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HISTORICAL AND CURRENT RESEARCH ON EDUCATIONAL TECHNOLOGY:

Juggling Strictness and Significance to Influence Academic Achievement

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ABSTRACT

The focus and significance of educational technology research have increased significantly in the modern era due to the exponential growth of technology utilization in education through applications like Internet access, simulations, educational games, and distant learning. In order to promote learning in schools, we look at both historical and contemporary research trends in this study, focusing on the function and value of research findings in guiding instructional methods and policy. The following specific subjects are covered in detail: (a) differing perspectives on what constitutes "effective" technology use in the classroom as research topics; (b) historical trends in research approaches and inquiry topics; (c) alternative research designs that strike a balance between internal (rigor) and external (relevance) validity; and (d) recommendations for future research directions. In addition to employing mixed-methods research to examine and comprehend technology applications in challenging real-life contexts, attention is paid to outlining several experimental designs as alternatives for attaining the proper rigor and relevance of study data.

KEYWORDS: ***Educational Technology, Learning, Research, Research Designs and Trends, Effect of Technology on Education***

1. INTRODUCTION

Researchers have been interested in comparing the effects of technology vs traditional forms of training since the debut of 16mm film in the 1950s and the first drill-and-practice computer programs in the 1970s and 1980s (Morrison, Ross, Kemp, & Kalman, 2010). This focus has been greatly increased by the exponential expansion in the use of technology in education today, including distance learning, Internet access, instructional games, and simulations. For instance, the number of yearly paper submissions to Educational Technology Research and Development (ETR&D), a highly regarded worldwide magazine, increased by 72% from 2004 to 2009 to 129 in the Research section. Robert Calfee (2006), recently quoted by Nolen (2009, p. 286), described educational technology as one of the "Really Important Problems (RIP)" that future scholars in educational psychology should look at.

However, questions have been expressed concerning the caliber and significance of research on educational technology. Regarding impact, Nolen (2009) recently came to the conclusion that, as a focus of research in the larger field of educational psychology, technology noticeably lagged behind other topics like classroom achievement, learning and memory, motivation, and cognition. This conclusion was drawn from an analysis of the content of 758 educational psychology studies published in prestigious journals. The number of experimental studies on educational interventions, particularly those utilizing technology, has been declining over the past 20 years, which is a cause for concern (Hsieh et al., 2005; Levin, 2004; Ross & Morrison, 2008). This change directly contradicts the current focus on more rigorous research in education to encourage the application of evidence-based approaches (e.g., Eisenhart & Towne, 2003; Slavin, 2008).

There are too many different ways to look into technology applications in education, making it impossible to evaluate or even characterize the study topic as it stands today. One might argue that there are equally compelling justifications for the significance of research methodologies ranging from: (a) Extensive, controlled basic research studies of cognitive processes resulting from computer interactions (Kaufman, 2004; Lee, Lim, & Grabowski, 2008), to (b) descriptive and exploratory studies of how students use ICTs as teaching tools (Greenhow, Robelia, & Hughes, 2009); to (c) contextually-specific "design-based research" studies of how specific technology products work in particular environments (Richey & Klein, 2008; van den Akker & Kuiper, 2008); to (d) applied research focused on finding solutions to particular issues confronting large education providers in our society, such as schools and training centers (see, e.g., Karr, Weck, Sunal, & Cook, 2003; Ringstaff & Kelly, 2002; Ross, Lowther, Wang, Strahl, & McDonald, 2004).

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Therefore, a more focused approach than the "entire domain" of applications is needed to attempt to meet the aims we have set for this work, which include "evaluating" the past contributions of educational technology research and proposing future prospects for it. Considering our backgrounds as K–12 education academics, we have chosen to focus on using technology to improve teaching and learning in classrooms. The following sections cover specific topics related to educational technology research: (a) different perspectives on what constitutes "effective" uses of technology in schools; (b) historical trends in educational technology research; (c) alternative research designs for striking a balance between internal (rigor) and external (relevance) validity; and (d) recommendations for future directions for areas of inquiry and research methodologies.

1.1. Is Technology Useful in Education? Research Domains with Significance

Does technology work well? Researchers, practitioners, and policy makers who concentrate on applications in schools often ask that question. The majority of the time, "effect sizes"—which show accomplishment improvements for the treatment (technology-supported) condition over the control condition—are used to determine efficacy exclusively or mostly (e.g., Bernard et al., 2004; 2009; Dynarski et al., 2007; Russell, 1999). Perhaps the most forcefully expressed objections to this strategy were made in the seminal paper by Richard Clark (1983) that discouraged "media comparison" studies.

Clark contended that comparing various media-based instruction modalities (such as lecture versus computer-based instruction) in order to determine which was “best” was illogical. Depending on the caliber of the instructional tactics used, any kind could either be beneficial or useless. According to him, the media is like grocery trucks—they provide food, but they don't actually feed you. (i.e., instruction). There are opposing viewpoints that contend that special "affordances" offered by educational technology cause instructional activities to differ from those conducted using traditional methods (such as "teacher-led") (Kozma, 1994). Morrison et al. (2010) state that these affordances also include increasing student accessibility to instruction and simplifying instructor management:

> “For instance: By offering the training in several places rather than in one central location, we can save time and money and reach more people of our target audience through the use of a distance education delivery method. Similar to this, we might use a drill-and-practice application that can control the content and sequence of the material and give instant feedback to teach foreign vocabulary words to a learner. In contrast to an instructor, the program is able to carry out these duties indefinitely without growing weary of them or losing interest in them (Chapter 10, p. X).”

The study topics that are explored and the methodology (e.g., qualitative vs. quantitative vs. mixed design) used to answer them are influenced by the researchers' perspective on the role of technology in classroom learning. We concur with Clark and have argued for several decades that using media comparison studies to "prove" the efficacy of technology seems rather narrow and is likely to under represent potentially significant contributions to enhancing education (Morrison, 2001; Ross & Morrison, 1989; Ross, Morrison & Lowther, 2005). Educational technology encompasses a wide range of learning modes, tools, and tactics rather than being a single, uniform "intervention." Therefore, the degree to which it assists educators and learners in achieving the intended learning objectives determines its efficacy. Based on a recent work (Ross & Lowther, 2009), the author outlines three broad areas that should be the main focus of future research.

1.1.1. Using Technology to Teach

The use of computers to aid with instruction is the most established and studied use of educational technology. Drill-and-practice exercises and tutorial lectures tailored to the needs of pupils are offered by modern CAI programs. The products are more intriguing and engaging than workbooks and textbooks because of the graphics and animation. Is CAI, however, likely to result in more effective learning than traditional, teacher-led instruction? Numerous studies over the years indicate that both strategies typically yield comparable outcomes (Dynarski et al., 2007; Kulik, 2003; Slavin et al., in press). Effective teachers also employ a number of evidence-based tactics, such as adaptable content, regular testing, instant feedback, etc., in addition to CAI programs.

On the other hand, monotonous, disorganized instructors and badly thought out CAI programs typically result in low exam scores and unfavorable comments from students. Research on effective ways to use computer-aided instruction (CAI) as an addition to traditional classroom instruction might be more fruitful than putting computers against instructors. Several beneficial applications include of (quoted from Ross & Lowther, 2009):

1. Allowing pupils to practice fundamental knowledge and abilities while releasing the instructor to mentor additional students, administer tests, or carry out other duties,
2. Giving low-achieving pupils remedial education,
3. Offering extracurricular activities to pupils who finish the standard lesson ahead of others who need more time to study.
4. Providing extra education after school, over the summer, or while children are absent from class, in situations where they do not have access to teachers.
5. Using alternative methods of instruction to help students who struggled to grasp the information the first time around or to encourage higher-order levels of learning, and
6. Increasing pupils' familiarity with and fluency with representative questions in order to get them ready for standardized assessments.

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1.1.2. The Use of Technology in Education

Technology also helps teachers organize and present classes more effectively, which is an important role. For instance, the Success for All Foundation's Reading Reels program (Chambers, Cheung, Gifford, Madden, & Slavin, 2006; Chambers et al., 2008) incorporates interactive question-and-answer exercises and carefully chosen video clips into each day's lesson plan. Establishing "virtual classrooms" in distant learning environments through the use of electronic tools like two-way audio and video is another example (Keegan, 1977; Morrison et al., 2010; Simonson, Smaldino, Allbright, & Zvacek, 2006).

Teachers can enhance their ability to make material more interesting and engaging by utilizing multimedia presentations. However, the more the number of options available to teachers to enhance the quality of their lessons, the greater the need to plan, or "orchestrate," a wide range of instructional activities. Recent British research have indicated that interactive whiteboards, as an emerging technology breakthrough, hold considerable promise for supporting these organizational processes (Somekh, 2007). The interactive whiteboard touch screen allows both professors and students to write, making learning much more dynamic and interesting. Teachers can preload lesson items (such as PowerPoints, videos, photos, letters, words, etc.) and lesson flow plans into the computer to help with lesson organization.

Interactive Classroom Communication Systems, or "clickers," are yet another example of technology used as a teaching tool (Penuel, Boscardin, Masyn, & Crawford, 2007; Slavin, 2009). With the use of these gadgets, students can reply to queries from teachers right away, and the responses are combined and presented visually right away. Advantages over traditional (non-technology-aided) instruction include: (a) valuable, instantaneous review and feedback for students; (b) instantaneous student progress data that teachers can review and use as a foundation for instructional modifications; and (c) high levels of student engagement and interaction during teacher-led instruction.

1.1.3. Using Technology as a Teaching Aid

Our colleagues and I have recently conducted a number of quasi-experimental studies (Lowther et al., 2008; Lowther et al., 2009; Lowther, Ross & Morrison, 2003) that look at various school districts' attempts to use computers as a teaching tool. In order to promote the greater use of mixed-methods designs for solving real-world school difficulties, we go on to explain some of this research later. In the "computer-intensive" circumstances, we discovered, in brief, increases in:

1. Higher-order, cooperative, and student-centered learning.
2. Student writing, problem-solving, and technology abilities.
3. Favorable perspectives held by educators, parents, school administrators, and students seeing technology as a tool for learning.
4. The effectiveness and durability of technology integration initiatives when continuous in-school peer coaching is coupled with initial professional development.

1.2. Trends, Types, and Topics in Educational Technology Research

1.2.1. Early Years: Using Technology to Treat

In the third edition of the Handbook of Research on Educational Communications and Technology (Spector, Merrill, Merrienboer, & Driscoll, 2008), a number of writers conducted an analysis of current trends in technology research. According to Hannafin and Young (2008), the subject "Do computers improve learning?" dominated early computer technology research in the 1970s and 1980s. Therefore, in research investigations, the computer functioned as a "treatment" as opposed to an instructor or a textbook. Though some of the excitement in demonstrating technology's potential as a causal treatment was tempered by the media comparison argument (Clark, 1983; Kozma, 1994), we are also witnessing a revival of interest (for better or worse) in this subject today.

1.2.2. Middle Years: The Use of Technology in Delivery

Technology's function in research studies changed from that of a treatment in and of itself in the late 1970s to that of a vehicle for transmitting or delivering various treatment strategies in the 1990s (Hannafin & Young, 2008). For instance, Morrison, Ross, et al.'s computer-based training might be used to give and evaluate the efficacy of various feedback systems. At that time, learner-control studies—such as those by Hannafin & Sullivan (1996) and Ross, Morrison, & O'Dell (1989)—became increasingly common. These studies examined the effectiveness of letting individual students choose the amount or kind of instructional help provided in sessions. Once more, computers were not the focus of the research but rather a tool for effectively executing the treatment (learner selected vs. prescribed instructional support).

1.2.3. Latest Times

As constructivist theories of learning continue to be popular (Jonassen, 1994; Tobias & Duffy, 2009), the ongoing media-effects debate (Clark, 1994; Clark & Feldon, 2005; Kozma, 1994; Kozma, 2003) opened up new directions for educational technology research in the 1990s and early 2000s. The following emphases emphasize this age, as summarized by Hannafin and Young's analysis (2008, pp. 733–734):

1.2.3.1. Analyzing how students use technology to solve higher-order problems in technology-enhanced learning environments (TELEs) and open-ended learning environments (OLEs) (e.g., manipulate variables and observe/evaluate outcomes in physics, chemistry, or mathematics etc.).

1.2.3.2. Evaluating results in "situated learning" environments—like the Jasper Woodbury series—that are designed to include students in higher-order thinking and simulations with real-world issues.

1.2.3.3. Putting more emphasis on "design-based research" to investigate the efficacy of TELEs and other computer-based learning resources in particular educational settings (Richey & Klein, 2008; van den Akker & Kuiper, 2008).

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Studies on cutting-edge technological applications, like Web-based learning (Greenhow, Robelia, & Hughes, 2009) and distant learning (Bernard et al., 2004; 2009), have proliferated in the last few years. It is concerning that the new research focuses frequently diverge from empirical results gathered using more traditional tools (Hannafin & Young, 2008) and from the educational field as a whole (Nolen, 2009). Kirby, Hoadley, and Carr-Chellman (2005) have recently found even less overlap in the citations and authorships between research in instructional systems and educational technology.

2. STUDY DESIGNS USED IN RESEARCH

Twenty-five papers, or the majority, were categorized as employing a descriptive design. Case studies, design-based studies, formative assessment, developmental research, observation, surveys, and qualitative studies were all used in these investigations. Table 1 summarizes the quantity and percentage of articles using each design.

Table 1: Study Designs Used in Research

Methodology	Frequency	Percentage
True Experiment	8	19%
Quasi Experimental	7	16%
Correlational-causal	1	2%
Descriptive	25	58%
Summary/Synthesis	2	5%

A distinct pattern in the application of research designs for papers published in the same journal between 1953 and 2001 was observed in a prior study (Ross & Morrison, 2004). Only 19% of the published papers during this time period were descriptive studies, while 58% of the articles used true-experimental designs. Quasi-experimental designs were utilized in one-fifth (20%) of the research, whereas time series designs were used in the remaining 3%. True and quasi-experimental designs, which once made up 78% of study designs, have decreased to only 35% in the last three years. Descriptive research designs have been used more frequently in journals, rising from 19% to 58% in the same comparison.

3. KIND OF INFORMATION GATHERED

The kind of data that was gathered was ascertained through a second analysis of the chosen publications. Articles were categorized according to whether they used mixed, qualitative, or exclusively quantitative methodologies. Of the published research, 44% employed approaches to data that were exclusively qualitative. A review of data collecting kinds is given in Table 2, and a summary of study designs broken down by data collection types is given in Table 3. The latter results indicate that genuine and quasi-experimental designs are more likely to use a mixed method approach. Given the nature of qualitative research methods, it is assumed that descriptive studies will employ a qualitative-only approach (i.e., case studies and observational studies).

Table 2: Kind of Information Gathered

Data Type	Frequency	Percentage
Quantitative only	10	23%
Qualitative only	19	44%
Mixed data	14	33%

Table 3: Research Design x Data Collection

Research Design	Quantitative only		Qualitative Only		Mixed	
	Frequency (%)		Frequency (%)		Frequency (%)	
True experiment	1	13	0	0	7	88
Correlational-Causal	1	100	0	0	0	0
Descriptive	4	16	18	72	3	12
Summary/Synthesis	2	100	0	0	0	0
Quasi-experiment	2	29	1	14	4	57

Hsieh et al. (2005) and Ross and Morrison (2008) expressed concern about the dearth of intervention studies in the literature on instructional technology and educational psychology in their earlier reviews of the field. According to both research, there were fewer intervention studies conducted between 1995 and 2004 than there were between 1983, the baseline year. We can make a broad conclusion based on the study designs used in the studies, even if the current analysis did not categorize the publications as intervention studies or non-intervention studies. A genuine or quasi-experiment is one type of experimental design that is needed for intervention investigations. These two types of designs were only used in 35% of the papers in the current evaluation,

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indicating that less than one-third of the publications were intervention studies.

This result is in opposition to our previous discovery that intervention studies accounted for 75% of the studies published in 1983. Additionally, the predicted trend for intervention studies published between 1995 and 2004 is lower than 45%. Some questions concerning the validity of technology studies for determining successful practices in schools are raised by this trend of dwindling trials and intervention studies.

4. FUTURE COURSES OF ACTION

Characterizing, let alone evaluating, educational technology research during the previous few decades is a difficult endeavor, as the preceding sections have made clear. This massive corpus of work covers a wide range of themes and encompasses all design types, from randomized trials to qualitative-descriptive studies. Since this work is expected to provide ways to enhance the quality (rigor and credibility) and relevance (meaningfulness and utility) of research, we acknowledge the possibility of a wide range of opposing views, each with a strong case. We thus proceed with the disclaimer that our thoughts are biased because they are based on our own experiences conducting research and assisting practitioners in making better use of technology in the field.

Our recommendations are predicated, among other things, on the idea that high-quality, pertinent research addresses concerns and challenges that are significant in education today. In order to develop and improve technology products, this theory acknowledges the need for ongoing basic research on cognition and learning with technology (e.g., Azevedo & Cromley, 2004; Azevedo, Cuthrie, & Seibert, 2004). It also acknowledges the need for formative evaluation and design-based research (Morrison et al., 2010; Richey & Klein, 2008; van den Akker, & Kuiper, 2008). Nonetheless, they give top attention to well planned research projects that directly assist practitioners in enhancing instruction in real-world settings. A second tenet is that rigorous, pertinent research is necessary to ensure that the findings are accepted as legitimate and trustworthy. A third hypothesis is that good research needs to do more than just show how successful a technological application was. Knowing the general results is important, but so is understanding why they happened in light of the specific setting (rural vs. urban school, for example), the fidelity of the implementation (fully applied vs. applied weakly or partially), and participant reactions (highly motivated vs. uninterested in the task).

It is evident that research design is not very useful for guiding K–12 activities when there aren't any relevant areas of investigation. What subjects seem to be crucial for enhancing education using technology both now and maybe in the upcoming ten years? We believe that the following four should be taken into account:

4.1. Distance learning encompasses several methods such as web-based classes, teleconferencing, hybrid courses, and more.
4.2. Social networking with an international student body
4.3. Utilizing technology to enhance learning in the classroom
4.4. Preparing pupils to use technology with competence and assurance

In K–12 education, technology is only going to become more and more important. The next ten years will surely present previously unheard-of chances for research findings to guide practices that improve teaching and learning. In order to accomplish that, we urge researchers to focus less on demonstrating the "effectiveness" of technology and more on carrying out thorough and pertinent mixed-methods studies that explain which technological applications are most effective at facilitating learning—in what ways, for whom, in what contexts, and for what reasons.

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