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A Conceptual Taxonomy of Technology Adoption and Diffusion in the Classroom

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Abstract

We suggest that faculty adoption patterns move through three identifiable stages (cf. Rayport and Sviokla 1995). In Stage 1, technology serves a support function which improves efficiency, but does not significantly impact teaching. During Stage 2, teaching technology enables faculty to efficiently "mirror" classroom activities utilizing new technologies. Stage 3 utilization of technology not only supports and mirrors current activities; the goal is to substantively improve teaching and to strengthen the interaction between students and professors; unique applications result in improved application of new technologies. Our conceptualization should help departments and individuals better understand how they are currently using technology, to identify barriers which hinder stage 3 adoption behavior, and to develop goals and create applications which will push faculty beyond using new technologies merely to support or mirror previous functions.

Introduction

In the past five years or so, computer technology and the Internet are radically changing organizations including universities; new business models and possibilities are not just supported and made more efficient, they are instead digitally and virtually created by new technologies. However, all too often, the *use* of technology in the classroom is confused with the more important concept of *innovation* in the classroom.

While new technology provides new means and mediums, innovation can only occur in interaction with instructors who use it to introduce new methods and content to create a newly defined classroom. Technology merely expands the avenues and means available to instructors; it does not supercede the need for instructors to creatively invent and implement new classroom techniques and solutions.

Our objectives are twofold: first, to provide language with which to discuss classroom innovation and second, to explore the process of faculty adoption or non-adoption of classroom technologies. We describe a number of areas where change and innovation are evolving in the classroom, some of which mirror existing functions, and some which have potential to be truly innovative applications. The adoption and diffusion of technology in the classroom has followed three general stages, each more sophisticated than the last: These three phases or "waves" of change are (1) technology-as-support, (2) mirroring, and (3) discontinuous innovation (cf. Rayport and Sviokla 1995). We describe each of these phases below.

Stage 1: Technology as a Support Function

In Stage I, technology is merely a support function for business (Rayport and Sviokla 1995). As in Stage I adoption in business environments, computer technology in teaching initially performed support functions primarily, such as the word processing of lecture notes and tests, spreadsheets to enter student grades, and data storage and retrieval.

While Stage I technologies make life easier and more efficient, Stage I applications do not significantly alter the teaching model or interactions with students in or outside of the classroom. Thus, Stage I adoption behavior inspires few faculty to become intrinsically interested in technology and encourages little creative experimentation. Instead, many faculty conceptualize technology as playing a relatively minor supporting role to their teaching.

Stage 2: Mirroring

The content of any new technological medium is typically the paradigm that precedes it in dominance (McLuhan 1964). Thus, when faculty began to engage in Stage II behavior, previous teaching functions are initially simply "mirrored" (Rayport and Sviokla 1995). For example, an activity performed in physical space (preparing physical transparencies for a lecture) is now performed in virtual space (using PowerPoint to prepare virtual slides for lectures). Syllabuses are posted electronically. While the mirroring process is a natural and necessary step in the adoption process of technologies. As well, until technologies such as PowerPoint are used in some unique way, they remain an wonderful yet incremental change in the classroom, technological improvement notwithstanding.

Faculty Responses to Early Stages of Change:

Clearly, the advances represented by technology support and mirroring applications in the classroom are significant compared to previous methods, but the potential of technology remains largely unrealized until further developments evolve as a function of faculty/student trial.

Many Stage II technology applications facilitate interest and experimentation among some faculty (and students). Faculty innovators adapt quickly through "bricolage" or "play" (Turkle 1995); as are children and young adults, faculty innovators, like other technology

innovators, display a willingness to experiment with no particular goal in mind (Kelly 1997; 1998).

However, late adopters or laggards often view the experimental efforts and bricolage of the innovators as being unnecessary and even inefficient; they hold fast to old ways of teaching and point to the failures and/or incremental gains of the early users. Because business is adapting at a much faster pace than professors, and kids are growing along with technology (Tapscott 1998), a technology gap emerges; in many cases students know more about technology than do professors (Miller 2000).

Stage 3: Discontinuous Innovation Emerges

More innovative uses of technology occur in Stage 3, changing the nature of products/services a business or University professor can offer, often by using information in new and innovative ways (Rayport and Sviokla 1995). What makes a technology or use of a technology innovative? Literature on new product introductions provides a useful starting point. A new product is innovative when it (1) provides "technological advancement" or relative advantage over existing products providing a substitute service, and (2) significantly affects or changes group, social or cultural behavior through adoption (Robertson 1967).

Most innovations do not offer significant advances in either parameter -- providing relative advantage or resulting in group, social, or cultural change --are thus classified as incremental or as *continuous innovations.* Innovations that represent a significant technological advance or "relative advantage," but do not significantly interact to change or alter socio/cultural behavior are *dynamically continuou.s* An innovation that both represents a significant technical advance *and* significantly interacts with individuals to alter social or cultural behavior is as a *discontinuous innovation* (Robertson 1967).

In Stage 3, classroom evolution emerges through both a top-down as well as a bottom-up process occurring largely by trial and error (Gates 1999). As *discontinuous* innovation emerges, faculty employing new classroom technologies begin to enhance content and to more fully understand the technological media and its effect on and with student behavior. Mainstream opinion leaders often learn from the efforts of innovators, and then translate those efforts into something understandable and usable for other colleagues; nevertheless, some colleagues still resist and become laggards and perhaps even resent and distrust all or most new technology.

While we cannot envision all types of Stage 3 changes that may occur, we suggest several ways in which discontinuous innovation (1) will help create stronger relationships with our students and alumni and (2) enable better achievement of learning goals.

Increased Interaction: It is not necessarily intuitive how technology, which some view as inhibiting relationships and separating people, can help create, support and sustain relationships. E-mail lists and online discussion groups facilitate sharing of information in ways not previously possible. Interactivity increases, for example, when "news" or other topics are posted by faculty and students to discussion, voice or script-chat groups, or sent to e-mail lists, and students respond with comments not only to the instructor but to each other. They begin to share sites and articles they come across which are relevant to the class; active learning is thus engaged. Feedback can be more easily gleaned from students, permitting early corrections for new courses or new instructors. All in all, a change takes place from teacher-centered, broadcast teaching to learner-centered, interactive teaching (Tapscott 1998).

Achieving Learning Goals: Stage 3 uses of technology are innovative when they improve achievement of learning goals. For example, online distance learning courses more than "mirror" current courses as they support asychronous learning; like early owners of phonographs, students can time and place shift performances, reviewing whatever material they would like at their own page. In-classroom technology is also being used to facilitate and intensify student group interaction; the increased involvement should result in improved learning outcomes.

Eventually, teachers from every discipline will be able to use notification systems and bots that select and deliver information on topics of interest to them and to take advantage of websites that are information aggregators for their particular discipline (Dyson 1998). The relatively long lag between research publications to textbook and then to the classroom can be significantly shortened. But, perhaps more importantly, students learn to read, critique, and actively cultivate the ability to determine the importance and validity of emerging trends.

Moreover, consider the lifelong learning implications when students are stay on class email lists after a class is over and to continue receiving selected articles, websites and software downloads. Eventually, this continuing contact with students should facilitate continuing interaction and feedback for assessment efforts. Ultimately, CBT-based online lectures and events can be created especially for alumni, thus formalizing long term learning relationships with studesnts.

Conclusion

The end goal regarding classroom innovation should be *discontinuous* innovation. If it is not, education, as we know it, may well be over taken by competitors known and unknown to us who will do things differently (Symonds, Lindorff and McCann 2000; Grove 1996; Tapscott 1996; 1998). What will happen when, for instance, top business schools such as Columbia and Stanford, leverage (as they are now doing) their names and the names of their famous faculty to offer courses to students all over the United States, and eventually,

internationally (Applebome 1999; Guernsey 1999)? At an institutional level, we must carefully define what we mean by innovation and just what that innovation affects or changes. Discontinuous classroom innovation occurs, for example, when the classroom itself and the learning experience changes significantly.

Finally, none of the innovations discussed above are intended to replace the classroom. Instead, they are intended to augment, extend, and create a dynamic and interactive classroom increasingly desired by our students.

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