Technology: Its influence in the Secondary School upon Achievement in Academic Subjects and upon Students' Attitude Toward Technology

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The integration of instruction in school subjects offers promise for the improvement of student achievement and the motivation of learners to pursue further study in these fields. Concurrently, the availability of new instructional technologies for the classroom enables curriculum planners to explore new patterns of instructional organisation and to present instruction through a wide range of innovative approaches. This paper presents results from research in the application of contemporary technology in integrated instruction in language arts, mathematics, social science, science, and technology.

It has been suggested that technology be utilised 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. The effect of exposure to technologically-rich environments upon achievement and upon attitudes toward technology has not been explored.

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 physical science, geometry, language arts, social studies, and technology groups; and (b) determine the effect of immersion in a technologically-rich environment on the attitude towards technology as displayed by the students in those groups.

Population and Sample

The population in this study was the 2200 students who attended McCullough High School in The Woodlands, Texas, USA., during the 1991-1992 academic year. The sample was comprised of the students who were randomly assigned to experimental and comparison groups being conducted as part of the TEC-Lab demonstration project in the school during that year. Particular emphasis was placed in the levels of achievement and attitude changes evident in the physical science and geometry classes during the fall semester.

Procedures

In February, 1991, the Texas Education Agency funded an innovative demonstration project at McCullough High School in The Woodlands, Texas. The project was funded for two years and allowed for the creation of a technologically-rich environment (TEC-Lab) in a former technology education laboratory. The TEC- Lab incorporated a wide range of technologies, including computers, audio and video equipment, computer numerically controlled (CNC) machine tools, and satellite communication equipment. The TEC-Lab was used as the location for the teaching of physical science (9th grade), geometry (9th, 10th, 11th grades), language arts (11th grade), social studies (12th grade), and technology (grades 9-12).

The physical science course covered density, the periodic table, atomic structure, chemical bonding, air and water flotation, and sound. The geometry course dealt with polygons and their basic properties, parallelism, elementary logic, transformations, complementary and supplementary angles, and triangle congruency (see Appendix). The language arts class studied topics in American literature; the social studies program covered local, state, and federal government in the American system, and economics. The technology class, communication systems, included the study of drafting, desktop publishing, photography, graphic arts, electronics, and telecommunications.

The teachers who conducted classes in the TEC-Lab environment were given the freedom to utilise the available technologies in any way they considered appropriate. The teachers and students made use of word processing software, drawing and mathematics applications programs, and data bases, together with audio/video cameras and editing equipment, and satellite communication systems.

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

Table 1:
January Achievement Scores of TEC-Lab and Comparison Groups in Geometry and Physical Science

Group	N	Mean	S.D.	*t*	DF	Prob>*t*
Geometry						
TEC-Lab	19	69.8	10.5	0.49	39	0.63
Comparison	22	71.5	11.5			
Physical Science						
TEC-Lab	19	53.5	16.9	1.76	34	0.09
Comparison	17	63.2	15.9			

Table 2: May Achievement Scores of TEC-Lab and Comparison Groups						
Group	N	Mean	S.D.	*t*	DF	Prob>*t*
Geometry and						
TEC-Lab	18	43.33	7.57	1.63	38	0.11
Comparison	22	47.05	6.81			
Physical Science and						
TEC-Lab	19	59.79	13.69	0.50	38	0.62
Comparison	21	62.14	15.48			
Technology and						
TEC-Lab	16	89.00	6.63	2.48	34	0.02
Comparison	20	83.88	5.76			
English and						
TEC-Lab	15	68.33	12.23	0.20	35	0.84
Comparison	22	69.55	24.48			
Economics and						
TEC-Lab	16	74.00	12.62	0.15	45	0.88
Comparison	31	74.58	12.29			

teach one class in the TEC- Lab. One of the other classes 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.

Achievement Assessment

Achievement tests were developed in co-operation with the teachers. All teachers developed examinations to compare the achievement of students in their TEC-Lab classes with the achievement of students in their comparison classes at the end of the academic year. Two teachers, the geometry and physical science teachers, developed multiple-choice achievement examinations for the end of the first semester, in January, 1992 and the end of the school year in May, 1992.

January Results. the results of the January, 1992 administrations of the achievement tests in Tec-Lab and comparison classes in geometry and physical science were analysed by *t*-test comparisons of the means of the experimental and comparison groups. Results of the comparisons in the geometry and physical science classes are reported in Table 1.

The results reported in Table 1 indicate that the TEC-Lab and comparison classes in geometry and physical science did not differ significantly in achievement levels at the end of the Fall, 1991 Semester (Bolin, 1992).

May Results. In May, 1992 each of the teachers in the TEC- Lab project administered a final examination in their TEC-Lab section and in their comparison class. Results of the final examinations were analysed as part of the assessment of the TEC- Lab project. The results of the statistical analysis of the May, 1992 achievement test scores are shown in Table 2.

The mean scores of students in TEC-Lab classes and students in comparison classes in geometry, physical science, English, and economics did not differ significantly. Significant differences in achievement between TEC-Lab and comparison groups were noted only between the technology classes. A likely explanation is that the technology students in the TEC-Lab section may have had an advantage in their achievement examinations in May, 1992, because of the overlap between the usual course content and the TEC-Lab experience. TEC-Lab students in the other courses may have been at some disadvantage in the May examinations in their courses, because their TEC-Lab activities may have displaced some of the time and attention devoted to the specific subjects in the comparison classes.

Only the students in the technology classes were tested for achievement in technology in May, 1992. Thus, it is not possible to speculate on the degree to which TEC-Lab experiences contributed to improvement in achievements in technology by students who were enrolled in other courses.

Attitude Assessment

An instrument to assess attitudes towards technology was developed by the researchers for use in the study; it was used to monitor shifts in attitude toward technology and toward the specific school subjects which might be attributed to the activities conducted by the TEC-Lab project. Work on the instrument began with a detailed analysis of previous research on attitude assessment. Raat and de Vries (1985) reported on the development of an instrument that assessed the attitudes toward technology of 13 year old boys and girls in The Netherlands. The instrument was comprised of 78 items which were grouped into 14 factors. Bame and Dugger (1990) reported on the adaptation of the Raat and de Vries (1985) instrument for use in the United States. Fife-Schaw, Breakwell, Lee, and Spencer (1987) published the results of research conducted in Britain to determine attitudes towards technology among undergraduate university students. The measuring instrument used by Fife-Shaw et.al. was comprised of 5 factors.

Careful analysis of the instrument developed by Raat and de Vries, Fife-Shaw *et.al.* and Bame and Dugger indicated that those instruments would not meet the specific requirements of the TEC-Lab project. Instead, an instrument was created by modifying selected items from previous instruments and by developing additional items that fell within the context of the factors which had been identified by the previous researchers. Thirteen items were included in the instrument to assess attitudes toward mathematics, science, language arts, social studies, and technology. The resulting instrument consisted of 65 items that could be ranked by the students on a scale of 1 to 10, where 1 represented 'strongly disagree' and 10 represented 'strongly agree.' The instrument is reproduced in Table 3.

The attitude measuring instrument was administered to all students (n=206) participating in the TEC-Lab project in September 1991, January 1992, and in May 1992. After each administration, a factor analysis was performed on the results (SAS Institute, 1985), using the varimax rotation with minimum criterion level of 0.30 (rounded to two decimal places) for the inclusion of an item in a factor (Anastasi, 1988). Each of the three analyses identified eight factors; however, the factors and the specific items included

Table 3: Attitude Assessment Instrument

1. Robots will replace people to do boring jobs.
2. Working and shopping at home may result in fewer social contacts.
3. I would like to take more science courses.
4. It is possible to learn about technology without a teacher.
5. Video games are exciting.
6. I am interested in the ways technologists solve problems.
7. I plan to study mathematics in college
8. Keeping personal information in computers goes beyond acceptable standards of privacy.
9. I enjoy using a computer
10. Technology increases our desire for comfort.
11. It will be necessary to understand technology to get a job in the future.
12. Technology offers many opportunities to exercise creativity.
13. I would like to take more technology courses.
14. I like to read about technology.
15. Everybody should know how to use a computer.
16. More free time will make life better.
17. Computers can make lessons more interesting.
18. I enjoy coming to school each day.
19. Mathematics is my favourite subject.
20. Technology needs to be watched closely to prevent its misuse.
21. I would like to take more mathematics courses.
22. We should share our technologies with developing countries.
23. America's international competitiveness depends upon technological development.
24. I am interested in making videos.
25. Technology will improve our standard of living.
26. Video games are a waste of time.
27. I plan to study technology in college.
28. Developments in technology will reduce the cost of living.
29. I prefer to learn from a teacher rather than from a computer.
30. Technological advancements solve more problems than they create.
31. Technology is safe.
32. I am interested in desktop publishing.
33. Language arts is my favourite subject.

Table 3 (continued)

34. Increased automation will result in mass unemployment.
35. New technologies are improving working conditions.
36. I would like to take more language arts courses.
37. Video games quicken the reflexes.
38. Nuclear arms development is essential for national security.
39. I would like to have a computer for my own use.
40. Technology is applied science.
41. Telecommunication will increase international trade.
42. Technology is scary.
43. I plan to study language arts in college.
44. Technology is a part of all jobs.
45. Telecommunication is essential for world peace.
46. Nuclear power stations are safe.
47. I am interested in telecommunications.
48. New technologies benefit only a few Americans.
49. Technology is my favorite subject.
50. Too much money is spent on the development of new military technology.
51. I would like to take more social studies courses.
52. Developments in technology will give us more free time.
53. Technology education can broaden one's interests.
54. Video games disrupt family life.
55. I am interested in computer-numerical controlled machining.
56. Life will become less pleasant because of increased pollution.
57. Technological jobs should be equally accessible to women and men.
58. Science is my favourite subject.
59. There should be more coverage of technology in the media.
60. I plan to study social studies in college.
61. Technology makes people more creative.
62. New technologies will create more jobs than they destroy.
63. Technology is too difficult for me.
64. I plan to study science in college.
65. Social studies is my favourite subject.

in the factors varied slightly across the three administrations.

The eight factors identified in the factor analysis of the September 1991 administration included 49 of the 65 items. These factors were identified as follows:

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

Eight factors were also identified in the factor analysis of the January, 1992 administration of the instrument. All 65 items on the instrument met the criterion of 0.30 loading and therefore were included in one of the factors. The factors which were identified as a result of this factor analysis were:

1. Attitude toward 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

After the January 1992 administration, 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 post-test factors (excluding factors 5 and 8) was assessed using the same SPSS software package used to assess the whole instrument. The 65 item attitude measuring instrument was found to be reliable (Guttman split-half reliability coefficient 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); factor 3, which included 7 items and assessed interest in language arts and social studies and a reliability of 0.64; the remaining factors showed reliabilities less than 0.55.

The eight factors from the May 1992 administration are listed below.

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

Several inconsistencies are obvious from the successive factor analyses. The most marked variations are those in which the factor, interest in science and technology, evolved into separate factors, interest in science and interest in technology, in the third administration. Also, the factor, applications of technology, did not appear in the third administration. In addition, the clusters of items within the factors varied slightly across the three administrations. Table 4 shows a listing of the factor assignments of each of the items for each of the administrations of the attitude measuring instrument.

After the completion of each factor analysis, an analysis of covariance was performed on the results of the entire group of students who had participated in the TEC-Lab project, either in the TEC-Lab classes or in the comparison classes. The analysis of convariance was performed separately for each of the factors, using the Septem-

Table 4: Factor Assignments of Attitude Items in Successive Administrations

Item Number	Item	Factor Sept.	Jan.	May
1.	Robots will replace people to do boring jobs	7	7	*
2.	Working and shopping at home may result in fewer social contacts	*	6	7
3.	I would like to take more science courses.	2	4	5
4.	It is possible to learn about technology without a teacher.	*	7	3
5.	Video games are exciting	5	7	4
6.	I am interested in the ways technologists solve problems	2	4	3
7.	I plan to study mathematics in college	4	5	6
8.	Keeping personal information in computers goes beyond acceptable standards of privacy	*	8	*
9.	I enjoy using a computer	1	1	1
10.	Technology increases our desire for comfort.	1	1	1
11.	It will be necessary to understand technology to get a job in the future	1	1	1
12.	Technology offers many opportunities to exercise creativity.	1	1	1
13.	I would like to take more technology courses.	2	2	1
14.	I like to read about technology	*	4	3
15.	Everybody should know how to use a computer.	1	1	1
16.	More free time will make life better.	7	6	4
17.	Computers can make lessons more interesting.	1	1	1
18.	I enjoy coming to school each day.	*	3	6
19.	Mathematics is my favourite subject.	4	5	6
20.	Technology needs to be watched closely to prevent its misuse.	1	1	7
21.	I would like to take more mathematics courses.	4	5	6
22.	We should share our technologies with developing countries.	*	6	3
23.	America's international competitiveness depends upon technological development.	1	1	1
24.	I am interested in making videos.	8	6	7
25.	Technology will improve our standards of living.	1	1	1
26.	Video games are not a waste of time.	5	7	4
27.	I plan to study technology in college.	2	2	3
28.	Developments in technology will reduce the cost of living.	4	7	8
29.	I prefer to learn from a computer rather than from a teacher.	8	2	8

Table 4: Factor Assignments of Attitude Items in Successive Administrations (continued)

Item Number	Item	Factor Sept.	Jan.	May
30.	Technological advancements solve more problems than they create.	1	1	1
31.	Technology is safe.	*	1	4
32.	I am interested in desktop publishing.	3	2	3
33.	Language arts is my favourite subject.	3	3	2
34.	Increased automation will result in mass unemployment.	*	8	7
35.	New technologies are improving working conditions.	1	1	1
36.	I would like to take more language arts courses.	3	3	2
37.	Video games quicken the reflexes.	5	6	4
38.	Nuclear arms development is not essential for national security.	*	6	*
39.	I would like to have a computer for my own use.	1	1	1
40.	Technology is applied science.	1	1	1
41.	Telecommunication will increase international trade.	1	1	1
42.	Technology is scary.	6	8	8
43.	I plan to study language arts in college.	3	3	2
44.	Technology is a part of all jobs.	*	1	1
45.	Telecommunication is essential for world peace.	1	1	1
46.	Nuclear power stations are safe.	*	2	5
47.	I am interested in telecommunications	2	2	3
48.	New technologies benefit only a few Americans.	6	8	8
49,	Technology is my favorite subject.	2	2	3
50.	Too much money is spent on the development of new military technology.	*	6	8
51.	I would like to take more social studies courses.	3	3	2
52.	Developments in technology will give us more free time.	7	1	1
53.	Technology education can broaden one's interests.	1	1	1
54.	Video games do not disrupt family life.	*	7	4
55.	I am interested in computer-numerical control machining.	2	2	3
56.	Life will become less pleasant because of increased pollution	*	1	1
57.	Technological jobs should be equally accessible to women and men.	1	1	1
58.	Science is my favourite subject.	2	4	5
59.	There should be more coverage of technology in the media.	2	1	1

Table 4: Factor Assignments of Attitude Items in Successive Administrations (continued)

Item Number	Item	Factor Sept.	Factor Jan.	Factor May
60.	I plan to study social studies in college.	3	3	2
61.	Technology makes people more creative.	1	1	1
62.	New technologies will create more jobs than they destroy.	*	1	7
63.	Technology is not too difficult for me.	*	4	1
64.	I plan to study science in college.	2	4	5
65.	Social studies is my favourite subject.	3	3	2

*Item was not assigned to a factor during this administration of the instrument.

Table 5: Summary of Analysis of Covariance by Factor, September, 1991-May, 1992.

Factor	F Value	Pr>F	R-Square
1	68.55	0.0001	0.39
2	53.35	0.0001	0.33
3	43.45	0.0001	0.29
4	13.72	0.0003	0.11
5	80.91	0.0001	0.43
6	97.84	0.0001	0.48
7	30.61	0.0001	0.22
8	25.17	0.0001	0.19
Total Instrument	106.51	0.0001	0.50

Table 6: Attitude Toward Technology Scores of All Female and Male Students in the Tec-Lab Groups and in the Comparison Groups, May, 1992.

Group	N	Mean	S.D.	t	DF	Prob>t
Females	70	7.06	3.60	–2.93	165	0.004
Males	97	8.66	3.34			

ber results as the covariate and the January and May results as the dependent variables. In each case, tests of significance indicated that significant shifts had occurred in each of the factors at the 0.01 level of statistical significance. All of the shifts were in the positive direction, that is, the mean rating of the items in each of the factors moved towards stronger agreement with the statements, each of which was written to express a positive attitude. It is not known, of course, whether the successive administrations of the instrument could have produced such an effect.

The results of the May, 1992 administration of the attitude assessment instrument were analysed in an attempt to identify any effects of gender upon attitude toward technology. The attitudes of females differed significantly from the attitudes of males when the scores of all 70 females and 97 males (167 students who completed the attitude measuring instrument) were compared. The mean attitude score of the male students was significantly higher than the mean attitude score of the female students.

Teacher Assessment of the Project

Near the end of the school year, the five teachers who had been teaching one of their classes in the TEC-Lab were asked to assess the success of the project by responding to a series of questions covering several dimensions of their experiences.

The five teachers were unanimously positive towards their experiences with the TEC-Lab. They were quite analytical and descriptive in their responses. In addition to comments that assist in assessing the first year of the TEC-Lab project, each teacher offered numerous observations that will be useful in guiding future work with the demonstration project and similar undertakings.

The activities that worked best were those which were relatively less structured. One teacher said, 'Open-ended student-determined class activities were the very best. When I told the students I wanted a set product, they gave me that product and that's all they did. When I gave them a lot of freedom and a lot of leeway, the stronger students in the class took off and developed and blossomed, and really became very good in terms of ability to decide what they wanted, and they were very creative. They were able to give me products that sometimes astounded me.'

Teachers reported that the students were most engaged by using the computer to develop presentations, using programs such as Persuasion, Geo-Explorer, and Autosketch, or illustrating their findings using graphic presentations in the Windows environment. Another teacher reported, 'Basically, the activities the students enjoyed the most were the ones that had video production or the use of the CD-ROM'.

In assessing the value of the equipment, one teacher wrote, 'The computer system has been the backbone for the senior level students. The Windows environment has been very useful because it allows the students to choose among several options: word processing, Excel to present statistical information in graphic format, Pagemaker to prepare visual results of surveys and statistical results, titler programs that spruce up video programs, and, of course, CD-ROM systems that enable access to a limited amount of research.'

The teachers found it necessary to change their teaching styles to work effectively in the TEC-Lab environment. One teacher said, 'I had to actually change my perception of what my class was going to be. The TEC-Lab students did not get anywhere near the content or the hands-on activity that my other students got.' Another said, 'I had to be more of a facilitator than lecturer.' A third teacher reported, 'Perhaps the most notable change in my day-to-day routine was development of toleration of 'think and do time' necessary for technology implementation. Technology promotes quality products. Quality products require additional time from youngsters who are learning subject matter and technology simultaneously.'

Student Assessment of the Project

Near the end of the school year, all students who were enrolled in one of the TEC-Lab sections were asked to describe their experiences throughout the year. While 37 students felt that the information they learned in the TEC-Lab is comparable to that in other classes of the same subject, 39 respondents felt that they had learned somewhat less of their regular subject in the TEC-Lab. Many of these thought that their increased technological understanding attributable to TEC-Lab more than compensated for the perceived differences in subject matter mastery.

The majority of the respondents, 58, thought that the TEC-Lab experience made it easier to learn the content of their courses, while 8 students thought that TEC-Lab made learning of the subjects more difficult. A total of 68 students reported enjoying the TEC-Lab class more than a similar subject in a previous year, while 4 found the TEC-Lab experience less enjoyable than previous study in the subject in a conventional setting.

The majority, 77 respondents, indicated that they would recommend TEC-Lab courses to others, while only 1 student gave a negative response and 3 withheld judgement. Given the opportunity, 71 respondents indicated a preference for an additional TEC-Lab class, while 6 indicated that they would prefer a traditional classroom setting for additional courses in the area. In summary, 78 students indicated that TEC-Lab had been a positive experience; no students gave a negative rating to their TEC-Lab experiences.

Summary

Many programs in the United States have undertaken to show the benefits to students of integrating academic disciplines. The TEC-Lab project, however, is unique among them because of its innovative approach. First, the TEC-Lab students are in senior high school, grades 9 to 12, while most innovative efforts are concentrated at the elementary and middle school levels. Second, the TEC-Lab approach uses technology as a means of meeting the usual academic requirements, rather than attempting to integrate the other academic areas into technology. The difference between these two approaches is subtle but profound.

The first semester of the project was fraught with problems as equipment deliveries were late and installation difficulties delayed implementation even further. There was too little time to provide adequate teacher preparation. The students' lack of familiarity with the technologies in the TEC-Lab complicated implementation.

It is actually remarkable that these serious implementation problems apparently had little negative effect on the achievement levels of the students in the project. The lack of significant differences between the TEC-Lab and comparison classes in physical science and geometry in January, 1992 gave an early indication that immersion in the TEC-Lab environment was not disadvantageous to students. The comparisons made in May, 1992 of all TEC-Lab and comparison classes identified only one significant difference in achievement levels, when the TEC-Lab technology class achieved significantly better than the comparison technology class. This difference may well be explained by the overlap between the subject matter of the course and the technologies in use in the TEC-Lab.

The changes in student attitudes towards technology during the academic year are particularly provocative. Participation in the TEC-Lab project, whether in one of the TEC-Lab classes or in one of the comparison classes taught by the TEC-Lab teachers, resulted in positive changes in attitude toward technology. The shift was consistent, appearing in each of the factors as well as the overall attitude scale.

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Appendix
Teaching Geometry in TEC-Lab

Plane geometry is typically a tenth-grade subject in American high schools, following the ninth-grade course in algebra. Textbooks and classroom assignments typically emphasise formal proofs, with relatively few opportunities for students to develop geometric concepts through activities such as the design and construction projects. In contrast, the teacher who instructed a geometry class in the TEC-Lab setting emphasised conceptual development through activities and assigned projects. This appendix describes some of those activities to provide an idea of the adaptations which teachers made in order to work in TEC-Lab.

In one instance, small groups of students worked together on a problem in the design of packaging. The problem consisted of the packaging of a teachers model kit (a set of geometric solids which serve as visual aids in the classroom). The groups were challenged to develop an orderly arrangement and secure packaging for this specified group of cubes, cones, cylinders, spheres, and pyramids. The groups were in competition to produce the best design for a package that would occupy the smallest volume when completed. Also, the competition included a design for the larger package to be used to ship the kits in their small packages from the manufacturer to the wholesaler.

Computer software was used on the IBM platform in several applications in the TEC-Lab based class in geometry. For example, AutoSketch was employed to develop designs for complex die-cut packages used to package cosmetics and other consumer items. This activity required students to identify the combinations of geometric components needed to provide the desired package and translate from two-dimensional drawing to three-dimensional model. The development of packaging designs including trapezoids and semi-circles provided a special challenge to students completing this exercise.

Students used home software to develop designs for one-bedroom apartment within specific limitations of area, volume, and cost. In addition to completing their architectural drawings, an activity not included in the typical American geometry course, the students applied their geometric understanding to estimate the costs of painting, installing wall-to-wall carpeting in specific rooms, and linear footage of mouldings required. Excel data base software was used to manipulate the data in dealing with this design problem.

PageMaker was used to produce reports of some of the class projects. In one instance, the students designed free-form swimming pools. Then, as young entrepreneurs they used their knowledge of geometry to develop advertisements featuring specifications describing the area and volume of the pools.

Video equipment has also been put to use in the TEC-Lab course in geometry. Students have used portable camcorders to record geometric shapes in the real-world environment: parallel lines, triangles of all sorts, adjacent angles, vertical angles, and so on. These video images then serve as classroom examples of the actual appearance of geometric constructs. Images have then also been scanned into computer files for measurement and manipulation using application software.

The variety of activities which were included in the geometry class in the TEC-Lab during the first year provides a glimpse into the potential of the technologically-rich environment in enriching learning experiences. The fact that this was the first opportunity for the teachers to use the equipment in this way means that many more potential activities may be envisioned. This year, the students were able to use a computer numerically controlled lathe to produce cones to their specifications; in the future, they may be able to use computer controlled milling machines to produce a wide variety of shapes to illustrate their designs. The prospects are exciting — and the second year of the TEC-Lab project has resulted in a number of new activities for students.