Literature Review:

Technology Use and Its Relevance to Academic Achievement

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Does the use of technology positively relate to academic achievement?

A review of the literature identified 66 articles on this topic. Twenty-three articles were studied for this report. Depending upon the focus of the article, a positive relationship was found in most cases while no relationship was found in a small number of cases reviewed. In reviewing all papers, articles, and studies, a number of other factors were identified as important considerations.

Positive Relationships Found

There are numerous studies that have been conducted that show a positive relationship between the use of technology and academic achievement. For example, in an Illinois blue collar rural community, math achievement levels improved (computation and problem solving skills) as well as student interest among elementary and secondary students (Blume, 2001). Using a computer assisted instruction (CAI) program called FUNdamentally MATH led to higher math achievement for students in two elementary and one middle school in a large urban North Carolina school district (Brown, 2000). In another study (Judson & Sawada, 2000) involving eighth grade students, math achievement increased through the integration of math and science using inquiry-based data-generation technology (graphing calculators and probes).

Reading achievement levels increased for struggling sixth and ninth grade students as a result of the Orange County Literacy Project in Orange County, Florida which utilized the Peabody Learning Lab and Scholastic, Inc.'s "Read 180" (Daley, 1999). Reading fluency and comprehension skills were addressed and as much as two grade levels each year were gained by the students. In another study by Idding, Ortmann, Pride, & Pride (1999), reading comprehension and vocabulary development achievement levels showed improvement through coupling technology with multiple instructional strategies. In Texas, higher classroom technology integration was found to positively associate with Iowa Test of Basic Skills scores in vocabulary, reading and writing for elementary students (Christensen, Griffin, & Knezek, 2001).

For kindergarten children, daily structured computer activities made a difference on the concept age for children in one classroom compared to free exploration and play activities on the computer in a traditional classroom (Grubb, 2000).

Studies and other reports exist that show a positive relationship between academic achievement in multiple content areas when technology has been incorporated into the curriculum. For example, Conyers, Kappel, and Rooney (1999) found that reading and writing achievement showed a consistent upturn by using technology strategies. Writing scores increased due to keyboard composition activities and the spellchecking, cutting, and pasting tools that are a part of the software. Reading test scores improved due to technology-assisted diagnosis and instruction provided to students. Science and math levels improved with the use of a video-disc curriculum ("Windows on Science and Math").

Kosakowski (1998) cites several studies where benefits of academic achievement were related to technology implementation. For example, in a 1994 meta analysis, Kulik (as cited in Kosakowski, 1998, p. 6) found the use of technology in the drill and practice of basic skills to be highly effective, and the ten-year project of Apple Classrooms of Tomorrow, reported by Dwyer (as cited in Kosakowski, 1998, p. 6), where gains were made in advanced skills of students.

A study by Paul, VanderZee, Rue & Swanson (1996) investigated the effects of the Accelerated Reader (AR) technology-based literacy program on attendance and standardized test scores at elementary, middle, and high schools. A comparative analysis of data revealed statistically significant evidence that, on virtually every subject test (including reading, writing, math, science, and social studies), the majority of schools that owned AR performed better than socio-economically comparable non-AR schools. Gains in academic performance increased with the length of time schools owned AR. Findings suggested that AR has a positive effect on student academic performance, especially for socio-economically disadvantaged children in urban areas.

The Illinois State Board of Education partnered with two outside groups, the National Computational Science Alliance (NCSA) and the North Central Regional Technology in Education Center (NCRTEC), to provide staff development, along with technological software, hardware, and support, to improve sixth grade student performance in the areas of mathematics, science, and reading (Rudy, 1999). The study involved schools with students of low socioeconomic status, high transfer rates, and large percentages special education. An evaluation of the project found confirming evidence that showed students achieved high academic standards.

A school district in Texas has nearly eliminated its achievement gap between advantaged and disadvantaged students (Duttweiler & Madden, 2001) attributable partly to its integration of technology into the schools.

A paper presented by Tuckman (2001) discussed how a technology-based course on study skills yielded significant differences in student grade point averages (GPA) for those taking the course compared to students not taking the course, especially among African Americans.

Fouts (2000) found in a review of several studies that achievement increased when computer use was combined with traditional instruction.

In the Technology and Education Standards Issue Brief (1996), studies on the use of technology for classroom instruction point to a range of benefits, including increases in student achievement levels.

Wenglinsky (1998) conducted a national study suggested by Education Week and inspired by concerns of Technology Counts regarding the relationship between academic achievement and the use of educational technology. Data were drawn from the 1996 National Assessment of Educational Progress (NAEP) in mathematics, consisting of national samples of 6,227 fourth graders and 7,146 eighth graders. The size of the relationship between the various positive uses of technology and academic achievement was substantial for eighth graders.

In 1998, Software Publishers Association (1998) reported on 219 research reviews and reports on original research projects. The report concluded that a measurable gain in student achievement could be achieved when technology is used as a learning tool.

In a meta analysis of over 700 empirical research studies, Schacter (1999) reported positive gains were observed in academic achievement with students who had access to:

" (a) computer assisted instruction, or
(b) integrated learning systems technology, or
(c) simulations and software that teaches higher order thinking, or
(d) collaborative networked technologies, or
(e) design and programming technologies,…" (Schacter, p. 9)

No Relationship Found

No relationship between technology use and academic achievement was found in a small number of studies. The Wenglinsky (1998) findings were negligible for fourth graders. In a study by Kozlowski (2000), an Illinois district found that there was no guarantee that student achievement would improve based on the use of educational technology. Other factors were also relevant, such as changing the classroom/school ambience, working within an environment that was high-tech, and effective use of technology through applying appropriate tools.

In almost all reports, no decrease in academic achievement occurred due to technology use. However, in one scenario, written tests administered on paper yielded lower scores for students accustomed to working with computers (Russell & Haney, 2000). However, writing achievement showed a positive relationship to high classroom use of computers if writing was also tested using computers.

Important Factors to Consider

Educational technology's impact on academic achievement should not be measured alone, but with a group of other important factors. Its impact is influenced by software design, the subject area, the specific student population, how the students are grouped, the educator's role and professional training, and the level of student access to the technology (Software Publishers Association, 1998). Dede (1998) states that new pedagogical models need to be mastered before improvements in student outcomes can be observed that are directly related to specific technology implementations. It must also be noted that knowledge and skills achieved through technology are more sophisticated and complex than multiple choice items on current standardized tests (pp. 210-211). Manzo (2001) presents the caveat that technology use can increase the achievement gap if care is not taken to include other factors that can influence the achievement of struggling students. Curriculum alignment, well-designed software, and innovative instruction are imperative, she asserts. In reviewing several studies, Fouts (2000) found that achievement increased not only by incorporating technology, but by also addressing instructional design, software design, and technology capabilities. The Wenglinsky (1998) study finds that the greatest inequities in computer use are not in how often they are used, but in the ways in which they are used. In essence, the study concluded that technology could matter, but that this depended on how it was used. Taken together, findings indicate that computers are neither a cure-all for problems facing the schools nor mere fads without impact on student learning. When used properly, computers may serve as important tools for improving student proficiency and the overall learning environment of the school.

The Technology and Education Standards Issue Brief (1996), proclaims that technology enables teachers to enrich student learning experiences by bringing the outside world into their classrooms and obtaining instructional resources that go beyond what a single school or district can provide. Also, parent involvement in their children's education can increase through using voice mail, electronic mail, and video. Additionally, technology can provide educational equity by providing access for all schools to information and high-quality learning experiences. By facilitating communication, providing greater access to information, and saving time, administrative uses of technology can support school improvement and in some cases cut costs. Using technology wisely can increase student metacognitive skills, the application of skills, and inquiry learning (Sherry, Billig, Jesse, & Watson-Acosta, 2001). Terrell & Rendulic (1996) point to increased student motivation through technology implementation in the classroom.

Conyers, et al, (1999) has noted how student use of technology can improve student attitudes and attendance.

To be effective, Kosakowski (1998) claims, technology cannot exist in a vacuum, but must become part of the whole educational environment and instructional process. Schacter (1999) stresses the importance of clear learning objectives and concentration of technology focus. To provide software developers and publishers with research based information to assist in educational software improvements, Software Publishers Association (1998) findings pointed to the importance of incorporating research-based instructional design into software. Certain design elements were observed to be crucial regarding the impact on achievement, self-concept and attitudes, and learning environment interactions for all students. These design elements include (1) offering students some control, (2) programs with feedback, (3) embedded cognitive strategies (e.g. paraphrasing, repetition of content, cognitive mapping), (4) embedded conceptual change strategies (e.g. sequences of instruction for increased understanding and knowledge), (5) animation and video, (6) content-related graphics, and others. Educational technology has positive effects on student achievement, attitudes and motivation toward learning, and self-concept. Introducing technology wisely into the learning environment makes learning more student-centered, encourages cooperative learning, and stimulates increased teacher/student interaction as academic achievement is addressed and impacted.

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