DOCUMENT RESUME

ED 412 217 TM 026 836

AUTHOR	Renkl, Alexander
TITLE	Intrinsic Motivation, Self-Explanations, and Transfer.
PUB DATE	1997-03-00
NOTE	12p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, March 24-28, 1997).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	College Students; *Education Majors; Higher Education; *Learning Strategies; *Metacognition; Probability; *Self Motivation; *Transfer of Training
IDENTIFIERS	Elaboration; Self Explanation Strategies; Self Report Measures

ABSTRACT

Intrinsic motivation is usually regarded as a significant determinant of the use of elaborative and metacognitive learning strategies that, in turn, foster the acquisition of well-structured and transferable knowledge. In studies testing this assumption the following pattern of results is usually obtained: Intrinsic motivation is significantly related to elaborative and metacognitive strategies, but the strategies are only marginally related to learning outcomes. This pattern of results may be due to the fact that learning strategies are usually measured rather indirectly by self-report questionnaires. In this study, the thinking-aloud method was used to analyze the learning strategies of 36 first-year students of education as they learned probability calculation from worked-out examples. Learning strategies in the context of learning from examples are usually called self-explanations. In contrast to studies assessing learning strategies by questionnaires, substantial correlations between self-explanations and transfer of the acquired skills were found. In addition, intrinsic motivation was related to self-explanations. However, intrinsic motivation does not seem to have favorable effects on all kinds of elaborative and metacognitive strategies. Furthermore, the relations between intrinsic motivation and self-explanations seem to vary between subgroups of learners. (Contains 1 figure, 1 table, and 22 references.) (SLD)

Intrinsic motivation, self-explanations, and transfer

Alexander Renkl
University of Munich (Germany)

Paper presented at the "Annual Meeting of the American Educational Research Association" in Chicago, March 1997

Author Note

This research was funded by the Deutsche Forschungsgemeinschaft (DFG, Re 1040/1-1).

Correspondence should be addressed to: Alexander Renkl, Institut für Pädagogische Psychologie und Empirische Pädagogik, University of Munich, Leopoldstraße 13, 80802 Munich, Germany. E-mail: renkl@mip.paed.uni-muenchen.de.

Abstract

Intrinsic motivation is usually regarded as significant determinant of the employment of elaborative and metacognitive learning strategies that, in turn, foster the acquisition of well-structured and transferable knowledge. In studies testing this assumption the following pattern of results is usually obtained: Intrinsic motivation is significantly related to elaborative and metacognitive strategies; the strategies are, however, only marginally related to learning outcomes. This pattern of results may be due to the fact that learning strategies are usually measured rather indirectly by self-report questionnaires. In the present study, the thinking-aloud method was used to analyze the learning strategies of 36 first-year students of education while learning probability calculation from worked-out examples. Learning strategies in the context of learning from examples are usually called self-explanations. In contrast to studies assessing learning strategies by questionnaires, substantial correlations between self-explanations and transfer of the acquired skills were found. In addition, intrinsic motivation was related to self-explanations. However, intrinsic motivation does not seem to have favorable effects on all kinds of elaborative and metacognitive strategies. Furthermore, the relations between intrinsic motivation and self-explanations seem to vary between subgroups of learners.

INTRINSIC MOTIVATION, SELF-EXPLANATIONS, AND TRANSFER

This study investigated the relations between situational intrinsic motivation, learning strategies in the context of learning from worked-out examples (i.e., self-explanations) and transfer of learned solution methods. Before the empirical study is described, the significance of intrinsic motivation for strategic learning and transfer performance is discussed, and what is specifically meant by intrinsic motivation in the context of this study is defined. Then the notion of self-explanation is explained. Finally, the main findings of a former investigation that provides the database for this study are presented.

The significance of intrinsic motivation for learning

Intrinsic motivation is usually regarded as an important determinant of learning, at least when the attainment of high-level learning goals is intended. A basic assumption of most authors working in this area is that intrinsically motivated learners tend to employ sophisticated elaborative and metacognitive learning strategies that, in turn, foster the acquisition of well-structured knowledge that constitutes "deep understanding" (e.g., Pintrich & Garcia, 1991). In other words, the effects of intrinsic motivation on high-level learning outcomes are mediated by the quality of the employed learning strategies. Studies testing this assumption usually show that intrinsic motivation is actually associated with elaborative and metacognitive learning strategies. However, these types of learning strategies are not always substantially related to achievement measures such as grades (e.g., Pintrich, 1989; Pintrich & DeGroot, 1990; Wild, 1996). It is argued that the typical demands of examinations test primarily low-level learning goals. Hence, the type of knowledge structures resulting from elaborative and metacognitive strategies is not necessary for being successful in examinations. This explanation can also account for the low associations between intrinsic motivation and achievement that have often been found (cf. the meta-analysis of Schiefele & Schreyer, 1994).

A limitation of the research on this topic is that in almost all studies both intrinsic motivation and learning strategies are measured by questionnaires. In other words, learning strategies are not directly observed, but assessed by retrospective self-reports. In addition, these self-reports often refer to what learners usually do and not to their strategies in specific learning situations. Hence, it is important to supplement studies in which questionnaires for strategy assessment were used with investigations in which learning strategies are measured in concrete situations by methods such as observation or thinking-aloud (for a similar argument see Pintrich & Garcia, 1993). This alternative is supposed to have the following advantages: (a) the strategies can be measured more directly and in a more fine-grained manner; (b) method-specific covariances (Campbell & Fiske, 1959; Fiske & Campbell, 1992) between intrinsic motivation and strategies are avoided; (c) substantial relations between achievement and strategies assessed by observation or thinking-aloud can often be found.

It is important not only to consider whether learning strategies are assessed as generalized individual tendencies or measured in specific situations, but also to regard that the theoretical and empirical approaches to the phenomenon of intrinsic motivation differ in this respect. Some authors regard intrinsic motivation as a habitual motivational orientation (e.g., Harter, 1981; Pintrich, Smith, Garcia & McKeachie, 1993), whereas others use this notion to refer to a situational motivational state: an action is performed because it is fun or interesting (Benware & Deci, 1984; Cordova & Lepper, 1996). The latter conception is used in the present investigation, especially because, as compared to habitual orientations, actual, situational intrinsic motivation is supposed to be a more proximal predictor of the learning strategies used in the corresponding situation.

In a recent study, Vollmeyer and Rheinberg (in press) analyzed the relations between (1) task interest (which could essentially be regarded as situational intrinsic motivation), (2) actual strategies when exploring a computer-based simulation and (3) knowledge acquisition (about the simulated system) as well as knowledge application (system control). The quality of the learners' strategies for exploring the effects of system inputs was assessed by the extent to which the so-called VOTAT strategy (i.e., Vary One Thing At a Time) or, at least, a systematic input pattern was employed (cf. Vollmeyer, Burns & Holyoak, 1996). It turned out that the quality of the strategy was substantially related to the performance measures of knowledge acquisition und knowledge application. Intrinsic motivation (task interest) was, however, unrelated to both the quality of strategies and to performance. This pattern of results underlines the assumption that the commonly found strong associations between intrinsic motivation and learning strategies may in part result from method-specific covariances.

There are additional studies on intrinsic motivation in which learning strategies were observed. For example, Cordova and Lepper (1996) showed that means such as contextualization, personalization, and provision of choices can enhance intrinsic motivation when learning with an instructional mathematics computer game. These factors also affected the learning activities such as the extent to which the learner showed "strategic play." Unfortunately, it remained open whether the effects of the instructional means on learning activities were really mediated by intrinsic motivation (the relations between intrinsic motivation and learning activities were not reported).

Taken together, it is still unclear whether intrinsic motivation substantially influences the actual (not reported) use of learning strategies and thereby affects high-level learning outcomes such as transfer performance. Therefore, the present study analyzes the relations between intrinsic motivation and a specific type of learning strategies (i.e., self-explanations) that is usually substantially related to the transfer of learned solution methods.

Self-explanations

In their meanwhile classical study, Chi, Bassok, Lewis, Reimann, and Glaser (1989) found that there are substantial interindividual differences with regard to the extent to which learners gain from the study of worked-out examples, depending on how well they explain the solutions to themselves and they monitor their own level of understanding. This is called the self-explanation effect. In principle, self-explanations are elaborative and metacognitive (monitoring) strategies in the context of learning from worked-out examples.

Specifically, the learners in the study of Chi et al. (1989) learned from worked-out examples in the domain of physics. During the study of the worked-out examples, the subjects had to think aloud. The learners were divided into two groups according to their performance in a later problem-solving phase: successful (n = 4) and unsuccessful problem solvers (n = 4). A comparison between these two groups revealed that the successful problem solvers--in comparison to the unsuccessful ones--devoted more time to the study of the worked-out examples and generated more task-relevant ideas while trying to explain the example solutions to themselves. Furthermore, the successful learners also differed from the unsuccessful learners with respect to qualitative aspects. The effective learners (1) more frequently elaborated on the application conditions and goals of operators, (2) more frequently related solution steps to domain principles (principle-based explanations), and (3) more adequately monitored their comprehension, that is, they more frequently diagnosed their own comprehension impasses and less frequently had the illusion of understanding. Pirolli and Recker (1994) obtained similar results in the domain of LISP learning.

As the quantity (time-on-task) and quality of the learning processes were confounded in these studies, it could not be definitely ruled out that the effective learners were superior merely because they devoted more time to the elaboration of the worked-out examples. Renkl (in press), however, showed that even when keeping time-on-task constant qualitative differences in self-explanations were substantially related to learning outcomes. As the data of this previous investigation were re-analyzed in the present study, it is described in the next section.

The database

Renkl (in press) analyzed the self-explanations of college students when they studied worked-out examples from the domain of probability calculation. Among others, it was tested to what extent the quality of self-explanations was related to the transfer of learned solution methods to isomorphic problems (i.e., same underlying structure, different surface features) and to "feignedly similar" problems (changed structure, similar surface features); these two types of problems made up a single transfer measure. With respect to individual differences in self-explanations and transfer performance, the following main results, which are relevant to the present study, were found. In fact, transfer performance could be substantially predicted by interindividual differences in the quality of self-explanations. Specifically, the successful learners in contrast to the unsuccessful ones tended to (1) assign meaning to an operator by explicating the underlying domain principle (i.e., principle-based explanations; correlation with transfer: $r = .31$), (2) assign meaning to an operator by explicating the goal to be achieved by this operator (i.e., operator-goal combinations; $r = .42$), and (3) spontaneously anticipate solutions steps in worked-out examples (i.e., anticipative reasoning; $r = .48$). In addition, transfer performance was enhanced by studying relatively many examples within the available learning time ($r = .40$). The frequency of self-diagnosed comprehension impasses (i.e., negative monitoring statements) was negatively related to transfer ($r = -.44$).

In addition, it was found that individual differences in the quality of self-explanations were multidimensional. The correlations between principle-based explanations, the explication of goal-operator combinations, anticipative reasoning, number of studied examples, and negative monitoring were near zero and thus failed to reach the level of significance. The only exception was a substantial correlation between principle-based explanations and the explication of goal-operator combinations. In addition, it turned out that the successful learners were not those who frequently employed all types of self-explanations which foster learning. Rather, there were two different ways of successful learning. The corresponding groups of learners were labeled anticipative reasoners and principle-based explainers respectively. Anticipative reasoners concentrated their efforts on the anticipative computation of to-be-found probabilities; they provided only a limited number of principle-based explanations and also explicated merely a restricted amount of goal-operator combinations. Principle-based explainers could be characterized by a self-explanation style that emphasized the assignment of "meaning" to operators, both by explicating the underlying principle and the corresponding (sub-)goal. Anticipative reasoning was adopted merely at a medium level.

There were also two unsuccessful groups: passive explainers and superficial explainers. Passive explainers' failure to profit much from studying worked-out examples resulted from the poor quality of their self-explanations, namely few principle-based explanations, few references to goal-operator combinations, and a low level of anticipative reasoning. Superficial explainers engaged in an average amount of principled-based explanations and explication of goal-operator combinations. Anticipative reasoning was relatively infrequent. Although the superficial explainers were not very successful, they hardly explicated comprehension problems and assigned relatively little time to each worked-out example (for details see Renkl, in press).

It is important to note that these types of learners were differentiated solely on the basis of their self-explanation characteristics (using cluster analysis) without taking their learning results into account. Nevertheless, the groups differed significantly with respect to their transfer performance ($F(3,32) = 4.29$; $p < .05$).

Motivational factors were not addressed in the study of Renkl (in press). This is made up in the present investigation.

Research questions

This study addressed the following specific research questions:

(1) To what extent is intrinsic motivation related to the self-explanation characteristics that predict transfer performance?

(2) To what extent is intrinsic motivation related to transfer performance?

(3) Does the level of intrinsic motivation vary with different types of self-explainers (anticipative reasoners, principle-based explainers, passive explainers, and superficial explainers)? In particular, it is asked to what extent strategic learners (anticipative reasoners, principle-based explainers) are more intrinsically motivated than unstrategic learners (passive explainers, superficial explainers).

Method

Sample and procedure

Thirty-six first-year university students of education volunteered to participate in this study. They worked in individual sessions of about two hours. Their primary task was to learn probability calculation from worked-out examples. The sessions started with mathematical pretests. Then, in order to provide or re-activate basic knowledge that allowed the subjects to understand the worked-out examples, an instructional text on basic principles of probability calculation was given to the subjects. The comprehension of these basic concepts was assessed by a criterion-referenced test that was evaluated immediately. If there was a wrong answer, the experimenter gave a semi-standardized explanation and had the subject re-read the corresponding text passage. Subsequently, the subjects were informed that they had to study the worked-out examples for 25 minutes. They were instructed to think aloud during this period. Finally, the subjects filled in a questionnaire on situational motivation and attempted the post-test.

Instruments and materials

The following description of the instruments and the materials is ordered according to the chronological sequence of the experimental session.

Pretests. Six relatively simple probability calculation problems were employed as a test of prior knowledge in probability calculation (e.g., "If you play the dice twice, what is the probability of two sixes?"; Cronbach's Alpha: .69). In addition, the subjects had to take an algebra test. This test was not considered in this study because it predicted neither self-explanations nor transfer (for details see Renkl, in press).

Instructional text and criterion-oriented test

The instructional text, which provided basic knowledge for the study of the worked-out examples, contained about 700 words (including formulae) and a diagram to illustrate the addition principle in probability calculation. The following principles were explained in a rather abstract manner: definition of probability, multiplication principle, addition principle, and principle of complementarity. The worked-out examples and the test items were based on these principles of probability calculation.

Worked-out examples. A computer monitor was used to present worked-out examples. The problem specification and the solution steps of each worked-out example were shown on four screen pages. On the first page, the problem givens were displayed. The subject could read them and then go to the next page where the first solution step was presented together with the problem formulation. After inspecting this solution step, the subjects continued to proceed to the following page where the next solution step was appended. The whole solution of each problem was presented on the fourth page. On the next page, the problem givens of a new example were presented.

The subjects were allowed to regulate the processing speed of the worked-out examples on their own. An external pacing control, for example, by fixing the presentation time for each page, would have interfered with the learners' strategies and would have diminished ecological validity. However, in order to keep the time-on-task for each subject constant, a study time of 25 minutes was fixed. Thus, when 25 minutes were over, the next mouse click on "Next Page" evoked a "thank-you screen." The subjects were informed about this procedure in advance.

Individual differences in processing speed caused the number of examples (pages) inspected by different subjects to vary. In order to preclude the pitfall that the faster subjects acquired a broader knowledge base through the inspection of further examples with different underlying structures (i.e., solution rationales), only four types of structures were used. Within the available time span of 25 minutes, every subject processed the first four problems and thereby encountered each type of structure. Hence, the faster subjects were confronted with examples containing new surface features (i.e., new numbers, new objects), but not new structures.

Assessment of self-explanations. The subjects were asked to verbalize their thoughts concurrently with the study of examples. The corresponding instruction was structured according to the guidelines of Ericsson and Simon (1993). The subjects were told to talk aloud and verbalize anything that comes to their mind. They were not instructed to provide special information. Thus, the subjects' spontaneous self-explanations were assessed.

Before the study of the examples, the thinking (talking) aloud procedure was trained using a warm-up problem (word problem in arithmetic). When the subject did not talk for more than 15 sec., the experimenter said to him or her: "(Please) keep talking".

The protocols were thoroughly examined for content segments that corresponded to the following categories:

(1) Anticipative reasoning. If a subject computed a probability in advance, that is, without looking at the worked-out solutions, this category was scored (e.g., "Then the probability of tiles with color and form faults is 1/50").

(2) Principle-based explanation. The frequency that subjects referred to the principles of probability calculation was counted. However, if a principle was merely mentioned without any elaboration (e.g., "This is the multiplication rule"), this category was not scored. There had to be some elaboration of a principle (e.g., "It gets multiplied because the events are independent from each other;" this statement referred to the meaning of the multiplication rule).

(3) Goal-operator combinations. This category was scored if a (sub-)goal and an operator that led to this (sub-)goal were explicitly mentioned (e.g., "Through this multiplication we get the probability of tiles with color and form faults").

(4) Negative Monitoring. All indicators of non-understanding were scored into this category (e.g., "Now I don't understand it any more").

The protocols were independently coded by both the author and a research assistant. The interrater agreement with respect to assigning the protocol segments to the coding categories was 89.3%, or expressed as Cohen's (1960) Kappa, which corrects for chance agreement, .87.[1] This amount of interrater agreement can be regarded as satisfactory. In cases of divergence, the author re-examined the protocols and made the final decision.

In addition to the interrater agreement, it was tested whether persons can be differentiated reliably across different examples with respect to the self-explanation variables or whether the quality of self-explanations was, instead, a function of specific person-example interactions. For this purpose, each person's scores were computed for the examples 1,3, ... and for the examples 2,4, ... respectively (odd-even method). Then they were correlated with each other and finally corrected by the Spearman-Brown formula. The reliabilities of principle-based explanations (.80), of the explication of goal-operator combinations (.80), and of anticipative reasoning (.81) were all sufficient. The reliability of negative monitoring statements was .59. This was not very satisfactory, but still acceptable.

Questionnaire on intrinsic motivation. A scale developed by Prenzel, Eitel, Holzbach, Schoenheinz, and Schweiberer (1993) was used. This scale included five items (e.g., "Learning was fun," "I felt curious") that were to be answered on a Likert scale from 1 (total disagreement) to 5 (total agreement). A sufficient reliability was obtained (Cronbach's Alpha: .69).

Post-test. The post-test consisted of 15 items. Three items were relatively simple problems such as those employed in the pretest. The other 12 items were constructed according to the following rationale. Four items were identical to the first four worked-out examples, except that some irrelevant information was inserted ("self-transfer"). Four other items had the same underlying structure, but different surface features ("near transfer"). Finally, there were four items that had similar surface features, but the underlying structure was changed ("far transfer"). For each correct solution of a post-test item, two points were awarded. If at least half of the solution was correct, one point was dispensed. Computational errors, which rarely occurred, were ignored.

In this study, merely the near and far transfer problems were considered (for examples see Figure 1). For the near transfer scale (Cronbach's Alpha: .73) and the far transfer scale (.65), satisfactory internal consistencies were obtained. The performances on these two types of problems were, however, strongly correlated (r = .71). Thus, these

[1] This interrater agreement refers to the coding of the four categories mentioned above and of three additional categories that were not, however, considered in this study (for details see Renkl, in press).

Givens of a worked-out example presented for learning
In an aptitude test for aircraft pilots, 40% of the applicants do not pass the physical examination and 60% do not pass the psychological tests. 20% of the applicants fail because of the physical and the psychological examination. What is the probability that two randomly selected applicants fit the job?

Near transfer: Same structure - different surface features
Production errors cause 15% of pencils to be of an incorrect length and 10% of the incorrect diameter. In 5% of the cases, both faults are present. If two pencils are randomly selected, what is the probability that neither has an error?

Far transfer: Different structure - similar surface features
In an aptitude test for aircraft pilots, 40% of the applicants do not pass the physical examination and 60% do not pass the psychological tests. 20% of the applicants fail because of the physical and the psychological examination. What is the probability that at least one out of two randomly selected applicants fits the job?

Figure 1
Types of transfer items and corresponding examples

two subscales were combined: "near and far transfer."[2]

Results

Pre-analyses: Extent of intrinsic motivation

Before answering the research questions, it should be examined how strongly the learners were intrinsically motivated in the present context. The mean score was 2.93 (SD = .99) which corresponds roughly to the center of the scale (1 [low intrinsic motivation] to 5). The individual minimum and maximum values were 1.20 and 4.80, respectively. This indicates that there was a rather large range of intrinsic motivation. This was a favorable condition for investigating the impact of interindividual motivational differences on strategy use und transfer performance.

To what extent is intrinsic motivation related to self-explanation characteristics?

As Table 1 shows, intrinsic motivation correlated significantly with anticipative reasoning, independently of whether prior knowledge was statistically controlled or not. Principle-based explanations, explications of goal-operator combinations, the number of inspected examples, and negative monitoring statements were not significantly associated with intrinsic motivation.

To what extent is intrinsic motivation related to transfer performance?

Intrinsic motivation was not significantly related to near and far transfer, independently of whether a zero-order correlation or a partial correlation (controlling for prior knowledge) was computed (Table 1).

Does the level of intrinsic motivation vary with different types of self-explainers?

An analysis of variance revealed that the four groups of learners differed significantly with respect to their intrinsic motivation ($F(3,32) = 3.27$, $p < .05$; anticipative reasoners (n = 4): M = 3.95, SD = 0.30; principle-based explainers (n = 8): M = 3.35, SD = 0.66; superficial explainers (n = 5): M = 2.84, SD = 0.81; passive explainers (n = 19): M = 2.57, SD = 1.07). With reference to the research question to what extent the strategic learners

[2] It should be noted that Renkl (in press) used a different terminology for this post-test subscale: "medium transfer" instead of "near and far transfer." The present terminology is, however, consistent with several recent publications of the author (e.g., Renkl, 1996).

Table 1
The relations of intrinsic motivation to self-explanations and transfer performance: Zero-order correlations and partial correlations (controlling for prior knowledge)

	Zero-order correlations	Partial correlations
Anticipative reasoning	.34 *	.41 *
Principle-based explanations	.01	.01
Goal-operator combinations	.15	.18
Number of inspected examples	.17	.19
Negative monitoring	-.06	-.08
Near and far transfer	.09	-.15

Note. * $p < .05$.

(principle-based explainers and anticipative reasoners) show higher intrinsic motivation as compared to unstrategic learners (passive explainers and superficial explainers), a planned contrast was computed. Descriptively, the strategic learners ($M = 3.55$; $SD = 0.62$) were more intrinsically motivated than the unstrategic learners ($M = 2.63$; $SD = 1.01$). The significance of this planned contrast had to be tested by a t-test for heterogeneous variances because the intrinsic motivation scores in the group of strategic learners were significantly more homogeneous as compared to the group of unstrategic learners ($F = 5,19$; $p < .05$). The group difference between the strategic learners and the unstrategic learners in the level of intrinsic motivation also proved to be statistically significant ($t[32.27] = 3.99$; $p < .05$); this effect could be classified as strong (effect size: $d = 1.10$). It should be noted that there was also a significant difference in transfer performance between the strategic and the unstrategic learners ($t(34) = 2.79$; $p < .05$; effect size: d: 1.01).

Post hoc-analyses

Given that the strategic and the unstrategic groups of learners substantially differed with respect to both intrinsic motivation and learning results, it seems puzzling why there was no significant relation between intrinsic motivation and transfer. Post-hoc analyses with focus on the individual scores of intrinsic motivation revealed that only one of the twelve strategic learners was intrinsically motivated to a below-average extent (negative z-score). Among the unstrategic learners, in contrast, fourteen learners had a below-average value of intrinsic motivation and ten learners had an above-average value. This pattern of results suggests that strategic learners are usually intrinsically motivated, but intrinsic motivation does not necessarily lead to strategic learning behavior. This finding is also compatible with the significantly higher homogeneity of the strategic learners with respect to their intrinsic motivation (see above).

Discussion

Transfer performance is not substantially related to intrinsic motivation. However, the assumption that intrinsic motivation enhances the employment of elaborative learning strategies is supported. This is primarily indicated by the significant difference between the different groups of strategic and unstrategic learners. The relation between anticipative reasoning and intrinsic motivation also underlines the importance of intrinsic motivation for high-level learning. It is, however, important to note, that not all types of elaborative strategies are related to intrinsic motivation and that there is no association between comprehension monitoring and intrinsic motivation. Probably, it would not even be functional if intrinsic motivation fostered all kinds of elaborative learning because this might lead to some suboptimal "over-elaboration" (Pirolli & Recker, 1994). This argument is supported by the fact that the typical successful learner did not frequently employ all types of self-explanations but rather concentrated on anticipative reasoning or on assigning meaning to operators (principle-based explanations and explication of goal-operator combinations).

There is an additional factor that probably causes bivariate relations between intrinsic motivation and learning strategies to be weak. As the post hoc-analyses have shown, strategic learners are usually intrinsically motivated but the intrinsically motivated learners often do not behave strategically. There may be several reasons why intrinsically motivated learners do not employ sophisticated strategies, but one reason is especially plausible: These learners may have deficits in their strategy repertoire. Given that the interrelations between motivation, strategy use, strategy repertoire, and learning outcomes are so complex, a data-analysis strategy that relies solely on bivariate correlations may overlook important relations.

A "methodological" factor that may have diminished the association between intrinsic motivation and learning outcomes is that the learning time was kept constant for all learners. Hence, high intrinsic motivation could not effect a prolonged study of the learning materials, as it might be the case in real-life situations when there are no strict time constraints. This argument is of special importance as Schiefele, Wild, and Winteler (1995) have found that the effect of interest (a construct quite similar to intrinsic motivation) on learning performance of university students was mediated by prolonged learning time but not by the quality of the learning strategies employed. In sum, the present finding that intrinsic motivation is not significantly related to transfer may hold only for learning situations with strict time constraints (e.g., learning during school periods).

In comparison to questionnaire studies, a clear drawback of investigations such as the present one in which learning strategies are assessed by thinking-aloud is that it is hardly possible to analyze the data of large samples in order to obtain precise estimations of relations. Nevertheless, studies like the present one lead to refined hypotheses that can be tested in further studies with larger samples. Specifically, the present findings lead to the following propositions:

(a) The lack of "high-level" demands in tests or examinations cannot be the sole explanation for weak correlations between intrinsic motivation and learning results. Even transfer measures that require deep understanding are not necessarily significantly correlated with intrinsic motivation.

(b) The assumption that intrinsic motivation fosters elaborative and metacognitive strategies is too gross. It is necessary to define more precisely which specific strategies are influenced by intrinsic motivation. In addition, the answer to this question probably depends on contextual factors such as learners' strategy repertoire and the degree of freedom in the learning environment because they determine which choices of strategy are available.

(c) Intrinsic motivation seems to have different effects in different groups of learners. This hypothesis is derived from the finding that there are two successful groups which both have high intrinsic motivation, but differ with respect to their preferred strategies (for similar results see Pintrich & Garcia, 1993). Hence, intrinsic motivation may enhance different strategies in different learners. In addition, there is a third subgroup of learners who presumably "had will, but no skill" so that intrinsic motivation was in some way "blocked." Given that there are subgroup-dependent relations between intrinsic motivation and strategies, it can be concluded that if merely bivariate correlations are considered, the actual interrelations between intrinsic motivation, strategies and learning results may remain masked. The research strategy of identifying different types of "actively elaborating" and of "intrinsically motivated" learners seems fruitful.

References

Benware, C. A., & Deci, E. L. (1984). Quality of learning with an active versus passive motivational set. American Educational Research Journal, 21, 755-765.

Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. Psychological Bulletin, 56, 81-105.

Chi, M. T. H., Bassok, M., Lewis, M. W., Reimann, P., & Glaser, R. (1989). Self-explanations: How students study and use examples in learning to solve problems. Cognitive Science, 13, 145-182.

Cohen, J. (1960). A coefficient of agreement for nominal scales. Educational and Psychological Measurement, 20, 37-46.

Cordova, D. I., & Lepper, M. R. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization, and choice. Journal of Educational Psychology, 88, 715-730.

Ericsson, K. A., & Simon, H. A. (1993). Protocol analysis (Revised edition). Cambridge, MA: MIT Press/Bradford.

Fiske, D. W., & Campbell, D. T. (1992). Citations do not solve problems. Psychological Bulletin, 112, 393-395.

Harter, S. (1981). A new self-report scale of intrinsic versus extrinsic orientation in the classroom: Motivational and informational components. Developmental Psychology, 17, 300-312.

Pintrich, P. R. (1989). The dynamic interplay of student motivation and cognition in the college classroom. Advances in Motivation and Achievement: Motivation Enhancing Environments, 6, 117-160.

Pintrich, P. R., & DeGroot, E. V. (1993). Motivational and self-regulated learning components of classroom academic performance. Journal of Educational Psychology, 82, 33-40.

Pintrich, P. R. & Garcia, T. (1991). Student goal orientation and self-regulation in the college classroom. Advances in motivation and achievement: Goals and self-regulated processes, 7, 371-402.

Pintrich, P. R., & Garcia, T. (1993). Intraindividual differences in students' motivation and self-regulated learning. German Journal of Educational Psychology, 7, 99-107.

Pintrich, P. R., Smith, D. A. F., Garcia, T. & McKeachie, W. (1993). Reliability and predictive validity of the motivated strategies for learning questionnaire (MSLQ). Educational and Psychological Measurement, 53, 801-813.

Pirolli, P., & Recker, M. (1994). Learning strategies and transfer in the domain of programming. Cognition and Instruction, 12, 235-275.

Prenzel, M., Eitel, F., Holzbach, R., Schoenheinz, R. J. & Schweiberer, L. (1993). Lernmotivation im studentischen Unterricht in der Chirurgie [Motivation for learning in university instruction in surgery]. German Journal of Educational Psychology, 7, 125-137.

Renkl, A. (1996). Lernen durch Erklären - oder besser doch durch Zuhören? [Learning by explaining - or better by listening?]. Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie, 28, 148-168.

Renkl, A. (in press). Learning from worked-out examples: A study on individual differences. Cognitive Science.

Schiefele, U. & Schreyer, I. (1994). Intrinsische Lernmotivation und Lernen. Ein Überblick zu Ergebnissen der Forschung [Intrinsic motivation and learning. A review of research findings]. German Journal of Educational Psychology, 8, 1-13.

Schiefele, U., Wild, K.-P., & Winteler, A. (1995). Lernaufwand und Elaborationsstrategien als Mediatoren der Beziehung zwischen Sudieninteresse und Studienleistung [Amount of learning and elaboration strategies as mediators of the relation between study interest and achievement] German Journal of Educational Psychology, 9, 181-188.

Vollmeyer, R., Burns, B. D., & Holyoak, K. J. (1996). The impact of goal specifity on strategy use and the acquisition of problem structure. Cognitive Science, 20, 75-100.

Vollmeyer, R. & Rheinberg, F. (in press). Motivationale Einflüsse auf Erwerb und Anwendung von Wissen in einem computersimulierten System [Motivational influences on the acquisition and application of knowledge in a computer-simulated system]. German Journal of Educational Psychology.

Wild, K.-P. (1996). Beziehungen zwischen Belohnungsstrukturen der Hochschule, motivationalen Orientierungen der Studierenden und individuellen Lernstrategien beim Wissenserwerb [Relations between reward structures in universities, students' motivational orientations, and individual learning strategies for knowledge acquisition]. In J. Lompscher & H. Mandl (Eds.), Lehr- und Lernprobleme im Studium. Bedingungen und Veränderungsmöglichkeiten (pp. 54-69). Bern, CH: Huber.

TM026836

AREA 1997

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

ERIC®

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: INTRINSIC MOTIVATION, SELF-EXPLANATIONS, AND TRANSFER

Author(s): ALEXANDER RENKL

Corporate Source: UNIVERSITY OF MUNICH

Publication Date: 3/26/1997

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic/optical media, and sold through the ERIC Document Reproduction Service (EDRS) or other ERIC vendors. Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce the identified document, please CHECK ONE of the following options and sign the release below.

[X] ← **Sample sticker to be affixed to document**

Check here
Permitting microfiche (4"x 6" film), paper copy, electronic, and optical media reproduction

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Sample
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Level 1

Sample sticker to be affixed to document → [ ]

"PERMISSION TO REPRODUCE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY
Sample
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Level 2

or here
Permitting reproduction in other than paper copy.

Sign Here, Please

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Signature: A. Renkl	Position: ASSISTANT PROF.
Printed Name: Dr. Alexander Renkl	Organization: UNIVERSITY OF MUNICH
Address: LEOPOLDSTR. 13 D-80802 MUNICH GERMANY	Telephone Number: ++49 (89) 2180 6255
	Date: 3/25/97

OVER