Goal Specificity and Learning with a Multimedia Program

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Abstract

Previous research has found that nonspecific goals (NSG) lead to better learning than a specific goal (SG). We studied this effect with a multimedia program in which participants had to learn about the outbreak of World War 1 either with the goal to find twenty dates (i.e., SG) or with the goal to explain the reasons for the war (i.e., NSG). As expected, the NSG-group better remembered facts about the text during the task and knew more at the end than the SG-group. The NSG-group may also better transfer what they had learnt to a new situation. To try to explain this effect, a number of process variables (strategy systematicity, motivation, number of pages read) were measured. SG- and NSG-group differed in terms of which variable best predicted learning: As expected, for the NSG-group challenge was the best predictor of performance, but probability of success was the best for the SG-group.

Introduction

Effects of goal specificity on problem solving have been found in a number of recent studies (Geddes & Stevenson 1997; Miller, Lehman, & Koedinger, 1999; Sweller, 1988; Vollmeyer, Burns, & Holyoak, 1996). All these studies have found that giving problem solvers a specific goal state to reach led to poorer learning of the task than if they were given a nonspecific goal, such as to explore. However a difficulty has arisen when trying to form general conclusions about this work and its scope: different researchers have used very different tasks and have given different instantiations to the concept of goal specificity. Further the question arises of what relationship does the work on goal specificity in problem solving have to other goal specificity in organization psychology (see Locke & Latham, 1990), and possibly related research, such as that into explanation effects (Chi, Bassok, Lewis, Reimann, & Glaser, 1989).

To deal with this issue, in this paper we propose a conceptualization that generalizes what goal specificity is and applies that concept to the development of a new task for investigating goal specificity effects. This paper is a preliminary study that aimed to demonstrate goal specificity effects with a new task, and to show that this task has the potential to increase our knowledge of why such effects occur. We chose to use a multimedia learning program as our task, both because of the explosion of interest in such programs (Issing & Klimsa, 1997) as cheap computer technology becomes widely available, and because it is very different to the problem solving tasks with which goal specificity effects have previously been found.

Defining Goal Specificity

In Vollmeyer et al. (1996) we proposed that goal specificity effects could be explained in terms of dual-space theories of problem solving (Klahr & Dunbar, 1988; Simon & Lea, 1974). Specific goals (SG) could be seen as encouraging search of an instance or experiment space. Such a space corresponds to what is usually meant when we refer to problem solving as search; that is, we set specific subgoals that are part of that space and reach the goal via those subgoals. A specific goal is a state in such a problem space, which is why specific goals encourage a focus on this space. In contrast, a nonspecific goal (NSG) could be seen as encouraging search of rule or hypothesis space. Such a search space contains the possible rules or hypotheses that may govern the task, but testing such rules requires a coordinated search of instance and rule space.

If we assume that dual space theories provide an appropriate way to characterize specific and nonspecific goals, then it provides a definition of goal specificity. Specific goals are goals that promote reaching set states, nonspecific goals are those that encourage discovery of the nature of the task. By this definition, goal specificity qualitatively affects how people learn, not just how much.

Self-explanation Theory. Chi et al. (1989) found that students who explained math problems to themselves did better than students who only worked out examples. Although they do not use the term *goal specificity*, their characterization of explanations seems to fit to our definition of a nonspecific goal. Explaining math problems requires understanding the principles they are based on, whereas not requiring explanation allows problem solvers to focus on the solution alone.

However, self-explaining students took more time for the same task, thus, it could have been that time on task was a moderating variable. In several studies of the self-

explanation effect, Renkl (1997; for an overview, see Renkl, 1999) pointed out that time-on-task could be a moderator of performance. Self-explaining students take more time if given the opportunity, so in his experiments Renkl controlled for time and manipulated self-explanation in asking the self-explanation group to learn in a way they could explain the task to another person. Although both groups worked for the same amount of time, the self-explanation group had better learning outcomes than a group who only solved the problems. Therefore time-on-task appears to be important in these types of tasks.

Goal Specificity in Organizational Psychology. In organizational psychology, what has been known as goal specificity has been studied extensively in terms of goal setting (see Locke & Latham, 1990). In this literature specific goals are a form of target (e.g., "Make ten widgets") whereas nonspecific goals are general admonitions to do well (e.g., "Make as many widgets as possible"). Tubbs' meta-analysis (1986) showed that specific goals help performance (d = .82), although some studies reported exactly the opposite. However these goals are specific and nonspecific in a different way to what has been meant in problem solving research. These goals are forms of targets, rather than states of the problem. Using our definition of goal specificity, we can see that the question of whether the two types of specificity are related depends on how these target goals might affect which space learners focus on. In this paper we will not address the possible connections between these two types of goal specificity.

Goal Specificity in Multimedia. In the literature on learning from multimedia texts, *open tasks* have been found to lead to better understanding than *closed tasks*. In their meta-analysis, Chen and Rada (1996) found consistently strong evidence that learners given an open task were more effective than learners given a closed task. However, there is a huge variety in what is subsumed under the closed or open manipulation. In general, closed tasks can be seen as those presenting learners with specific goals, for example to find a particular piece of information, whereas open tasks have very general goals, for example to learn for a test. Thus this distinction can be seen as roughly fitting to our definition of goal specificity: closed and open tasks are those with specific and nonspecific goals, respectively. Learning with multimedia is a particularly interesting domain for examining goal specificity as how people gather information can be explicitly coded by looking at the sequence of actions they perform on the computer. So it provides an opportunity for us to try to measure strategies.

Goal Specificity and Motivation. Kanfer and Ackerman (1989) proposed that goal specificity might affect motivation. To examine this issue we applied Vollmeyer and Rheinberg's model (1998). They proposed a model that assumes that initial motivation affects learning through the mediating variables of motivational state during learning and strategies used for learning. The initial motivation contains four factors: (1) *probability of success*, which is the learners' level of certainty about whether they will succeed in performing the task; (2) *fear*, which is how anxious learners are about failing in the task; (3) *challenge*, which is the extent to which learners perceive this task as requiring competence; and, (4) *interest*, which is how much learners like the topic of the program.

Schiefele (1996) reported that in several experiments interest had a positive effect on text learning, especially on understanding texts as opposed to learning facts. Given that interest and challenge are highly correlated (Rheinberg & Vollmeyer, in press), we assumed that challenge would have the same effect. For facts, we assumed that good learning depends more on the learner's expectancy of receiving a good result. Our nonspecific goal definition can be seen as equivalent to what Schiefele called *understanding-oriented learning*, whereas our specific goal definition corresponds to *fact learning*. Therefore we expected that in a nonspecific goal condition initial interest and challenge would predict learning but in the specific goal condition probability of success and fear (which are indicators of expectancy) should be better predictors.

Study Aims

This paper reports our first exploration of a multimedia program we developed to study goal specificity. To develop this task we had to determine how to apply the concept of goal specificity in problem solving to a very different task.

Multimedia Program. The topic of the program was the outbreak of World War 1. The computer could present up to 51 different pages describing the events leading up to the start of the war. Each page had links to other pages and could have links to videos, sound files, or text boxes containing additional information. Most of the pages were arranged into five sequences, each describing the events occurring in one of the five critical countries (Austria-Hungary, England, France, Germany, and Russia). In addition, topics such as nationalism and imperialism were covered. As an event could concern two or three countries (e.g., declaration of war), learners sometimes saw the same page in the sequence for multiple countries. After every page learners could decide whether to continue reading pages about the same country or to switch to another country or topic. Thus the program provided us with a way to examine the learners strategies. In Vollmeyer et al. (1996) we found that strategy systematicity was critical to performance but the task was so different that we could not use this operationalization. Therefore in the multimedia program we operationalized systematicity as the extent to which learners followed sequences, instead of jumping from one topic to another.

To operationalize goal specificity, Chi et al.'s (1989) idea of explanation seemed most applicable to this task given our definition of goal specificity. So we had NSG learners go through the program with the goal of explaining the outbreak of World War 1 to someone else. However unlike Chi et al. we did not have participants give explanations during the task. To increase the contrast between NSG and SG learners, the SG-learners were given a list of 20 specific events and asked to fill in the dates for those events.

Predictions. We expected the NSG group to learn more than the SG group, and to be better able to transfer the lessons of the outbreak of World War 1 to another situation. We expected this greater learning to be a result of NSG learners being more systematic. As the NSG learners are more systematic, that is they put more effort into understanding the content of a page they should spend more time per page than SG participants.

We did not expect goal specificity effects on initial motivation. However, the motivational state during learning may change during the task in different ways for the two groups as they react to their perceived success or failure in attaining their goal. In particular we tested Schiefele's (1996) proposal that challenge and interest would relate more strongly to performance for NSG than for SG learners.

Experiment

Method

Participants. Forty-five students at the University of Potsdam participated in the study and received DM 10.00 (~ US$5) or course credit.

Design. There were two levels of goal specificity. The SG group consisted of 24 participants who received instructions to look for dates in the history multimedia program. The NSG group consisted of 21 participants who were told to understand the problem as if they would have to explain it to another person.

Procedure. Before the participants started working with the multimedia program they read that they would learn about the outbreak of World War 1. They were informed that they would work with the program for about 25 minutes and then answer a questionnaire. We set a fixed time span as we felt it was important to control for time in order to remove any possibility of time-on-task being used as a factor to explain goal effects. We also told participants that they would be interrupted at various times so that we could ask them what they thought about the task. These interruptions were necessary in order to measure participants' motivational states and to sample their knowledge. The instructions also contained the goal specificity manipulation. The NSG participants were asked to "...work with the program so that you could tell another person about the reasons for the outbreak of World War 1." The SG participants were asked to "... work with the program so that you can fill out correctly the following time-line." The time-line consisted of twenty events, such as the assassination in Sarajevo, for which the learners had to find the dates in the program.

After reading the instruction participants answered the QCM (*Q*uestionnaire of *C*urrent *M*otivation, by Vollmeyer & Rheinberg, 1998). This questionnaire measured their initial motivation on the four factors *probability of success* (example items: "I think I am up to the difficulty of the task", "I probably won't manage to do this task"), *fear* (example items: "It would be embarrassing to fail at this task", "I feel petrified by the demands of this task"), *interest* (example items: "After having read the instruction the task seems to be very interesting to me", "For tasks like this I don't need a reward, they are lots of fun anyhow."), and *challenge* (example items: "This task is a real challenge for me", "If I can do this task, I will feel proud of myself").

When working with the multimedia program participants were interrupted every seven minutes for a total of three times. During each of the three interruptions they were asked to answer two types of questions: a motivational state questionnaire, and one factual question about each of the last three pages the participants had seen in the program.

Process Variables. Three process variables were measured while learning.
(1) *Motivational state*. Every seven minutes participants answered ten questions (example items: "The task is fun", "I'm sure I will find the correct solution") on a seven-point scale. A composite score was calculated to represent motivational state. Responses were averaged together.
(2) *Strategy systematicity.* Our aim was to find indicators for how systematically a learner works through the program. As this was our first use of this multimedia program, it was not clear what the best measure was. We chose to measure how often learners read a page that followed from the previous one, as opposed to jumping to a new topic. This variable was called sequence. For this we counted the pages that followed logically from the previous one. We then divided this count by the total number of pages participants looked at. An example of following a sequence would be if after the first page for Germany the second page for Germany was looked at. Switching to the first page of France would have been counted as not following the sequence.
(3) *Number of pages.* We counted the number of pages that participants looked at for more than five seconds. Pages looked at for 5s or less were probably mistakes, or arose because the learner realized they had already read the page. Given that each learner was given about the same amount of time to work with the program, we expected that looking at fewer pages would be an indicator of going into the contents of the pages in greater depth.

Outcome Variables. To measure knowledge we used a pilot study to develop a questionnaire. For every page that was part of a sequence for a country or side topic (34 in all), we formulated a multiple-choice question with five options. As we had the hypothesis that NSG-learners would read more carefully than SG-learners we formulated factual as well as inference questions, similar to the suggestion of Royer, Carlo, Dufresne and Mestre (1996). So 24 pages had factual questions, ten had inference questions, and one general question was asked.

There were three outcome variables, two were indicators of knowledge and one of transfer.
(1) *Sampled knowledge*. The relevant item from the questionnaire was asked about each of the last three pages learners had seen.
(2) *Accumulated knowledge*. After participants had worked with the multimedia program for approximately twenty-five minutes, they were given the whole questionnaire.
(3) *Transfer*. If NSG-participants understood the program on a deeper level then they should have an advantage in

understanding a similar situation. So we asked them to imagine a scenario in which four tribes were deciding whether to form alliances. Analogous to World War 1, between some tribes there were permanent conflicts over resources and between some there were no fundamental problems. Participants took the role of one tribe's leader and decided whether to form an alliance, then justified their answer. The arguments of participants agreeing to make an alliance were classified into two categories: *security* ("It's more secure to have partners."), and *nationalism* ("Having a partner gives my tribe more power."). Participants who disagreed with making an alliance had their arguments classified as either *war avoidance* ("My tribe has to help the partner in a conflict even if it is not our conflict."), or *egoism* ("I don't want to fight for others."). The participants' statements could be assigned to categories with an inter-rater reliability of Cohen's (1960) $\kappa = .94$. Nationalism and egoism explanations were considered less interesting as they were only seldom mentioned in an unpublished pilot study.

Results

Preliminary Analyses. Our intention was to examine the process of learning by measuring the variables motivational state and sampled knowledge, so we interrupted learning three times. However, motivational state during learning stayed constant (motivational state at time point 1: $M = 5.42$, $SD = 0.76$; at time point 2: $M = 5.49$, $SD = 0.82$; at time point 3: $M = 5.52$, $SD = 0.90$; $F[2, 86] = 0.84$, $p = 0.44$) and at a high level (scale from 1 = low motivational state to 7 = high motivational state). There was no feedback given to participants, but this result suggests that learners did not experience success or failure while working with the program. If they had done so, then motivation would probably have increased or decreased, as Vollmeyer, Rheinberg, and Burns (1998) showed.

The second variable was sampled knowledge. As a consequence of the design this measure should not change over time as participants always received questions about the last three pages they saw. As the pages were not cumulative, answers to these questions cannot reflect accumulation of knowledge. Instead they sample how well the participants were learning as they worked through the program. For each set of three questions learners scored between 0 and 3. We also tested whether knowledge was constant during learning. Because we expected no difference between knowledge sampled at different points, we averaged the knowledge scores as well as the motivational states.

Effects of Goal Specificity. The first aim of our study was to test the hypothesis that learners with a specific goal acquired less knowledge then participants with a nonspecific goal. Achieving a worse outcome may be a result of poor strategies and/or motivation, which were measured as mediating variables.

The most important measures were knowledge during learning and accumulated knowledge, as these should demonstrate that giving participants specific goals decreased their learning performance. For knowledge during learning, the possible range for correct answers was 0 to 9 (three times questions about three pages). As expected, the SG-group could not answer correctly as many questions as the NSG-group, $t(43) = 3.34$, $p = .002$, as the means in Table 1 show. The same effect was found on the multiple-choice questions after learning with the program. The answers were adjusted in that answers were only analyzed to questions about pages participants had actually seen. Thus the means in Table 1 show the proportion of correct answers to pages seen. For the factual questions, the NSG-group answered 44%, compared to 29% for the SG-participants, $t(43) = 4.18$, $p < .001$. NSG-participants were also better on inference questions, $t(43) = 3.20$, $p = .003$. Even if we had not applied the adjustment, the effect for goal specificity on knowledge for facts holds (SG: $M = 8.96$, $SD = 3.62$; NSG: $M = 12.67$, $SD = 3.34$, $t[43] = 3.56$, $p = .001$) as well as for inferences (SG: $M = 3.08$, $SD = 1.21$; NSG: $M = 4.52$, $SD = 1.86$, $t[43] = 3.11$, $p = .003$).

Table 1: Descriptive statistics for the SG-group ($n = 24$) and the NSG-group ($n = 21$) on process and dependent variables.

	Groups	M	SD
sampled knowledge	SG	3.79	1.74
	NSG	5.52	1.72
knowledge (facts)	SG	0.29	0.12
	NSG	0.44	0.13
knowledge (inference)	SG	0.23	0.12
	NSG	0.37	0.16
number of pages	SG	46.58	13.72
	NSG	39.43	9.83
Interest	SG	4.93	1.32
	NSG	4.93	0.99
Challenge	SG	4.96	1.00
	NSG	4.58	0.89
probability of success	SG	5.47	0.85
	NSG	5.45	1.04
Fear	SG	2.68	1.10
	NSG	3.06	1.38
motivation during learning	SG	5.47	0.70
	NSG	5.49	0.86
sequence	SG	0.71	0.01
	NSG	0.73	0.01

We found a clear effect of goal specificity on learning outcomes, so we tested whether our goal specificity manipulation affected process variables. As Table 1 shows, SG-participants looked at more pages, $t(43) = 1.98$, $p = 0.054$. Although this effect was not quite significant, we analyzed the process and dependent variables by relating them to the number of pages looked at.

We did not expect any effect of goal specificity on initial motivation. As the means in Table 1 indicate, none of the four factors of initial motivation (interest, challenge, probability of success, fear) differed, p's < 0.15. As the items were answered on a scale from 1 to 7, the means

demonstrate that all participants regarded the task as easy (probability of success: M = 5.26, SD = 0.93), interesting (interest: M = 4.93, SD = 1.17), challenging (challenge: M = 4.78, SD = 0.95), and that it aroused few fears (fear: M = 2.85, SD = 1.24).

As process variables, motivational state and strategy systematicity were measured. The motivational state measure (averaged over three time points) did not differentiate the SG-group from the NSG-group, $t(43)$ = 0.11, p = 0.92. The indicator for how systematically learners work with the multimedia program was the proportion of pages that followed logically from the previous page. Although we had expected that the SG-group would jump around more in the program, we could not find a difference, $t(43)$ = 0.83, p = .41. Across both groups, participants chose the next logical page 73% of the time; that is, they followed the sequence for the country they were reading about

We expected that NSG participants faced with our transfer task would be less likely to agree to an alliance that risked a wider war. Therefore, we tested whether the groups differed in who would agree to an alliance and what argument they would use. As Table 2 shows, there was a tendency for more SG-participants than NSG-participants to agree to an alliance, $\chi^2(1) = 3.27$, p = .071.

Table 2: Number of participants in SG- and NSG-group agreeing to an alliance.

	agreement to alliance	
	alliance	no alliance
SG	12	12
NSG	5	16

When we categorized the arguments used to justify whether to enter an alliance, we dropped the categories of *nationalism* (one in each group) and egoism (7 in SG, 6 in NSG) from the analysis. These two categories are unlikely to be influenced by the program. Of the remaining two categories, we found that war avoidance (the theme our participants would be likely to use if they understood the program) was used as a justification more often by NSG participants than SG participants, who instead were more likely to use security as a justification, χ^2 (1) = 4.82, p = .028 (see Table 3). Thinking in terms of security might be a more surface reaction to the event described in the program.

Table 3: Distribution of the SG- and NSG-group which arguments were given for or against alliance.

	argument pro/con alliance	
	war avoidance	security
SG	5	11
NSG	10	4

Cognitive-motivational Model. The aim of the study was to explore whether the concept of goal specificity could be applied to a more realistic multimedia task. Previously we have looked at how motivation may affect the learning process in different ways depending on the goal (Vollmeyer, et al., 1998). However, the sample size in this preliminary study is not large enough for the type of path analyses required to examine this issue. Therefore, a first step was to look for differences between groups in term of which variables affected accumulated knowledge. As knowledge for facts and inferences were correlated, r = 0.66, $p < 0.001$, and there were fewer inference questions than fact questions, we will only report knowledge for facts. Number of pages also did not relate to motivation. Correlations of final knowledge with initial motivation and process variables are presented in Table 4.

Independent of the manipulation, sampled knowledge and strategy systematicity (i.e., *sequence*) should be positively correlated with accumulated knowledge. Whereas for sampled knowledge a relationship to accumulated knowledge was found, this was not the case for sequence. The latter result makes doubtful whether sequence is a valid indicator for strategy systematicity.

We examined Schiefele's (1996) proposal that interest and challenge could play a more important role for NSG learners. Table 4 shows that interest and challenge correlate with accumulated knowledge for the NSG-group but not for the SG-group. However, the difference in correlations is only significant for challenge (z = 2.59, p = 0.014).

To analyze which variable was the best predictor for accumulated knowledge, we calculated a regression on the four initial motivational factors, motivation during learning and sampled knowledge. As the correlations had shown different patterns in the experimental groups, they were analyzed separately. For the SG-group the best predictor for knowledge is probability of success, β = 0.46, t = 2.56, p = 0.018, R^2 = .23, whereas for the NSG-group challenge, β = 0.61, t = 3.42, p = 0.003, R^2 = .27, is the best.

Table 4: Correlations r (p) of accumulated knowledge with initial motivation and process variables separated in SG- (n = 24) and NSG-groups (n = 21).

	Correlations with accumulated knowledge	
	SG	NSG
sampled knowledge	***0.35*** (0.10)	**0.46** (0.03)
interest	0.02 (0.92)	**0.51** (0.02)
challenge	-0.23 (0.28)	**0.51** (0.02)
probability of success	**0.48** (0.02)	0.31 (0.17)
fear	**-0.45** (0.03)	-0.31 (0.17)
motivation during learning	0.19 (0.37)	***0.39*** (0.08)
sequence	-0.11 (0.62)	-0.14 (0.55)

Discussion

The major result of our study was that we could demonstrate an effect of goal specificity on a more realistic task than those on which this type of research has previously been based. Switching from a problem-solving task to multimedia learning in the domain of history presented two difficulties: the first was that goal specificity had to be re-interpreted, the second was that the theoretical constructs needed new operationalizations.

Goal Specificity. With a new task and a different operationalization of goal specificity we could replicate the effect that an NSG group would learn more than a SG group, even when the task was to learn about the causes that led to the outbreak of World War 1. Therefore we met our aim of generalizing the concept of goal specificity from problem solving to multimedia learning.

Goals and Motivation. Compared to our research on problem solving, motivation during the task seemed to play a different role when working with a multimedia program. As our previous task was difficult to solve, motivation changed while working with that task. When working with this shorter and easier program no changes of motivation during learning were observed, but initial motivation was more predictive than was previously found. However, what motivational factors were most influential varied with goal specificity. For NSG interest and challenge were most important, but for SG fear and probability of success were. This provides further evidence that the way motivation affects performance varies with the type of goal.

Operationalizations of Theoretical Constructs. In a problem solving task every input can be categorized on a continuum of systematicity, but with a multimedia program it is not clear how to operaterationalize this variable. Even if learners can choose after every page what to see next, it is unclear whether choosing the next page in the sequence is a systematic strategy as we defined it. As our measure does not correlate with performance it is still open as to whether this is a valid measure. However, we have shown that this is a useful task for examining goal specificity, so it should be worthwhile in future research to try to develop and validate better measures of strategy.

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