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ABSTRACT

The purpose of this study was to design and develop a multimedia-based anchored program and to examine the effects of students' and group characteristics on the problem-solving process in anchored instruction with the multimedia program in a situated learning environment. Sixty-eight students were assigned to small groups via a stratified random sampling procedure. The students were working cooperatively as a group on the authentic task of multimedia-based anchored instruction. The results of the analysis show that group composition as well as students' characteristics significantly exerted differential effects on the problem-solving process. The implications of the results for anchored instruction are discussed. (Contains 28 references and 2 tables.) (Author)

Anchored Instruction in a Situated Learning Environment

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Abstract: The purpose of this study was to design and develop multimedia-based anchored program and to examine the effects of students' and group characteristics on the problem-solving process in anchored instruction with the multimedia program in a situated learning environment. Sixty-eight students were assigned to small groups via a stratified random sampling procedure. The students were working cooperatively as a group on the authentic task of multimedia-based anchored instruction. The results of the analysis showed that group composition as well as students' characteristics significantly exerted differential effects on the problem-solving process. The implications of the results for anchored instruction were discussed.

Introduction

Along with advances in information and communications technology, there has been a shift towards a new paradigm of education and training. The emerging paradigm entails the characteristics that distinguish between industrial-age and information-age educational systems (Kang & Kim, 1999; Reigeluth, 1999). The educational system based on a new paradigm supports a constructivist approach to the teaching and learning process and fosters learner-centered, interactive, contextualized, and meaningful learning environments with diverse, multiple perspectives.

There have been an increasing number of studies on anchored instruction in authentic and situated learning environments with highly interactive and engaging forms of technology-supported contents (e.g., Bransford et al., 1994; Brown et al., 1989; Cognition and Technology Group at Vanderbilt, 1991; 1992; 1993a; 1993b; Crews et al., 1997; McLellan, 1996; Shih, 1997; Ruokamo, 2001; Young, 1993). The anchored instruction approach emphasizes authentic learning in solving complex problems typically found in real world situations and collaborative work in small groups to generate sub-problems and develop solutions utilizing embedded data. This approach can provide students a situated learning environment that facilitates problem-solving as well as problem-definition skills and collaborative efforts among students during group work on the authentic task.

In general, research on anchored instruction has shown positive effects on students' cognitive and social-affective outcomes (e.g., Cognition and Technology Group at Vanderbilt, 1992; 1993a; 1993b; 1997; Hmelo et al., 1993; Lee & Hwang, 2001; Serafino, 1999; Shih, 1997; Ruokamo, 2001). Most of the studies have utilized the *Adventure of Jasper Woodbury* series developed by Cognition and Technology Group at Vanderbilt as the anchored program. Until recently, however, few studies have investigated anchored instruction with different forms of anchored program for students from a different cultural background. To this end, the present study attempted to develop multimedia-based anchored courseware that is adaptive to elementary school curriculum in Korea and to examine the factors affecting the problem solving process in anchored instruction with multimedia courseware in a situated learning environment.

The purpose of this study was to design and develop multimedia-based anchored courseware and to examine the effects of cognitive style of the student, the type of problem-solving task, and group composition on achievement in anchored instruction with multimedia courseware in a situated learning environment. The achievement results in understanding of problems, accuracy of problem solving, and reasoning and organization of problem solving of students working on original and analogy tasks were compared in heterogeneous and homogeneous groups featuring individual and group accountability.

Method

Sample

The subjects for the study were sixty-eight students (33 females, 35 males) in the sixth grade at two elementary schools in a metropolitan city in Korea. All the subjects had some previous experience with computers and the Internet at or outside of school in a variety of subject areas. The subjects were assigned to small groups via a stratified random sampling procedure on the basis of pretest results. They remained in the same groups throughout the study.

Procedure

Before the study began, students were asked to complete a background survey regarding students' previous experience with computers. The pretest was administered to assess students' previously acquired knowledge with the subject or content areas of the authentic task. Stratified random sampling was used to assign students to heterogeneous and homogeneous groups. Heterogeneous groups consisted of high- and low-score students. Homogeneous groups consisted of students of the same-level score. Students were unaware of the composition of the group. Students also took the Group Embedded Figures Test so as to identify those with field dependence or field independence. Students were then given practice sessions of anchored instruction with multimedia courseware developed for the study. They were instructed to work cooperatively as a group on the authentic task of multimedia courseware, to help each other learn, and to make group decisions on the course of their actions in solving a set of problems. Students worked for five 80-minute instructional sessions.

Multimedia Courseware

For the purpose of this study, multimedia courseware was designed and developed for Anchored Instruction. This courseware appears to be one of the first programs for anchored instruction that was designed to be adaptive to elementary school curriculum in Korea. In developing multimedia courseware, the author attempted to meet the design principles for the development of the anchored program identified by Cognition and Technology Group at Vanderbilt (1990; 1991; 1992; 1993a; 1993b; 1997). The design principles include: (1) video-based presentation format, (2) narrative format, (3) generative learning format, (4) embedded data design, (5) problem complexity, (6) pairs of related adventures, and (7) links across the curriculum. The subject or content areas are cross-curricular, including proportion and ratio in mathematics, geography in the social studies, and environmental awareness in science. The multimedia courseware provides a situated learning environment where students work together as a group on the authentic task so that they can generate and solve a series of problems and sub-problems and relate the solutions to the complex problem. Through their learning process, students can explore the hyperlinked multimedia contents of the anchored program with embedded data. In designing and developing the user interface of the courseware, a special emphasis was placed on user-friendliness and efficiency. A simple, intuitive design with a text-based menu, rather than a complicated design, was preferred (e.g., Harper et al., 1993; Hedberg at al., 1994).

Research Design and Data Analysis

The study employed a randomized block factorial design. The between-subjects factors included Cognitive Style, Task Type, and Group Composition. The within-subjects factor included achievement scores of understanding of problems, accuracy of problem solving, and reasoning and organization of problem solving. The analysis of covariance (ANCOVA) was performed to determine the interaction effects as well as the main effects of cognitive style, task type, and group composition on achievement in understanding of problems, accuracy of problem solving, and reasoning and organization of problem solving with students' pretest results serving as the covariate. The level of significance was set at .05 in this study.

Results and Discussion

The means and standard deviations for achievement in understanding of problems, accuracy of problem solving, and reasoning and organization of problem solving are presented in Table 1. The results of the analysis of covariance for achievement by cognitive style, task type, and group composition are shown in Table 2.

Understanding of Problems. Significant main effects were found for cognitive style, $F(1, 59) = 4.306$, $p < .05$, for task type, $F(1, 59) = 6.189$, $p < .05$, and for group composition, $F(1, 59) = 5.328$, $p < .05$. Significant interaction effects were also found for cognitive style and group composition, $F(1, 59) = 4.078$, $p < .05$. These results indicate that students working on the analogy problem-solving task scored higher than did those working on the original problem-solving task and that cognitive style of the student and group composition exerted differential effects on achievement in understanding of problems, as shown in Tables 1 and 2. Field independent and dependent students tended to achieve differentially across the groups of different composition on the posttest of understanding of problems. The students in heterogeneous groups scored higher than did those in homogeneous groups. This pattern is more noticeable among field-independent students than field-dependent students. The mean score of the field-independent students in heterogeneous groups was the highest (4.28); the mean score of the field-dependent students in homogeneous groups was the lowest (2.38).

Accuracy of Problem Solving. There were significant main effects for cognitive style, $F(1, 59) = 6.012$, $p < .05$, and for task type, $F(1, 59) = 7.303$, $p < .05$, and significant interaction effects for cognitive style and task type, $F(1, 59) = 2.655$, $p < .05$. Yet, main effects for group composition were not statistically significant, as seen in Table 2. These results indicate that the achievement of field-independent and field-dependent students was dependent on the type of problem-solving task on which they were working within a group. Field dependent students with analogy task tended to score higher on the accuracy posttest than those with original task (3.85, 2.94, respectively). For field independent students, however, this pattern did not emerge: There were only slight differences between students working on analogy task and those working on original task (4.31, 4.29, respectively).

Reasoning and Organization of Problem Solving. As the results in Table 2 show, no statistically significant effects were found for cognitive style, task type or group composition, or for the interaction among cognitive style, task type and group composition. The results in dicate that the differences between the posttest means were not statistically significant, probably due to the relatively large standard deviations, as shown in Table 1. For reasoning and organization of problem solving, the achievement scores of field-independent and field-dependent students were not significantly different from each other, regardless of the type of task and the composition of the group.

This study examined the effects of cognitive style of the student, the type of task, and group composition on achievement in understanding, accuracy, reasoning and organization of problem solving in anchored instruction with multimedia courseware in a situated learning environment. As pointed out earlier, this study appears to be one the first studies that have focused on the factors affecting anchored instruction at the elementary school level in Korea. The findings of the present study corroborate and extend current knowledge of anchored instruction. The results of the analysis of covariance indicate that group composition as well as students' cognitive style and task type significantly exerted differential effects on the learning outcomes. In general, both field-independent and field-dependent students in heterogeneous groups showed higher achievement than did those in homogeneous groups. With regard to the type of task, students working on analogy tasks tended to understand the problems better and to be more accurate in problem solving than did those working on original tasks. The results show that the effects of cognitive style of students were dependent on the composition of the group and the type of problem-solving task. Thus, the results of the present study allow for a closer examination of the relationship of students' individual and group characteristics in the problem solving process in a situated learning environment, and corroborate and lend further support to the previous studies on anchored instruction (e.g., Bransford et al., 1994; Chinien & Boutin, 1992; Chou & Lin, 1997; Crews et al., 1997; Leader & Klein, 1994; Lin & Davidson, 1994; Liu & Reed, 1994; Mevarech et al., 1991; Ruokamo, 2001; Shih, 1997; Small & Grabowski 1992; Summerville, 1998; Williams et al., 2001).

While important and interesting findings have been revealed, the study needs to be replicated. In addition, there are several suggestions for future research. First, the subjects of the study were relatively homogeneous in terms of the socioeconomic background. The analysis of data from a nationwide probability sample across various student populations might yield more generalizable results. Second, the problem-solving tasks that students were working on in small groups included original and analogy tasks. Future research employing other types of problem-solving tasks may be worth further investigation.

Table1. Means and standard deviations of the achievement scores

		Understanding	Accuracy	Reasoning and Organization
Cognitive Style				
Field Independence	M	3.53	4.30	2.65
	SD	1.45	0.83	1.80
Field Dependence	M	2.60	3.40	1.76
	SD	1.57	1.30	1.65
Task Type				
Original Task	M	2.37	3.24	1.74
	SD	1.79	1.57	1.77
Analogy Task	M	3.30	4.01	2.26
	SD	1.27	0.76	1.68
Group Composition				
Heterogeneous	M	3.25	3.77	2.33
	SD	1.37	1.24	1.49
Homogeneous	M	2.54	3.57	1.75
	SD	1.70	1.27	1.90

Table 2. ANCOVA results for problem solving by cognitive style, task type, and group composition

Source of Variation	Sum of Squares	DF	Mean Squares	*F*	*P*
Understanding					
Cognitive Style (A)	9.385	1	9.385	4.306	.042
Task Type (B)	14.137	1	14.137	6.189	.016
Group Composition (C)	11.614	1	11.614	5.328	.025
A x B	1.815	1	1.815	.833	.365
A x C	4.529	1	4.529	4.078	.049
B x C	.327	1	.327	.150	.700
A x B x C	1.263	1	1.263	.579	.450
Residual	128.595	59	2.180		
Accuracy					
Cognitive Style (A)	8.357	1	8.357	6.012	.017
Task Type (B)	10.152	1	10.152	7.303	.009
Group Composition (C)	.733	1	.733	.053	.819
A x B	3.691	1	3.691	2.655	.049
A x C	.874	1	.874	.063	.803
B x C	.781	1	.781	.056	.813
A x B x C	.115	1	.115	.579	.775
Residual	82.014	59	1.390		
Reasoning and Organization					
Cognitive Style (A)	9.997	1	9.997	3.361	.072
Task Type (B)	2.057	1	2.057	.698	.407
Group Composition (C)	9.516	1	9.516	3.228	.077
A x B	.256	1	.256	.087	.769
A x C	5.506	1	5.506	1.868	.177
B x C	.284	1	.284	.096	.757
A x B x C	1.413	1	1.413	.479	.491
Residual	173.896	59	2.947		

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NOTICE

Reproduction Basis