively simple and can be structured in a variety of ways is the use of Venn diagrams. A Venn diagram, in its simplest form, consists of two overlapping circles. Each circle represents a topic or idea to be compared. The overlap between the two circles represents things that are common to both, while the nonoverlapping areas of the circles represent those things that are true only to the topic in that circle—that is, the differences between the two topics. The instructor supplies the two things that are to be compared, and students are then asked to put as much information as they can into appropriate locations in the overlapping circles.

When students are first introduced to Venn diagrams used in this way, it is helpful to explain why the strategy is being used, and to give them some practice in the form of a simple diagram using familiar items to be compared. In one course, before using a three-circle Venn diagram in a specific course-related comparison, the whole class spent five minutes adding information to a two-circle diagram comparing cars with bicycles (Figure 1). Some obvious things were mentioned first, such as steering wheels for cars, handlebars for bicycles, and wheels for both. Then one student indicated that pedals should be placed in the bicycle circle, but another student quickly said pedals should go in the overlap area, because cars have pedals too (albeit gas pedals and brake pedals). With that seemingly trivial discovery, student interaction and interest moved to a new level as they

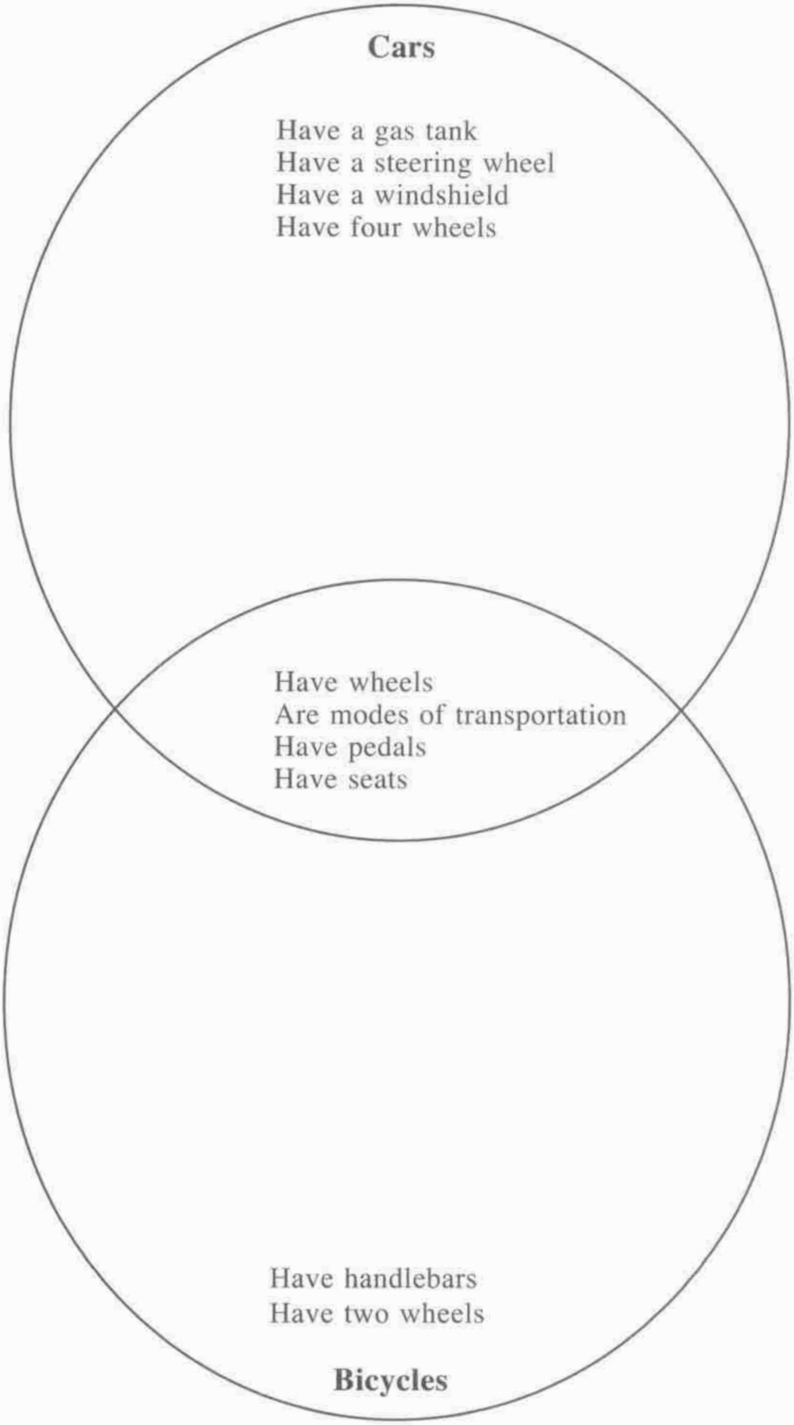

Figure 1. Example of a two-circle Venn diagram identifying similarities and differences between cars and bicycles.

tried to think of things that seemed different but were, in fact, common to the two.

At the end of the two-circle exercise, students were assigned to teams of two people. Each team member was given a three-circle Venn diagram with each circle representing a height determination method that had been studied in this aerial photo interpretation class. With a three-circle Venn diagram, there are zones of overlap for each combination of two of the three things being compared, and one zone of overlap for all three. It is possible, depending on the things being compared, that one or more of the zones of overlap might remain empty, but students were encouraged to do their best to come up with meaningful items of comparison for each of the zones.

Initially, students were instructed to work independently for 10 minutes to do the most complete job they could of filling in the various zones on the diagram. At the end of that time, they were instructed to share what they had developed with their teammate, and to add and note information that their partner identified but they had missed in their initial individual efforts. They were also asked to work together to identify still more items, and to clearly indicate which items were additions made as a result of discussions with their partners that neither of them had thought of previously. After completion of that portion of the exercise, a three-circle diagram was constructed on the chalkboard, and through whole-class discussion, the circles were filled in as completely as possible. Again, students were asked to add to their own diagrams anything discussed by the whole class that they might have missed in their two-person teams.

This approach involves eliciting students' intrinsic motivation (motivational/affective domain of the LCPs; see also McCombs & Pope, 1994), improves students' abilities to organize their knowledge, and makes it easier for them to retrieve appropriate information when faced with a task requiring use of one of the height determination methods (cognitive domain of the LCPs). Test scores to date for students exposed to this instructional strategy appear to bear this out. In addition, this exercise has multiple self-regulating/metacognitive points. Students become aware of items they failed to identify (or items that they could identify but did not apply to the correct situation), and they clearly recognized differences between their original individual version and the whole-class diagram (addressing the metacognitive factors as well as social/developmental and individual differences domains).

Yet another strength of this learner-centered approach is the use of graphic representation, which has been shown to enhance student understanding of and ability to use knowledge (Halpern 1992; Marzano et al., 2001; Robinson & Kiewra, 1995).

Categorization grids. Another example of a similarities and differences strategy uses categorization/classification as an instructional tool. Categorization grids (Angelo & Cross, 1993) have been described as an assessment tool to evaluate students' skills in analysis of information, but they also are very effective as a learning device. "Cat grids" can be created by the instructor and given to students as a direct way to introduce or summarize information. Marzano et al. (2001) indicate that such direct methods are surprisingly effective. Alternatively, the ordinates alone can be determined by the instructor and students can provide information to fill each cell, or the grid can be completely created by students using ordinations they invent. Ordination topics should be large ideas or concepts around which other ideas can be organized, and they can be simple or hierarchical.

The first and most direct method works well in introductory-level courses or in the introductory sessions of more advanced courses in which students will later create their own cat grids. Offering the completed grid allows students to learn possible ways to organize information, and provides a concrete example of knowledge organization they can then apply to concepts taught later in the course or the curriculum. Figure 2 shows an example of the second approach, providing only the classification variables, for plant structural and functional characteristics from an advanced class in urban forestry. This approach is useful when the instructor wants to clearly define the intended organization and to have more influence on what is remembered and how it is remembered. The third approach is more effective at illustrating students' own organization of knowledge and helps students begin to recognize the large concepts and principles and sort subordinate information related to them.

An example of the use of categorization grids with student-invented ordinations comes from an urban forestry course. After a discussion of pollutants in urban environments and their effects on plants in urban settings, students working in groups of three were asked to develop categorization grids on overhead transparencies and then present their grid to the class. Different sets of student-invented ordinates included comparisons of the nature of the pollutants (e.g., solid, liquid, or gas) and the time frame over which they had an effect (long-term versus short-term); portions of the environment most directly affected by the pollutant (air, water, soil) and sources of pollutants (industrial, commercial, residential); and affected portions of the environment and level of ease with which they thought the pollutant could be controlled. Students then answered questions from the instructor and their peers about the organization of information in their grids.

Characteristics of this exercise that assist students in developing expertise include providing practice in effectively organizing knowledge (cognitive domain), helping students create their own mental models that will enhance knowledge retrieval in the future (cognitive and motivational domains), and requiring students to reflect on their process and product by responding to questions (metacognitive factors). In addition, preparation of the grids in small groups provides a social context for construction of new knowledge and metacognition (cognitive and social/developmental domains; see also King, 2002). This is especially true of cat grids with student-invented ordinations that are developed while working in small groups.

In the Venn diagram exercise, students practice with simple representations and move to more complex ones, whereas in the cat grid exercise the shift is usually from instructor-structured to student-structured grids. In both cases, these progressive strategies are employed with the intention and often the explicit suggestion that students can recognize possibilities for generating their own diagrams and grids based on other forms of information in other contexts.

Similes. Experts mentally compare or categorize not only the specific, concrete aspects of information, they also look for patterns at more abstract levels. Using similes and developing students' skills in creating similes are good ways to help students practice identifying abstract similarities and differences between two different elements. Using and creating similes at first seems more challenging to students than other strategies

	STRUCTURE		FUNCTION	
	Genetic Influence	Environmental Influence	Genetic	Environment
Crown (branches/leaves)				
Stem/Trunk				
Roots				

Figure 2. An instructor-generated set of ordinates for a categorization grid for plant structural and functional charateristics.

for identifying similarities and differences. However, this strategy helps students uncover what they may know or believe about a concept or idea prior to more formal instruction. And, with some practice, students can start to develop their own similes for important concepts.

We have used an activity involving similes in a seminar about creativity. Many people, including our students, have some ingrained ideas about creativity, the most typical being that "I'm not creative," a negative response that forms a barrier to additional learning. Engaging students in thinking about how creativity is like a random set of inanimate objects can remove barriers to deeper thinking.

In this exercise, students were divided into groups of four, and each group was given a paper sack that contained a number of objects. The task for each group was demonstrated by the seminar leader, who reached into a sack and pulled out an object, a bar of soap. Holding up the soap and considering how creativity might be compared to it, the leader said, "Creativity is like a bar of soap because its shape can change as it is used." A second demonstration, after the leader pulled a rubber band from the sack was, "Creativity is like a rubber band because it can stretch our thinking." Next, the leader engaged students in guided practice with this kind of thinking by holding up a third object, a dog bone, and asking students to write down a thought that came to mind about how creativity is like a dog bone. It is important to note here that the leader gave time for all students to create an individual answer because the process takes longer for some than others. After students had time to do their own thinking, several student suggestions were solicited.

Next the leader demonstrated how students should continue the process in their groups. The instructor asked each of the four students in each group, in turn, to provide his/her simile to the group using the complete statement each time, "Creativity is like a _____ because _____." It was emphasized that students should write down their own thoughts independently before any other student offered an idea out loud.

Students were told to use the same process, and to make note of what every student said about every object until each person in the group had the opportunity to draw an object from the sack. After completing this process, students were instructed to each choose one simile used that had particularly strong meaning for them and to post it for the entire class to consider. The class was then invited to examine the similes posted by their classmates and to try to find patterns, similarities, differences, and/or any other observations they could make about the information before them. Finally, as a last step, students were instructed to reflect by writing about their own thinking during this process, how their thinking about the abstract concept might have changed, and to generate questions this raised for them. It is interesting to note that after using similes to explore creativity, nearly all participants expanded their knowledge about creativity, believed they could be creative, and even suggested ideas to motivate themselves to think in more creative ways.

Each time this technique was used, it was quickly apparent that there were many diverse similes for creativity (individual differences domain). In addition, this activity has consistently generated active engagement in discussion about the concept (motivational/affective domain). This process has generated similar results for other abstract concepts such as leadership, learning, assessment, and outcomes. In short, students gain deeper understanding, construct their own working meanings, recognize patterns in thinking about abstract concepts, and self-reflect about the process and products associated with this exercise (cognitive/metacognitive and developmental/social domains).

Conclusion

We arrived at our own understandings of social constructivist theory and cognitive theory incrementally, through research, interaction with our colleagues engaged in college teaching, and through classroom experimentation. The LCPs provide integration of these elements and a holistic framework (Lambert & McCombs, 1998) that furthers our understanding of effective classroom practice. The use of strategies for identifying similarities and differences support much of what we know about human learning. Original research on the novice-expert continuum and on the important role of metacognition supports the LCPs and underscores the importance of these strategies. Use of these strategies in a learner- and learning-centered collaborative environment leads to deep understanding of content, and helps students develop abilities that will enhance their expertise.

Although our examples come from individual courses, at a curriculum level purposeful design of a sequence of exercises with increasing complexity (e.g., Glaser, 1992) will motivate students to independently and intentionally seek to identify similarities and differences as a habit of mind. Acquiring this habit will truly allow students to begin to think like a professional. In addition, increased emphasis on the LCPs in postsecondary education will assist educators in meeting the needs of all learners and providing opportunities for learners to develop specific expertise.

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References

Angelo, T., & Cross, K. (1993). *Classroom assessment techniques: A handbook for college teachers*. San Francisco: Jossey-Bass.

APA Work Group of the Board of Educational Affairs. (1997, November). *Learner-centered psychological principles: A framework for school reform and redesign*. Washington, DC: American Psychological Association.

Barr, R., & Tagg, J. (1995, Nov/Dec). From teaching to learning: A new paradigm for undergraduate education. *Change*, *27*(6) 13-25.

Bransford, J., Brown, A., & Cocking, R. (Eds.). (2000). *How people learn: Brain, mind, experience, and school*. Washington, DC: National Academy Press.

Caine, G., & Caine, R. (1997). *Teaching and the human brain*. Tucson, AZ: Zephyr Press.

Chi, M., Feltovich, R., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science*, *5*, 121-152.

DeGroot, A. (1965). *Thought and choice in chess*. The Hague, Netherlands: Mouton.

Gardiner, L. (1994). *Redesigning higher education: Producing dramatic gains in student learning*. Washington, DC: George Washington University. (ASHE-ERIC Higher Education Report Vol. 23, No. 7)

Glaser, R. (1992). Expert knowledge and processes of thinking. In D. Halpern (Ed.), *Enhancing thinking skills in the sciences and mathematics* (pp. 63-75). Hillsdale, NJ: Erlbaum.

Halpern, D. (1992). A cognitive approach to improving thinking skills in the sciences and mathematics. In D. Halpern (Ed.), *Enhancing thinking skills in the sciences and mathematics* (pp. 1-14). Hillsdale, NJ: Erlbaum.

Hatano, G., & Inagaki, K. (1986). Two courses of expertise. In H. Stevenson, H. Azuma, & K. Hakuta (Eds.), *Child development and education in Japan* (pp. 262-272). New York: Freeman.

Huba, M., & Freed, J. (2000). *Learner-centered assessment on college campuses: Shifting the focus from teaching to learning*. Boston: Allyn and Bacon.

Johnson, D., & Johnson, R. (1989). *Cooperation and competition: Theory and research*. Edina, MN: Interaction Book Co.

King, A. (2002). Structuring peer interaction to promote high-level cognitive processing. *Theory Into Practice*, *41*(1), 33-39.

Lambert, N., & McCombs, B. (1998). Learner-centered schools and classrooms as a direction for school reform. In N. Lambert & B. McCombs (Eds.), *How students learn: Reforming schools through learner-centered education* (pp. 1-22). Washington, DC: American Psychological Association.

Leamnson, R. (2000, Nov/Dec). Learning as biological brain change. *Change*, *32*(6), 34-40.

Markman, A., & Gentner, D. (1993). Structural alignment during similarity comparisons. *Cognitive Psychology*, *25*, 431-467.

Marzano, R., Pickering, D., & Pollack, J. (2001). *Classroom instruction that works: Research-based strategies for increasing student achievement*. Alexandria, VA: ASCD.

McCombs, B. (1997). Self-assessment and reflection: Tools for promoting teacher changes toward learner-centered practices. *NASSP Bulletin*, *81*(587), 1-14.

McCombs, B., & Pope, J. (1994). *Motivating hard to reach students*. Washington, DC: American Psychological Association.

Niemi, D. (1997). Cognitive science, expert-novice research, and performance assessment. *Theory Into Practice*, *36*(4), 239-246.

Robinson, D., & Kiewra, K. (1995). Visual argument: Graphic organizers are superior to outlines in improving learning from text. *Journal of Educational Psychology*, *87*(3), 455-467.

Slavin, R. (1992). When and why does cooperative learning increase achievement? Theoretical and empirical perspectives. In R. Hertz-Lazarowitz & N. Miller (Eds.), *Interaction in cooperative groups: The theoretical anatomy of group learning* (pp. 145-173). New York: Cambridge University Press.

Spiro, R., Coulson, R., Feltovich, P., & Anderson, D. (1994). Cognitive flexibility theory: Advanced knowledge acquisition in ill-structured domains.

In R. Ruddell, M. Ruddell, & H. Singer (Eds.), *Theoretical models and processes of reading* (4th ed., pp. 602-610). Newark, DE: International Reading Association.

Stage, F., Mullen, P., Kinzie, J., & Simmons, A. (1998). Creating learning-centered classrooms: What does learning theory have to say? Washington, DC: George Washington University. (ASHE-ERIC Higher Education Report Vol. 26, No. 4)

Svinicki, M. (1992). Practical implications of cognitive theories. In K. Feldman & M. Paulsen (Eds.), *Teaching and learning in the college classroom* (pp. 27-39). Needham Heights, MA: Ginn Press.

Thompson, J., Jungst, S., Colletti, J., Licklider, B., & Benna, J. (in press). Experiences in developing a learning-centered natural resources curriculum. *Journal of Natural Resource and Life Science Education*.

Wineburg, S. (1998). Reading Abraham Lincoln: An expert-expert study in the interpretation of historical texts. *Cognitive Science, 22*(3), 319-346.