

Focused Assessment
Geometry and the Math Lab
evaluating the effectiveness of technology

Summary by Leslie Howe
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Knoxville, Tennessee
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Four teachers cooperated in this study: Geometry teachers, Mary Emma Bunch, Kellie Ivens and Sallie Ralston, and math lab coordinator, Leslie Howe.

Leslie Howe planned to expand the computer lab activities for geometry and the others planned to evaluate the effectiveness of the activities gathering information about student success and also requesting feedback from student from an open-ended written survey. (Students were not given a list of activities; we wanted to see what they remembered.)

Activities available to geometry teachers.

Software created by L. Howe (*Howe-Two Software*) from previous years:

Traveling Transversals, teaches students terminology related to parallel lines.
Angle Problems, using vertical angles, linear pairs and perpendicular lines.
Name the Parallels, teaches students to identify parallel lines from given information.
Parallel Problems, using angles formed by parallel lines.
Triangle Investigator (triangle inequality theorem & classification)
The Why and How of Congruent Triangles, analyzing given information to do with proof.
Quadrilateral quiz (definitions, true-false, properties)

New Software created this year (*Howe-Two Software*)

(The five teachers conferred, identifying points of difficulty for students and Leslie wrote programs to address those needs. Because of time constraints not all suggested programs were written. In some cases teachers did not have opportunity to become familiar with the new programs before their use.)

Definitions, reviews students on initial terms and definitions.
Logic (converse, inverse, contrapositive, truth tables, syllogism, detachment)
Mindpower, a logic game
Purloined Parts (overlapping triangles, gathering information for proofs)
Pythagorean Triples and the Pythagorean Theorem
Special Angles (30-60-90; 45-45-90)
Electronic Geoboard
Reflections (in a line or in a point)

Other activities

Mathematica (slicing a cube-demonstration by J. Beckett)
Cabri (introduction and linear pair/vertical angles: a dynamic view)
Cabri (altitude, median, angle bisector, perpendicular bisector, in-circle, circumcircle, centroid, nine-point circle)
Peanut Software (Graphing 3-D), by Rick Parris (freeware)

Research Summaries

Teachers implemented a number of techniques to evaluate the effectiveness of the lab. Each teacher used slightly different evaluation techniques.

by Sallie Ralston

Sallie Ralston prepared a pre and post test evaluation for the lab activity. The average pre-test score on the material covered in the program Definitions was 82%. The post-test average was 91%. This lab activity produced a nine point improvement on the average.

After this study Sallie decided to try to conduct a controlled study. She planned to take one of her two geometry classes to the lab for each of the new activities and use the other class for a control. She alternated which class was the control throughout the term. Each time she made a test she identified the questions that pertained to the lab activities. When she graded the tests she recorded the number of correct responses to these questions for each group. Over the semester her second period class proved to be by far the stronger math class so from a scientific point of view the control and study groups were not evenly matched. In some ways this made the study even more interesting. She tracked the results of these activities. (I have put an 'S' in parentheses by the "stronger" class and a 'W' by the weaker class.

Program	% correct by group not using the program	% correct by group using the program
<i>Angle Problems</i>	87% (S)	88%(W) (the weaker class did slightly better than the stronger class!)
<i>Logic</i>	68%(W)	90%(S)
<i>Name the Parallels</i>	81%(S)	87%(W) (again the weaker class did better)
<i>Purloined Parts</i>	69%(W)	77%(S)

In every case the group using the lab activity outperformed the group not using the lab activity. Sallie chose to use the older programs with both groups. She had used them before and found them to be helpful to all students.

The survey given to Sallie's students revealed the following:

1. Forty-one out of fifty one students stated that they would like more activities.
2. In response to the free response question (with no prompted list)
"Which program helped you the most?"
twenty-two stated specific programs and fourteen responded
"All of them"
3. Fifty out of fifty-one students stated that they preferred to practice concepts using the computer to using text book activities.

Sallie was consistent in her commitment to track the effectiveness of the computer activities using a control group for comparison. Her feedback is invaluable.

by Kellie Ivens

Kellie Ivens first and third period geometry classes were brought to the math lab and used the *Definitions* program, *Angle Problems*, *Traveling Transversals* and *Parallel Problems*, *Quadrilateral Quiz*, *Tesselmania* (Mecc software) and *Special Triangles*.

Kellie conducted research on the *Definitions* program for Chapter one and two. She gave a 20 question quiz on the definitions after teaching the unit but before coming to the lab and then again after using the review program in the lab. Her results were as follows:

% Correct	Number correct	Number of students	Number of students
		with score before coming to the lab.	with score after coming to the lab.
100%	20	3	20
95%	19	0	0
90%	18	4	2
85%	17	2	1
80%	16	8	1
75%	15	1	0
70%	14	3	1
65%	13	3	1
60%	12	0	1
55%	11	0	0
50%	10	1	0
45%	9	1	0
40%	8	1	1
35%	7	1	0

before coming to the lab
mean score was 75.7%
mode at 80%
median was at 80%

after coming to the lab
mean score was 92.1%
with a mode at 100%
median was 100%

Kellie also conducted a survey of student reaction to lab activities. Students stated that they liked *Tesselmania* the best. Many students left the open question "Which program did you like least?" blank. Those who responded to this question listed the *Quadrilateral Quiz* most often (8 entries). An unexpected response was noted in the answer to the third question, "Which program helped you the most?" Thirteen students said the *Quadrilateral Quiz*, helped them the most. Fifteen students said the *Definitions* program helped them the most. Ten of Kellie's students responded that "all of them" helped them learn. Kellie noted that quite often a student would state that the program they "liked least" also helped them "the most."

Kellie's survey also revealed that the students preferred learning concepts in the lab (Forty-eight out of fifty-three) to text book activities. Forty said they would like for there to be more computer activities and the remaining students thought about the same amount was what is needed. Eleven said explicitly that they wanted to go to the lab more often.

Mary Emma Bunch

Mary Emma Bunch teaches two honor's geometry classes. These students learn very quickly. Many of the above mentioned programs were created to meet the instructional needs of those who require more repetition and practice. Her classes were brought to the lab for *Cabri Geometry* investigations including the construction of the nine-point circle and the Euler line. The computers were also used to help students visualize 3D problems. *Win Geom*, *Peanut Software*, by Rick Parris proved most helpful for this activity. Both classes came to the lab and used the *Logic*, the *Quadrilateral Quiz* and *Special Triangles*.

Mary Emma brought one class to the lab for the *Angles Problems* and one class for *The Why and How of Congruent Triangles*. On the unit test on congruent triangles the 9 students in the control group and 9 students in the lab group both missed stating congruency correctly. Data collected on the angle problems program the class coming to the lab missed a total of 4 more problems than the class that did not come to the lab. On the whole in these two instances the honors' students perform well with or without computer activities.

Mary Emma also gave the survey of student opinion to her classes. Thirty-four students from the two classes indicated that they liked using the Cabri Geometry program the most. Sixteen listed the *Logic* program as the one they liked the least. Seventeen stated that the *Special Triangles* program helped them the most. Thirty-seven students felt that we need to develop more programs. Forty-eight out of fifty-two students responded that they preferred to practice concepts on the computer rather than using text book practice alone. At one point Mary Emma reported that a student commented after a test that she "saw" the corresponding parts of triangles in color. This is what was done in *The Why and How of Congruent Triangles*. This indicates that the program gave "something extra" even to those who already understood the underlying concepts.

Additional Research

During final exams in the spring of 1988 several teachers passed out a voluntary survey to students after their course exam. One hundred twenty-two students filled out the surveys but not all answered all the questions. Here is a summary of the attitudes reflected on this survey:

107/115 (93%) said they enjoyed going to the math lab at least "sometimes"

90/112 (78%) said that they enjoyed going to the math lab with no qualification.

119/122 (98%) said that the math lab helped them understand at least a little better.

65/122 (53%) said that the math lab helped them understand "a lot."

97% responded that they thought other school should have such a lab.

Conclusions by Leslie Howe

The integration of technology into the curriculum is an on-going process. In the past computers have not been widely used for instruction so teachers cannot rely on their own experience as students. The development of new teaching strategies that involve the use of technology requires imagination and concentration. Something new has to be invented. Topics that lend themselves to computer instruction have to be identified. Activities have to be planned. Then new strategies have to be tested, evaluated and modified. Teachers have to be willing to try something new. Adjustments have to be made as to when and how to use a given technology most effectively. This also takes imagination and planning. The successful implementation of new methods takes cooperation and communication among the members of the staff and feedback from students. This is a major focus for the teachers who use the Farragut High School math lab.

Here are a few my personal observations.

1. The stereotype of treating computer activities as optional or supplemental at the end of the chapter has to be replaced with true integration. In the past text books have included technology in this manner (treating it as an extra) since there was no guarantee that a school would have available computers. To make these changes teachers need to be familiar with computer activities and strategies available to them so that they can plan for their use at the optimal time. The appropriate use of activities can reduce the need for re-teaching and can give the teacher the ability to provide students with individual attention and immediate feedback and correction of mistaken perceptions. The use of computer activities after a unit test is only demoralizing to students who wish they had the opportunity to learn before the unit test. The department could facilitate this familiarity by providing inservice training times for the purpose.
2. Teachers need to choose activities that are appropriate for their students. No two classes are exactly alike and teachers need to constantly reevaluate the teaching/re-teaching needs of their students. We generally use *Mathematica* as tool in the upper level courses such as Pre-Calculus and Calculus. Students use it to work with three-dimensional graphing, Newton's method, the mean value theorem, and other Calculus topics. It would not be appropriate to use the "Solve" command in *Mathematica* with students who have not yet grasped the concept of an equation. Our limited research has shown that the practice programs are of great benefit to the regular college preparatory courses. The honors' students learn as effectively from regular homework assignments although they appreciate the computer activities. Many honors' students have commented to me that the lab activities "always help."
3. I have found that the observations of classroom teachers as to the needs of students often lead to the most useful technological teaching strategies. Interactive, electronic versions of tried-and-true paper/pencil activities can be created providing all students with immediate feedback and giving teachers the ability to identify those who need one-on-one help.
4. Students like to interact with computers. They like having the computer tell them they are right. They are even willing to ask teachers for help so that they can get that positive feedback. They are generally willing to engage in more extensive practice on a computer.
5. The decision to "man" the computer lab with math teachers with computer skills rather than a technology administrator only is an effective model for enhancing instruction. The two teachers can work together in planning and preparing activities to enhance the teaching of mathematics and for the time that students are in the lab the teacher/pupil ratio is doubled thus providing more learning opportunities for

students. This would not be the case if the lab coordinator felt obligated only to assist in keeping the computers operational. It is also important for the classroom teacher to be involved when the class comes to the lab. Teachers who feel comfortable with technology are welcome to direct the activities, in which case the lab coordinator will serve as an assistant. Lab coordinators are willing to give instruction for computer activities if the classroom teacher requests it and then the classroom teacher is expected to participate in the activity, monitoring and instructing as needed. The experience of seeing of adults working together is also of benefit to students.

6. There is always the need for communication between the lab coordinators and the classroom teachers. They need to work together so that students are using the lab for meaningful and useful activities.

What happens now?

I plan to continue “listening” to my co-workers. I will do my best to prepare lab activities that address identified areas of need. I am pleased to see that the current activities have had a positive impact on student learning and am grateful for the work done by my colleagues to measure that impact. The surveys also provided good feedback. I hope that teachers will continue to suggest activities and work with me to integrate them into the curriculum. I believe that a greater use of *Cabri* Geometry using the computer and the calculator will enhance the teaching of Geometry and would provide some appropriate technological activities for that subject.

A final observation

I asked the teachers to include a specific question in their survey. I wanted to know whether students preferred computer or textbooks activities. I wanted to get the answer to this question because of an article I had seen on the internet at the web site: <http://www.edutainment.com.au/val4.html> (an Australian site which provides teachers with software reviews.) At this site there is an article entitled *Five Steps To Getting Value For Money in Educational Software* This site gives advice on a variety of subjects and suggests useful educational software. This is what it says regarding math software. (*You know you are at an Australian site because they refer to math as maths-I guess there are many math skills and maybe it deserves the plural form.*)

MATHS

Maths software concentrates on improving specific skills. For subjects such as maths, practicing specific skills can result in a general benefit. Mental addition and subtraction of numbers to twenty, for example, is fundamental to higher maths. The most appropriate maths programs for Australia are Australian developed although some US programs are good if you are prepared to translate imperial to metric.

Primary school maths covers an immense area, taking seven years to learn. Therefore software with only three levels - easy, medium and hard, is of doubtful value. Look for software with several levels and a variety of activities, often set in an adventure format, to hold interest and increase learning. Generally speaking, avoid maths software in an arcade game format or with time limits that can't be switch off. **There is a shortage of good maths software for secondary school students. Most students find text books more interesting.**

It can be seen from the surveys conducted at FHS that our students have a very different opinion. They overwhelmingly prefer to use software! (146/156 or 94%) I suspect that the opinions reflected in the above internet statement came because students were given slow paced electronic workbooks or multiple choice test question in program form. We are using interactive applications that address actual concepts being taught in the classroom. It is this integration that makes technology meaningful and useful. I hope that our experience can in time be of assistance to other systems.

