



MERIDIAN

A MIDDLE SCHOOL
COMPUTER TECHNOLOGIES JOURNAL

[Home](#) | [Current Issue](#) | [Editorial Board](#) | [Reader Survey](#) | [Submissions](#) | [Archive](#)

Technology: A Tool for Science Learning

[Angelia Reid-Griffin](#)

www.ncsu.edu/meridian/sum2003/technology/

Abstract

The National Science Education Standards describe technology as a tool to help students appreciate the natural world and conduct inquiry projects (National Research Council, 1996).

Related Articles

[Middle School Science and Mathematics Teachers and Their Students: Adapting to Technologies that Work](#)
Winter 2001

[A Critical Look at Technology Use in Middle Grades Earth Science](#)
Summer 2002

[Internet Tools for Facilitating Scientific Inquiry](#)
Winter 2001

However, to develop this learning environment, a broad range of scientific materials, science tools and technological resources must be accessible for all students. Science educators are faced with the task of providing students with experiences and examining the impact of these experiences to fully understand how the presence of technology affects student learning. Studying the students' use of tools in an educational setting might also provide some evidence as to how these tools enhance the cognitive growth of adolescents. The purpose of this study was to observe middle school students' uses of technology as a tool for learning science in a elective course offered to 7th and 8th graders (n=23). Students' use of data collection devices, subsequent interactions and responses to surveys were recorded through audio and video recordings, field notes, interviews, and student artifacts. Embedded with a Vygotskian perspective this research study is based on a social constructivist framework.

Introduction

Technology is a social and technical process, which involves the application of knowledge, tools, and skills to solve practical problems and extend human capabilities (Johnson, 1989). In the past decades, the implementation of technology in America's classrooms has been a major focus of several educational reforms and policies (U.S.

Department of Education, 2000). The launch of Sputnik and the release of Goals 2000, both earmark events in scientific history in which government has taken a firm stance in favor of implementing the use of technology in science classrooms. After the development of the nation's first educational technology plan in 1996, American schools have noticed a significant increase in the use of instructional tools in classrooms (Office of Educational Technology, 1999).

Today, technological tools used in industry and research laboratories have established new homes in many classrooms throughout the world. Therefore, at the height of a technological revolution, educators, parents, and governmental officials are challenged with offering students the technological skills needed to become successful citizens (U.S. Department of Education, 2000). However, having technology in classrooms for the purpose of producing technologically literate citizens should not be the only goal. Rather the challenge is to find ways to use technology as an instructional tool to improve the academic achievement of all students (Bush, 2001). Educators find themselves faced with addressing these issues, as they teach students how to apply technologies to core subjects such as reading, mathematics, and science. Through student investigations, educators can offer students the opportunity to use technology to appreciate the interplay of scientific concepts as well as social and economic issues. Therefore, it is imperative that science educators provide students with a variety of experiences that highlight the advances of these technological tools (Rakow, 1998). This study was designed for students to integrate advanced technology tools through authentic experiences.

The activities in this course were structured using three instructional phases. The purpose of this was to promote understanding of concepts as students gradually learned to use the technology to conduct investigations. In the first phase, students were taught how to use the list and graphing functions of the Casio graphing calculator. Students completed activities requiring them to enter data into a list and generate different types of graphs to familiarize them with the calculators. Students later learned to use the data analysis system embedded in the calculator to measure and interpret data related to temperature, voltage, movement, and light intensity. Once students became competent using the technology, they were asked to use the tools to solve a problem and design their own experiment. One example of the activities assigned during this course was the probability activity called Carnival Games ([Appendix C](#)). This activity along with others assigned in the course taught students the list and graphing functions of Casio graphing calculator as well as how to collect and interpret data.

Middle school students' used Casio's data analysis system ([Appendix D](#)) as a tool to collect various measurements in this study. Due to the limited amount of research on technological tools in context of the middle school science classroom, this study can provide valuable information about how middle school students perceive learning science through the use of this type of technology (Jones et al., 2000; Wetzel, 2000).

Methodology

Qualitative and quantitative methods were used in gathering data. Multiple sources of data were collected adding to the validity of the study's findings. Data consisted of fieldnotes, audio/video transcripts, survey data and student artifacts. The study investigated how the presence of technological tools might affect

students' attitudes toward using advanced technologies to solve problems. To accomplish this task the interactions of the middle school students using technological tools will be described along with some of the students' responses to the surveys.

Background

The nine-week elective class, Exploring Technologies, offered to twenty-three, 7th and 8th grade students, was taught at a gifted and talented magnet middle school. The middle school is located in the southeastern region of the United States. The class was designed so that students would learn to use technologies in the context of learning science and mathematical concepts. Through the efforts of a school-university partnership, monies were allocated for Casio graphing calculators, data analysis systems, probe ware, computers, a printer and a scanner to help teachers integrate technology in their science and mathematics classes. The focus of this study was to use the Casio data analysis system in the class to actively engage students in using technologies and giving them various thought-provoking activities that would increase their knowledge of science, mathematics and technology. (American Association for the Advancement of Science [AAAS], 1989). The real-time data collection system included the EA100 Data Analysis System, FX7400G plus graphing calculator and sensitive probes to measure temperature, light, voltage, and motion (Casio, 2001).

Most of the activities were carried out in small and whole group settings. By integrating student presentations in activities, students shared and defended their ideas with peers. Students were provided the opportunity to build upon each other's suggestions within their small group in an attempt to better understand data collection experiments. The students' use of language and gestures as they utilized the tools in their problem-solving and critical thinking tasks were carefully analyzed and explored. Studying the classroom discourse and interactions of students as they used the tools over the nine-week period enabled the researcher to search for evidence of advances in the students' scientific reasoning ability. Initial and Final Technology Skills Surveys (Appendices A and B respectively) were administered to students during the first and final week of the course to determine any changes in their attitude towards using the technologies. The results were also used to further understand students' feelings towards using technology as a tool. Specifically, the study examined middle school students' ability to analyze and interpret data gathered using the tools. Evidence that the presence of technologies contributed to students' skills in scientific inquiry and added to their understanding and interpretation of graphically presented data using data collection tools was investigated (Newton, 2000).

Exploring Technologies

Twenty-three middle school students participated in a structured set of activities, which resulted in their eventual use of technology as a tool to explore scientific ideas. Cazden's model of scaffolding (1998) was used in structuring the curriculum for changing the students' use of technology as a novelty, to a tool capable of mediating higher learning. The three instructional phases: teacher directed, teacher/student directed, and student directed were effective in providing students with the necessary knowledge and skills to use technologies

as tools. Students were first taught fundamental skills in using the tools in data



collection. Then students were provided with several experiences using technologies to conduct scientific inquiry and engage in scientific discourse. The gradual release of responsibility by the teacher afforded students' the opportunities to take increased responsibility for the use of the technology tools. During the next step of the instructional approach, the instructors presented lessons to help students gradually gain

confidence in using the tools to carry out investigations. The next two activities enabled students to use the technologies to complete problem solving tasks. Students were able to design a carnival game that met the instructors' specific probability criteria and solve a mystery by using specific clues. By completing these activities, students were able to make mistakes, learn to diagnose and correct errors while becoming independent learners. The data collection devices relieved the tedious aspects of data collecting so that students were willing to recollect data when, in the process of their investigation, necessary corrections to their experimental designs were recognized (Brasell, 1997).

Some students were able to construct initial understandings of scientific phenomena as a result of using the technologies to perform scientific experiments. For example, one group of students was able to explain how the presence of humans in the classroom influenced the temperature measurements of the room. Another group explained the importance of insulation in gloves, while another group used the tools to calculate the calories in potato chips. In essence, the learning environment created in the study afforded students' opportunities to process scientific and technological ideas and skills using technology as a tool.

Conversations recorded during student presentations reflect the students' abilities to carry out investigations and engage in the sense making process.

Lana - okay, we tested gloves to see which one was warmer. We put our hands in the gloves for...Amy did it each time. We put the temperature probe in our hand each time and...oh we switched...they were all done in Celsius.

Jane - how long did you do it for, like how long?

Lana -...2 minutes

Joseph - it says 2.1...degrees Celsius...

Lana - Yaw, I think we messed up on this...that's what it said on the thing....

Clair - and how we calculated the calories we took the ending temperature... and we subtracted it from the starting temperature and then we multiplied it by ten cause there are 10 ml of water and um that equals the calories.

Joseph - *you said that... you kept the matches under there but wouldn't that like keep the fire, the water burns more.*

Pierce - *yeah but we used the same amount of matches though.*

Initial & Final Technology Skill Surveys

The initial Technology Skills Survey ([Appendix A](#)) was administered to students during the beginning of the class (n=23). This survey focused on the students' attitudes towards using the tools throughout the nine-week period of the class. The initial and final Technology Skills Survey results are listed in Tables 1 and 2. According to the survey results, 78.2 % of the students responded positively towards enjoying the activities to learn science and mathematics. Less than 5% of the students responded negatively towards enjoying the activities. For question 8, comfort with using tools to determine voltage, over 90% of the students responded positively to the question. The final Technology Skills Survey asked students if they believed the activities using probes and motions detectors motivated their learning: 36.8% strongly agreed while 63% agreed. For question 8 on the survey, comfort using tools to solve problems, over 90% responded positively, while almost 5% of the students answered not sure.

The final Technology Skills Survey ([Appendix B](#)) was given to students' who were present (n=19). The results of the students' perception of technologies did not change from the initial Technology Skills Survey. Overall, students answered the questions on the final survey positively.

There were two short answer questions listed on the initial and final Technology Skills Surveys. The researcher used the students' responses to determine what the students' thought about the activities presented during the nine-week elective course. All of the students were able to describe at least one activity that they enjoyed during the course, such as the ball bouncing activity. During this activity, students were able to calculate the rebound ratio of different balls: basketball, volleyball, and kickball. Another activity commonly selected was the Carnival Game Activity ([Appendix C](#)). This probability activity allowed students to design a game that had an estimated odd of 1:4. The students were responsible for establishing the rules and making sure they kept a tally of the number of wins and losses for their games.



For both the initial and final Technology Skills Surveys, students described activities they learned the most from, while using the technological tools. Many commented that the activities were “fun” and they “learned to use tools.”

Adam: *The carnival game. It made learning very fun. We created our own game, and then found our profit with a spreadsheet.*

Pierce: *Carnival and Mr. Circuit because they were hands-on activities.*

James: *I learned the most during the drawing pictures activity, as I*

had not previously been familiar with a Casio graphing calculator, and it helped me to acquaint with its features.

Lana: The police report project, when I learned how to set up different experiment using EA100, calculators, and probes.

Conclusions

The Exploring Technologies elective class provided evidence that the three-tiered structure of scaffolding could be used in teaching students to use new technologies as well as allow them to construct understandings of scientific ideas. In this research study, a class of 23 middle school students participated in a carefully planned set of activities, which resulted in their eventual use of technology as a tool to explore scientific ideas. The time spent introducing the middle school students to new technologies was well spent based on the students attitudes and conceptual understanding. The construction of understandings the students obtained from this course would not have been possible without these technological tools.

Findings of this study indicate that the middle school students were able to use the technologies provided to improve the quality of their scientific investigations. The technologies enhanced students' learning of science concepts by providing them opportunities to collect high quality data efficiently and easily. As the students themselves pointed out, if they had tried to collect data using a thermometer rather than a temperature probe there would have been a greater likelihood of human error.

The findings may be perceived as evidence that technology can effectively be infused in the context of a middle school science classroom. However, the author acknowledges the limitations of this study and that the findings are based on the context of this study. These findings should be viewed as a basis for seeking additional research on how to implement an instructional approach for teaching students to use technology as a tool for learning science.

If an instructional approach is used in presenting technologies in the context of a general science classroom, perhaps technology as a tool will no longer be considered an end unto itself, rather as a means to improving science teaching and learning (Bush, 2001; Mergendoller, 1996; U.S. Department of Education, 1995). Further research is needed to define the proper role of technology and in determining how this instructional model can affect middle students' use of technology as a tool to process, manipulate, and analyze data.

About the Author:

Angelia Reid-Griffin is a post-doctorate research associate in the Science Education department at NC State University. She has taught various science courses at the high school and middle school level. Her research interests include improving the use of technology as a tool in science classrooms at all educational levels, increasing its influence on the success of minorities, and examining the role of science education in community colleges.

Email: areid18@hotmail.com

Appendix A

Table 1
Initial Technology Skill Survey Results

No.	Question	Criteria*				
		SA	A	NS	D	SD
1.	The graphing calculator activities have increased my enjoyment in learning math and science.	5	13	4	1	0
2.	The graphing calculator activities make science and math more interesting.	15	7	1	0	0
3.	I know how to enter and delete a list using the graphing calculator.	20	2	1	0	0
4.	I know how to use the main menu of the graphing calculator to perform several jobs.	18	2	3	0	0
5.	I can create pictures using the graphing calculator.	16	4	1	2	0
6.	I know how to write my own program using the graphing calculator.	4	4	8	2	5
7.	I can transfer programs from one graphing calculator to another.	10	5	5	0	3
8.	I know how to use the graphing calculator and data analyzer to determine the voltage of some foods.	14	7	2	0	0

Note. Criteria: SA=Strongly Agree; A=Agree; NS=Not Sure; D=Disagree; SD=Strongly Disagree. Total number of students surveyed = 23.

Appendix B

Table 2
Final Technology Skill Survey Results

No.	Question	Criteria*				
		SA	A	NS	D	SD
1.	The data collection activities using the probes and motion detectors increased	7	12	0	0	0

	my enjoyment in learning math and science.					
2.	The data collection activities make science and math more interesting.	9	9	1	0	0
3.	By using the data analyzer, probes (voltage & temp.) and motion detector, I can easily collect and analyze data.	12	7	0	0	0
4.	I know how to use the graphing calculator to show data collected using the data analyzer, probes, and motion detector.	16	2	1	0	0
5.	I can create graphs using the data collected on the graphing calculator.	18	1	0	0	0
6.	I know how to use the motion detector to determine bounce of a ball.	12	7	0	0	0
7.	I can determine changes in temperature and using temperature probes.	14	4	1	0	0
8.	I am able to solve problems using the graphing calculator, data analyzer, probes (voltage & temp.) and motion detector.	10	8	1	0	0

Note. Criteria: SA=Strongly Agree; A=Agree; NS=Not Sure; D=Disagree; SD=Strongly Disagree. Total number of students surveyed = 19.

Appendix C

Carnival Game Activity

Goal: To understand the notion of fair versus unfair games and probability.

We are hosting our first class carnival. You have just been hired to develop a game for the carnival. As operators of the games you will determine the design of your game and the general rules. You should design a fair game so that your classmates will have an opportunity to win. The estimated odds of winning for your games should be 1:4 (1 out of 4 tries a person should be able to win at your game.)

Instructions

- You will work in cooperative groups of three or four to create a game for the carnival. You are responsible for developing the game rules and making sure that the game is fair. You should design your game so that the

- players have a 1 out of 4 chance of player winning.
- You will be assigned roles during the carnival to make sure that each of you has the opportunity to play the games.
 - Game operator: person operating the game
 - Record keeper: person records the number of the players that win and lose on tally sheet

Carnival Tally Sheet

Player Name	Wins	Losses	Frequency of Wins	Frequency of Losses

Total number of Players	Total number of tickets

Answer the following questions:

1. Using the information above determine the total frequency of winners and the total frequency of losers for your game. (Place data in List 1) Using a pie chart determine the percentage of winners and losers for your game.
2. Using the information in List 1 create a bar chart.
3. Describe in your own words, which graph, pie chart or bar chart, (or you may suggest another graph that you can create on the graphing calculator using the data from the tally sheet), will allow you to determine the fairness of your game?

Appendix D

Data Analysis System

Data Analysis System is a data collection tool developed by Casio. This system was created to compete with the Texas Instruments CBL and CBL2 (2001) data gathering devices. This real-time data collection tool is composed of the EA100 data analyzer, Casio graphing calculator (FX7400G plus) and sensor probes to measure temperature, light, voltage, and motion (Casio, 2001). The three components of the Data Analysis System have specific functions in collecting and graphing real-time data. Similar to the CBLs, the Data Analysis System is capable of transforming a graphing calculator into a mini-science laboratory (Wetzel, 2000). Figure 1 displays the features of the Data Analysis System (Casio, 2001).

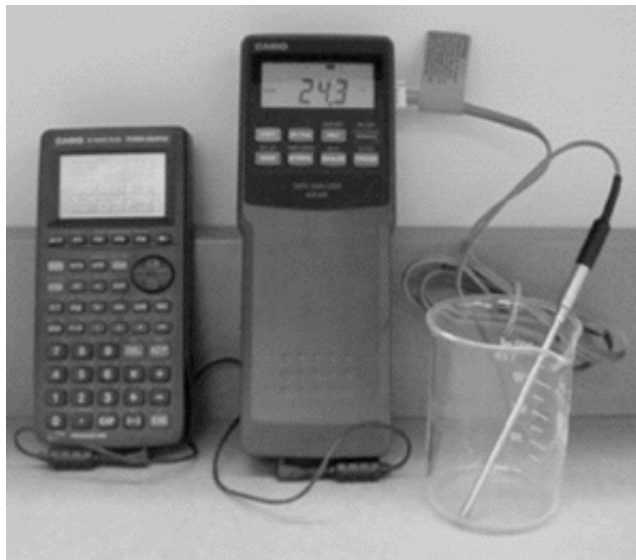


Figure 1. Photograph of the Casio Data Analysis System. In the photograph depicted, a temperature probe linked to the EA100 data analyzer, which is also connected to the graphing calculator collects temperature readings of a substance in the beaker.

References

- American Association for the Advancement of Science [AAAS]. (1989). *Science for all Americans: A project 2061 report on literacy goals in science, mathematics, and technology*. Washington, D.C.
- Brasell, H. (1987). The effect of real-time laboratory graphing on learning graphic representations of distance and velocity. *Journal of Research in Science Teaching*, 24(4), 385-395.
- Bush, G.W. (2001, January). Enhancing education through technology—No child left behind [On-line]. Retrieved May 16, 2001, from <http://www.ed.gov/offices/OESE/esea/nclb/partx.html>
- Casio. (2001, July). Casio accessories and products [On-line]. Casio. Retrieved July 8, 2001, from <http://www.casio.com/accessories/>
- Cazden, C.B. (1998). *Classroom discourse: The language of teaching and learning*. Portsmouth: Heinemann Educational Books, Inc.
- Johnson, J.R. (1989). *Technology (report)*. Washington, DC: American Association for the Advancement of Science.
- Jones, M.G., Brader-Araje, L., Carboni, L.W., Carter, G., Rua, M.J., Banilower, E., & Hatch, H. (2000). Tool time: Gender and students' use of tools, control, and authority. *Journal of Research in Science Teaching*, 37(8), 760-783.
- Mergendoller, J.R. (1996). Moving from technological possibility to richer student learning: Revitalized infrastructure and reconstructed pedagogy. *Educational Researcher*, 25(8), 43-46.

National Research Council [NRC]. (1996). National science education standards. Washington, DC: National Academy Press.

Newton, L.R. (2000). Data-logging in practical science: Research and reality. *International Journal of Science Education*, 22(12), 1247-1259.

Office of Educational Technology. (1999, January 25). e-Learning putting a world-class education at the fingertips of all children: The national education technology plan [On-line]. U.S. Department of Education. Retrieved May 11, 2001, from <http://www.ed.gov/Technology/elearning/index.html>

Rakow, S.J. (Ed.). (1998). NSTA pathways to the science standards middle school edition (Middle School ed.). Arlington.

Texas Instrument. (2001). Features of the CBL2 [On-line]. Texas Instrument. Retrieved July 21, 2001, from <http://education.ti.com/us/product/tech/datacollection/features/cbl2.html>

U.S. Department of Education. (1995, January). An invitation to your community-use of technology [On-line]. U.S. Department of Technology. Retrieved May 11, 2001, from <http://www.ed.gov/pubs/CommInvite/technlgy.html>

U.S. Department of Education. (2000). Teachers' tools for the 21st century: A report on teachers' use of technology (Statistical Analysis Report NCES 2000-102). Washington, D.C.: National Center for Education Statistics, Office of Educational Research and Improvement.

Wetzel, D.R. (2000). Calculator-based laboratory probeware implementation and integration by middle school science teachers (Doctoral dissertation, George Mason University, 2000). *Dissertation Abstracts International*, 61(02), AAI9962680.

[Current Issue](#) | [Editorial Board](#) | [Reader Survey](#) | [Special Honors](#)
[Submissions](#) | [Resources](#) | [Archive](#) | [Text Version](#) | [Email](#)
[NC State Homepage](#)

Meridian: A Middle School Computer Technologies Journal
a service of NC State University, Raleigh, NC
Volume 6, Issue 2, Summer 2003
ISSN 1097 9778
URL: <http://www.ncsu.edu/meridian/>
[Contact Meridian](#)
All rights reserved by the authors.



Meridian is a member of the GEM Consortium