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ABSTRACT

In two studies, college students' self-regulated learning was assessed and used as a predictor of transfer. Study 1 (n=229 undergraduates) explored whether components of self-regulation related to the ability to transfer information from a base problem-solving task to a target problem-solving task. Study 2 (n=98 undergraduates) replicated the methods of the first study and extended them to transfer of text structure by groups trained or not trained with a reading strategy focusing on text structure. Components of self-regulated learning reliably predicted transfer on the problem-solving task. Self-regulation did not predict transfer of text structure for participants trained to use the text structure strategy, but was a reliable predictor for participants who did not receive training. (Contains 4 tables and 17 references.) (Author/SLD)

Can Self-Regulated Learning Predict Transfer of Problem-Solving and Text Structure?

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Abstract

In two studies, college students' self-regulated learning was assessed and used as a predictor of transfer. Study 1 explored whether components of self-regulation related to the ability to transfer information from a base problem-solving task to a target problem-solving task. Study 2 replicated the methods of first study and extended them to transfer of text structure by groups trained or not trained with a reading strategy focusing on text structure. Components of self-regulated learning reliably predicted transfer on the problem-solving task. Self-regulation did not predict transfer of text structure for participants trained to use the text structure strategy, but was a reliable predictor for participants who did not receive training.

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Can Self-Regulated Learning Predict Transfer of Problem-Solving and Text Structure?

The creation of flexible knowledge structures is crucial in this information age. One way to promote flexible knowledge is transfer. Transfer involves noticing corresponding information between familiar and novel tasks, creating connections between relevant background knowledge and new information, and applying that information to facilitate learning or problem solving (Gick & Holyoak, 1980). This process leads to meaningful, flexible schemata (Salomon & Perkins, 1989). However, transfer is an effortful process and rare (Gick & Holyoak, 1980; Catrambone & Holyoak, 1989). This paper examines whether self-regulated learning can predict those college students who will transfer and those who will not.

Garcia and Pintrich (1994) and Zimmerman (1994) suggested that knowledge, motivation, metacognitive control, and self-regulatory strategies are all components of self-regulated learning (SRL). The role of self-regulated regulation is important in providing insight into processes used to learn (Garcia & Pintrich, 1994; Zimmerman, 1994). Knowledge and use of self-regulatory strategies can facilitate performance on academic tasks (Garcia & Pintrich, 1994, Zimmerman, 1994). Self-regulation links cognitive, metacognitive and motivational variables, providing a holistic account of what might influence transfer. The relationship between transfer and self-regulation has not been examined in depth (Borkowski, Weyhing, & Carr, 1988; Garcia & Pintrich, 1994).

Transfer is effortful, difficult, and rare in school and everyday learning (e.g., Gick & Holyoak, 1980; Catrambone & Holyoak, 1989). Investigating the relationship between SRL and transfer may provide educators with insights about how to promote it.

The first study explored whether different components of SRL could differentiate among college students that could proficiently transfer information in a problem-solving tasks and those that could transfer part or none of the relevant information. The problem-solving materials for the transfer task were those studied by Gick, Holyoak and colleagues (e.g., Gick & Holyoak, 1980; Catrambone & Holyoak, 1989). These materials are challenging for college students; Gick and Holyoak reported that without help only 20% of students could transfer a solution provided in a military context to another context where the solution would also be effective. Catrambone and Holyoak also found that the percentage of participants who transferred with the same tasks ranged from 10% to 16% before a hint was provided. We hypothesized that students with higher self-regulated learning would be better able to demonstrate transfer on this challenging problem-solving task. SRL was hypothesized to predict successful transfer, and a combination of cognitive, metacognitive, and motivational components of SRL was hypothesized to predict transfer better than any component alone.

Study 1

Method

Participants

Participants were 229 volunteer undergraduate students enrolled in an introductory course in Educational Psychology at The Pennsylvania State University. All students were given extra credit for their contribution to the study.

Measures/Tasks

Transfer task

For the transfer task a base story and a target problem were used. The base story was Gick and Holyoak's (1980) military story. The story refers to a general trying to capture a

fortress, given the following constraints: all his troops need to attack the fortress simultaneously, without blowing up the mines planted in the roads leading to the fortress. The solution, which is provided, involves small groups of the general's army going through different routes, attacking the fortress simultaneously. The target problem was Duncker's (1945) radiation problem, which is structurally similar to the military story, involving use of radiation to eliminate a tumor in a patient's stomach, avoiding the destruction of healthy tissue. The solution involves aiming less powerful rays at the tumor from different angles, which will converge at the tumor.

Self-regulated learning measure

The Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1991) was administered to assess college students' motivation and use of learning strategies (Pintrich, Smith, Garcia, & McKeachie, 1993). The questionnaire involves two scales: (a) the motivational scale, and (b) the cognitive scale (see Table 1). The Motivated Strategies for Learning Questionnaire was scored using the guidelines provided by Pintrich et al. (1991).

Procedure

At the time of recruitment, participants were given the MSLQ to complete on their own time and return at a session. During the session, participants independently read and solved a set of six problems. These were the military story, the radiation problem, and four buffer problems. The military story was always the first task. The radiation problem was presented second, third, fourth or fifth task. There was no effect of the order of presenting the radiation problem on students' performance (χ^2 (3, N = 229) = .736, p = .879) and the order variable will not be considered further. Students responded to the tasks in the order of presentation, but were allowed to review previous problems in their materials.

Scoring Procedures

The Motivated Strategies for Learning Questionnaire was scored based on the guidelines provided by Pintrich et al. (1991). Students rated themselves on 81 items on a seven-point Likert scale from "not at all true of me" to "very true of me". To obtain scale scores, the mean score of the items that make up each scale is computed. For example, an individual's score for self-efficacy was computed by summing up and taking the average of the person's scores on the eight items making up the self-efficacy scale.

The target, radiation problem was scored based on Gick and Holyoak's (1980) scoring system. For a participant's proposed solution to be scored as complete transfer, three criteria had to be satisfied: (a) rays should be applied to the tumor from different directions, (b) the rays should be applied at a lower intensity, and (c) it was necessary for the rays to reach the tumor simultaneously for their combined intensity to be sufficient to destroy the tumor. Students' solutions containing at least the first feature, were scored as partially transferring the solution from the base to the target task. Solutions containing the second and third points, but not the first were assigned a no transfer score, since the first feature was the critical element of the solution (Gick & Holyoak, 1980). Finally, solutions that did not satisfy any of the three criteria were also given a no transfer score. To determine the interrater agreement on the scores obtained for the transfer task, an independent rater rated a random sample (11%) of students' solutions to the radiation problem. Both raters used the criteria provided by Gick and Holyoak (1980) to assign a score on the transfer task. Interrater reliability was .86.

Results and Discussion

Did Self-Regulated Learning predict transfer?

Self-regulation variables were hypothesized to differentiate among groups of participants displaying complete transfer, partial transfer or no transfer. Similar to findings of prior studies (Gick & Holyoak, 1980, Catrambone & Holyoak, 1989), transfer was rare; 6% of the 229 participants showed complete transfer and 12% showed partial transfer.

Three discriminant analyses were used to examine the data, and the significance level was set at .05. The goal of discriminant analysis is to predict group membership from a number of predictors (Tabachnick & Fidell, 1996). The use of discriminant analysis was justified, in that a number of continuous variables (MSLQ variables) were used to predict a categorical variable (complete, partial, or no transfer).

In the first discriminant analysis the five major scales of the MSLQ (value, expectancy, affective, cognitive and metacognitive components, and resource management components, see Table 1) were used to predict group membership on transfer performance. The results indicated that there was one significant discriminant function, Wilk's $\lambda = .907$, $F(10, 410) = 2.57$, $p < .027$. Root 1 through 2 was significant, χ^2 (10, $N = 212$) = 22.032, $p < .015$. Participants' ratings on value, expectancy and cognitive and metacognitive components loaded on the first root; the discriminant function coefficient for value was .412, for expectancy .912, and for cognitive and metacognitive components .354. Participants rating themselves high on these scales were more likely to transfer. The predictors accounted for 8% of the variance in transfer ($R^2 = .08$). Out of 229 cases, 105 (45.6%) were correctly classified χ^2 (9, $N = 229$) = 36.639, $p < 0.001$.

The predictors in the second discriminant analysis were the six motivation scales of the MSLQ (intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs, self efficacy and test anxiety, see Table 1). The results revealed one significant discriminant function (Wilk's $\lambda = .897$, $F(12, 434) = 2.028$, $p < .021$). Root 1 through 2 was significant, χ^2 (12, $N = 225$) = 24.495, $p < .017$. Table 2 lists the canonical loadings for each of the six scales. Participants rating themselves high on intrinsic goal orientation, task value, control beliefs, and self-efficacy tended to transfer. Students viewing themselves as interested in their content of their class and as competent learners tended to show more transfer on the problem-solving task. The other motivation scales, test anxiety and extrinsic motivation, did not relate to transfer; since performance on the problem-solving transfer task had no consequences for the students and was unrelated to grades, it seems reasonable that these scales would not relate to transfer.

The third discriminant analysis was conducted using the nine MSLQ cognitive scales as predictors (see Table 1). The results revealed one significant discriminant function (Wilk's $\lambda = .845$, $F(18, 410) = 2.0$, $p < 0.009$). Root 1 through 2 was significant, χ^2 (18, $N = 225$) = 37.539, $p < .004$, indicating that groups differed reliably on one discriminant function. Table 3 displays the loadings for each of the nine variables. Contrary to past research and expectations, only peer learning loaded positively on the discriminant function.

Overall, these analyses indicated that value, expectancy, and cognitive and metacognitive components were related to participants' performance on the transfer problem. These results supported the findings of Pintrich and De Groot (1990) and Pintrich et al. (1993). Pintrich and De Groot (1990) found that higher intrinsic value and higher self-efficacy were correlated with better performance on classroom tasks and students' final grade. Pintrich et al. (1993) found that intrinsic goal orientation, task value, and self-efficacy correlated with college students' final course grade. However, the fact that peer learning was the only cognitive variable that positively related to transfer is puzzling. Since the transfer problems presented did not require group work,

it was expected that peer learning would be unrelated to performance on the radiation problem. Instead, variables such as elaboration or self-regulation were expected to positively relate to transfer, but surprisingly they did not.

Was transfer predicted better by a composite of SRL components or by individual components?

Table 4 compares the variance explained by the combined or individual components of SRL. The table also shows the accuracy in classification decisions. The amount of variance explained when motivational and cognitive variables were combined (8%) is not better than the amount of variance explained when either only the motivation or only the cognitive variables were used (9% and 12%, respectively). In addition, the classification decisions made using the combined motivational and cognitive variables were less precise than the classification decisions based on motivational or cognitive variables alone. Contrary to our predictions, the combined SRL components did not predict transfer better than the motivational or cognitive components alone. The cognitive components explained the most variance, but the loadings of their individual scales appeared nonsensical and did not increase understanding of factors that promote transfer.

Some findings from study 1 were promising in that cognitive and motivational components of SRL predicted transfer. Students with high intrinsic motivation, task value, control beliefs, and self-efficacy tended to be more likely to transfer than those low on these scales. The motivation scales not related to transfer (extrinsic motivation and test anxiety) seemed reasonable for the experimental task. However, the cognitive loadings did not support past research and were not interpretable.

Some of the problems interpreting these findings may relate to the way SRL was assessed. Participants were asked to respond to the MSLQ at their convenience. This might have resulted in variance in students' responses due to the different conditions of administering the questionnaire. Also, the students responded to the MSLQ in regard to their introductory Educational Psychology course, but their responses were used to predict their performance on a task independent of classroom context. The second study attempted to remedy some of these problems, and examine two transfer tasks, problem-solving and text structure.

Study 2

The generalizability of the findings of Study 1 were examined with another sample and more controlled testing conditions. In Study 2, the Motivated Strategies for Learning Questionnaire was administered under standardized conditions in the laboratory. Also, administered under laboratory conditions was an adaptation of the MSLQ. This adapted version used a subset of subscales from the MSLQ and asked students to answer the questions in regard to an experimental task, rather than in regard to their Educational Psychology class.

Catrambone and Holyoak (1989) found that aids, such as questions, increased transfer from 16% transfer to 47% transfer. A subsequent experiment by Catrambone and Holyoak provided support to this finding indicating that twice as many students (20%) transferred from a base to a target problem when they answered questions about the similarities of the two tasks, compared to 10% of the students who did not receive comparison questions. Three questions, focusing on structural information in the base story, were asked in an attempt to increase the number of participants who successfully transferred. With the addition of questions, we expected more students to successfully transfer the solution in the problem-solving task because the questions forced them to look at transferable aspects of the solution to the military problem.

One of the main purposes of the second study was to investigate the relationship between self-regulated learning and an additional transfer task, college students' transfer of a reading strategy from a base to a target passage to increase learning from text. An additional purpose of Study 2 was to examine the relationship between a task-specific appraisal of self-regulated learning and participants' transfer of the reading strategy. Study 2 investigated transfer of a reading comprehension strategy from a base to a target passage. According to Meyer, Young, and Bartlett (1989), the author of a passage uses an organizational structure to organize information in a text. Readers can effectively use this structure to facilitate their understanding and recall of information from texts. The structure strategy (e.g., Meyer et al., 1989; Meyer & Poon, 2001) was designed to help learners detect and utilize this structure. In this experiment, a brief written version of Meyer et al.'s (1989) training materials was used. The training focused on only one type of organizational structure, problem/solution, where one part of the text presented a problem and another part presented a solution to the problem.

Study 2 examined the hypothesis that students high in self-regulated learning would be more likely to demonstrate transfer than students with lower SRL scores on both the original MSLQ and the adapted version. Self-regulated learning was expected to predict transfer of both the solution in the problem-solving task and text structure in the reading task, particularly without direct instruction about the structure strategy. The MSLQ adapted to the reading tasks was expected to better discriminate between those who transferred text structure and those who did not than the MSLQ answered in relation to a class. Additionally, it was expected that the addition of questions focusing on the structure of the base story, would result in more students successfully transferring the solution in the problem-solving task.

Method

Participants

Participants during the summer were 98 undergraduate students at The Pennsylvania State University enrolled in introductory courses in Educational Psychology. All students received extra credit for their participation in the study.

Materials

Self-regulated learning measure

The original Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991) was administered to assess participants' self-regulation relative to a course. The MSLQ was modified for Study 2 to measure aspects of students' self-regulated learning in respect to the specific passages encountered in the experiment. The revised MSLQ is a self-report, Likert-scale instrument measuring selected variables of the original MSLQ. These include intrinsic value, task value, control beliefs, and self-efficacy and items assessing elaboration and metacognitive self-regulation.

Vocabulary Test

The Quick Word Test (Borgatta & Corsini, 1964; 1993) was administered to assess verbal ability. This is an 80-item multiple-choice test for which participants have to read a word and choose among four given words the one closest to the meaning of the original word.

Transfer Tasks

The problem-solving transfer materials were the same as in Study 1 (military story; Gick & Holyoak, 1980, radiation problem; Duncker, 1945). Participants were not allowed to review the base story. Immediately after reading the military story, participants answered three questions, aimed at focusing students' attention to the structure of the base and target problems.

The second transfer task involved reading and recalling two passages. Both passages contained 506 words and 191 scorable idea units (Meyer et al., 1989). The first passage on schizophrenia served as the base text. Two variations of this passage were used (Meyer, 1975). The first variation was organized with the problem/solution structure with signaling (e.g., "a major problem is") highlighting the problem/solution structure. The second variation of the schizophrenia passage was organized with a structure other than problem/solution, and it contained no signaling words pointing to a problem or a solution. The target text on trusts, was organized with the problem/solution structure, and included signaling words for this structure.

Procedures

Small groups of students participated in one two-hour session. Participants were given the same oral introduction by the researcher and solved all tasks individually. Students were randomly assigned to three conditions (structure with training, structure only, control). During the session, they were instructed to first read and think about the military story and answered three questions about the story. The base story and students' answers were removed. Participants were given a booklet with the rest of the materials. The first task on the booklet was the radiation problem. Then, participants were instructed to work on the rest of the materials at their own pace. Following the radiation problem, participants read a set of general instructions, with information about the recall tasks.

Participants in the structure with training condition read two pages with information about the structure strategy (Meyer et al., 1989). They read an example of the problem/solution writing plan, signaling words that help readers identify the problem/solution organizational structure, a template for writing with this plan, and five steps to follow in utilizing the structure strategy as they recalled a text. Then, they read the schizophrenia passage. Participants in the other two groups immediately proceeded to the schizophrenia passage. The structure only and the structure with training conditions read a passage on schizophrenia organized with the problem/solution structure and signaling words. The control condition read a base passage on schizophrenia organized with a structure other than problem/solution. After reading and recalling the base passage, participants in all groups were administered the original MSLQ. Then, they read and recalled the trusts passage. Upon completing this task, participants were administered the Quick Word Test (Borgatta & Corsini, 1964; 1993). Finally, they responded to the revised MSLQ questionnaire.

Scoring

The Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991) was scored in the same way as in the Study 1. The same guidelines were also used to score the revised MSLQ. For the scoring of the Quick Word Test, the scoring key provided by Borgatta and Corsini (1993) was used. The radiation problem was scored based on the criteria provided by Gick and Holyoak (1980). Interrater agreement was very high ($r = 1.0$).

The prose analysis system of Meyer (1975, 1985) was used to score students' recalls of the schizophrenia and trusts passages. The purpose of scoring was to examine participants' recall of topic content and of relationships among aspects of the topic content. Use or failure to use the problem/solution text structure to organize recall was determined by using Meyer's system for scoring top-level structure of recall protocols (Meyer, 1985;Meyer & Poon, 2001). Two recall protocols were collected for each participant, one for the base and one for the target passage. Ten recalls from each of the two passages were randomly selected for reliability check. Intrarater reliability for the total number of idea units recalled from the schizophrenia passage was 92.4%.

Intrarater reliability for top-level structure was 91.2%. For the trusts passage, the intrarater reliability was 93% for the total number of ideas recalled and 93.4% for the top-level structure.

The criterion for determining whether participants transferred the problem/solution structure from the base to the target passage was based on students' scores regarding their use of the top-level structure in their recalls. Use of the top-level structure on both the base and target passages indicated successful transfer.

Results and Discussion of Study 2

Did Self-Regulation Variables Predict Transfer on the Problem Solving Task?

Frequency of Transfer of the Solution

The results of Study 2 indicated that transfer was rare. Specifically, only 3% of the 98 participants produced a complete solution to the target problem, compared to 6% who transferred in Study 1. Partial transfer in Study 2 was also rare. Specifically, 7% of the 98 participants in Study 2 transferred a partial solution, while 12% transferred a partial solution in Study 1. Students' poor performance on the transfer task supports previous findings by Catrambone and Holyoak (1989) and Gick and Holyoak (1980) who found that transfer with the same task only occurred 10%-16% and 20% of the time, respectively.

One of our hypotheses was that questions would focus participants' attention on structural information in the military story that was essential to the solution of the radiation problem. Thus, it was expected that the addition of questions in Study 2 would increase transfer. Contrary to our expectations, participants in Study 2 transferred less frequently compared to participants in Study 1, indicating that the presence of questions did not have a positive effect on transfer. This finding contradicts previous findings by Catrambone and Holyoak (1989) who found that the addition of comparison questions improved transfer substantially. It has to be noted that Catrambone and Holyoak's questions were asking students to identify similarities and differences between the two tasks. Asking participants to compare the two tasks may have provided them with an implicit hint that they could utilize the solution of the base story to solve the target problem. In contrast, our questions focused on the structural information of the base story only, thus providing no direct comparison between the two tasks. Thus, participants in Study 2 may have attended to the structural information of the base story, but may have failed to see how that information corresponded to the structural information presented in the target problem.

Prediction of Transfer on the Problem-Solving Task

The predictors for the first discriminant analysis were value, expectancy, affective, cognitive and metacognitive components, and resource management components (see Table 1). The results indicated the existence of one significant function (Wilk's $\lambda = .180$, $F(10, 184) = 24.998$, $p < .001$). Root 1 through 2 was significant (χ^2 (10, $N = 98$) = 159.599, $p < .001$). All five variables had high, positive loadings on the significant function. Cognitive and metacognitive components had the highest loading (.985), expectancy, value, and resource management components loaded .964, .953, and .949, respectively, and affective components loaded .735 on the significant function. The amount of variance explained was 81.5% (R^2 = .815). Overall, 40 out of 98 participants (41%) were classified correctly (χ^2 (4, $N = 98$) = 4.772, $p < .312$).

The predictor variables in the second discriminant analysis were the motivational MSLQ components (see Table 1). The results indicated that there was one significant discriminant

function (Wilk's $\lambda = .182$, $F(12, 182) = 20.414$, $p < .001$). Root 1 through 2 was significant (χ^2 $(12, N = 98) = 157.750$, $p < .001$), indicating that the groups differed significantly on one dimension. A third discriminant analysis was conducted using the cognitive variables of the MSLQ as predictors (see Table 1). One function was significant (Wilk's $\lambda = .158$, $F(18, 176) = 14.848$, $p < .001$). Only root 1 through 2 was significant (χ^2 $(18, N = 98) = 168.109$, $p < .001$). Variables' loadings on the discriminant functions and the accuracy of classification decisions are presented in Tables 2,3, and 4.

The results support the findings of the first experiment and the findings of Pintrich and De Groot (1990) and Pintrich et al. (1993), indicating that there is a relationship between self-regulation variables and performance on the problem-solving transfer task used in this research. As found in Study 1, the amount of variance explained when motivation and cognitive/metacognitive variables were combined was not greater than the amount of variance explained when either only the motivation or only the cognitive predictors were used. In fact, using motivation and cognitive predictors together (81.5%) accounted for about the same amount of variance as cognitive predictors alone (82%), and was only slightly better than the use of the motivation variables alone (80%). Predicting group membership based on the combination of motivational and cognitive variables resulted in correct decisions 41% of the time, compared to 43% and 66% for only motivation or only cognitive predictors, respectively.

Did Self-Regulated Learning Predict Transfer of Text Structure?

Differences among the Three Experiment Groups

Prior to examining the relationship between self-regulation and transfer, the experimental conditions (structure with training, structure only, and control) were compared on the problem solving transfer task and vocabulary. First, differences between the three conditions on problem solving transfer performance were examined. Participants in the structure only condition performed significantly better than the other two groups on the problem solving transfer task (χ^2 $(4, N = 98) = 11.2$, $p < .02$). Next, differences on verbal ability were examined. An analysis of variance indicated that the three conditions significantly differed on verbal ability $F(2, 95) = 4.75$, $p < .01$, $MSE = 134.239$. Pairwise comparisons between the three groups using Tukey's multiple comparisons procedure showed that the control ($M = 45.93$, $SD = 13.41$) and the structure only groups ($M = 52.53$, $SD = 11.34$, $p < .01$) were significantly different. These findings suggest that the structure only group was comprised of individuals with more cognitive abilities than the other groups.

The effects of structure strategy training on use of the text's top-level structure on the schizophrenia passage were examined. Significantly more participants in the structure with training group used the problem/solution top-level structure in their recalls than those in the structure only group (χ^2 $(1, N = 68) = 9.676$, $p < .002$). Next, differences among the three conditions' use of the problem/solution structure on the trusts passage were examined. Participants in the structure with training group used the problem/solution structure significantly more frequently than participants in the other two conditions (χ^2 $(2, N = 98) = 13.353$, $p < .001$). Clearly, direct instruction about the structure strategy increased its use on both passages.

An analysis of covariance for differences on the total number of idea units recalled from the schizophrenia passage, controlling for verbal ability, revealed no significant differences. A second ANCOVA examined differences on the total number of ideas recalled from the trusts

passage, controlling for verbal ability. The results showed significant differences among the three groups ($F(2, 94) = 5.988$, $p < .004$, $MSE = 143.095$). Tukey post hoc tests indicated that participants in the structure with training group recalled significantly more ideas than the structure only group ($p < .049$) and the control group ($p < .003$). No difference was found between the control and structure only groups ($p = .49$). An ANCOVA was used to examine the effects of training on the type of information remembered from the trusts passage for participants in the three conditions. Significant main effects were found for condition ($F(2, 94) = 5.988$, $p < .004$, $MSE = 71.547$) and level ($F(1, 94) = 8.1$, $p < .005$, $MSE = 26.78$). The interaction of condition by level was significant ($F(2, 94) = 3.1$, $p = .05$, $MSE = 26.78$), indicating that the training aided individuals recall of high level information. This finding replicates past research (e.g., Meyer et al., 1989) showing that structure strategy instruction increases recall of main ideas. In summary, direct instruction with the structure strategy and practice reading a text with the same structure was more effective in promoting recall on the transfer passage than practice reading a text with the same structure or just practice reading. In fact, without direction instruction about the structure strategy, practice reading a passage with the same structure did not improve recall.

To examine whether students in the structure with training and structure only conditions transferred the top-level structure a Chi Square analysis was conducted. Significantly more participants in the structure with training than in the structure only group transferred the reading strategy (χ^2 (1, $N = 68$) = 10.02, $p < .002$). Again, direct instruction with the structure strategy was critical for students to see the problem/solution structure in one passage and use it again on the second passage.

Prediction of Transfer of Text Structure

Separate discriminant analyses were conducted for the structure with training and the structure only groups. Since training was found to have an effect on transfer it might interfere with the results of the discriminant analysis if both groups were entered in the analysis simultaneously. The control group was excluded from these analyses; transfer was not possible for this group because the organization of their base text did not match the organization of the target text.

Two discriminant analyses examined whether the combination of motivation and cognitive MSLQ scales would improve the prediction of performance on the reading strategy transfer task compared to using the motivation or the cognitive variables alone. The predictor variables in both analyses were value, expectancy, affect, cognitive and metacognitive components, and resource management. The first discriminant analysis included data for the structure only group. The results indicated the existence of one significant function (Wilk's $\lambda = .68$, $F(5, 29) = 2.73$, $p < .04$). Root 1 through 2 was significant (χ^2 (5, $N = 34$) = 11.37, $p < .04$). All scales loaded high on the significant function (.7 to .83). The predictors accounted for 32% of the variance in transfer ($R^2 = .32$). Overall, 23 out of the 34 participants (68%) were correctly classified (χ^2 (1, $N = 34$) = 2.2, $p = 0.14$). The second discriminant analysis included data for the structure with training condition. No significant discriminant functions were found (Wilk's $\lambda = .85$, $F(5, 29) = .99$, $p = .44$).

To investigate whether the MSLQ motivation variables alone predicted performance on the reading strategy transfer task, two discriminant analyses were conducted. The predictor variables entered in these analyses were participants' intrinsic and extrinsic goal orientation, task

value, control beliefs, self-efficacy, and test anxiety. The first analysis included data for participants in the structure only condition ($N = 34$). The results indicated that there was one significant discriminant function (Wilk's $\lambda = .631$, $F(6, 28) = 2.726$, $p < .033$). Root 1 through 2 was significant, (χ^2 (6, $N = 34$) = 13.341, $p < .038$). The loadings of the motivation variables on the significant discriminant function and the accuracy of the classification decisions are presented on Tables 2, 3, and 4. A subsequent discriminant analysis looked at data for participants in the structure with training group. No significant discriminant functions were found (Wilk's $\lambda = .895$, $F(6, 28) = .548$, $p = .77$).

Two discriminant analyses investigated whether the cognitive variables of the MSLQ predicted participants' performance on the reading strategy transfer task. The predictor variables entered in both discriminant analyses were rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, and help seeking. The first discriminant analysis looked at data for participants in the structure only condition. One discriminant function was significant (Wilk's $\lambda = .48$, $F(9, 25) = 3.01$, $p < .014$). Root 1 through 2 was significant, (χ^2 (9, $N = 34$) = 20.2, $p < .017$). The loadings of the cognitive variables and the accuracy of the classification decisions can be seen on Tables 2, 3, and 4. The second discriminant analysis included data for the 34 participants in the structure with training condition. The results showed that no significant discriminant functions existed (Wilk's $\lambda = .61$, $F(9, 25) = 1.78$, $p = .12$).

Overall, the combination of motivation and cognitive variables, as well as the motivation or cognitive variables of the MSLQ alone, reliably predicted performance on the reading strategy transfer task for participants in the structure only condition. Thus, if students are not provided with explicit strategies, they tend to rely on their motivation and metacognition to learn and remember text information. However, for participants trained to utilize the structure strategy, self-regulation variables could not reliably predict performance on the reading strategy transfer task. This indicated that when students are given training about a strategy, they tend to rely on that strategy. It is interesting to note, that with direct instruction in the structure strategy those students with poorer resources in terms of their own self-regulated learning could perform as well as those with more personal resources immediately after training. Future research is needed to see if self-regulated learning predicts maintenance over time of the structure strategy.

Results for participants in the structure only condition support findings from the problem solving tasks in Studies 1 and 2 that combining the motivation and cognitive predictors does not significantly improve classification decisions. Using the motivation subscales of the MSLQ alone led to correct classifications of participants' performance on the reading transfer task 68% of the time (see Table 4, overall accuracy). Correct classifications using the cognitive variables were considerably higher (88%). The combination of motivation and cognitive subscales resulted in accurate predictions 68% of the time. Combining the motivation and cognitive variables of the MSLQ accounted for 32% of the variance compared to 37% and 51.2% for only motivation and cognitive variables, respectively (see Table 4, variance explained).

Did the combination of motivational and cognitive variables of the adapted MSLQ better differentiate among students who transferred and those who did not transfer?

Two discriminant analyses examined whether using the adapted version of MSLQ that measured self-regulation regarding reading and recalling the specific passages would better predict transfer of text structure. The first analysis examined this for the structure only condition.

The predictor variables were intrinsic goal orientation, task value, control beliefs, self-efficacy, elaboration, and metacognitive self-regulation. The results indicated the existence of one significant function (Wilk's $\lambda = .44$, $F(6, 28) = 5.84$, $p < .001$). Root 1 through 2 was significant, (χ^2 (6, $N = 34$) = 23.52, $p < .001$). The loadings of the predictor variables on the significant root ranged from .37 to .59, indicating that higher self-ratings on the modified MSLQ related to better performance on the reading strategy transfer task. The predictors accounted for 55.5% of the variance ($R^2 = .555$) on the reading strategy transfer task. Finally, 29 out of the 34 (85.3%) participants were correctly classified (χ^2 (1, $N = 34$) = 13.8, $p < 0.001$). It appears that the adapted version of the MSLQ predicted transfer for the structure only group better than the original version of the MSLQ (see Table 4). The amount of variance explained when the original MSLQ was used was 32%, while participants were correctly classified 68% of the time.

An additional discriminant analysis examined the relationship between the same predictors and the performance of the structure with training group. The results indicated that none of the discriminant functions were significant (Wilk's $\lambda = .723$, $F(6, 28) = 1.8$, $p = .14$). Root 1 through 2 was nonsignificant, (χ^2 (6, $N = 34$) = 9.422, $p = .15$).

In summary, the two discriminant analyses involving the revised MSLQ questionnaire supported the findings based on the original MSLQ variables. When participants were taught to use a strategy to enhance their performance on a reading and recalling text information task, their levels of self-regulation did not relate to their performance. Instead, training seemed to have the primary role on whether they would transfer the reading strategy. On the other hand, participants not instructed to use the reading strategy relied more on their self-regulation strategies.

General Discussion

Both experiments showed that transfer of a problem solution was difficult. Other studies have pointed to the difficulty of transfer (Gick & Holyoak, 1980; Catrambone & Holyoak, 1989). Study 2 examined transfer of text structure from a base to a target passage. The results indicated that transfer of text structure was more frequent compared to transfer of the problem solution. Six percent of the participants in Study 1 and only 3% of the participants in Study 2 transferred a complete solution to the problem-solving task. Transfer of text structure was more frequent. Transfer in the structure only condition was demonstrated by 26% of the students. In contrast, 67% of the participants trained to use the structure strategy transferred the text structure.

A primary goal of this investigation was to examine whether components of self-regulated learning could reliably predict college students' performance on the problem solving and reading strategy transfer tasks. Overall, the results showed a relationship between components of self-regulated learning and college students' performance on the two transfer tasks. The findings support the relationship between aspects of self-regulation and cognitive performance found by others (e.g., Pintrich and De Groot, 1990). In summary, motivational aspects of the MSLQ had stronger relations to the significant discriminant function in Study 1, compared to cognitive subscales and to the combination of motivational and cognitive scales. Classification decisions made in the first experiment were accurate 50% of the time. The findings of Study 2 indicated that cognitive variables were better predictors of performance on the transfer task compared to motivational variables. The discrepancy between the two studies is puzzling, but might be explained by a number of factors, such as differences in cognitive and motivational variables between participants in the two experiments. Another plausible explanation might be that students' self-reports of their self-regulation might not reliably reflect

their true levels of motivation and cognition. Alternatively, the lack of control in administering the MSLQ questionnaire in the first experiment may have influenced students' responses.

Study 2 investigated the relationship between self-regulated learning and transfer of the text structure from a base to a target text. Additionally, Study 2 examined the relationship between task-specific appraisal of self-regulated learning and participants' transfer of text structure. Overall, the results showed that for participants who read a base passage with the problem/solution structure, motivational, cognitive, and the combined motivational and cognitive variables from the original MSLQ were very good predictors of transfer. However, for participants who were trained to use the structure strategy and practiced this skill with the base passage, the MSLQ variables were unreliable predictors of transfer performance. A plausible explanation for the differences in predictive power of the MSLQ for the two experimental groups is that participants in the structure with training group relied on the training about using the structure strategy, rather than on their own motivation and cognitive strategies. On the other hand, participants in the structure only group, who were not trained on using the strategy, relied more on their own motivation and cognitive and metacognitive strategies.

As predicted, the MSLQ adapted to the experimental task better predicted transfer in Study 2 than the original MSLQ geared to a classroom context. This finding suggests that using context-specific measures of self-regulation may improve prediction of performance on specific tasks.

Future research needs to focus on a number of issues related to both self-regulated learning and transfer. First, it is essential that more reliable and valid measures of self-regulation be developed. In addition, triangulation methods should be used with the current measures of self-regulation. A second issue is to examine ways to enhance learners' performance on transfer tasks. Possible ways have been identified in the literature, such as providing hints (Catrambone & Holyoak, 1989; Gick & Holyoak, 1980) and training students on using the structure of texts (Meyer & Poon, 2001). Finally, transfer and its relation to self-regulation variables need to be examined with various types of learners (e.g., children, experts, gifted students, older adults).

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Table 1.

Scales of the Motivational Strategies for Learning Questionnaire (MSLQ)

Motivation Scales		
Value	Expectancy	Affective
Goal Orientation		
Intrinsic	Control Beliefs	Test Anxiety
Extrinsic	Self Efficacy	
Task Value		

Cognitive Scales	
Cognitive and Metacognitive Components	Resource Management Components
Rehearsal	Time and Study Environment
Elaboration	Effort Regulation
Organization	Peer Learning
Critical Thinking	Help Seeking
Metacognitive Self Regulation	

Table 2.

Canonical loadings of MSLQ motivation variables on significant discriminant function

	Canonical loadings		
	Experiment 1	Experiment 2	
Predictors	Problem-solving transfer task	Problem-solving transfer task	Reading strategy transfer task: structure only condition
Goal Orientation			
Intrinsic	0.49	0.96	0.78
Extrinsic	-0.02	0.85	0.63
Task Value	0.45	0.88	0.73
Control Beliefs	0.77	0.96	0.67
Self-Efficacy	0.83	0.94	0.68
Test Anxiety	-0.02	0.74	0.75

Table 3.

Canonical loadings of MSLQ cognitive variables on the significant discriminant function

	Canonical Loadings		
	Study 1	Study 2	
Predictors	Problem-solving transfer task	Problem-solving transfer task	Reading strategy transfer task: stucture only condition
Rehearsal	0.13	0.90	0.51
Elaboration	-0.26	0.89	0.52
Organization	0.02	0.93	0.42
Critical Thinking	0.02	0.84	0.60
Metacognitive Self-Regulation	-0.31	0.95	0.51
Time and Study Environment	0.07	0.93	0.42
Effort Regulation	0.01	0.92	0.43
Peer Learning	0.43	0.75	0.57
Help Seeking	-0.22	0.78	0.44

Table 4.

Accuracy of classification decisions in studies 1 and 2

	Experiment 1	Experiment 2		
	MSLQ	MSLQ		Modified MSLQ
	Problem-solving transfer	Reading strategy transfer: structure only group		
Motivation subscales				
Variance explained	8.6%	81.0%	37.0%	
Overall accuracy	52.0%	43.0%	68.0%	
No transfer	50.0%	41.0%	58.3%	
Partial transfer	73.0%	66.0%		
Complete transfer	28.0%	57.1%	78.0%	
Cognitive subscales				
Variance explained	12.0%	82.1%	51.2%	
Overall accuracy	48.6%	66.0%	88.0%	
No transfer	42.6%	68.0%	92.0%	
Partial transfer	73.0%	66.0%		
Complete transfer	78.6%	43.0%	78.0%	
Combined subscales				
Variance explained	8.0%	81.5%	32.0%	55.5%
Overall accuracy	45.6%	41.0%	68.0%	85.3%
No transfer	44.0%	38.6%	32.0%	79.0%
Partial transfer	63.0%	66.0%		
Complete transfer	35.7%	57.0%	55.0%	78.0%

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