Teaching Causal Reasoning Through Cognitive Apprenticeship: What Are Results From Situated Learning?

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ABSTRACT **The author investigated whether situated instruction produces more usable, transferable knowledge than instruction that is abstracted from the context of its use. To test that theory, 220 Grade 7 students were instructed on the topic of causality. Half the students were taught how to determine whether a research study shows a cause-and-effect relationship under the situated-learning model. The remaining students were taught the same concept under the abstracted instruction model. An additional factor, teaching for transfer, also was investigated. Although there were significant differences in learning immediately following instruction, there were no differences on the transfer task due to instructional condition or transfer training. Of the 194 participants who completed the transfer task, only 2 students spontaneously transferred their learning.**

Key words: cognitive apprenticeship, situated cognition, transfer

Situated cognition exists in various forms and assumes different names, including cognitive apprenticeship, situated learning, and legitimate peripheral participation. The different forms share the idea that learning and doing are inseparable and that learning is a process of enculturation. Situated cognition is based largely on the work of Vygotsky (1979) but also is linked to Leont'ev (1981) and Luria (1979, in Reynolds, Sinatra, & Jetton, 1996) and to anthropological studies of craft apprentices (Brown, Collins, & Duguid, 1989; Lave, 1988, 1993; Lave & Wenger, 1991).

Vygotsky (1977) explained that thinking, knowing, and understanding are the result of sociohistorical experience. That experience includes using and understanding the signs and symbols of one's culture to become part of a social group (Gredler, 1997). Children and other novices receive information about their culture's tools and practices through interaction with experienced members of the culture (Rogoff, 1984).

The idea that learning results from complex social interaction is central to the theory of situated cognition. Brown et al. (1989) called that theory of learning a process of enculturation and applied it not only to how craft apprentices learn their trades but also to how students learn. From childhood through adulthood, individuals continually adopt the behavior and beliefs of the social groups with which they interact. That interaction can result in remarkably complex behavior, which some persons believe can occur only when individuals are allowed to observe members of a culture and practice relevant behaviors in situ (Brown et al., 1989).

The intellectual goal of situated cognition is acquiring cognitive skills and strategies; this occurs through sustained participation within a community (Brown et al., 1989; Collins, Brown, & Newman, 1989; Lave, 1988, 1990; Lave & Wenger, 1991; Prawat & Floden, 1994). Collins et al. explained that in situated learning, students are able to see how experts tackle problems, and they learn to solve problems in the same way by "learning-through-guided-experience" (p. 457). The focus is on gaining problem-solving strategies in authentic activities that can be used to solve problems encountered in everyday situations.

That goal is much different from the goal of traditional schooling (Brown et al., 1989; Collins et al., 1989; Lave, 1988, 1990). Lave (1990) maintained that traditional schooling is based on the idea that learning and doing are separate. An assumption of that type of schooling is that learning must be removed from the fields in which it is useful to ensure broad transfer. Lave (1990) explained as follows:

> This belief underlies standard distinctions between formal and informal learning, so-called context-free and context-embedded learning, or logical and intuitive understanding. Schooling is viewed as the institutional site for decontextualizing knowledge so that, abstracted, it may become general and hence generalizable, and therefore transferable to situations of use in the "real" world (p. 310).

Traditional schooling, then, is based on the idea that children can be taught concepts outside of their specific uses to increase general learning so that broad transfer to many sit-

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uations can occur. The idea that knowledge must be abstracted from its uses for broad transfer to occur is strongly opposed by situated "cognitionists." Examples of training through abstraction are learning vocabulary definitions through rote memorization (Brown et al., 1989) and solving word problems in algebra (Lave, 1993). Those who rely on that type of learning assume that it can occur in situations in which information is presented in abstract rather than in concrete or specific terms. Situated cognitionists believe that when learning occurs through abstract instruction, it is bound to the context in which it occurs and cannot be generalized to real-world problems and situations.

To deal with the problems of inert, decontextualized knowledge and the inability of students to generalize their learning, situated cognitionists propose the use of authentic activities to promote learning and understanding. They believe that students should engage in the same types of activities in which experts in the various disciplines engage (Brown et al., 1989). The notion that students should learn in context is a fundamental tenet of situated cognition, although a specific situated teaching model accepted by all situated cognitionists does not exist.

In a description of the situated classroom, learning in context is typically exemplified using an apprenticeship metaphor. Brown et al. (1989) described the situated classroom as one in which the teacher uses modeling, coaching, scaffolding, and fading as students solve authentic problems. Collins et al. (1989) added articulation, reflection, and exploration to the model. Those methods are used so that students can adopt the strategies of experts.

Although some researchers have begun to describe situated teaching models, few empirical studies have been conducted to test the theoretical assumptions of situated learning. The majority of research on situated cognition includes case studies that illustrate good teaching practices (Lampert, 1986; Palincsar & Brown, 1984; Scardamalia & Bereiter, 1985; Schoenfeld, 1985; Rojewski & Schell, 1994; Young, 1993) and ethnographic descriptions of learning within a certain context to support theoretical tenets (Carraher, Carraher, & Schliemann, 1985; Lave, 1988; Lave & Wenger, 1991; Saxe, 1991; Scribner, 1984).

Several researchers have challenged the theoretical assumptions of situated cognition. Boaler (1993) disagreed with Lave's (1988) contentions that (a) school learning is bound to the context in which it occurs and (b) transfer cannot be improved through any factors in the learning environment. Addressing the ethnographic studies of learning within context, Anderson, Reder, and Simon (1996) stated that, "Even if these claims are valid and generalizable beyond these specific cases, they demonstrate at most that particular skills practiced in real-life situations do not generalize to school situations. They assuredly do not demonstrate the converse" (p. 6). Anderson et al. also cited studies that show that transfer can occur (Brown & Campione, 1994; Kotovsky & Fallside, 1989; Schoenfeld, 1985; Singley & Anderson, 1989; Smith, 1986). Renkl, Mandl, and Gruber (1996) criticized the difficulty in studying situated cognition as lacking the characteristics of a clearly defined and empirically testable theory.

My purpose in the present study was to compare transfer of causal reasoning skills between a group of students taught using a situated learning model and another group of students taught using an abstracted instruction model. I chose that comparison because assessing causality and making correct inferences from data and research are part of the National Science Education Standards (National Research Council, 1996) as well as part of the South Carolina science curriculum standards (South Carolina State Department of Education, 1998). *Causality* is defined in this study as a relationship between variables in which change in one variable causes a change in another variable (Moore, 1995). Furthermore, the temporal order of events is that a cause must precede its effect (Sedlak & Kurtz, 1981). The purpose of the instruction was to enable students to identify whether studies encountered in real-life situations are studies of causation or merely association.

Because many researchers (Bassok, 1990; Butterfield & Nelson, 1989; Ellis, 1965; Fong, Krantz, & Nisbett, 1986; Lehman, Lempert, & Nisbett, 1988; Neeper, 1991; Marini & Genereux, 1995; Perkins & Salomon, 1988; Sternberg & Frensch, 1993; Wollman, 1983, 1984) suggested that to improve transfer, students must be taught to transfer their learning, I also investigated teaching for transfer. I hypothesized that spontaneous transfer could be increased if students were taught to transfer their learning regardless of whether they were taught with situated or abstracted instruction.

Method

Participants

Participants were 220 seventh-grade students in a suburban public middle school in Charleston, South Carolina (194 students completed all parts of the study). School records were reviewed to determine demographic information. Approximately 64% of the students were receiving free or reduced-price lunches. The ethnic make-up of the school was 56% African American, 40% Caucasian, and 4% Other (Hispanic and Asian). Twenty-five percent of the students were from middle-class households. Fifty-two percent of the seventh-grade students were girls.

Academic achievement of participants, as measured by the Metropolitan Achievement Test, Seventh Edition (MAT7), is reported in Table 1. The information represents the achievement of all seventh graders during their sixth-grade year. The table also provides information on the percentages of students in the top and bottom quartiles in reading, mathematics, and language.

A power analysis conducted prior to this study (Kirk, 1995, pp. 401–402) indicated that 128 participants were needed in this study to detect a medium effect with an error rate (α) of .05 and desired power ($1-\beta$) of .80. The 52%

Table 1.—MAT7 Scores of Participating Sixth-Grade Students (From Previous School Year)

Reading	Mathematics	Language	Science	Social studies
Students above national average (in %)				
30	40	37	39	39

Students in top and bottom quartiles (in %)

Reading		Mathematics		Language		3 R's battery	
Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
12	40	17	33	15	28	12	35

Source. Charleston County School District (1997).

increase in sample size to 154 students expanded the power of the test to detect a medium effect to .90.

Design

I used random assignment to place students into either the abstracted instruction group or the situated instruction group. Both participating teachers taught science during Periods 1, 3, 4, 7, and 8. I acquired a list of both teachers' combined students from each period and used it to randomly assign students to an instructional condition. Prior to the study, one of the teachers was teaching a section of gifted students during seventh period, but random assignment evenly dispersed these students into each instructional condition for the duration of the study. During the transfer training phase of the study, students remained in the instructional conditions to which they had been assigned. Classes that met during Periods 1 and 3 for the abstracted instruction condition, and during Periods 4, 7, and 8 for the situated instruction condition, also were taught for transfer. Class periods were assigned to the transfer conditions in that manner to keep the sample sizes nearly equal for each transfer condition. Thus, each student was in one instructional condition (abstracted or situated) and one transfer condition (transfer instruction or no-transfer instruction).

Instructional Conditions

The two Grade 7 science teachers at the participating school served as instructors during the study. Both teachers were women, had less than 2 years of teaching experience, and were approximately the same age. The teachers were interviewed prior to the study; both reported that most students in their classes were struggling in science, had low grades, and showed little motivation in class. Comparisons of student grades for each teacher were made before the study began and no significant differences were found. The teachers were considered to be matched; therefore, one teacher was assigned to teach using situated instruction and the other one was assigned to teach using abstracted instruction. Although that procedure confounds teacher and instructional method, a bigger concern was treatment diffusion, which can occur when standard conditions are not maintained for the duration of the study. In a design in which teachers use both methods, the possibility exists that one or both may alter instruction during the study and revert to the method that was previously used, particularly if that method seemed to be more successful for teaching the concepts.

The lesson plans were scripted and provided to the participating teachers.[1] The lesson plan for the abstracted instruction condition was completely scripted because instruction was identical for each group of students in this condition. The lesson plan for the situated instruction condition was only partly scripted because each group in this condition brought different knowledge and experiences to the lesson that determined how the lesson proceeded. The lesson plan for the instructional condition served as a guide to keep the lesson focused on the topic of causality. A scripted lesson plan also was used for the transfer condition and was identical for both the abstracted instruction and situated instruction conditions.

Students in both instructional conditions received the same examples and the same number of practice problems. The only difference in the examples were the manner in which they were presented to students. The examples used in the situated instruction condition were presented as exact copies of the magazine articles or pamphlets from which they were taken. The same examples were presented in text form (retyped in worksheet form) to the abstracted instruction condition.

Abstracted instruction. In the abstracted instruction condition, the teacher provided students with a brief explanation of the process of research including definitions of relevant terms (e.g., experiment, cause factor, effect factor, nuisance factor, experimental manipulation, random assignment). The teacher explained that not all studies show cause-and-effect relationships. Through lectures, students were taught the general principle of causality, including the necessity of manipulating the cause factor by the researcher and reducing the effects of nuisance factors using random assignment. Students were given practice in determining whether example studies showed causality.

Situated instruction. The instructional model proposed by Collins et al. (1989) was used as a situated instruction prototype. During situated instruction, students were engaged in a discussion of research. Students were informed that not all studies show a cause-and-effect relationship. The teacher used modeling to show students how to find important pieces of information (cause-and-effect factors, whether manipulation and control of extraneous factors were used) in actual studies in order to assess causality. During that stage, relevant terms were discussed. Using actual research studies, the teacher used coaching to help students find cause-and-effect factors and determine whether experimental manipulation and control of nuisance factors were used.

Once students were able to locate important information in research studies, the teacher used coaching and scaffolding to help students determine whether the studies showed a cause-and-effect relationship. During scaffolding, the teacher allowed students to complete all the steps of assessing causality in which they were proficient, while she completed the steps that were just beyond the students' current ability levels. Fading was then used to gradually decrease the amount of assistance given to students as they assessed causality in research studies.

During the articulation phase of instruction, students were asked to verbalize what they had learned about assessing causality in research studies. Following articulation, students were asked to compare their strategies for determining causality with the teacher's strategies (reflection phase). Finally, during exploration, students were provided with a series of real research studies taken from magazines and pamphlets and were asked to explain ways in which the studies could be conducted to show cause-and-effect relationships.

Transfer instruction. In the transfer instruction condition, students received additional instruction in the application of the principle of causality. At the beginning of instruction, students were told that the principle learned could be applied to a variety of real-world situations. The teachers suggested that key words and phrases such as "research," "study," and "findings suggest" could help students remember to use the information learned about causality when making judgments about reports described in magazines, newspapers, or on news programs. Students were asked to create their own strategies for applying the principle of causality. Students were then assigned to small groups in which they used their strategies to assess causality in example problems found in current magazines. Each small group was given a magazine (*Time, Self, or Health*) to examine. In each magazine, two pages were marked that contained brief articles to which learning could be applied. After the students practiced on the marked articles, the teachers told them to seek additional articles or advertisements in the magazines and to apply their learning.

Validation of Instruction

All instruction was audiotaped except for the final day (transfer training) when difficulties with the tape recorder occurred. The teachers reported, however, that they strictly followed the scripted lesson plans for transfer instruction; neither teacher reported any irregularities on that day of instruction. Analysis of the audiotapes confirmed that both teachers followed the lesson plans and maintained instruction that was appropriate for the type of expected teaching. Noninstructional events also were similar for both teachers during the experiment. The tapes did indicate differences in teacher personality. The teacher for the situated instruction condition was more animated than the teacher in the abstracted instruction condition, although both teachers frequently explained to students the importance of learning about causality. There was no evidence, however, that the teachers' personality difference affected students' achievement or motivation prior to the study. As reported earlier, both teachers said their students showed little motivation or interest, and the majority of students in each of the classes were low achievers.

Instrumentation

The instruments used in this study consisted of two posttests, two transfer tasks, and student interviews.

Posttest 1. I developed a posttest (see Appendix A) to assess whether students were able to apply the principle of causality immediately following training. I used a table of specifications to ensure a representative sampling of content. The posttest consisted of three scenarios based on the type of research studies that students are likely to encounter through the media. For each scenario, students were asked to answer objective questions that included (a) listing the cause-and-effect factors, (b) determining whether the cause factor was manipulated, (c) deciding whether random assignment was used to control nuisance factors, and (d) determining whether cause and effect was shown. Students also were asked to answer an open-ended question by explaining how they knew whether cause and effect was shown.

Possible raw scores on the posttest ranged from 0 to 15, which were converted to percentage scores. The open-ended questions were not scored, but instead, were used to gather additional information regarding the level of student understanding. Responses to the open-ended question were analyzed to determine whether students were able to explain their answers to the objective questions and to determine whether there was a difference in conceptual understanding due to instructional condition. Internal consistency was calculated using the Kuder–Richardson 20 (KR_{20}) formula (Kuder & Richardson, 1937); for Posttest 1, KR_{20} = .78.

Posttest 2. A second posttest was administered to gather test-reliability information. The format of the second posttest was identical to Posttest 1. The tests differed only in the scenarios used. Posttest 2 contained the same questions as Posttest 1, was scored in the same manner, and was administered under identical testing conditions. Reliability of equivalent forms over time was calculated using the percentage of consistency formula described by Subkoviak (1984). I used that formula to determine the number of individuals who showed mastery and nonmatery on both forms, as well as the total number of individuals who took both forms of the test to determine the percentage of consistency. The percentage of consistency for the two forms was 81%. I used the KR_{20} formula to calculate internal consistency for the second posttest to be .72.

Transfer Task 1. For the transfer task, students read a study reported by CNN Interactive™, CNN's Internet site, titled "Study: Grapes Inhibit Cancer Growth" (1997). Analysis using the Fry Readability Graph (Fry, 1972) revealed that the story was at a low eighth-grade reading level. For that reason, the teachers read the study aloud to the students while the students read along; and the teachers defined unknown words as necessary. After reading the study, the students were instructed to write a short summary judging the believability of the story with support for conclusions. Specifically, students were asked to answer the question, "After reading this study, do you think grapes inhibit cancer growth? Why or why not?"

The scoring rubric (see Appendix B) for the summaries was developed by a professor of educational research and measurement and two doctoral students in the same program who were given a description of the instruction and transfer task and then were asked to describe the characteristics of answers scored 0, 1, 2, and 3. The group also was informed of the task specifications, including the necessity of creating a task that did not unintentionally cue students to transfer nonspontaneously, and the need to use a transfer task that assessed students' understanding of the concept of causality as applied to an authentic situation. On the basis of those specifications, the panel agreed that the task was valid for assessing understanding of causality.

An external scorer was trained to use the scoring rubric, then the scorer and the researcher each scored approximately 125 summaries. Twenty-five summaries were randomly chosen for scoring by the external scorer and the researcher. Interrater reliability for the 25 summaries, on the basis of percentage of agreement, was 1.0.

Transfer Task 2. A second transfer task was administered to a group of 18 students in one language arts class 6 weeks after the first transfer task. The second task was used to determine task reliability. The alternate-forms reliability was 1.0. The second task was taken from CNN Interactive™ and was similar to the first transfer task. The assignment was administered in the students' language arts class, and students were not aware that the task was related in any way to the experiment.

Student interviews. Six weeks after students completed the transfer tasks, 20 students were interviewed. The purpose of the interviews was to learn why students did or did not transfer their learning of causality to the transfer task. The 2 students who successfully transferred their learning to the transfer task were interviewed. The other 18 students were chosen randomly. All students who were interviewed were asked whether they believed that information learned in school was useful in everyday life. Students were also asked about the instruction they received on causality and the ways in which they perceived that this instruction differs from regular science instruction.

Procedures

The two participating teachers received approximately 5 hr of training in how to use the lesson plans. Instruction began 2 weeks after teacher training had commenced. Instruction in causality lasted 4 days for 50 min per day. On the fifth day, students were given Posttest 1 to assess their understanding of the concept of causality. On the sixth day, some of the students received transfer training. Students who did not receive transfer training were administered Posttest 2 four calendar days after Posttest 1.

Transfer training activities took place for the entire 50-min period. Scripted lesson plans were used during transfer training; instruction was identical for both the abstracted and situated instructional conditions. At the end of the 6-day instructional phase, which included causality instruction, transfer training, and completion of the posttest(s), students returned to their regular science classes and continued with their regular science curriculum.

Two weeks after instruction, students received Transfer Task 1 during their language arts class. The science teachers were not informed that a transfer task would occur, and the language arts teachers were instructed not to reveal that the assignment was related to the experiment. To lessen the effects of demand characteristics, neither the researcher nor the science teachers who participated in the instructional phase of the experiment administered the transfer task or were present during this phase of the experiment. Students were in no way encouraged to use the information learned during the instructional phase of the experiment to complete the task.

Six weeks after the administration of Transfer Task 1, Transfer Task 2 was administered to one language arts class. The procedures were identical for both administrations of the transfer tasks. After Transfer Task 2 was administered, 20 students were interviewed.

Results

I used analysis of variance to analyze the posttest scores. Results indicated a significant effect for instructional condition, $F(1, 219) = 37.1$, $p < .001$, and class period, $F(4, 219) = 5.3$, $p < .001$, although the interaction was not significant, $F(4, 219) = 1.7$, $p = .15$. Regarding the variance in posttest scores, the instructional condition accounted for 14% ($\eta^2 = .14$); class period accounted for 8% ($\eta^2 = .08$); and the interaction of instructional condition and period accounted for 3% ($\eta^2 = .03$). Posttest means for instructional condition by period are shown in Table 2. The means represent average percentage scores.

Comparison of Instructional Conditions on Posttest

I used the Welch-Aspin adjusted t procedure (Welch, 1947) to construct a confidence interval for the mean difference between scores earned in the abstracted instruction and situated instruction conditions. The 99% confidence interval for that difference was $8.1 < \psi < 21.3$, meaning that one can be 99% confident that teaching students using situated instruction rather than abstracted instruction would result in an increase of between 8 and 21 percentage points on the posttest.

Table 2.—Means of Posttest Percentage Scores, by Instructional Condition and Class Period

	Abstracted instruction			Situated instruction			
Period	*M*	*SD*	*n*	*M*	*SD*	*n*	Effect size[b]
1	70.7	13.8	21	84.8	15.3	22	1.0
3	61.0	24.4	22	86.4	17.0	27	1.0
4	71.8	19.1	22	79.3	20.4	27	.4
7[a]	83.3	14.6	20	93.7	13.2	19	.7
8	63.4	18.4	20	80.4	19.6	20	.9
Total	69.9	19.8	105	84.6	17.9	115	.7

[a]There were approximately 30 students in each class, except for Period 7. The sample size represents the number of students included in the analysis (students who returned informed consent forms). Period 7 included approximately 22 students per section and a total of 14 gifted students. [b]Effect sizes shown are differences between group means in standard deviation units.

Comparison of Class Periods on Posttest

I conducted pairwise comparisons for period with the Games-Howell (1976) procedure, which is the most powerful post hoc technique when sample sizes are unequal and variances are heterogeneous. I found significant differences between the seventh period and each of the other four periods. There were no other significant differences. The seventh period contained gifted students who had been randomly assigned to one of the two treatments, and class sizes for both instructional conditions were much smaller for this period. Effect-size statistics comparing conditions within each period indicated that students in the situated instruction condition scored between .4 and 1.0 standard deviations above students in the abstracted instruction condition. Effect sizes are shown in Table 2.

Analysis of Open-Ended Questions

The posttest included open-ended questions that prompted students to explain how they knew whether cause and effect was shown in the scenarios given on the test. Responses were coded as correct if they included explanation of the need for experimental manipulation and control of nuisance factors to show cause-effect relationships.

Table 3 shows that of the 135 students with percentage scores of at least 80% on the posttest, 59% also provided correct answers to the open-ended questions, which showed a conceptual understanding of causality. The 95% confidence interval for that proportion was $.51 < p < .67$, meaning that one can be 95% certain that knowledge of the concept and conceptual understanding would occur for between 51% and 67% of the students represented by this sample, regardless of instructional condition. To determine whether there were differences in conceptual understanding due to instructional condition, I constructed a confidence

Table 3.—Cross-Break Table of Open-Ended Responses

Instructional condition	Mastery and correct response	Mastery and incorrect response	Total
Abstracted instruction	12 (25.5)	35 (74.5)	47 (34.8)
Situated instruction	68 (77.3)	20 (22.7)	88 (65.2)
Total	80 (59.3)	55 (40.7)	135 (100.0)

Note. Numbers in parentheses are percentages.

interval for the difference in proportions of knowledge understanding in the two conditions. The 95% confidence interval revealed that one can expect the proportion of students who both know and understand the concept of causality when taught with situated instruction to be between .37 and .67 higher than the proportion of students who both know and understand causality when taught using abstracted instruction.

Analysis of Transfer Task

The transfer task was administered 2 weeks after instruction. The purpose of the task was to examine whether students would spontaneously transfer the information learned in science class about causality to a related assignment in language arts. Responses were scored 0, 1, 2, or 3. To receive a score of 1, 2, or 3, responses had to include reference to the information about causality that was taught in science class during the instructional phase of the study (Appendix B).

Because of student absences during either instruction or testing, only 194 of the original 220 students who received instruction completed the transfer task. Only 2 students transferred their learning to the transfer task; therefore, there were 192 tasks that received a score of 0 and two tasks that received a score of 3. The 2 students who transferred their learning were in the situated instruction and transfer conditions and were students who had been identified as gifted learners prior to the study. Because of the consistency of the finding that students did not spontaneously transfer their learning, no significant differences existed among any of the instructional or transfer conditions.

Analysis of Interviews

Interviews were conducted approximately 6 weeks after administration of the transfer task. Twenty students were interviewed, including the 2 students who transferred their learning. The other 18 students were chosen randomly to participate in the interviews. The first part of the interview was set up to elicit students' honest answers without revealing to them that the language arts assignment was related to the instruction in science class. Students were then told the purpose of the language arts assignment and were asked whether it had occurred to them that the assignment was related to something that had been learned in science class. During the second part of the interview, students described their experiences during the causality instruction and what they liked and disliked about their instructional conditions.

There were two categories of responses to the transfer task: deterministic and causal. *Deterministic* responses provided nonexperimental justification that grapes inhibit cancer growth. Those explanations included personal beliefs about grapes (e.g., "grapes are healthy") or opinions based on trust in scientists. *Causal* responses included answers based on the science instruction on causality (see Appendix C for sample student responses). Of the 20 students interviewed, 17 provided deterministic responses and 3 provided causal responses.

Both students who transferred their learning understood during and after instruction that assessing causality was useful and relevant for real life. Those students stated during their interviews that they continue to apply the concepts they learned during the experiment, and both said that they had taught their parents to do the same. When the nontransferring students were asked whether the concept of causality was useful, the majority said they believed it was, although none of them were able to verbalize how it might be useful.

Discussion

This study provides evidence that situated instruction can increase immediate learning effects. Approximately twice as many students in the situated instruction group as students in the abstracted instruction group had a good understanding of the concept of causality. However, although mean scores for students who received situated instruction were .4 to 1.0 standard deviations higher than students' scores in the abstracted instruction group, the results of this study do not support the claim made by situated cognitionists that situated learning results in robust knowledge that is transferable to real-life situations.

The lack of transfer of learning for both groups supports the contention made by some researchers (Chi, 1988; Detterman, 1993) that far transfer is extremely difficult to produce. The transfer task used in this study was created to imitate the type of real-life situations students are likely to encounter. Because the task was given in the context of school, however, it was not real life in the purest sense. It seems logical, though, that if students were unable to transfer learning from science class to language arts class, they also would not transfer learning outside the school setting. Transfer of learning, both in school and outside of school, may be influenced by factors such as meaningfulness and context of the learning environment, type of situation or context to which learning can be transferred, and student motivation. Although I did not examine those factors in this study, their impact on transfer should be examined in future research on situated learning.

The results of this study support the idea that learning is context specific. Both abstracted instruction and situated instruction resulted in context-bound learning. Almost all the students, regardless of the type of instruction given, were unable to apply their learning outside the setting of the science classroom. That finding does not imply, however, that all learning is bound to the context in which it occurs. The 2 students in the study who successfully completed the transfer task also indicated during the interviews that they had used the learned information at home, and both said they had taught their parents how to determine whether relationships described in research studies are causal. Each of the students used real-life situations (a report on a televised news program and an article in a magazine) to teach their parents about causality.

Both transferring students received situated instruction and transfer training, but it is unclear whether the instruction and training or other factors contributed to successful transfer. It is evident, however, that there were large differences in learning between the situated and abstracted groups on the posttest that immediately followed instruction. Students in the situated class were more active and motivated than were the students in the abstracted instruction condition. During the interviews, students in the situated class reported enjoying the format of the class, and many said that instruction was fun and different from standard science instruction. Students in the abstracted class were much less involved in the lessons, and many reported during the interviews that instruction was boring and repetitive.

There are several limitations of this study. First, a variety of factors may have contributed to the lack of transfer of learning. The concept of causality may have been difficult for students to understand. Piaget (1974) explained that children's concept of causality and operational level are interrelated: ". . . there exists a remarkable convergence between the stages of formation of the operations and those of causal explanation" (p. 4). Lavoie and Good (1988) found that students who are at the formal operations stage, which begins around age 14, are more successful at predicting the causal outcomes of experiments than are students who are at the concrete operations stage. Most participants in this study were younger than 14 years, although most also achieved mastery of the causality instruction as measured by the posttest.

Second, there was a low average achievement level of students in the sample. Many students were poor readers and may have had trouble reading the transfer task, even though teachers read the task aloud at the first reading. Also, the surface features of the transfer task may have been misleading. For that task, students read about an experiment conducted on mice. During the instructional phase, almost all examples focused on experiments on people.

The results of this study provide evidence that spontaneous transfer of learning to authentic situations is difficult to achieve, regardless of whether students are instructed according to an abstracted instruction model or a situated learning model. The paucity of empirical studies on situated cognition and the failure to achieve transfer in either condition in this study suggest the need for replication.

Broad, spontaneous transfer is the goal of education. The purpose of instruction is not to prepare students to pass a test on covered material, but to prepare students to use what has been learned in a useful and meaningful way outside of school. Unfortunately, the ways in which teachers instruct students do not always help them reach that goal. Situated cognitionists have presented a theory of teaching and learning, and they claim that using situated practices will greatly increase transfer of learning to real-world problems. The evidence gained from this study does not support that contention. However, the effects of situated instruction on immediate learning were encouraging. Situated instruction may still have the potential to increase spontaneous transfer, particularly if teachers prolong instruction and emphasize to students the ways in which school learning can be useful beyond the learning environment.

NOTE

1. Scripted lesson plans are not printed here because of their length. A copy of the lesson plans will be provided for teaching or research replication purposes upon request.

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APPENDIX A
Posttest 1

Directions: Read each paragraph and answer the questions that follow.

1. A recent study claims that long, slow workouts burn more fat than quick, hard workouts. In this study, researchers randomly placed participants in one of two groups. The first group worked out for 2 hr, resting 2 min between exercises. The second group worked out for 2 hr, resting 15 s between exercises. The first group burned an average of 25% more fat calories than the second group.

What is the cause factor? ____________________

What is the effect factor? ____________________

Did the researcher manipulate the cause factor? ☐ Yes ☐ No

Did the researcher use random assignment to control nuisance factors? ☐ Yes ☐ No

Is cause and effect shown? ☐ Yes ☐ No

How do you know?

____
____
____
____
____

2. Researchers report that keeping a journal can lower men's blood pressure. The researchers told 20 men with high blood pressure to write in a journal at least once a day. After 6 weeks, the researchers compared the blood pressure of these men with 20 men who had high blood pressure but did not keep journals. The researchers found that men who kept journals had lower blood pressure than men who did not keep journals.

What is the cause factor? ____________________

What is the effect factor? ____________________

Did the researcher manipulate the cause factor? ☐ Yes ☐ No

Did the researcher use random assignment to control nuisance factors? ☐ Yes ☐ No

Is cause and effect shown? ☐ Yes ☐ No

How do you know?

____
____
____

3. It was reported that stress causes cuts to take longer to heal. The researchers found one group of women who rated their lives as highly stressful and one group of women who rated their lives as nonstressful. The researchers then measured how long it took for small cuts on their arms to heal. On average, the wounds of the stressed-out women took 9 days longer to heal.

What is the cause factor? ____________________

What is the effect factor? ____________________

Did the researcher manipulate the cause factor? ☐ Yes ☐ No

Did the researcher use random assignment to control nuisance factors? ☐ Yes ☐ No

Is cause and effect shown? ☐ Yes ☐ No

How do you know?

____
____
____
____
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____

APPENDIX B
Rubric Used to Score Transfer Tasks

Levels of Performance			
3 (An above-adequate response)	2 (An adequate response)	1 (A less-than-adequate response)	0 (An inadequate response)
Student applied the principle of causality to the transfer problem with a high level of accuracy.	Student applied the principle of causality to the transfer problem but gave a response that was not entirely correct.	Student attempted to apply the principle of causality to the transfer problem, but used it incorrectly.	Student did not apply the principle of causality in any way to the transfer problem.
Student must mention causality or instructional terms such as cause factor, effect factor, nuisance factor, experimental manipulation, or random assignment to give evidence of transfer of learning.	Student must mention causality or instructional terms such as cause factor, effect factor, nuisance factor, experimental manipulation, or random assignment to give evidence of transfer of learning.	Students must mention causality or instructional terms such as cause factor, effect factor, nuisance factor, experimental manipulation, or random assignment to give evidence of transfer of learning.	

APPENDIX C
Sample Deterministic and Causal Responses in Student Interviews

Deterministic Responses

"I believed it because grapes are used for other things and maybe it might be used for that, too."

"They say that all fruits and stuff like that helps people's body and things. I love fruits . . . I always eat it. . . . I think that it can take cancer from people."

". . . Well, if it does cure cancer, then how come a lot of people are sick and everything? A lot of people eat grapes, and I know I like grapes. I eat a lot of them, and I get sick and stuff."

"They said that grapes inhibit cancer growth, and to show that was true they did an experiment, so I think it was right."

Causal Responses

"Because we were sort of doing it in science and then . . . I was supposed to prove it to [the teacher], convince her whether I believed the article or not. So I used what I learned in science class because it's actually what scientists and other people do."

"When I read it, I was thinking about what [my teacher] had said and stuff and how you couldn't really believe it if it didn't have certain stuff in it like experimental manipulation and random assignment. And it didn't have none of that in it, so I knew right off the top I can't believe it."