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Transforming Instruction with Technology for Developmental Students

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Abstract: The results of a national study suggest how technology can improve education for developmental students. Currently, much of college teaching is dominated by an ancient paradigm typified by the lecture method. Similarly, much of today's technology presents information to students and reinforces passivity in them. Developmental educators must break out of this presentational paradigm if they are to transform developmental education to help developmental students become independent, successful learners. The mastery learning model (Bloom, 1968) suggests manners by which the effects of technology can be beneficially multiplied as it is applied to a wide array of developmental courses.

In 1995 the Annenberg/CPB Projects funded developmental education faculty at the General College of the University of Minnesota to identify, analyze, and disseminate information about the best practices and transforming effects on teaching and learning of newer technologies in seven developmental education discipline areas: developmental mathematics, writing, introductory psychology, speech communication, English as a second language, and learning resource centers. In that 18 month project, individual project members conducted literature and WEB searches, participated in listserv discussions, contacted colleagues, and attended conferences to look for leads on emerging practices and programs. The project team sent a national survey to the memberships of the National Association for Developmental Education and the League for Innovation in the Community Colleges asking recipients to describe technology they were using and whether they thought it was transforming curriculum or (if administrators) to identify faculty in their institutions using technology for subsequent contact. The team then sent discipline-based surveys asking specific questions about transformational technologies to those identified in the first round of surveying and to others identified by other means. Project results are accessible from a database via the World Wide Web (http://www.gen.umn.edu/research/currtran/) and describe innovations using several generic technologies: overhead projection, video and audio equipment, computers and hand held calculators, e-mail, and Internet/World Wide Web/Network applications.

Although there were some differences in technology utilization between discipline areas, introductory psychology illustrates very well how technology could improve education for developmental students. Approximately 1.5 million students in virtually all colleges and universities in the United States take it each year (Cush & Buskist, 1997). Although many students find the heavy concept load in a typical introductory psychology course difficult, the subject matter suggests ways for them to remediate deficiencies. In addition to chapters on learning, memory, and motivation, some introductory psychology textbooks include "how to study" sections based on sound psychological principles (e.g., Myers, 1995).

For these and other reasons, introductory psychology can be useful in delivering interventions for developmental students. For example, Brothen (1992, 1994) showed how computer-assisted introductory psychology course exercises could be used to assess developmental students' academic skills and help them become more independent, effective learners. And Gebelt, Parilis, Kramer, and

Wilson, (1996) used an introductory psychology course to integrate developmental students into their university's regular curriculum. This paper's primary argument is that technology appropriately applied can help developmental students improve learning skills as they learn. As an illustration, the article examines the case of introductory psychology and reviews current and possible uses of technology to show how developmental educators could use it to help their students be successful.

Technology and Textbooks

An important starting place to assess the developmental potential of any course is the textbook. Beginning with a series of texts published in the late 1930s, introductory psychology textbooks have become increasingly student oriented and infused with learning technology. Color illustrations, tables, graphs, boxes, running glossaries, summaries, and suggested readings lists have been instituted over the decades to make texts more "user-friendly." Publishers supply instructors with presentational aids related to the text which employ technology. Some examples include slides, transparencies, audio/video tapes, laser disks, and compact disks designed to "liven up" lectures and computerized test banks and grade books to manage their classes. Students are offered computerized study guides, computer simulations and data bases, and, more recently, access to World Wide Web sites from which they can download information about psychology.

An outside observer might surmise that with the technology infused in and accompanying many texts, introductory psychology must typically be taught in new, technologically-driven ways. However, this is not true; the lecture method dominates introductory psychology in developmental education (Brothen, 1997) as it has psychology and higher education since their beginnings (Keller, 1985). This domination derives not from lecture having been shown to be educationally superior to other methods: Discussion, for example, is clearly superior at fostering student retention of information, transfer of knowledge, problem solving, thinking ability, attitude change, and motivation (McKeachie, 1994, p. 54). Beins (1992) pointed out that in many instances over the decades since 1910, psychologists have written that the lecture method is maintained because instructors (a) feel good for having made things "clear" in class, (b) like expressing themselves freely and hearing themselves talk, and (c) are reinforced by grateful students who appreciate nicely packaged information that relieves them from thinking. With only a few exceptions, such criticism has not changed the method of introductory psychology teaching. Instructors lecture for many reasons, but chief among them may be acceptance of a formal tradition of what "teaching" is supposed to be and a comfort level with what is familiar and accepted. These conceptions have also influenced the direction technological innovations have taken in teaching.

Current Technology

Much current classroom technology hews to the traditional conception of what teaching is: presentation of information. Papert (1997) asserts that technology in general has been an "add-on" in education, simply helping educators do what they've always done. For example, if an instructor uses a video disk to show examples of what was covered in lecture, he or she is still presenting information. Beins (1992) reviewed several experiments on adapting the lecture method to technology over the last six decades. Delivering lectures by radio, television, and even telephone have been tried without noticeable effects on student achievement. Two modern counterparts of these experiments are courses taught by interactive TV and some courses delivered over the World Wide Web. In the former, students simply are connected to a lecture class somewhere else. In the latter, students download the text of "lectures" (sometimes "spiced" up with computer presentation software) as the equivalent of actually being in class. The use of computers to supplement lectures has been attempted sporadically but Daniel (1985) reviewed these attempts and concluded that they will not replace traditional methods. One must

ask why this might be so given that the most salient technological innovation currently affecting education is the computer. An answer is that replacing lectures would require a major shift in the accepted approach to teaching.

Future Directions for Technology

However, the current approach to teaching is unlikely to change until there is a general sense of what direction education ought to be taking with technology. In a series of articles, Twigg (1994a, 1994b, 1994c) described the traditional lecture classroom as a learning technology that's simply out of date. She called for a new national learning infrastructure in which students are required to learn more independently, work to test and enhance their learning with each other in cooperative learning communities, and are freed from the rigid time constraints of the traditional academic term. She holds out hope that educators will develop a clear vision of what higher education should accomplish in the field of technology-mediated learning and escape Skinner's (1984) pessimistic assessment of education as hopelessly teacher-centered with students expected to develop in lock-step and instructors held prisoner by the traditional lecture method. A way to achieve this new vision is through computers.

Lepper and Guertner (1989) reviewed several meta-analyses that evaluated hundreds of individual, control-group studies on computer-assisted instruction effectiveness. Overall, they report moderate, positive effects on learning. These effects are even greater for "lower ability or remedial" (p. 175) students, those we typically see in developmental education programs. Supporting this assessment is a recent study sponsored by the League of Innovation in the Community Colleges (Johnson & Perez, 1996) that showed computer-assisted instruction to be effective for developmental students.

However, the computer has not yet led to the dream of a major revolution in the way people learn nor has it yet made much of an impact in higher education. This has certainly been the case for introductory psychology. Although Stoloff and Couch (1992) have published three directories of computer use in psychology and Hornby and Anderson (1990) collected and reviewed 18 computer-assisted packages designed for use in introductory psychology several years ago, there are virtually no reports in the psychology or developmental education literature of psychologists' using them to teach introductory psychology. For example, in the most recent compendium of the best articles published in *Teaching of Psychology* (Ware & Johnson, 1996), only 2 of 16 deal with computers and no others with any form of electronic technology to teach introductory psychology. It is clear, perhaps for the reasons detailed previously, that technology has not had a great impact on the teaching of introductory psychology in any educational environment.

However, Ely (1996) pointed out three trends in education. First, computers are pervasive in educational institutions and increasingly so in home and community. In most cases, it seems, they are available to be put to good uses. Second, there is increasing advocacy for use of educational technology and for teachers to become technology literate. A wide variety of educational policy groups recognize that there is a lag between the increasing availability of hardware and creative uses of it. Third, educational technology is increasingly perceived as a major vehicle in the movement toward educational reform. And this reform is increasingly seen as moving from teacher-centered to student-centered modes of instruction. The trends reported by Ely surely point to computers as playing a crucial role in transforming the status quo.

Goals For Technology in Developmental Education

By definition, the behaviors of developmental students that led them to be identified as such must

change if they are to succeed in higher education. In a recent review of research on remedial instruction, Stahl, Simpson, and Hayes (1992) set an agenda for teaching developmental students. Central to their agenda is that instructors should strive to help developmental students become what they typically are not: independent learners or students who are autonomous, good strategy users, and self-regulated (cf., Zimmerman, 1989).

Thomas and Rohwer (1986) proposed a specific approach to the development of self-regulation in learning. They advocated teaching a process to facilitate learning called executive monitoring: Students appraise their need for further study, deploy strategies to meet those needs, and assess their learning progress. This technique can foster feelings of self-efficacy, defined as believing one has the capabilities to attain academic success (Bandura, 1986; Shunk, 1990). According to self-efficacy theory, students require feedback on their learning progress; positive feedback results in an increased sense of their ability to master learning tasks. If acquisition of monitoring behaviors is a goal for high-risk students, then what techniques could instructors use to facilitate this behavior? The answer to this question must be specific: Behaviors need changing and exactly how technology can assist the process must be spelled out.

To be effective in helping developmental students become more independent, self-regulating, self-confident learners, technology should function at the level of the student. That is, it should stimulate behavior change and help students and instructors monitor that change. Technology that makes for a "better" lecture helps the instructor but is unlikely to change the student. Technology that is "interesting" to students may have only entertainment value unless it systematically advances course learning objectives and helps students see themselves differently. The best way for technology to have a transformational role in developmental education is for it to be effective in transforming students.

Technology and Developmental Students: Implications for Practitioners

How should technology be used then? Before posing an answer to that question one must consider, as Kipnis (1994) has pointed out, that technology is often developed to preserve the status quo. Throughout history technological advances have made economic systems more viable and helped preserve whole societies in times of crisis such as war. Similarly, the traditional lecture method was designed to efficiently transmit information to large groups of students, and most classroom technology serves this purpose. For example, appliances such as overhead projectors make the lecturer more "efficient," projectors and recorders present lecture information visually and aurally, and computers combined with projection devices project outlines of lectures with presentational software or computer-mediated images from laser disks and CDS. All of these maintain the presentational format status quo. The challenge is to differentiate technology that transmits information via technology focused on the student.

We as developmental educators need a new context within which to integrate technology into developmental education. The current presentational paradigm does not help because within it the use of technology is limited to an adjunct of the lecture, and the inherent difficulties with technology often discourage its use. Instructors faced with a recalcitrant computer projection system fall back on an overhead projector. If the overhead projector is unreliable, they fall back on chalk, and if the chalk is missing there's always the human voice (amplified or not). If this retreat to the lowest form of "lecture adjunct technology" is not accompanied by a corresponding fall-off in student learning, instructors might ask if adjunct lecture technology is really worth the bother. Thus, a high degree of dependability (excepting bouts of laryngitis) is why the lecture method is amazingly resilient (Keller, 1985) and not likely to be abandoned soon.

In his classic formulation of the mastery learning model Bloom (1968) suggested that students with academic deficiencies can be nearly as successful in mastery courses as well-qualified students. A mastery learning method with special promise for developmental students is Keller's (1968) Personalized System of Instruction (PSI). PSI has four distinguishing characteristics. First, there is emphasis on written materials rather than lecture as the major teaching activity. Instead of presenting information to students orally, instructors select and/or create appropriate reading materials, create behavioral objectives and study questions, and prepare multiple forms of tests that measure student progress and provide feedback. Second, students pace themselves through the course, finishing assignments as they are able. Flexibility is a cornerstone of the method and is based on the realization that students have many other obligations and learn at different rates. Third, the course is broken down into manageable units that students are to master before they move on to the next. Mastery is determined by successful completion of short unit tests that provide feedback to unsuccessful students so they may remediate deficiencies before trying again. Finally, undergraduate proctors have typically been used to score tests and help students understand what their deficiencies are and how they might deal with them.

Several reviews and meta-analyses of dozens of control-group studies over the years (Keller, 1974; Kulik, Kulik, & Bangert-Drowns, 1990; Kulik, Kulik, & Cohen, 1979; Robin, 1976; Ryan, 1974) have found superior student learning in PSI compared to traditional forms of instruction, and this advantage is even greater for students with lower academic ability. To complement the real gains developmental educators foster in their students, the noted educational researcher James A. Kulik recommends the use of PSI with developmental students (Bonham, 1990). He notes that PSI interventions are beneficial for 90% of students and typically move average performance from the 50^{th} to the 70^{th} percentile on examinations (p. 17).

Instructors who adopt models such as PSI have new possibilities opened to them. They are more likely to find ways to integrate technology with teaching methods that decades of research on learning have shown to be more effective but have yet to be realized due to tradition and inertia. They can practice what Bork (1997) says must be combined to create effective and transformative educational computer software: learning and assessment. In his approach, the computer helps students assess their progress and directs appropriate learning interventions.

PSI is especially fertile ground for the transformative effects of technology. Each of the four pillars of the method are easily adapted to computers (cf. Brothen, 1996a; Hornby & Anderson, 1996). For example, emphasis on written rather than oral materials could be facilitated by the ability of students to download information from the Internet as they need it. Also, self-pacing and mastery learning require adapting to students' schedules. The traditional lecture method is "lock-step," delivering content whether the students are ready or not. Computers are infinitely patient and can deliver progress feedback whenever students are ready to discover if they are mastering the material at the pace they set for themselves. Computerized assessment devices (quizzes, pretests, drills, etc.) tell students how well they know the material and what they have yet to do. They facilitate content learning as well as validate current or suggest new learning strategies. And with authoring systems now available to help computer-assisted instruction novices (Brothen, 1995), instructors can create their own courseware.

Future Directions: Multiplying the Effects of Technology

One way to view applications of technology is through the multiplier effect concept borrowed from evolutionary biology (Wilson, 1975). The multiplier effect refers to how a small change (such as an individual, inherited, behavioral change) is amplified on a larger class of events (such as social

organization). For example, a new tendency toward cooperation is amplified so that a society eventually becomes based on shared rights and responsibilities. In a general sense, technology can function as a multiplier effect if it is used correctly. A multiplier effect occurs in this context when a simple application of technology amplifies some essential student behaviors. For example, computerized quizzes that give students immediate feedback on their content knowledge and refer them to their textbook or other source of information to restudy amplify two important student characteristics. First, students learn the information better and come to appreciate the value of feedback and review. Brothen (1996a) showed that developmental students receiving A grades in a PSI introductory psychology class did not differ from F students in academic aptitude but had made more use of the retesting option and the resulting feedback. Second, students learn something about the effectiveness of their learning strategies and how to improve them. Brothen (1996b), showed that developmental students who were induced to review their course progress on an up-to-date computerized grade book generalized this simple behavior and became more characteristic of self-regulated learners by utilizing a computerized practice final exam more than similar students in the same class not using the grade book. The simple act of monitoring their grades was multiplied in their academic behavior resulting in higher scores on the final examination and greater improvement in study skills. Similarly, Brothen (1994) demonstrated that inducing developmental students to take a computerized practice final examination changed their study patterns for the final examination in a more self-regulated direction and resulted in final exam scores as much as 12 points higher than previously equally performing students in the same class.

We need to look for positive changes in our students' approach to and success with learning. Students should learn more but they should also be developing into self-regulated learners who persist in their pursuit of academic success. For example, Brothen (1996a) showed that the basic difference between developmental students receiving A grades and those receiving Fs in a psychology class was sticking to the task and doing the work.

In one sense, a structured approach to using technology is a technology in itself. Kipnis (1997) defines technology as "the use of systematic procedures to produce intended effects" (p. 208). In his view, the most powerful technology is a behavioral methodology that moves people in an intended direction. Thus, application of psychological principles to structure the learning environment may be the most significant technology available to developmental educators.

Those of us working in developmental education should keep in mind that our basic goal is changing students' behavior. The question of how technology should be used to teach developmental students should always be answered first with a statement of how it is designed to make students grow and develop as students who are successful because they've taken control of their learning and persist until they are successful. Only then can technology truly help to transform developmental education for our students.

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