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Design Research: A Socially Responsible Approach to Instructional Technology Research in Higher Education

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ABSTRACT

DESIGN RESEARCH has grown in importance since it was first conceptualized in the early 90s, but it has not been adopted for research in instructional technology in higher education to any great extent. Many researchers continue to conduct studies that principally seek to determine the effectiveness of the delivery medium, rather than the instructional strategies and tasks. This article explores the various incentives for conducting research on the impact of computing and other technologies in higher education, examines the social relevance of that research, and recommends design research as a particularly appropriate approach to socially responsible inquiry. A description of the characteristics of design research is given, together with an argument for the more widespread adoption of this approach to enhance the quality and usefulness of research in computers and other technologies in education. *(Keywords: design research, design experiments, development research, research methods, instructional technology research, socially responsible research)*

INTRODUCTION

ADMITTEDLY, the *New Yorker* magazine is an unexpected source of information about research focused on applications of instructional technology in higher education. However, the February 9, 2004, issue of this normally urbane magazine included a short piece titled "Chew On" by Ben McGrath. The story describes an educational computing research study undertaken by Dr. Kenneth L. Allen, an Assistant Professor of Dentistry at New York University. The purposes of the research, as also reported by Dr. Allen and his colleagues at the annual conference of the International Association of Dental Research (Allen, Galvis, & Katz, 2004), were to "(1) to compare two methods of teaching dental anatomy: 'CD + lab' versus 'standard lecture + lab'; and, (2) to determine whether actively chewing gum during lecture, lab and studying would have an effect on learning."

According to the *New Yorker* article, Allen and his colleagues originally intended only to compare the effectiveness of a commercial anatomy CD-ROM and a standard anatomy lecture, but lacking funding, incorporated chewing gum into the study at the behest of the Wrigley's company which was interested in the effects of chewing its products on learning. No one familiar with the frustrating history of instructional technology's impact on learning (Clark, 2001; Cuban, 2001) will be surprised that there were no statistically significant differences found between the test scores of the students using the dental anatomy CD-ROM versus those who attended a dental anatomy lecture. Although the chewing gum results also failed to reach statistical significance, the authors concluded that the finding that "the chewing gum group (n=29) had an average of 83.6 [on a 25 question objective exam] vs. 78.8 for the no chewing gum group (n=27)" appeared to be "educationally significant."

The *New Yorker* writer poked fun at Dr. Allen, suggesting that he might want to extend his research to investigations of the impact on learning of chewing tobacco or biting fingernails, but there is little doubt that Dr. Allen, like numerous other faculty members from

virtually every academic discipline, sincerely hoped to find that the interactive multimedia CD-ROM was a more effective instructional treatment than a traditional lecture. What motivates this widespread belief in the potential of instructional technology among so many higher educators despite the considerable evidence (Dillon & Gabbard, 1998; Fabos & Young, 1999; Russell, 1999) that such faith is misplaced? This article explores the various incentives for conducting research on the impact of computing and other technologies in higher education, examines the social relevance of that research, and recommends a particular approach to socially responsible inquiry called *design research*.

PUBLISH OR PERISH AND OTHER RESEARCH MOTIVES

MANY FACULTY MEMBERS, especially those working in institutions classified as Doctoral/Research Universities by the Carnegie Association for the Advancement of Teaching (http://www.carnegiefoundation.org/), recognize, but rarely admit publicly, that the primary reason that they conduct instructional technology research (or any other research for that matter) is that they must publish in refereed research journals or perish, that is, fail to achieve tenure or be promoted. Novices as well as experienced professors often struggle to get substantive research underway in their own disciplines because of lack of funding, inadequate laboratory equipment, or the difficulty of finding a feasible context for their investigations. These faculty members are sometimes encouraged to turn to explorations of instructional technology in their own teaching.

With widespread access to computers, the Internet, course management systems, and other technologies, instructional technology research has become feasible for academics in any field of study. Such studies can be reported in discipline specific journals: the *Journal of Chemical Education*, *Computers and Composition: An Inter-*

national Journal for Teachers of Writing, and the *International Journal of Computers for Mathematical Learning*, or in general research journals like the *Australasian Journal of Educational Technology*, the *Journal of Interactive Learning Research*, and the *Journal of Computing in Higher Education.*

Although publications focused on instructional technology may not be valued as highly as reports of research studies in their fields, they count for something when faculty committees review promotion and tenure applications. Over the years, numerous professors have successfully supplemented their curriculum vitae with educational research, often involving computers and other technologies. Indeed, such endeavors have been encouraged by Boyer (1990) and Shulman (2001), among others, as evidence of the "scholarship of teaching."

As long as the academic reward system continues to be based primarily upon the quantity of research publications rather than their quality or merit, career advancement will remain the largest incentive for conducting any type of research in higher education. Books like *Publishing for Tenure and Beyond* (Silverman, 1999), *Successful Publishing in Scholarly Journals – Survival Skills for Scholars* (Thyer, 1994) and *Publish, Don't Perish* (Moxley, 1992) are just one indicator of this problem.

Of course, the admission that scholarly publication in academe is largely driven by concerns for personal advancement does not discount other incentives for instructional technology research. Indeed, many higher education instructors conduct instructional technology research to meet important challenges, for example, providing access to higher education for people otherwise disenfranchised by traditional delivery systems. Other scholars earnestly seek to find innovative approaches to employing technology to enhance the quality of teaching and learning in higher education. Alternatively, instructional technology research may be motivated by the drive to reduce costs or even make a profit, or by the desire to make faculty more productive (Reeves, 2003).

SOCIAL RESPONSIBILITY AND INSTRUCTIONAL TECHNOLOGY RESEARCH

THE MOTIVES FOR CONDUCTING RESEARCH in higher education are related to the concept of social responsibility. The social relevance of research is an issue that is obviously subject to much debate. One's age, race, gender, socioeconomic status, education, religion, and political allegiance influence one's interpretation of the social relevance of any given research study. For example, the 2004 presidential election in the USA was at least partially contested on the basis of differing perspectives on the value and morality of stem cell research.

The following principles represent a core set of values to guide scientific research of any kind (derived from Casti, 1989):

- Science is an ideology that consists of a cognitive structure concerning the nature of reality together with processes of inquiry, verification, and peer review.
- Views of reality differ according to one's philosophy of science, for example, realism maintains that an objective reality actually exists, instrumentalism asserts that reality is the readings noted on measuring instruments, and relativism claims that reality is what the community says it is.
- Scientific research is a social activity that has certain standards and norms, for example, it should not intentionally harm humans and it must be able to be replicated by other researchers.

Socially responsible research in education in general, and instructional technology in particular, must adhere to the basic principles listed above while at the same time addressing problems that detract from the quality of life for individuals and groups in society, especially those problems related to learning and human development. Viewed simplistically, instructional technology research might appear unquestionably "socially responsible." After all, at some level, all instructional technology research can be said to focus on questions of how people learn and perform, especially with respect to how learning and performance are influenced, supported, or perhaps even caused by technology. As long as research is focused on learning and performance problems, and adheres to the principles listed above, it would seem to be socially responsible.

Some authorities argue that concern for the social responsibility of instructional technology research is ludicrous. These people maintain that the goal of research is knowledge in and of itself, and that whether research is socially responsible is a question that lies outside the bounds of science (Carroll, 1973). Researchers in the "hard" sciences like biology and chemistry appear to rarely concern themselves with the relevance question. However, this debate has raged for decades among educational researchers. For example, as reported by Farley (1982), Nate Gage, a past president of the American Educational Research Association (AERA), was long a staunch defender of the notion that the goal of basic research in education is simply "more valid and more positive conclusions" (p. 12). Farley reported that another past president of AERA, Robert Ebel, proclaimed:

> . . . the value of basic research in education is severely limited, and here is the reason. The process of education is not a natural phenomenon of the kind that has sometimes rewarded scientific investigation. It is not one of the givens in our universe. It is man-made, designed to serve our needs. It is not governed by any natural laws. It is not in need of research to find out how it works. It is in need of creative invention to make it work better. (p. 18)

Ebel's statement speaks directly to the issue of socially responsible research in instructional technology. There is little social relevance in research studies that are largely focused on understanding "how" instructional technology works without substantial concern for how this understanding might make education better. On the other hand, there is considerable social relevance in instructional technology research studies that are largely focused on making education better (and which in the process may also help us understand more about how instructional technology works). As Desforges (2000) wrote: "The status of research deemed educational would have to be judged, first in terms of its disciplined quality and secondly in terms of its impact. Poor discipline is no discipline. And excellent research without impact is not educational" (p. 2).

Most of the published research in instructional technology in higher education has been grounded in a "realist" philosophy of science, that is, conducted under the assumption that education is part of an objective reality governed by natural laws and, therefore, can be studied in a manner similar to other natural sciences like chemistry and biology (Reeves, 1993). If this assumption about the nature of educational phenomena is erroneous, then the wrong questions are being asked by much of our research. And even if there are underlying "laws" that influence learning, the complexity inherent in these laws may defy our ability to perceive, much less control, them. Three decades ago, the noted educational research authority, Lee Cronbach, (1975) pointed out that quantitative comparative research of the kind most often conducted in instructional technology may be doomed to failure, because we simply cannot pile up generalizations fast enough to adapt our instructional treatments to the myriad of variables inherent in any given instance of instruction.

DESIGN RESEARCH FOR HIGHER EDUCATION FACULTY

ALTHOUGH STILL CONTROVERSIAL (Maxwell, 2004; Olson, 2004), there is renewed enthusiasm for experimental research designs among some well-known educational researchers (Feuer, Towne, & Shavelson, 2002; Slavin 2002) of the kind described in this special issue by Ross, Morrison, and Lowther (2005). However, we maintain that this is not the most fruitful path for a design field like instructional technology, and thus we urge higher education faculty members to consider a *design research* approach. (As described below, design research is distinctly different in both its goals and methods from the *developmental research* model described in this special issue by Richey and Klein (2005).)

Design research (Bannan-Ritland, 2003; Design-Based Research Collective, 2003; Kelly, 2003), also called *development research* (not *developmental*) by van den Akker (1999), has the following characteristics:

- A focus on broad-based, complex problems critical to higher education,
- The integration of known and hypothetical design principles with technological affordances to render plausible solutions to these complex problems,
- Rigorous and reflective inquiry to test and refine innovative learning environments as well as to reveal new design principles,
- Long-term engagement involving continual refinement of protocols and questions,
- Intensive collaboration among researchers and practitioners, and
- A commitment to theory construction and explanation while solving real-world problems.

Each of these characteristics is described in more detail below.

Focus on Complex Problems. Most instructional technology research reported in the higher education literature has studied the effects of relatively small changes to specific courses. The aforementioned Allen et al. (2004) study is a case in point in that the researchers compared one 50-minute lecture in a dental anatomy course with the use of an interactive multimedia CD-ROM. Decades of similar small-scale, isolated studies have failed to provide academics with a robust set of design principles that can guide them in the integration of computers and other technologies into teaching and learning at the postsecondary level.

Given a dismal research record, it is hardly surprising that some in academe are questioning the high investments in technology made on most campuses (Cuban, 2001; Noble, 2001). For example, a recent report titled *Thwarted Innovation: What Happened to Elearning and Why* (Zemsky & Massy, 2004) challenges three of the major assumptions about technology in higher education, specifically: (1) If you build it they will come; (2) Students will take to elearning like ducks to water; and (3) Elearning will force a change in the way faculty teach. Zemsky and Massy conducted their study at six very different institutions (Foothill College, Hamilton College, Michigan State University, Northwest Missouri State University, the University of Pennsylvania, and the University of Texas at Austin). They found that elearning enterprises at these institutions have not found substantial markets, that students view elearning at best a convenience, and at worst, a distraction, and that despite ubiquitous access to computers, course management systems, and software, most faculty continue to teach the way they always have, through lectures.

Faculty members interested in engaging in design research should tackle complex, difficult problems that cut across multiple disciplines. One such problem could be the failure of students to transfer whatever learning they accomplish in traditional lecture/lab courses to more advanced classes and eventual work in the real world. The problem of inert knowledge that students can regurgitate on exams, but that they are unable to transfer to other contexts, has been well-documented at all levels of education (Bransford, Brown, & Cocking, 2000).

Consider the following hypothetical scenario: Geosciences instructors at a large university are frustrated by the continuing problem of inert knowledge that forces them to teach scientific fundamentals again and again in their courses. To address this problem, they decide that inquiry-based learning is a pedagogical approach worth exploring. Based on theoretical work stretching back to Dewey (1938), inquiry-based learning:

> . . .
> is an approach to learning that involves a process of exploring the natural or material world, that leads to asking questions and making discoveries in the search for new understandings. Inquiry, as it relates to science education, should mirror as closely as possible the enterprise of doing real science (Exploratorium, 1998).

The theoretical work of Dewey and others suggests that inquiry-based learning yields outcomes that are more robust and transferable. To pursue socially responsible research in this context, these geosciences instructors wish to establish a substantive, but achievable, goal that will be the focus of their design research. They decide that over the next three years, they will investigate the effectiveness of inquiry-based learning strategies in undergraduate courses in the geosciences, including atmospheric science, geography, and geology.

Integration of design principles with technological affordances. Clark (2001) has long maintained that it is pedagogical methods, not technology per se, that most directly influence learning. Sharing this belief, Herrington, Reeves, Oliver, and Woo (2004) have described design principles for integrating authentic inquiry-based tasks into learning environments. To help in their design research initiative focused on inquiry-based course activities, the earth science researchers could construct a prototype online learning support system that integrates real-world inquiry problems (for example, investigating the potential for mud slides in local communities under normal and extreme precipitation conditions) with Web-based educational resources; for example, those found in the Digital Library for Earth System Education (http://www.dlese.org/). The foundation for the learning support system might be developed using a commercial course management system like Blackboard or WebCT, or it might be built using an open source toolkit such as Moodle (http://moodle.org/) or LRN (http://www.dotlrn.org/).

Inquiry to refine the learning environment and reveal new design principles. In the earth science scenario described above, the researchers would conduct numerous small and large scale studies aimed at testing and refining the prototype learning environment, and at the same time, investigating the feasibility and effectiveness of inquiry-based learning and digital library resources in undergraduate earth science courses. Quantitative, qualitative, and mixed-methods (Creswell, 2003; Gorard, Roberts, & Taylor, 2004) could be employed to provide the evidence needed to make progress toward the overall goal of enhancing teaching and learning in the geosciences through inquiry-based learning strategies while seeking to reveal design principles that could be applied in other initiatives. A qualitative investigation of student attitudes toward the new learning approach might reveal that they value inquiry-based learning, but believe that the workload required is much heavier than that required in traditional lecture/lab based courses. Accordingly, the faculty researchers might decide to cutback on the number of inquiry-based activities in specific courses but increase the depth of the remaining ones. Alternatively, a quantitative investigation of the actual time students put into the various courses in which they are enrolled might reveal that the students are putting much less time into traditional courses than their instructors expect. This might support a design principle that higher education courses should clearly state the time-on-task allocations expected for students beyond actual class meeting time.

Long-term engagement and refinement of research method. Design research is not something that is normally undertaken in one month, one semester, or even one year. Two to five years are a more normal cycle, and in some cases, design research will be an ongoing enterprise for even longer periods. Design researchers must also be receptive to changes in the goals, methods, instrumentation, and reporting cycles of a particular research agenda. Integrating inquiry-based learning methods into undergraduate science courses would never be easy, especially when it appears to be possible for people to graduate from a university without ever having been engaged in any authentic scientific research (National Research Council, 1999). The researchers in this hypothetical scenario have established a feasible, but ambitious, three-year timeline for their design research project. It is likely that the design research initiative will extend beyond the initial three years, especially if the process and results of the project are rewarding.

Intensive collaboration. Whereas previous instructional technology research in higher education has usually involved one or a few faculty members in a single department, design research requires the collaboration of academic instructors and other staff of diverse stripes. In the earth science scenario, the research team might include faculty members from various geosciences departments (e.g., geology, geography, and meteorology) as well as instructional design, educational research, multimedia production, and programming specialists from other campus units—an office of instructional development or the department of computer and networking services. While a few earth sciences faculty members might form the core of the initiative, remaining together throughout the three-year project, other participants like graduate students and programmers might come and go from time to time.

Theory construction and problem solution. Design research has its origins in educators' pragmatic desire to improve learning, not in a purely functional sense, but from an informed theoretical perspective (Newman, 1990). Design research is grounded in the practical reality of the instructor, from the identification of significant educational problems to the iterative nature of the proposed solutions. However, theoretical foundations and claims are critical to the design of solutions—as noted by Cobb, Confrey, diSessa, Lehrer, and Shauble (2003), "the theory must do real work" (p. 10). Theory informing practice is at the heart of the approach, and the creation of design principles and guidelines enables research outcomes to be transformed into educational practice.

If the group of faculty members involved in the earth science initiative simply sought to adopt inquiry-based learning methods without identifying generalizable design principles, they would be engaging in what educators call *action research*. This action-oriented research strategy has been around for more than fifty years. Corey (1953) defined action research as the process through which instructors study their own teaching practice to solve personal challenges in the classroom. Although action research certainly has merit (Reason & Bradbury, 2001), there is much more potential value in design research, because it combines seeking practical solutions to classroom problems with the search for design knowledge that others may apply.

van den Akker provides a succinct description of design/development research:

> More than most other research approaches, development [design] research aims at making both practical and scientific contributions. In the search for innovative 'solutions' for educational problems, interaction with practitioners . . . is es-

> sential. The ultimate aim is not to test whether theory, when applied to practice, is a good predictor of events. The interrelation between theory and practice is more complex and dynamic: is it possible to create a practical and effective intervention for an existing problem or intended change in the real world? The innovative challenge is usually quite substantial, otherwise the research would not be initiated at all. Interaction with practitioners is needed to gradually clarify both the problem at stake and the characteristics of its potential solution. An iterative process of 'successive approximation' or 'evolutionary prototyping' of the 'ideal' intervention is desirable. Direct application of theory is not sufficient to solve those complicated problems. (pp. 8-9)

Is design research the only socially responsible approach to instructional technology research in higher education? Perhaps not. Higher education researchers should select the research approach that is most appropriate to their overall research goal and specific research questions. That said, it seems unlikely that the increasing popularity of both quantitative and qualitative research studies will have the levels of impact on teaching and learning practices that are needed in higher education today. The history of the impact of quantitative and qualitative research on practice in instructional technology is dismal at all levels of education and training (Clark, 2001; Cuban, 2001). Indeed, contemporary proponents of qualitative approaches make few claims to generalizability (Lagemann, 2000). In our estimation, instructional technology researchers who sincerely wish to advance teaching and learning in higher education should engage in design research.

REPORTING DESIGN RESEARCH

DESIGN RESEARCH is such a new approach to educational inquiry that many journal editors and reviewers are unfamiliar with it. Many reviewers confuse the method with simple evaluations of software, or unfairly emphasize the *development* at the expense of the *research*. In addition, the narrative nature of design research reports (Bannan-Ritland, 2003) means that they often easily exceed the word number limitations of traditional print journals. Therefore, design researchers must be creative in their efforts to disseminate the findings of their research endeavors. First, we recommend that they regularly present in-progress reports of their design research initiatives at general international conferences like ED-MEDIA (http://www.aace.org/conf/) and ASCILITE (http://www.ascilite.org.au/) as well as at discipline specific conferences such as (in the case of the geosciences scenario described above) the annual conference of the Digital Library for Earth System Education (http://www.dlese.org) and the meetings of the American Geophysical Union (http://www.agu.org/). Second, they should maintain a series of numbered interim reports of their findings on a project Web site. Third, from time to time, they should submit syntheses of their conference papers and interim reports to both print and online journals. Fourth, at the conclusion of a major design research cycle, they should seek to publish a book and associated Web resource that summarizes the methods, results, and design principles emerging from the project. This sounds easy, but it requires a sharply focused attention to dissemination. The members of the former Cognition and Technology Group at Vanderbilt University (1990a, b) were masters at this publications process. Such a process is important as it helps to encapsulate the findings of each iterative cycle or stage into a whole and substantial contribution to the educational community, in the form of frameworks or guidelines for others to apply.

CONCLUSIONS

DESIGN RESEARCH requires that faculty members:

- Explore significant educational problems, rather than conduct research for its own sake.
- Define a pedagogical outcome and create learning environments that address it.

- Emphasize content and pedagogy rather than technology.
- Give special attention to supporting human interactions and nurturing learning communities.
- Modify the learning environments until the pedagogical outcome is reached.
- Reflect on the process to reveal design principles that can inform other instructors and researchers, and future development projects.

If design research proliferates, it could contribute more than the ubiquitous, but ultimately futile, media comparison studies, and additionally overcome the sterility of most qualitative studies. If it becomes the preferred model in instructional technology research, design research may well advance the quality and usefulness of a field that is presently at risk of becoming inconsequential and irrelevant. Clearly, design research presents a way forward towards more significant and socially responsible research. However, changing the mental models of academic researchers from those that are primarily experimental to those that are focused on design research will not be an easy task, especially given the ongoing preference for media comparison studies using experimental methods that have dominated this field for many decades. Saettler (1990) found evidence of experimental comparisons of educational films with classroom instruction as far back as the 1920s, and comparative research designs have been applied to every new educational technology since then.

Nonetheless, the dominant mental models must evolve, and it is hoped that this special issue of the *Journal of Computing in Higher Education* is a positive step in the right direction. Certainly, the need for a more socially responsible research agenda in instructional technology has never been greater. Instead of continuing to tinker around the edges of teaching and learning challenges by conducting quasi-experimental studies focused on small changes in learning environments or even conducting one-off qualitative studies of esoteric cases, instructional technology researchers and their colleagues in other academic disciplines must begin to tackle the huge problems we face in the first quarter of the 21st Century. Design research offers a positive step in that incredibly important quest.

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