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ABSTRACT

This study investigates the effects of computer-aided videodisc-based anchored instruction on promoting elementary school students' problem-solving skills in Taiwan. Anchored instruction combines theories such as situated cognition, cognitive apprenticeship, cooperative learning, and constructivist theories. With the help of interactive videodisc and computer technology, anchored instruction presents situations of daily life in the way of storytelling by providing an inquiry and real-life learning environment and authentic tasks that help students enhance their problem-solving skills. Fifth-graders (n=37) from an elementary school in suburban Taipei (Taiwan) were randomly selected and divided into six groups according to their mathematical and science abilities, with two high-ability, two middle-ability, and two low-ability groups. Students were given a pretest and post-test to measure different problem-solving strategies used before and after the video instruction. Students engaged in problem solving in small groups, and were given the tests individually. Results from a two-way repeated measure analysis of variance show that student problem-solving skills improved significantly with anchored instruction. Anchored instruction provided a more motivating environment which enhanced all students' problem-solving skills, regardless of students' mathematic and science abilities. (Contains 15 references.) (SWC)

Effects of Anchored Instruction on Enhancing Chinese Students' Problem-Solving Skills

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Abstract

The purpose of this study was to investigate the effects of computer-aided videodisc-based anchored instruction on promoting students' problem-solving skills for Chinese (Taiwanese) elementary students. Results from a two-way Repeated Measures ANOVA showed that student problem-solving skills were improved significantly with anchored instruction [$F(1,34)=26.76$, $p<.000$]. In summary, the finding suggested that anchored instruction provided a more motivating environment where enhanced students' problem-solving skills. Results also indicated that all students benefited from anchored instruction on the effects of problem-solving despite of their mathematics and science abilities. This study was significant because it provided empirical evidence for its effectiveness on teaching problem-solving strategies for Chinese (Taiwanese) fifth-graders.

Introduction

The topic of situated cognition and learning has recently received a great deal of attention in the communities of educational researchers, particularly of educational technologists. Based upon the notion that knowledge is contextually situated and is fundamentally influenced by the activity, context, and culture in which it used, situated learning offers an approach to structuring learning experiences that captures both experiential and reflective dimensions of cognition and to enculturating students into authentic practices through activity and social interaction in a way similar to craft apprenticeship (Brown, Collins, & Duguid, 1989; McLellan, 1996). With the widespread application of multimedia technology, the notion of situated leaning can be best achieved because computer technology has been deployed to expand the power and flexibility of resources. There were groups of researchers who have been developing and studying learning environment based on the theory of situated learning to maximize learning in school classrooms. One successful example was anchored instruction. Anchored instruction, proposed by the Cognition and Technology Group at Vanderbilt University (CTGV, 1990, 1991,1992,1993), aims to help students develop the confidence, skills, and knowledge necessary to solve problems and become independent thinkers. By taking advantage of the emerging of videodisc and multimedia computing technology, its major features are: (1) instruction is anchored in a videodisc-based, problem-solving environment; (2) instruction itself provides multiple perspectives; (4) instruction promotes everyday cognition and cognitive apprenticeship; (5) information is designed in an embedded format. Based on the theories of situated learning, cognitive apprenticeship and cooperative learning, anchored instruction made it possible to provide a life-like inquiry situation for teaching several mathematical concepts and problem-solving strategies (Bransford & Vye, 1989; Cobb, Yachel & Wood, 1992). The perfect program of anchored instruction developed by the Cognition and Technology Group at Vanderbilt (CTGV) was called *The Adventures of Jasper Woodbury Mathematical Problem Solving Series (The Jasper Series). The Jasper Series* are based upon set of theory-based design principles, such as video-based format, narrative with realistic problems (rather than a lecture on video), generative format, embedded data design, problem complexity, pairs of related adventures, and links across the curriculum. These design principles have been described in detail elsewhere (e.g., CTGV, 1991, 1992, 1993). The materials were developed to teach mathematics, mathematical problem solving, and critical thinking skills in 5th to 8th grade classrooms. At the core of each adventure is 15-25 minute video-based story that presents a complex problem with a mathematical solution. To solve the problem, students must generate the appropriate subgoals in each adventure and 10-15 steps involved in achieving a solution.

Research on *the Jasper Series* showed many important and positive evidences for its effectiveness on promoting problem-solving abilities as well as enhancing attitudes toward mathematics and instruction (CTGV, 1990, 1991, 1992; Hickey, Pellegrino, Goldman, Vye, Moore, & CTGV, 1993 ; Van

Haneghan, Barron, Young, Williams, Vye, & Bransford. 1992 : Shyu,1996). There was also ample evidence that situations involving the use of instructional technologies that are authentic, relevant, and stimulating to the learners is likely to influence attitudes and thinking skills(Simonson & Maushak, 1996). However, the contexts of *the Jasper Series* were anchored in American culture. Does anchored instruction contribute to Chinese (Taiwanese) student's problem-solving as well as promoting attitudes toward mathematics? How does it work? This study tried to answer the above questions. The purpose of this study was to design a video-based anchored instruction and to investigate the effects of computer-aided videodisc-based anchored instruction on promoting students' problem-solving skills for Chinese (Taiwanese) elementary students.

Methods and Techniques

Subjects

A class of thirty-seven fifth-graders from an elementary school located in suburban area of Taipei city in Taiwan were randomly selected and divided into six groups according to their mathematical and science abilities. Two groups were high-ability groups; two were middle-ability; two were low-ability.

Materials

A videodisc, ***Encore's Vacation,*** was used in this study. ***Encore's Vacation*** is a technology-based program designed to motivate students and help them learn to think and reason about complex problems in mathematics learning. It involved the adventures of a college student named ***Encore*** with three of his classmates: The story begins with four college students planed to arrange a trip by train. During their trip, they had to change their schedule because someone had an accident. How did they make a reasonable decision to back home on time? Did they have to reschedule their trip? Why? How did they share the expenses spent on this trip? The videodisk started as a highly motivating third-person experience---- watching a linear story told via video. But, it finally became a personal (first-person) experience when students actively engage in helping the actors in the story solving a meaningful, real-life challenge. An important design feature of the **Encore's Vacation,** similar to the Jasper series, was the "embedded data design." Student had to generate the problems to be solved and then find relevant mathematical information presented throughout the video story. All the data needed to solve the problem were embedded in the story.

The sequencing of the videodisk instruction was programmed and controlled by a personal computer (486) and Pioneer model VD-4400 laserdisc player using the Authorware Professional for Windows software.

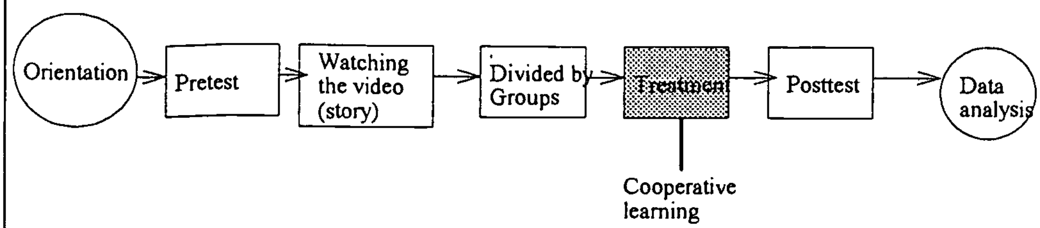
The instruction was needed to be done through many problem-solving steps. The activities in the curriculum included watching the story from the videodisk, learning the strategies in solving problems, and solving the (mostly mathematical) problems cooperatively presented in the videodisk.

Procedures and Treatment

This experiment was one-group time series with pretest and posttest design. Subjects were given an orientation of the instruction first and then they were asked to watch the story ***Encore's Vacation*** linearly. Then, subjects was given a pretest based on the content of the story. The scores of this pretest were used as a baseline to examine what strategies students used in problem-solving process before the treatment. The treatment was then followed. The treatment was the instruction. It began with the presentation of the video segments. At the end of the story, the video presented problems and challenged subjects to solve the problem cooperatively. The instruction used totally eight periods of class in a week. During the instruction, the role of teacher was to guide students to recognize the problems and to provide them necessary scaffoldings to solve problems. After the treatment, all students were administered a 12-item posttest (parallel to the pretest but not the same). Students in the treatment investigated two major questions. As each question (i.e., calculate time and money) was introduced in class, students were encouraged to generate subordinated questions of the stated question and to recall the facts and retrieve relevant data from the videodisk to answer the questions. This segment of instruction was designed to engage students in planning for problem solving and to focus their attention on gathering the needed information. Students were guided to generate complete solutions for all of the sub-problems identified. As sub-problem solutions were generated, students were encouraged to relate the solutions to the overall problem. Students engaged in problem solving in a small-group format. Each group included six persons.

Students under the treatment were divided into groups and worked collaboratively, but they were given the tests (both pretest and posttest) individually. Four-step problem-solving procedure was measured and scored for both pretest and posttest. They were problem-identification, problem-formulation, subgoal-generation, and solution execution according to Polya's mathematical problem solving model (1957). Tests were scored by three experts, with an inter-ratter reliability of 0.965. The procedure of this study is shown on Figure 1.

Figure 1. Flowchart of the treatment



Research Design and Research Questions

This study was a field-experimental, one group time series with pretest and posttest design. It aimed to answer the following three research questions: (1) Did anchored instruction help to promote students' problem-solving abilities for 5th-graders? (2) For different-ability (high-, medium-, low-ability) students, did anchored instruction help to promote their problem-solving abilities? (3) Were there any significant difference among ability groups (high, middle, low) on their improvement of problem-solving abilities? The independent variables in this study were group(i.e., high-, medium-, and low-ability group) and time series(i.e.,pretest, posttest). The dependent variables were scores on problem-solving. Data were analyzed from a 3 x 2 Repeated Measures ANOVA through SPSS-x .

Results

Mean scores of pretest and posttest for different ability groups were listed on Table 1. Results from a two-way Repeated Measures ANOVA showed that student problem-solving skills were improved significantly with anchored instruction [$F(1,34)=26.76$, $p<.000$](See Table 2). Furthermore, data also indicated anchored instruction obviously has contributed to students problem-solving for all three groups (high-, middle-, and low-ability group)($p< .01$).

Table 1. Mean scores of pretest and posttest for different ability students

Ability	N pretest	N posttest	Mean* pretest	Mean* posttest	SD pretest	SD posttest
high-	12	12	15.76	21.94	11.09	13.49
mid-	11	11	13.40	21.59	7.75	13.72
low-	14	14	15.29	25.65	8.50	14.95
total	37	37	14.88	23.24	9.02	13.86

- Based on a total score of 60.

Table 2. A two-way (Group x Time) Repeated-Measures ANOVA on problem-solving scores

Tests of Between-Subjects Effects

Sources	D. F.	SS	MS	F ration	P. prob.
Within+Residual	34	8108.32	238.48		
Group (H,M,L)	2	110.71	55.36	.23	.794

Tests of Within-Subjects Effects

Sources	D. F.	SS	MS	F ration	P. prob.
Within+Residual	34	1579.85	46.47		
Time(pre-,post-)	1	1243.64	1243.64	26.76	.000*
Group x Time	2	56.59	28.30	.61	.550
Total	37	3272.89			

*<.001

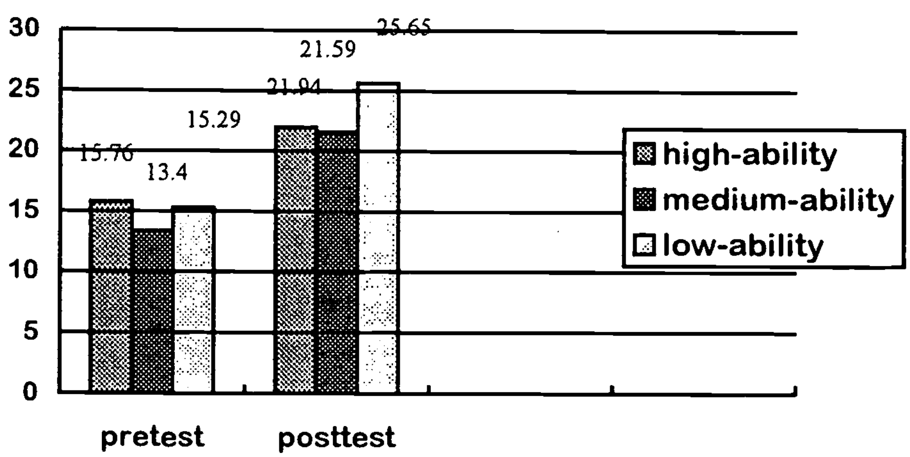
This result was identical with a test of pretest and posttest across all ability groups($t=5.33$; $p<.000$)(See Table 3). However, there were no significant difference among ability-groups on their increment of problem-solving skills [$F(2,34)=.23$; $p=.794$](See Table 3). There was no interaction effect between three groups and improvement of problem-solving. In summary, the finding suggested that anchored instruction provided a more motivating environment where enhanced students' problem-solving skills. Results also indicated that all students benefited from anchored instruction on the effects of problem-solving despite of their mathematical and science abilities

Table 3. A t-test on pretest and posttest of problem-solving scores

Scores	N	mean	S.D.	T value/ prob.
pretest	37	14.88	9.02	t= 5.33
posttest	37	23.24	13.86	p = .000*

*<.001

Figure 2. A bar graph of pretest and posttest on problem-solving Scores



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Discussion and Educational Importance of This Study

Anchored instruction is a new instructional method that combines theories such as situated cognition, cognitive apprenticeship, cooperative learning and constructivist theories. With the help of interactive videodisk and computer technology, it presents the situations of daily life in the way of storytelling. The aim of anchored instruction is to provide an inquiry and real-life learning environment and authentic tasks that help students enhance their problem-solving skills. The results in this study indicated that students' using problem-solving strategies significantly differed after receiving the experimental instruction, which proved anchored instruction improved students' thinking skills. Moreover, the results also showed that anchored instruction obviously has contributed to students problem-solving for all three groups (high-, middle-, and low-ability group). However, there were no significant difference among ability-groups on their increment of problem-solving skills. This study provided an inspiring result that all students benefited from anchored instruction on the effects of problem-solving despite of their mathematical and science abilities.

This study supports Hickey et al.'s argument (Hickey, Pellegrino, Goldman, Vye, Moore, & CTGV, 1993) and provides evidence that the *Encore's Vacation* environment is indeed highly motivating and enjoyable, and that the experience has a positive impact on students' problem solving skills.

Numerous research (CTGV, 1991,1992; Hickey & et al,, 1993; Van Haneghan & et. al, 1992) provided evidence in supporting *The Jasper Series* (the perfect example of anchored instruction) on promoting problem-solving skills for American elementary students. However, none of research concerning the effects of anchored instruction were done for students with a different cultural background. This study was significant because it provided empirical evidence for its effectiveness on teaching problem-solving strategies for Chinese (Taiwanese) fifth-graders.

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