

A Cultural Study of a Science Classroom and Graphing Calculator-based Technology

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## Abstract

Social, political, and technological events of the past two decades have had considerable bearing on science education. While sociological studies of scientists at work have seriously questioned traditional histories of science, national and state educational systemic reform initiatives have been enacted, stressing standards and accountability. Recently, powerful instructional technologies have become part of the landscape of the classroom. One example, graphing calculator-based technology, has found its way from commercial and domestic applications into the pedagogy of science and math education.

The purpose of this study was to investigate the culture of an "alternative" science classroom and how it functions with graphing calculator-based technology. Using ethnographic methods, a case study of one secondary, team-taught, Environmental/Physical Science (EPS) classroom was conducted. Nearly half of the 23 students were identified as students with special education needs. Over a four-month period, field data was gathered from written observations, videotaped interactions, audio taped interviews, and document analyses to determine how technology was used and what meaning it had for the participants.

Analysis indicated that the technology helped to keep students from getting frustrated with handling data and graphs. In a relatively short period of time, students were able to gather data, produce graphs, and to use inscriptions in meaningful classroom discussions. In addition, teachers used the technology as a means to involve and motivate students to want to learn science. By employing pedagogical skills and by utilizing a technology that might not otherwise be readily available to these students, an environment of appreciation, trust, and respect was fostered. Further, the use of technology by these teachers served to expand students' social capital--the benefits that come from an individual's social contacts, social skills, and social resources.

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## Overview of Study

This study interprets what goes on in a science classroom while students and teachers use graphing calculator-based technology. This technology was introduced statewide as a means to support the recently adopted Virginia Standards of Learning for Math, Science, and Technology. This study illuminates that for those that use this technology, it advances various pedagogical functions--both educational and social.

Graphing calculators are a portable, economic alternative to classroom computers and make possible many learning experiences not otherwise possible. A graphing calculator appears somewhat similar to, and has many of the same functions as, a scientific calculator but has a larger viewing window where graphical images can be displayed. In addition, graphing calculators can hold several, relatively simple, programs for performing a set of basic mathematical algorithms. However, perhaps the most powerful use of the technology, particularly for science education, is when a calculator is connected to an interfacing device. An accompanying electronic probe is then introduced which can sense ambient environmental conditions (such as temperature, pressure, and pH level) and send that information back to the calculator to be collected and displayed in table or graph form. This study looks at the use of an instructional technology for science education, but also considers broader social and cultural implications that came to the surface during the study.

Chapter I presents an argument for considering technology from a broader social perspective than is typically offered. The subsequent discussion presents recent perspectives by historians of technology debunking the notion of technology as being asocial and value-free. The selected works demonstrate that technology can be explored within philosophical, cultural, and political contexts.

The successive discussion presents a brief chronological compilation of calculating devices used for enumeration. In this way, counting is weighed as a characteristically human activity, performed by utilizing contemporary resources and technologies within social and temporal context.

Subsequently, calculators are considered in the context of recent educational reform initiatives pertaining to standards, mathematics, and politics. Reflecting national and state political, economic, and social conditions, the language of standards referring to technology

varies greatly. Further, questions are posed regarding the political tenor of Virginia's Standards of Learning regarding the technological support of one academic area over others. Policy decisions and those who stand to be impacted are considered throughout the document and recommendations are made in Chapter IV.

The last section connects recent studies involving graphing calculators, computers, and probeware to learning theory. Studies involving probeware when used with computers or graphing calculators are considered. Several studies discuss the use of graphical inscriptions produced using probeware. Inscriptions can help learners explore ideas, construct and defend viable explanations, and serve as a tool for teachers to assess concept understanding. The results of these studies contributed to the construction of the study questions that are discussed in the Chapter II.

The second chapter discusses the ethnographic nature of the researcher's study, followed by a brief discussion of personal experiences that led to the development of a rationale, and ends with a description of the research design. As the researcher explains, this study differs from prior studies in the way that it considers technology. Prior technological studies, the researcher contends, have focused too narrowly on the use of technology, often to the exclusion of larger educational and social issues. Further, technology is considered not only as an instructional technology for learning but also as an cultural artifact imbued with social significance.

The researcher defines the theoretical framework for this study as social constructivist in nature and explains that this perspective affords a detailed rendering of classroom happenings and social interactions. This frame concurs with recent qualitative social studies that question traditional views of the nature and history of science and technology.

Before detailing the study method, the researcher explains what the assumptions were prior to the study. While the researcher believes graphing calculator-based technology can be an effective instructional technology, much depends on the teacher's ability to use the technology and to manage the classroom.

The researcher's study questions were aimed at interpreting the culture of a science classroom--how the participants talk about science, how technology is used, what inscriptions are produced, how those inscriptions are used, and what technology means for the participants.

Chapter III begins with a description of the study site and a brief history of Environmental/Physical Science. The teacher and student participants are described followed by

three ethnographic vignettes. Figures are used, illustrating the experimental setup, a classroom floor map, and sample inscriptions produced by students and teachers. The vignettes detail classroom activities and interactions that occurred during this time. Following each vignette, discussion sections illuminate evidence as pertaining to the research questions. The chapter ends with teachers' reflections and perspectives. This section discusses the social nature of technology in this classroom.

The final chapter begins by revisiting the research questions in regard to the literature and emergent theory. Topics include technology as a social artifact, graphing calculator-based technology, inscriptions as social practice, special education, classroom discipline, personal experience, cooperative learning, and social capital. The chapter ends with a discussion of educational implications and recommendations. Recommendations are made regarding cooperative learning, technical considerations, and school division policy.