The Effects of Metacognition and Concrete Encoding Strategies on Depth of Understanding in Educational Psychology

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The study compared the academic achievement, as measured by final examination scores, of an experimental group of undergraduate educational psychology students who were provided with concrete mechanisms designed to promote metacognition and the use of specific encoding strategies to the achievement of a control group of similar students who were not provided with the same concrete mechanisms. The two groups were taught by the same instructor, who used the same teaching methods and identical class activities, homework, quizzes, and tests. The results indicated a statistically significant difference between the two groups, favoring the experimental group. Implications of the study for instruction and suggestions for further research are included.

This study explored instructional designs that encourage learners to become responsible for their own learning. Responsible learners are metacognitive, strategic, and high achievers. Therefore, researchers have become interested in investigating ways to foster learners' metacognition and strategy use.

The purpose of the study was to examine the impact of concrete mechanisms for promoting metacognition and the conscious use of encoding strategies on the achievement of undergraduate educational psychology students. The theoretical frameworks that guided this study included (a) information processing and human memory, (b) metacognition, and (c) strategies for promoting encoding.

Information Processing and Human Memory

Information processing is the conceptual framework used to describe the way humans gather, organize, store, and retrieve information. It describes learning structures in terms of a system composed of a sensory memory that receives and briefly holds information until it can be organized, a limited-capacity working memory that consciously organizes information into conceptual structures that make sense to the individual, a long-term memory that stores knowledge and skills in a relatively permanent fashion, and metacognitive monitoring that regulates this processing (Atkinson & Shiffrin, 1968; Chandler & Sweller, 1990; Mayer & Chandler, 2001; Paas, Renkl, & Sweller, 2004; Sweller, 2003; Sweller, van Merrienboer, & Paas, 1998). The way knowledge is stored in long-term memory has an important impact on learners' ability to retrieve that knowledge and effectively organize and store new information. Meaningful knowledge is more easily retrieved and more effectively aids the organization and storage of new information than is knowledge stored in isolated bits, most commonly represented in long-term memory through rote memorization (Lin, 2007; Mayer, 2002).

Meaningfulness describes the extent to which individual elements of a conceptual structure are interconnected, such as a history student understanding the relationships between Marco Polo's visit to the Far East, the Portuguese explorers, and Columbus's visit to the new world, as opposed to knowing isolated information about each (Gagne, Yekovich, & Yekovich, 1997). Attempting to make content meaningful is essential in all content areas, and it is particularly important in educational psychology, because educational psychology courses are designed to help students apply their understanding of the content to their personal lives and to the real world of teaching and learning.

Metacognition and Encoding

Metacognition refers to individuals' awareness of and control over the way they process information (Meltzer, Pollica, & Barzillai, 2007), and *encoding* is the process of representing information in long-term memory (J. R. Anderson, 2007). Research indicates that metacognition has an important influence on the way students learn, in general, and encode information, in particular (Pressley & Hilden, 2006). Students who make conscious attempts to meaningfully encode information consistently achieve higher than those who are less metacognitively aware (Kuhn & Dean, 2004).

Encoding Strategies and Cognitive Activity

Encoding strategies refer to learners' conscious attempts to encode information into long-term memory in ways that are meaningful to the individual. Four encoding strategies are commonly described. They include (a) *organization*, an encoding strategy that involves the clustering of related items of content into categories that illustrate relationships (Mayer, 2008); (b) *schema activation*, a strategy that involves activating relevant prior knowledge so that new information can be connected to it (Mayer & Wittrock, 2006); (c) *elaboration*, the process of increasing the number of connections among items of existing knowledge (Terry, 2006); and (d) *imagery*, the process of forming mental pictures (Schwartz & Heiser, 2006). Learners who consciously use encoding strategies are mentally (cognitively) active as they make decisions about how to make the information they're studying as meaningful as possible. In contrast, simply reading a textbook, for example, or memorizing information can be a relatively passive process. The study attempted to measure the extent to which providing concrete mechanisms that promote metacognition and encoding strategies impacts introductory educational psychology students' depth of understanding.

Method

Participants

Fifty three undergraduate students (35 females and 18 males) in a 3-credit hour introductory educational psychology course made up the experimental group, which was provided with the mechanisms for promoting metacognition and the use of encoding strategies. Their achievement was compared to the achievement of the control group consisting of 64 undergraduate students (41 females and 23 males) who were not offered the concrete mechanisms. No statistically significant differences existed between the experimental and control groups with respect to aptitude, as measured by the SAT.

Educational Psychology Course

The experimental group and the control group were taught by the same instructor who used the work of Bransford, Brown, and Cocking (2000) and Stiggins (2008) as a model for organizing the learning environments for both groups. Bransford et al. (2000) suggested that productive learning environments must be learner centered, knowledge centered, and assessment centered; and Stiggins (2008) embraced the conception of assessment for learning. Using this work as a guide, the instructor explicitly stated her learning goals for each topic and carefully aligned her assessments with her learning goals. She developed the content of the classes with real-world examples and high levels of interaction to promote deep understanding, frequently assessed the students' understanding of the content and provided detailed feedback to gain insight into the students' thinking and increase their learning. The instructor used the same methods and class activities, as well as the identical quizzes, midterm, and final exam for both the experimental and the control groups. Students in both groups were given detailed feedback about their performance on the class activities, quizzes, and midterm. Practice quizzes written in the same format as the quizzes used in the class were available on the website for both the experimental and the control groups. Both classes were taught during the day and in a format of two 75-min class sessions per week.

Treatment: The Concrete Mechanism

The treatment for the experimental group consisted of the opportunity to bring one 8.5 × 11-in. sheet of information to each of the 13 quizzes, the midterm, and the final exam. The students were told that they could include any information on the sheet that they believed would help them perform well on the assessment, organized in any form they chose. The treatment was an attempt to encourage the students in the experimental group to use the encoding strategies described in theoretical frameworks. Therefore, this study did not intend qualitative analysis on the concrete mechanism (i.e., how sophisticated they were or which type of strategies was used more frequently); however, every student created the information sheet for each of the quizzes, the midterm, and the final exam.

Nevertheless, because the students were limited to information that they could fit on one 8.5 × 11-in. sheet of paper (one side only), they were required to be metacognitive about what information they would include, and as they prepared the sheet they had to activate relevant schema and organize and elaborate the information in a way that was as meaningful as possible to make it usable. If they created diagrams, flow charts, or any other form of visual representation, they would also be using imagery. Using any or all of the encoding strategies required the students to be cognitively active.

This process is very different from using an open-book or open-note approach to the quizzes and exams, which doesn't require the use of any of the encoding strategies in addition to those they used when they originally took and organized their notes. In addition, beyond their routine quiz and test preparation procedures, an open-book or open-note approach allows students to remain cognitively passive. In fact, using an open-book–open-note approach might detract from preparing thoroughly for assessments, because students often overestimate the help their book or notes will provide during the assessments themselves.

Data Sources

The data sources for the study were the experimental and control group members' scores on the final exam for the course. The final exam was cumulative; therefore, students' understandings of all the topics in the class were assessed on the exam. The final exam created by the instructor consisted of 60 multiple-choice questions. All of the items on the final exam were interpretive exercises (Miller, Linn, & Gronlund, 2009), each of which was composed of a short vignette combined with four choices that "interpreted" the information in the vignette. The students were then required to select the most accurate interpretation (see Appendix for a sample item). All of the items could be classified into the "understand conceptual knowledge" cell or the "apply conceptual knowledge" cell using the taxonomy table created by L. Anderson and Krathwohl (2001), or could be classified into the comprehension or application levels using the taxonomy developed by Bloom, Englehart, Furst, Hill, and Krathwohl (1956). Because the items were similar in difficulty, the Kuder-Richardson Reliability Formula 21 was used to measure the reliability of the exam. The reliability coefficient was .89.

Results and Discussion

An independent-samples *t*-test was used to analyze the data. The results showed a statistically significant difference between the mean scores on the final examination of the experimental group (M = 38.21, SD = 4.998) and that of the control group (M = 35.66, SD = 6.111), p = .017. In addition, the effect size of .455 indicated a medium to large practical significant difference. The findings suggested that providing concrete mechanisms for promoting metacognition and the systematic application of encoding strategies significantly increased the achievement of the experimental group.

It is believed that the students in the experimental group achieved higher since they took active roles in their own learning by organizing information, activating relevant prior knowledge, elaborating on existing ideas, and forming mental pictures. Therefore, these results supported the contention that the encoding strategies outlined in the theoretical frameworks are effective. The nature of the assessment system is also likely a factor in this process. An assessment system that requires deep processing of the course content makes the use of encoding strategies more important than they would be if assessments were largely composed of items that require only knowledge of facts and definitions.

Conclusions

Implications

This study offers several implications for teaching educational psychology as well as other content areas. First, it suggests that providing a concrete mechanism for promoting metacognition and the use of specific encoding strategies can increase student achievement. It is reasonable to assume that instructors of educational psychology routinely encourage their students to be metacognitive as they study the content of their classes as well as encourage their students to use effective encoding strategies. However, they probably are less likely to provide concrete mechanisms for promoting metacognition and the use of the strategies. This study suggests a process for doing so that is both concrete and, within the limitations of the study, effective.

Second, it supports the widely held, and intuitively sensible, conclusion that educational psychology is more effectively taught and assessed at a level that requires the deep processing of information. The following quote underscores this assertion:

> All too often, classroom evaluation places heavy emphasis on the recall or recognition of comparatively isolated pieces of information to which the students have earlier been exposed. This encourages surface (memorizing) approaches to learning. Further, it has been repeatedly demonstrated that isolated details are especially readily forgotten, and that information is remembered better and is more useable if students learn it within a broader framework of meaningful interrelationships and understanding.
> (Crooks, 1988, p. 467)

These assertions have been consistently corroborated by other research (e.g., Diperna, 2006; Hussain, 2008; Roach, Niebling, & Kurz, 2008) since Crooks (1988) published his review.

Last, it appears that the suggested mechanism for promoting metacognition and the use of encoding strategies should generalize to content areas other than educational psychology. By providing opportunities for learners to become metacognitive and strategic, instructors can foster students' deep understanding of content areas, which would lead higher achievement.

Limitations and Future Research

This study is limited in some areas that need to be examined in future research. First, this study focused only on cognitive outcomes. Examining students' emotional reactions to the process of providing concrete mechanisms for promoting metacognition and encoding strategies, and their intrinsic motivation as well as their self appraisals of competence and autonomy in response to the process appear to be worthwhile topics for further study. Second, this study didn't include qualitative data. Future studies should examine students' information sheet to analyze types of encoding strategies (e.g., organization, elaboration) used and levels of sophistication to more fully investigate the process of effective learning.

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Appendix

Sample Item

Morgan, who is taking a math test, looks it over and decides to answer all the multiplication problems first, because those are easy for her. Next, she will turn to the division problems, which are a little “tricky.” She saves the word problems for last, because she finds them fun. Morgan always leaves five minutes at the end of the test to go back and check any answers she’s unsure about, especially the division problems. The concept from information processing best illustrated in this description is:

A. activity
B. metacognition
C. rehearsal
D. retrieval