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Technology: a cross-curricular catalyst

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Abstract

This paper reports results of the first year of an innovative cross-curricular project. The technology laboratory (TEC-Lab) serves as the setting for classes in geometry, government, economics, literature, physical science and technology. TEC-Lab is used in grades 9 through 12 (ages 15-18) in a Texas (USA.) high school for their usual academic pursuits.

TEC-Lab incorporates a wide range of technologies, including computers, audio and video equipment, computer numerically controlled (CNC) machine tools, and satellite communication equipment.

Comparisons are made between the achievement of students who studied in the TEC-Lab environment and the achievement of students who studied the subjects with the same teachers in regular classrooms. Changes in attitude toward technology are compared between students who worked in the TEC-Lab and students who worked in regular classrooms. Also, attitude shifts are compared among students who studied the respective subjects.

It has been suggested that technology be utilized in science and mathematics classrooms as a means of increasing the levels of achievement of students in these classes (AAAS, 1989; Bennett & King, 1991; Haynie, 1989; Maley, 1987). However, secondary school students rarely experience multimedia technologies as part of their regular course work in science and mathematics. The effect of exposure to technologically-rich environments upon achievement and upon attitudes toward technology has not been explored.

This study was conducted in response to the need to examine the effects of a technologically-rich environment on the learning of students in physical science, geometry, language arts, social studies, and technology, and upon their attitudes toward technology. The technologically-rich environment was a laboratory which incorporated a wide range of technologies, including computers, audio and video equipment, computer numerically controlled (CNC) machine tools, and satellite communication equipment. Teachers and students in the experimental classes had full access to the media available in the technologically-rich environment during each class session.

Purposes

The dual purposes of this study were to: (a) determine the effects of immersion in a technologically-rich environment on the achievement levels of students in classes in physical science, geometry, language arts, social studies, and technology; and (b) determine the effect of immersion in a technologically-rich environment on the attitude toward technology as displayed by the students in those groups.

Population and Sample

In 1990, the Texas Education Agency (TEA) funded an innovative technology demonstration project at McCullough High School in The Woodlands, Texas. The project was proposed by Bernhardt and McHaney (1990), who were both McCullough High School faculty members.

Funds from the TEA were used to create a technologically-rich environment (TEC-Lab) in a former technology education laboratory and to restructure the school schedule so that classes in physical science, geometry, language arts, government/economics, and technology could be taught in the TEC-Lab. The population in this study was the 2200 students who attended McCullough High School in The Woodlands, Texas, U.S.A., during the fall semester of the 1991-1992 academic year. The sample was comprised of the students who were randomly assigned to the experimental and comparison groups in physical science, geometry, language arts, social studies, and technology being conducted as part of the TEC-Lab demonstration project in the school.

Procedures

Each of the five teachers from the five subject areas taught four classes and had two class periods for preparation. One of the preparation periods was scheduled as a mutual preparation period when the five teachers could meet in the TEC-Lab. In each subject, the teacher was assigned to teach one class in the technologically-rich environment of the TEC-Lab. One of the other classes taught by the teacher was designated as the comparison class in that subject; that class was taught in a traditional classroom setting. This arrangement allowed for

comparisons to be made within each subject between the two classes comprised of students who had been randomly assigned to the classes.

The Technology Education Curriculum Laboratory (TEC-Lab) project was undertaken to determine the effects of a technologically-rich environment on the students in traditionally academic areas. The TEC-Lab was equipped with 20 networked 386 computers, laser printers, video cameras and editing equipment, CNC machine tools, cable and satellite television, and a software library to support the class activities.

The teachers in the project were encouraged to develop or modify existing curricula so that the best advantage could be taken of the technologically-rich environment of the TEC-Lab. They began in-service training during the summer of 1991 in order to begin the project at the start of the Fall, 1991 semester.

The physical science classes in the project were comprised of ninth grade students (15 years old), with 19 students in the experimental (TEC-Lab) class and 19 students in the comparison class. The geometry classes included students from grades 9, 10 and 11 (15, 16 and 17 years old), with 19 students in the TEC-Lab class and 23 students in the comparison class. The experimental geometry class was comprised of 4 students from grade 9, 13 students from grade 10, and 2 students from grade 11. The geometry comparison class was made up of 7 students from grade 9, 12 students from grade 10, and 4 students from grade 11. The language arts classes were comprised of students in grade 11, with 20 students in the TEC-Lab class and 18 in the comparison class. The government classes were made up of 20 and 28 students in the experimental and comparison classes respectively. All were in grade 12 (18 years old). Both technology classes included students in grades 9 through 12, and were made up of 18 and 17 students respectively.

Assessment of the demonstration project was made on two levels. First, the comparative levels of achievement of the experimental and comparison classes was examined. This assessment was conducted using a posttest only design using the Fall 1991 semester examinations as the measuring instruments. The performance of the students in the physical science and geometry classes were examined in particular detail, and the semester examinations in those subjects were developed by the teachers and the researchers in cooperation. Multiple choice items on the two teacher-prepared six-week tests which had been administered earlier in the semester were submitted to an item analysis,

and the best items were selected from these earlier tests for inclusion in the measuring instruments. The final examinations consisted of 100 objective questions. The collaboration between the teachers and the researchers resulted in a physical science examination with a reliability of 0.93, and in a geometry examination with a reliability of 0.87. The final examinations in the other three subjects were developed by the teachers in those areas, and each was at least partially comprised of objective questions.

An instrument to assess attitudes toward technology was developed by the researchers for use in the study. Previous instruments (Raaf & de Vries, 1985; Fife-Schaw, Breakwell, Lee, & Spencer, 1987; Bame & Dugger, 1990) did not incorporate contemporary American language usage and were not designed to assess the range of attitude shifts anticipated in the study. However, factors that had been identified in previous research as comprising the attitude toward technology were included in the instrument developed for this study.

The attitude assessment instrument was administered at the beginning of the Fall, 1991 semester and again at the beginning of the Spring, 1992 semester. Factor analysis was performed on the results of the administration of the instrument, and eight factors were identified. The results of the posttest indicated that all 65 items on the measuring instrument were placed into factors. The eight factors were:

1. Attitude to technology
2. Interest in technology
3. Interest in social studies and language arts
4. Interest in science and technology
5. Interest in mathematics
6. Benefits of technology
7. Applications of technology
8. Effects of technology

Each item on the measuring instrument was rated by each student in the study on a scale of 1 to 10, where 1 represented "strongly disagree" and 10 represented "strongly agree." Examination of the attitude posttest factor analysis results indicated that 5 of the 65 items were negatively correlated with the other items in their factors. These five items were re-scored on both the pretest and posttest for all students in the project, and ANCOVA (analysis of covariance) was used to assess the changes which occurred between the two administrations of the instrument pretest. ANCOVA was used as a control for any differences which may have existed between the experimental and comparison classes at the beginning of the semester.

The reliability of the 65 item attitude measuring instrument was assessed using the SPSS software package. Factors 5 and 8 were not used in the reliability assessment because they contained fewer than 6 items each. The reliability of each of the posttest factors (excluding factors 5 and 8) was assessed using the same SPSS software package used to assess the whole instrument.

A univariate analysis was conducted for each item on the 65 item attitude measuring instrument for each student in the physical science groups and geometry groups in the study, and for all 142 students in the project. Because the same students took the pretest and the posttest, a difference score for each item on the measuring instrument was obtained for each student in the study. The mean difference score was then calculated for each of the 65 items for each group in the study and t-tests were performed on these difference means to assess the change in attitude for that item from the pretest to the posttest.

The scores for the 65 items on the attitude measuring instrument were summed for each student in the physical science groups and geometry groups in the study and for all 142 students in the project for both the pretest and the posttest. The pretest scores for each student were used as a covariate in the analysis of covariance of the posttest scores.

Scores for the items in each of the factors identified on the posttest were summed for these same students in the project. The scores for each factor on the pretest were used as a covariate for each student in the analysis of covariance of the posttest scores per factor.

Results

Achievement

The means on the semester examinations in each of the subject areas were compared by *t* tests to check for significant differences in achievement between the experimental and comparison classes. The *t* tests showed no significant differences between the experimental and comparison classes in any of the five subject areas. The *p*-values for the tests were: 0.09 for the physical science groups, 0.63 for the geometry groups, 0.53 for language arts, 0.31 for social studies, and 0.25 for the technology groups.

Attitude

The results of the ANCOVA procedures conducted on the 65 item attitude measuring instrument using the pretest scores as a covariate showed the following results: *p*-value = 0.60 in the experimental physical science group; *p*-value = 0.10 in the physical science comparison group; *p*-value = 0.01 in the

experimental geometry group; *p*-value = 0.01 in the geometry comparison group; and *p*-value = 0.00 for all students in the project. The procedures also indicated a 21% positive change in attitude for all 142 students in the project; that is, the students were more favorably disposed toward continued and increased usage of technology, its benefit to society, and its future impact.

The ANCOVA procedures conducted on the summed scores for each of the factors yielded the following results: factor 1 showed a significant change in the physical science comparison group, in the geometry experimental group, in the geometry comparison group, and for all students in the project; factor 2 showed a significant change in the physical science comparison group, in the geometry comparison group, and for all students in the study; factor 3 showed no significant change in any of the physical science or geometry groups but it showed a significant change for all 142 students in the project; factor 4 showed a significant change in each of the physical science and geometry groups and for all students in the project; factor 5 showed a significant change in the physical science experimental group, in the physical science comparison group, in the geometry experimental group, and for all students in the project; factors 6 and 7 showed no significant change in any of physical science or geometry groups, but there were significant changes for all students in the project; factor 8 showed significant changes in the geometry experimental group and in the geometry comparison group, and for all students in the project.

The 65 item attitude measuring instrument was found to have a reliability of 0.81. Factor 1 of the instrument, which included 24 items and assessed attitude toward technology was found to be highly reliable (0.91); factor 2, which included 8 items and assessed interest in technology was found to be moderately reliable (0.77); the remaining 6 factors showed reliabilities less than 0.55.

Conclusions

1. Immersion of physical science, geometry, language arts, social studies, and technology students in a technologically-rich environment for one semester does not appear to affect the level of achievement of the students in those subjects in either a positive or a negative way.
2. Immersion of physical science and geometry students in the technologically-rich environment for one semester has a marked, but not consistently positive effect on the attitude toward technology displayed by those students.

3. Immersion of students in physical science, geometry, language arts, social studies, and technology classes at various grade levels in a technologically-rich environment for one semester has a marked positive effect on the attitude toward technology of those students.
4. Occasional use of computers by students who are not enrolled in a course taught in a technologically-rich environment appears to have a positive effect on the attitudes of those students toward technology.
5. Involvement in an innovative technology project appears to have a positive effect upon the teaching style, expectations, motivation, and level of creativity of teachers.

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