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ABSTRACT

The purpose of this study was to determine if a combination of computer assisted instruction (CAI) with hands-on science activities would significantly enhance students' abilities in the cognitive and affective domains. The study consisted of three treatments. Treatment one (47 students) included a hands-on activities emphasis. A second treatment (46 students) included the hands-on activities in combination with the Weatherschool software program. The Weatherschool Meteorology program was selected because of its compatibility with the local science curriculum topics, appropriate grade school reading level, and its flexibility to be integrated within the curriculum. The third treatment (21 students) did not contain either hands-on activities nor CAI, but employed more text-based learning. Hands-on activities appeared to increase scores from pretest to posttest. Included in this paper are the introduction, the methodology, results, summary, and implications. (KR)

The Effects of CAI and Hands-On Activities on Elementary Students' Attitudes and Weather Knowledge

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Introduction

Computer-aided instruction (CAI) is designed to be a more effective and efficient method for teaching and learning than the traditional approach. However, teachers must be aware of the quality of available software and supplemental materials in order to fully utilize CAI (Camuse, 1985). Unfortunately, most teachers lack the time to adequately evaluate and to develop methods of incorporating CAI in science classrooms.

Computers are primarily used in the science classroom to teach about computers and their uses. Only 1% of classroom time is allotted to using computers to teach about science (Becker, 1984). The National Survey on Instructional Use of School Computers indicated that only 14 elementary classes were using computers in 1985 for science instruction and that computers were used in these classes only occasionally (Becker, 1984). There are several studies that support the effectiveness of CAI in math (Gabel, 1984; Camuse, 1985). However, there are currently insufficient data as to the type of science computer activities in grades K-5 to evaluate the effectiveness of CAI on this level (Becker, 1984). Therefore, this preliminary study was undertaken to determine if combining CAI with hands-on science activities can significantly increase students' abilities in the cognitive and affective domains.

Methodology

The Weatherschool Meteorology program was selected to test the effectiveness of CAI in the elementary school classroom. The selection of this piece of software was based on the following criteria: compatibility with the local science curriculum topics, appropriate grade school reading level, and its flexibility to be integrated within the curriculum. Weatherschool takes advantage of the classroom computer by combining an interactive software package with other classroom activities, experiments, and instruments into one coordinated program. WSB-TV (Atlanta, GA) sponsored this program by making it available free of charge to all classroom teachers in the metropolitan Atlanta area.

Two instruments were designed to measure the students' abilities in the cognitive and affective domains. One test was constructed to measure students' knowledge of meteorology. The test consisted of 13 questions: six questions measured the knowledge level and seven questions measured applications level of Bloom's Taxonomy. Content validity was established by a panel of science educators and reading specialists. Reliability was not established due to the low number of questions in each area. Considering the developmental skills of third graders, the number of questions in each area had to be limited.

A second test was designed to measure students' attitudes toward science and computers. The instrument consisted of 15 questions. There were five questions in each of the following areas: attitudes toward science, attitudes toward computers, and attitudes toward manipulatives. Construct validity was established by a panel of science educators and reading specialists. Reliability was not established because of the small number of items in each area. Due to the fact that third graders were taking the test, it was necessary to limit the number of items on this test.

The study consisted of three treatments. Treatment One included a hands-on activities emphasis. A second treatment included the identical hands-on activities in combination with the Weatherschool program. Treatment Three did not contain either hands-on activities or CAI, but employed more text-based learning.

The hands-on activities in Treatment One included seven learning centers. Students constructed thermometers, barometers, psychometers, rain gauges, wind vanes, and anemometers from basic materials such as test tubes, straws, mineral oil, and so forth. They employed each instrument to measure a particular aspect of weather and also observed cloud formations. The students were then asked to use their measurements to predict specific weather patterns and conditions. In Treatment Two, the students worked with eight learning centers. They followed the same procedure as in the first treatment (constructing instruments and using them to measure the weather). The eighth learning center consisted of an Apple IIe computer with the Weatherschool program. The students entered the data they previously collected. Through autotutorial instruction, the program aided the students in predicting the weather. In both treatments, students were asked to watch Channel 2, WSB-TV news to predict the success of a professional meteorologist.

The study was conducted in five third grade classrooms. The same teacher gave instructions, administered tests, and worked with the students in learning centers. The school chosen for this study was a public school where children were randomly assigned to the classes. There were 47, 46, and 21 students in Treatments 1, 2, and 3, respectively. A pretest and posttest were administered to each student to assess in affective and cognitive outcomes. The paper and pencil tests were modified from existing attitudinal measures used for elementary school students. These instruments were designed and written to assess conceptual knowledge and changes in attitudes toward meteorology at the appropriate grade reading level. Identical items were administered in pretest and posttest situations. Eleven multiple choice and short answer items comprised the conceptual assessment. Students were given the option of responding with "I don't know" to discourage guessing. Correct responses were tallied for each student and each treatment with the greater number of correct responses indicating a greater conceptual knowledge of meteorology. The attitudinal measure contained sixteen items. Students could respond with yes, no, and I don't know options. Parallel items were employed to check for consistency between students' responses. Positive responses were tallied for each student within each treatment, with a greater number of positive responses indicating a more positive attitude. Scores from the pretest and posttests were subjected to paired-t comparisons and analysis of variance using the Means and General Linear Model procedures of the Statistical Analysis System.

Results

Analysis of variance of the pretest scores for attitudes demonstrated no significant difference ($p = 0.5824$) among the treatment groups prior to instruction. The overall pretest mean score was 10.534 positive responses per student with a standard error of 0.2385. Analysis of variance of the conceptual pretest scores indicated a significant difference ($p < 0.01$) among the treatment groups with respect to the conceptual knowledge of meteorology. Mean numbers of correct answers were 2.2, 2.1, and 3.9 per student for Treatments 1, 2, and 3 respectively. The overall pretest mean score was 2.453 correct answers per student with a standard error of 0.1594. A paired-t test compared pretest and posttest scores for both attitude and conceptual tests. Results of these analyses are listed in Tables 1 and 2. Net changes in the mean scores for the attitude and conceptual tests were not significant ($p < 0.0001$) for Treatment 3 (control). Moreover, mean scores for both the attitude and conceptual tests increased significantly ($p < 0.00001$) from the pretest to posttest for Treatments 1 and 2. For the attitude assessment, the mean increase in a positive direction for each student was +1.4 (SE=+ 0.4) and +2.5 (SE=+.3) for Treatments 1 and 2, respectively. Similar differences also were noted for the conceptual tests scores with mean increases of 3.0 (SE=+ 0.4) and 4.8 (SE=+ 0.4) for Treatments 1 and 2, respectively.

Analysis of variance of the posttests scores for concepts differed significantly ($p < 0.0001$) among the three treatment groups. Mean numbers of correct responses for students were 5.18, 7.16, and 3.02 for Treatments 1, 2, and 3 respectively. Least squares means analysis showed that mean scores of the control group were significantly lower than mean scores of either the hands-on activities group with ($p < 0.0014$) or without CAI ($P > 0.0001$). Mean scores of the hands-on group with CAI also differed significantly ($p < 0.00001$) from treatment III.

Analysis of variance of the posttest attitude scores differed significantly ($P > 0.0001$) among the three treatment groups. The mean number of positive responses per student for the hands-on activities with CAI ($x = 12.9$, $SE =+0.3$) were significantly higher ($P = 0.0001$) than the control group ($x = 9.3$, $SE =+0.4$). Mean scores of the hands-on activities with and without the CAI differed only at the $p = 0.05$ level.

Summary and Implications

From this study, hands-on activities appeared to increase scores from pretest to posttest. When combining hands-on activities and CAI, the gains from pretest to posttest scores were significantly higher than the gains with only hands-on treatment. Treatment group Three, with neither hands-on nor CAI, exhibited higher pretest scores on conceptual assessments than did groups in Treatments 1 or 2. On the posttest, Treatment group Three had a lower mean number of correct responses. These results indicated that taking the test twice did not result in increased scores. Hands-on activities, CAI, or both apparently lead to increased understanding and more positive attitudes.

These are exciting implications for further research in science education and CAI. Very few students encounter adequate science instruction during elementary school years (Spooner, W., Szabo, S., & Simpson, R. D., 1982). Teachers ranked knowing more about hands-on activities and CAI as very important according to the 1984-85 Research Committee of NSTA. As computers become more available and accessible to elementary school teachers, the effective use of science software programs coupled with hands-on activities requires more attention through appropriate preservice and inservice programs. The kinds of learning experiences which involve hands-on and CAI can significantly enhance attitudes of students toward science. The goals of classroom teachers are to provide stimulating learning environments that help children learn science and foster positive attitudes toward science. Such learning environments can influence lifelong learning. (Simpson, R.D. and Oliver, S., 1990) CAI is one tool which can be employed to achieve these goals of providing positive and stimulating learning environments.

WEATHER KNOWLEDGE

Group	Pretest Mean	Posttest Mean	Difference	t-value
1	2.2 ± 0.2	5.2 ± 0.4	+ 3.0	7.91*
2	2.1 ± 0.2	7.1 ± 0.4	+ 5.0	12.71*
3	3.9 ± 0.4	3.0 ± 0.3	- 0.9	- 0.45ns

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Group	Pretest Mean	Posttest Mean	Difference	t-value
1	10.6 ± 0.3	11.9 ± 0.3	+ 1.3	4.79*
2	10.3 ± 0.4	12.8 ± 0.3	+ 2.5	7.92*
3	11.0 ± 0.8	9.6 ± 0.7	- 1.4	- 2.00ns

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Abstract

Computer-aided instruction (CAI) is designed for the teacher and student to experience more effective and efficient learning and teaching than with more "traditional" teaching methods. Teachers must be aware of the quality of available software and supplemental materials in order to utilize CAI to its maximum potential. The National Survey on Instructional Uses of School Computers indicated that only fourteen percent of elementary classes were using computers for science instruction in 1985, and that computer usage in these classes occurred on an occasional basis. This preliminary study was undertaken to determine if a combination of CAI with hands-on science activities would significantly enhance students' abilities in the cognitive and affective domains.

The study consisted of three treatments. Treatment One included a hands-on activities emphasis. A second treatment included the identical hands-on activities in combination with the Weatherschool program. Treatment Three did not contain either hands-on activities nor CAI, but employed more text-based learning. The study was conducted in five third grade classrooms. The same teacher gave instructions, administered tests, and worked with the students in learning centers. The school chosen for this study was a public school where children were randomly assigned to the classes. There were 47, 46, and 21 students in Treatments 1, 2, and 3, respectively. A pretest and posttest were administered to each student to assess any changes in affective and cognitive parameters.

Analysis of variance of the pretest scores for attitudes demonstrated no significant difference ($p = 0.5824$) among the treatment groups prior to instruction. Mean scores for both the attitude and conceptual tests increased significantly ($p > 0.0001$) from the pretest to posttest for Treatments 1 and 2. Analysis of variance of the posttest attitude scores differed significantly ($p > 0.0001$) among the three treatment groups. The mean number of positive responses per student for the hands-on activities with CAI ($x = 12.9$, SE=+0.3) were significantly higher ($p = 0.0001$) than the control group ($x = 9.3$, SE=+0.4). Mean scores of the hands-on activities with and without the CAI differed only at the $p = 0.05$ level. Based on the results from this preliminary study, hands-on activities resulted in increased scores from pretest to posttest. When combining hands-on activities and CAI, the gains from pretest to posttest scores were significantly higher than the gains with only hands-on treatment.

As computers become more available and accessible to elementary school teachers, the effective use of science software programs coupled with hands-on activities requires more attention through appropriate preservice and inservice programs. CAI is one tool which can be employed to achieve these goals of providing positive and stimulating learning environments to elementary school students.