Various factors inhibit the adoption of new technology, but corrective measures can redress many of the problems

# Barriers to Adopting Technology for Teaching and Learning

By **Darrell L. Butler** and **Martin Sellbom**

In the right circumstances, new technologies adopted by members of a community will spread by diffusion. One of the most robust findings about innovation diffusion is that shifts from one technology or product to another follow a sigmoid, or cumulative normal, distribution.[1–3] Thus, the rate of adoption usually starts low, accelerates until about 50 percent of the community has adopted the technology, then decelerates, eventually approaching zero, as nearly everyone in the community has adopted the technology. Adoption or diffusion also can be characterized as a normal distribution, or bell curve. Using the normal distribution model, Rogers identified five major categories of individual adopters (see Figure 1).[4]

Many factors affect the rate of adoption, including an innovation's characteristics and various economic, sociological, organizational, and psychological variables. Understanding the rate of adoption in any given situation requires analyzing factors that may facilitate the adoption and those that may operate as barriers to adoption.

One recent study conducted at Illinois State University identified several factors that affected adoption of instructional technology by faculty, especially Internet and Web technologies.[5] The

majority of the faculty agreed or strongly agreed that three factors imposed barriers to adoption: lack of institutional support, lack of financial support, and, most importantly, lack of time to learn new technologies.

This article aims to

- extend what is known about the factors affecting faculty adoption of modern instructional technologies,
- identify the factors that faculty believe are important either in facilitating adoption or in creating barriers that work against adoption, and
- propose recommendations to solving problems and reducing barriers to technology adoption.

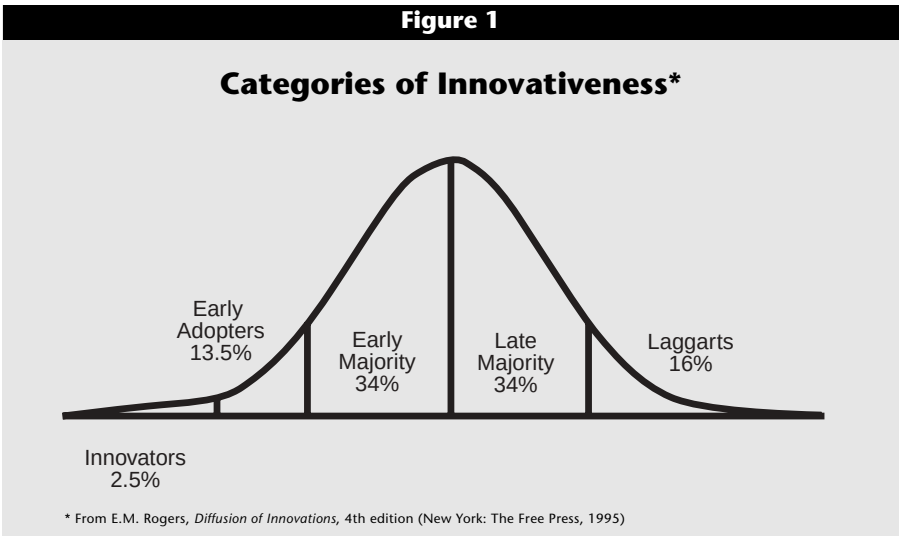
We expect that the factors identified as facilitators or barriers will depend on the level of existing adoption by faculty, an assertion that the Illinois State study supports.[6]

The study presented here took place at Ball State University, located in Muncie, Indiana. Ball State has consistently ranked as one of the nation's most wired universities.[7] Based on several dozen interviews with faculty, researchers (ourselves, assisted by Jerome Kotecki and Web Newbold) developed a questionnaire[8] and cover letter, which the dean's staff sent through campus mail to all faculty in the College of Sciences and Humanities (approximately 410 faculty). Faculty had three weeks to complete the questionnaire and return it either to the dean's office or to one of the researchers. The return rate was approximately 30 percent, or 125 participants. This sample matched very well with the overall faculty population on a wide variety of variables, such as relative percent of professors, associate professors, assistant professors, and lecturers; relative percent tenured; percent of each gender; and percent from each department.

## Findings

The study results divide into several areas, discussed in turn: proficiency with technology, barriers to adoption, and reliability (or rather, lack of) of the technology. We conclude each section with recommendations for addressing these issues.

**Figure 1**




* From E.M. Rogers, *Diffusion of Innovations,* 4th edition (New York: The Free Press, 1995)

### *Faculty Proficiency with Technology*

We computed a measure of overall proficiency by adding up all the individual hardware and software proficiency ratings to create a combined score, the total proficiency. Statistical analysis showed that all individual proficiency ratings were significantly related to the total proficiency score (see Table 1). The study considered faculty proficiency in the technologies most commonly used in teaching and learning. Table 1 also shows that individual technology proficiency scores correlated with the total proficiency score.

The survey asked faculty to compare themselves to other faculty on a 5-point self-rating proficiency scale. Both the total proficiency scores and the self-rating of proficiency were similar and distributed normally, consistent with the characterization of innovation adoption presented earlier.

The faculty varied widely in technology proficiency, but most believed that they have many proficiencies with regard to technologies for teaching and learning. The majority rated themselves as either proficient or very proficient in older technologies (chalkboards, overhead projectors, and VCRs) and newer technologies (whiteboards, computers, word processing, e-mail, and Internet browsing). The best discriminators of those most proficient from those least proficient are the levels of proficiency with presentation software, graphics software, Internet browsing, and spreadsheets.

### *Barriers to Technology Adoption*

This study revealed a number of barriers to adoption of technology, the most common of which are summarized in Table 2. We were surprised that even faculty with high levels of proficiency generally identified the same barriers as faculty with low levels of proficiency. In the following sections we describe each of the major barriers along with recommendations for reducing them.

### *Reliability*

From a faculty perspective, the biggest problem with using technology for teaching is reliability. Unreliability was the most commonly cited "significant problem," the problem most often addressed by faculty who offered solutions to correct problems, and the most commonly cited factor in whether faculty will adopt a technology. Table 3 shows the means and standard deviations for factors affecting the adoption of technology, including unreliability. The factors come directly from the questionnaire.

Several other problems described by faculty seem closely akin to unreliability: software incompatible with office and home, mistakes by support services, software malfunctions, burned out light bulbs, slow Internet access, and out-of-date software.

**Table 1**

## Faculty Proficiency in Technology

| Technology | Mean Proficiency (1–4) | Correlation to Total Proficiency ($df = 124$, $p < .01$) |
|---|---|---|
| Presentation software (office) | 2.47 | .74 |
| Graphics software (classroom) | 2.04 | .74 |
| Presentation software (classroom) | 2.51 | .74 |
| Internet browser (classroom) | 3.24 | .74 |
| Spreadsheet software | 2.46 | .68 |
| PC (classroom) | 3.31 | .66 |
| Internet browser (classroom) | 3.18 | .61 |
| E-mail | 3.59 | .60 |
| PC (office) | 3.39 | .60 |
| Word processing | 3.66 | .56 |
| FTP | 1.94 | .52 |
| Elmo projectors | 2.54 | .51 |
| Statistical software (office) | 1.94 | .51 |
| Statistical software (classroom) | 1.94 | .49 |
| Web file manager | 1.68 | .47 |
| Frontpage | 1.26 | .42 |
| InQsit | 1.24 | .40 |
| Overhead projector | 3.71 | .39 |
| MacIntosh computer (classroom) | 1.81 | .39 |
| MacIntosh computer (office) | 1.74 | .32 |
| Web grade book | 1.94 | .29 |
| Whiteboard | 3.10 | .28 |
| VCR (classroom) | 3.58 | .28 |
| Slide projector (classroom) | 2.96 | .27 |
| Campus video information systems | 2.92 | .26 |
| Chalkboard | 3.69 | .24 |
| CourseInfo's Blackboard software* | 1.75 | .23 |

* Since the survey, CourseInfo has spun off the Blackboard product.

In some sense, the faculty's general agreement about reliability as a big problem was surprising because the survey suggests that the majority of faculty define reliability for teaching and learning rather generously — as about three failures per semester. Assuming that faculty mean three of all their class meetings, we can estimate a major problem occurring more than two percent of the time.

We suspect that faculty would not be this tolerant of other technologies. For example, if a person drove his or her automobile two times a day every day, an automobile that had a breakdown 2 percent of the time would total about 14 breakdowns per year. Faculty would not be happy with an automobile that broke down 14 times a year. Similarly, such frequent breakdowns of coffee machines, TVs, and many other technologies would be perceived as unacceptable.

The attitude that technology for teaching and learning should be reliable is not unique to the faculty in this study. In a recent report on online higher education, one study provided evidence of a bright future for online, computer-based distance education.[10] However, the authors also warned that "zero breakdowns" (including uninterrupted accessibility, regular system checks and repairs, and fast, reliable e-mail) is the backbone of a successful online program.

We do not believe that standards for on-campus classes should be any lower than those for distance education. However, zero breakdowns is unrealistic. Recent books on quality control suggest that the goal should be .0001 percent errors.[11] In this context, it is worth noting that Chizmar and Williams did not ask faculty about reliability in their recent study.[12]

What can be done to improve reliability? New attitudes and procedures are needed. One faculty member described a recent example, a burnt-out projector bulb that took three weeks to fix. This is clearly unacceptable. For large classrooms, thousands of students a day can be affected by such breakdowns. Based on these findings, we recommend that universities encourage improved quality control.

**Recommendations for Reliability.** Some specific recommendations will help campuses achieve reliability of the technology used to support teaching and learning.

- Convince the staff involved with technology for teaching and learning of the importance of reliability and the criticality of the equipment, its integration into the classroom, and its maintenance.
- Purchase highly reliable technologies, not the cheapest ones. Low reliability will likely require more expensive maintenance, frequent repair, and earlier replacement. Furthermore, poor reliability drives professors away from technology use. Campuses should seriously consider their definition of reliability and use it as one criterion of purchase.
- Establish clear lines of responsibility for checking and maintaining quality control of classroom technologies, especially large classrooms often shared by departments. Regularly check and maintain batteries in remote controls, software upgrades, bulbs, and other components of the classroom technologies. Many faculty we interviewed or surveyed had no idea who was supposed to maintain technologies. If part of the responsibility should be theirs, they should know that.

- Maintain supplies properly and take new approaches (including staff training) to assure rapid responses to breakdowns. Based on comments from faculty, many staff and student employees do not understand the critical need for rapid response.

### *Learning to Use New Technologies*

The second biggest concern reported by faculty was the time it takes to learn to use new technologies. Several other problems are associated: portable carts used to bring technology to some classrooms are hard to use; classrooms are too different, so faculty learning doesn't generalize; and faculty do not know where to get the training they need. Many of the solutions offered by faculty concerned ways to make learning easier (see Table 4).

Knowing how to use a technology was the second most important factor in determining faculty adoption (see Table 4). Two other, similar factors were also rated as important in terms of adoption: difficulty in using the technology and difficulty in learning to use the technology. Moreover, in the Chizmar and Williams study, respondents identified lack of time to learn as the most critical factor in adoption of Web-based instructional technology.[13]

There is a general tendency in academic culture to believe that "training" solves problems of "learning." No doubt training is useful for some faculty for some complex systems. However, faculty sometimes have a hard time learning to use things because of bad design: things don't work the way people expect, controls map poorly to the devices they control, or controls are hard to figure out. Recently, for example, in at least one classroom on our campus, the procedure for starting videos changed — a faculty member had to press the play button on the box in the room not just once, but twice. The room contained no information about this odd change, even though it was not something easily figured out. Training can solve this problem, but both the problem and the need for training could have been avoided by better design.

**Table 2**

## Problems Reported by Faculty Members

| Problem | Frequency of Faculty Reporting |
|---|---|
| Equipment failure or malfunction | 37 (29.6%)* |
| Time to learn new technology | 18 (14.4%)* |
| Carts too hard to use; don't like carts | 11 (8.8%)* |
| Equipment too different across classrooms | 11 (8.8%)* |
| Campus support weak | 11 (8.8%)* |
| Software out of date | 10 (8.0%)* |
| Takes too long to learn given value to learning | 9 (7.2%)* |
| Software incompatible with classroom/office/ students' systems | 6 (4.8%)** |
| Difficult to schedule classrooms with technology | 6 (4.8%)** |
| Nowhere to learn; need to learn | 6 (4.8%)** |
| Domain too slow | 5 (4.0%)** |
| VIS screwed up[9] | 5 (4.0%)** |
| Software malfunction | 5 (4.0%)** |
| Light bulb burned out | 5 (4.0%)** |

* 99% confidence interval did not include 0
** 95% confidence interval did not include 0

**Table 3**

## Factors Affecting Adoption of Technology*

| Factor | Mean | Standard Deviation |
|---|---|---|
| Reliability of the technology | 3.64 | 0.61 |
| Knowledge of how to use the technology | 3.57 | 0.64 |
| Believe the technology improves or enhances learning | 3.36 | 0.80 |
| Difficulty in using the technology | 3.15 | 0.87 |
| Institutional support for using the technology now | 3.06 | 0.89 |
| Institutional support for using the technology in the future | 3.04 | 0.91 |
| Difficulty in learning to use the technology | 2.98 | 0.96 |
| I have used the technology often in the past | 2.69 | 1.00 |
| The technology helps me with thinking and planning | 2.59 | 1.08 |
| I expect the technology to save me time in the long run | 2.55 | 1.14 |
| Unique or innovative technology | 2.35 | 0.98 |
| Others in my department are using the technology | 2.00 | 0.93 |

* Range is 1–4, where 1 = not important and 4 = very important.

Assuming that technology staff can improve classroom technologies to be more intuitive and that they can provide clear instructions for those who need them, there will still be a need for training. Not all faculty are innovators when it comes to technology. Many would prefer some help to learn such things as what tools to use for developing Web sites, or for editing graphics or digital video. Many campuses have programs to aid faculty. However, are they the right ones, and how can faculty know?

**Recommendations for New Technologies.** To support faculty in learning new technologies, consider the following recommendations.

- Have faculty with different levels of proficiency test new classroom technology setups before implementing them in other classrooms. Such testing can assure that the systems are easy for faculty to learn. On many campuses, some faculty like to experiment with the way they teach. These faculty must have opportunities to reveal problems and get them corrected before the technologies move into regular use.
- Classrooms should be as similar as possible — one system is easier to learn than many.
- Given that classrooms need to differ sometimes, they should contain simple, well-designed and tested documentation about the technologies in the room, how they work, and, if appropriate, any differences from the basic classroom setup on campus. This information should be available to faculty for reference (Web site or paper) outside of the classroom so that they can prepare properly.
- Offer training programs. Chizmar and Williams also suggest establishing special venues in which faculty can come together and exchange experiences with usage and adoption, software used for instruction, and so forth.[14] We completely agree.

**Universities should encourage appropriate assessment and evaluation of the impact of technology for teaching and learning.**

### *Is Technology Worth It?*

A third barrier to faculty adoption of technology is the concern that technology might not really be critical for learning. Many faculty wonder whether it is worth their effort to learn many of the available technologies, given the skepticism that those technologies facilitate learning in higher education. Faculty cannot easily find convincing data that technology matters, nor can they easily determine if this is because technology doesn't matter or because the right studies aren't widely available. Very few journals summarize the results of well-run experiments on the impact of technology, and little useful scientific information is available on the Web. Which technologies used in the classroom (if any) facilitate the learning of discipline content or skills? Does the level or capability of the students matter?

Given the cost of technologies and the time needed to learn how to use them properly, universities should encourage appropriate assessment and evaluation of the impact of technology for teaching and learning. Universities should also encourage faculty to share what they learn with each other and with technology staff.

**Recommendations for Evaluating Technology.** Universities can take steps to verify the value of technology for teaching and learning, as follows:

- Universities should identify faculty who have assessed and evaluated the impact of technologies on learning on their campus. Depending on the number, consider organizing a workshop, conference, or set of papers to make this information more widely available to faculty. Panel discussions with skeptics and critics of the use of technologies can help stimulate faculty awareness.
- Encourage faculty to assess and evaluate the impact of technologies on learning. It may be appropriate to bring together faculty who have done such studies to discuss how to work individually and collaboratively to study these issues.

### *Institutional Support*

Another concern, although somewhat vaguely expressed, is the perception of inadequate campus support. In our study, a large percentage of the faculty were not satisfied with campus responses to problems. The study showed no relationship between satisfaction with the response and faculty's level of proficiency. Some faculty indicated that they were not satisfied because the problem was not

**Table 4**

**Suggested Solutions to Problems**

| Suggested Solution | Frequency (Percent of 30 faculty who made the suggestion) |
|---|---|
| Increase information about equipment | 8 (26.7%) |
| Equipment should be checked regularly | 6 (20.0%) |
| Make classrooms very similar | 4 (13.3%) |
| Create system for quick response | 3 (10.0%) |
| Increase student familiarity | 2 (6.7%) |
| Have a tech available in beginning of class | 2 (6.7%) |
| Keep a log over problems | 2 (6.7%) |
| Have better staff | 2 (6.7%) |
| Decentralize the decision making | 1 (3.3%) |

corrected in a timely fashion. Others said that the support personnel behaved nonchalantly and did not take the problem seriously, or that support personnel only sometimes fixed the problem. Undoubtedly, many faculty would identify slow responses to equipment breakdown as lack of institutional support.

Some of the solutions faculty offered for problems concerned how to improve institutional support. Institutional support and expected institutional support were rated as important determinates of faculty adoption of technology (see Table 4). Also, faculty indicated that lack of institutional support posed a major barrier to adoption and use of instructional technology.

Models of technology adoption in organizations identify users' perceptions of system and organizational support as one of the two major factors affecting whether a person will attempt to learn and use a technology.[15] Faculty in this study are apparently normal in this regard. In the interviews associated with this project, many faculty offered examples of what they perceived as examples of poor support. Some related stories of what had happened to them, but others reported stories they had heard. Some faculty were adamant that they would not try a particular technology because of what happened to someone else.

**Recommendations for Institutional Support.** Universities need to overcome the perception that they do not support technology. To do this, they must address existing weaknesses and work to correct misperceptions.

- Universities should work with technology staff and faculty to identify attitudes and behaviors interpreted by faculty as poor or inadequate support and take steps to reduce these. Technology staff must understand that the perception that they are providing excellent support is just as important as the high-quality support they do provide.
- Universities should restructure institutional support programs on campus to make them as effective as possible. To provide the best opportunities for each student's education, the university needs to assure that the campus has a rapid response system that can deal with a wide range of problems.

**Table 5**

**Summary of Recommendations**

| General | Some Specifics |
|---|---|
| Improve quality control to raise reliability of technologies. | 1. Work to convince technology staff that reliability is very important, especially concerning technology in classrooms.<br>2. Encourage the purchase of highly reliable technologies.<br>3. Improve systems for checking and maintaining classroom technologies.<br>4. Create new approaches (including staff training) to assure that extremely rapid responses are made to breakdowns. |
| Simplify learning to use technology. | 1. New classroom technology setups should be tested by faculty before they are installed.<br>2. Classrooms should be as similar as possible.<br>3. Differences in the technologies in each classroom should be well documented.<br>4. Help faculty learn by encouraging faculty discussions about teaching, learning, and technology. |
| Help faculty determine if learning and using technology are really worth it. | 1. Identify faculty who have assessed and evaluated the impact of technologies on learning and organize a workshop, conference, or set of papers to make this information more widely available to faculty.<br>2. Encourage faculty to assess and evaluate the impact of technologies on learning. |
| Improve institutional support. | 1. Identify attitudes and behaviors that are seen as poor or inadequate support, and work with technology staff to reduce these.<br>2. A rapid response system must be in place that can deal with a wide range of problems. |

## Conclusion

Our Ball State University study identified a number of important barriers to the adoption of technology. We believe that the problems and recommendations (see Table 5) described here are relevant for other schools. Most universities and col-

leges, regardless of their present levels of technology, will have faculty members falling into all categories along the adoption curve, from innovators to laggards. Our results were quite consistent across faculty at different levels of adoption.

The general categories of barriers to adoption of technology include reliability, lack of time to learn, uncertainty that using technology matters, and lack of support. Organizational and cultural differences among campuses will make implementing our recommendations quite different at each institution. Nonetheless, faculty in general have made it clear that they consider these issues important across modern technologies. To successfully implement new technologies in teaching and learning, institutions must address these barriers to faculty adoption. *e*


## Acknowledgments

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## Endnotes

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