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The Effect of Technology on Student Science Achievement

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ABSTRACT

Empirical data from the 2000 National Assessment of Education Progress (NAEP) in Science will be analyzed to determine the effects of technology on student science achievement.

Research has shown that technology has had little effect on raising student achievement. Little empirical evidence exists however, that examines the effects of technology as a tool to improve student achievement by developing higher order thinking skills. Prior studies have also not focused on the manner in which the technology is being used in the classroom to enhance teaching and learning.

The method of analysis for this study is a path analysis using the student's scaled score of twelfth grade students on the 2000 NAEP Science Assessment as the ultimate exogenous variable. Preliminary results indicate that the way in which technology is used in the classroom has significant direct and indirect effects on student achievement.

INTRODUCTION

The issue of technology implementation and its effect on student achievement has received much publicity. As schools are being held more accountable for meeting state and national standards through their performance on standardized tests, the focus on improving student achievement through technology becomes an even greater issue. The question arises, "What factors impact the effectiveness of technology as a tool to raise student achievement "? Archer (1998) believes, "Computers can raise student achievement and even improve a school's climate". Levinson (2000) agrees adding, "Many factors, such as staff development, infrastructure, and effective instructional materials, influence the effectiveness of technology". Simply put, if schools are to realize benefits from education technology, teachers and students must have adequate and equitable access to hardware and network connections; states and districts must give schools the capacity to use technology well by devising a thoughtful technology plan and offering adequate teacher training and technical support; and teachers and students must use technology in effective ways (Jerald 1998). The following paragraphs will address each factor with emphasis on effective use.

Accessibility to technology must be addressed when measuring technology's effect on student achievement. According to Skinner (2002), "Nationally, in 2001, there were just over four students to every instructional school computer, and the number of students per Internet-connected computer in schools dropped from 7.9 in 2000 to 6.8 in 2001". While these numbers are not uniform between students in high-poverty and low-poverty schools, the gap between the two is narrowing. Approximately 94 percent of the high poverty schools were wired compared to 98 percent of all public schools (Skinner, 2002). Besides accessibility and connectivity at school, students' accessibility to technology at home is noteworthy. According to Skinner (2002), "School is filling a void for kids whose families can't afford, or for other reasons don't have, the Internet at home".

A second important factor in evaluating the effectiveness of technology is both the availability and type of staff development. Trotter (1999) reports that nearly four out of every ten teachers who do not use software for instruction say they do not have enough time to try out software and do not have enough training on instructional software. K-12 experts agree that the biggest impediment to teachers' ability to learn and use technology integration strategies is time – often there are simply not enough hours in the day or days in the year for teachers to become techno-wizards (Sandham 2001). Skinner (2002) found that staff development is not as high a funding priority as hardware – accounting for only 14 percent of school technology spending in 2001 while hardware accounted for two-thirds of spending and software spending remained at 20 percent. Fatemi (1999) found that training on "integrating technology into the curriculum" was more helpful to teachers than training in "basic technology skills".

The third and most important factor to consider in studying the effects of technology on achievement is effective use. Disparities about how the computer is used for instruction are again lining up along ethnic, achievement, and language lines. The percentage of schools where a majority of teachers use computers daily for planning or teaching rose slightly across schools overall, but remained flat in schools where more than half the students are members of racial or ethnic minorities (Skinner 2002). "A NCES study last year found that 45 percent of teachers in schools that served predominantly minority students used computers or the Internet for instruction during class as compared with 56 percent of their colleagues in schools with few minority students. Schools targeted for poor performance are dealing with other issues. Technology is last on the totem pole" (Reid 2001). Smerdon, et al, (2000) concur with the following findings:

1. "Teachers in lower minority enrollment schools were generally more likely than teachers in the highest minority enrollment schools to assign students to use technologies for multi-media presentations and CD-ROM research.
2. Teachers in schools with smaller proportions of minority enrollments were more likely to use computers or the Internet for Internet research than those in schools with higher proportions of minority enrollments".

Equally disturbing is the evidence that teachers of students with different ability levels are also using the computer differently. Manzo (2001) reports that in most places the general application of technology with low-achieving students is for "drill and practice" in academic skills. Becker (2000) also states, "Teachers of low-achieving classes use substantially more skills-based software, while teachers of advanced students use a mix of more sophisticated programs". What effect this use or misuse of computers has on student achievement concerns educators. Wenglinsky (1998) found that for all the investment in educational technology, there is a surprising lack of hard data on its effects

The indirect effects of technology use – computer use at home, student access and use of paper research material, and teacher preparation and experience– may provide more interesting results than the direct effects (number of computers, socioeconomic factors, etc.) on increasing student science achievement. Clearly, "purchasing computers and improving Internet connections are just part of what it takes to make technology an integral part of teaching and learning. Preparing teachers to use and integrate technology into their work in meaningful ways remains a challenge" (Skinner, 2002).

METHODOLOGY

Analysis Methods

This study will use path analysis to investigate the direct and indirect effects of technology as it relates to a twelfth grade student's scaled score on the 2000 NAEP in Science. The specific variables to be studied can be categorized as major reporting groups, student factors, factors beyond school, instructional content and practice, teacher factors, and community factors. The ultimate endogenous variable will be the student's scaled score on the 2000 NAEP in Science. Descriptive statistics for key variables, results from the multiple regressions, calculations involving error vectors, and decomposition tables for bivariate covariation will be presented. The proposed path model is shown in Figure 1.

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Research Questions

The issues about the relationships of these factors can be expressed in empirically testable terms through the following questions:

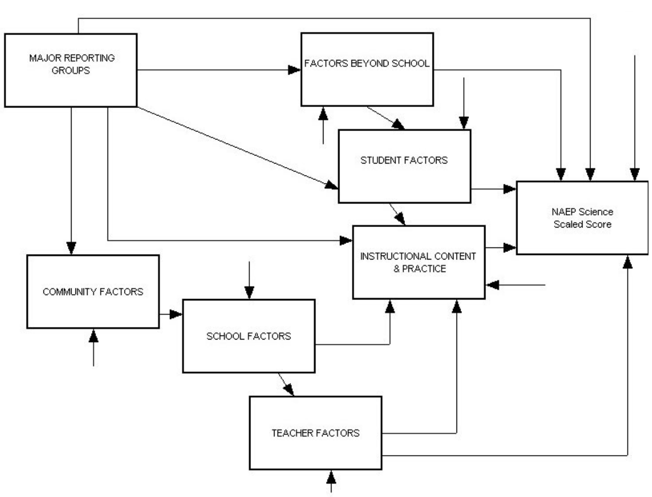
1. Does technology significantly affect a twelfth-grade student's NAEP scaled score in Science?
2. Are the indirect effects of technology significant predictors of a twelfth-grade student's NAEP scaled score in Science?

RESULTS

Descriptive Statistics

The average twelfth grade student's scaled score on the 2000 Science NAEP at each level of proficiency (Basic, Proficient, and Advanced) declined from the1996 Assessment. This decrease was most significant at the Basic Level (148, down from 152). Four ethnic groups (White, American Indian, Hispanic, African American) declined. Asian/ Pacific Islander rose (154 up from 149). The most significant decrease occurred among White students (153 down from 159). White students

Figure 1: Proposed path model of student science achievement predictors



scored higher (153) than African American (123), Hispanic (128), or American Indian (139) students. Along gender lines, males scored higher (148) than females (145). Males had a larger percentage at or above both Basic (51) and Proficient (17) than females (51 and 16 respectively).

Twelfth-grade students who used computers to collect, download, or analyze data scored higher (151) than those who did not (146). Students using the Internet at home had higher average scores (153) than those who did not (136).

Multiple Regression Statistics

It is expected that the final analysis of path coefficients, sig t's, and bivariate decomposition tables will augment the above findings. It is also expected that Instructional Content and Practice, Factors Beyond School, and Teacher Factors will have significant direct effects. Significant indirect effects are anticipated among School Factors, Community Factors, and Major Reporting Groups.

CONCLUSION

Interpretation

The decline in the average scaled score in the 2000 NAEP data from the 1996 assessment supports the skeptic's argument that technology is not helping to improve achievement. Results show that the focus of research should be on how computers are used in the classroom, not simply how many are in the classroom or school. Wenglinsky's analysis of the 1996 NAEP Mathematics Assessment found that at all grade levels studies (Grades 4, 8, and 12) teachers who are knowledgeable in the use of computers are more likely to use them for higher-order purposes. When computers are used to perform certain tasks, namely applying higher order concepts, and when teachers are proficient enough in computer use to direct students toward productive uses more generally, computers do seem to be associated with significant gains in mathematics data (Wenglinsky, 1998). Scores by demographics and access to technology at home also align with prior research. Skinner (2002) states, "While disparities in access to technology based on poverty and minority enrollment diminished in schools in 2001, several indicators suggest a wider digital divide at home".

Implications

The study provides a piece (effective technology use) to a much larger puzzle (increasing student achievement in science). It indicates that how technology is used in the classroom is more interesting and important than how much technology is in the classroom. It provides business and educational personnel with information on how and where monies should be allocated in local, state, and federal budgets. Teacher training on effective use of technology must become a priority if this puzzle piece is to have a significant effect on student achievement.

This study offers analysis of the nation's children at the start of the 21st century. Further research is needed in the form of a longitudinal study using the same analysis model. It offers one possible solution for improving the teaching and learning process.

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