Identifying barriers to technology-enhanced learning environments in teacher education

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Abstract

Creating technology-enhanced learning environments is a particularly challenging task when the environment includes a complex set of actual and virtual features. The challenge is readily evident in teacher education programs attempting to prepare future educators to use technology in their teaching. Unfortunately, most of these attempts have been marginally successful. What factors are restraining teacher education programs in terms of creating and implementing technology-enhanced learning environments for preparing tomorrow’s teachers to use technology? This paper offers a performance improvement framework for addressing this question. Data illustrating the framework’s utility are provided, along with a brief description of actions taken based on the data. © 2001 Elsevier Science Ltd. All rights reserved.

Teacher education programs across the United States have been challenged to respond to advances in information technology. Unfortunately, most programs have been slow to respond, continuing to rely on “technology utilization” courses to meet the challenge, rather than creating actual and virtual learning environments where technology is pervasive and integral to the teacher development process. What factors are restraining teacher education programs in terms of creating and implementing technology-enhanced learning environments1 designed to prepare tomorrow’s teachers to use technology? Using a performance improvement perspective, this paper:

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1 In this article, a technology-enhanced learning environment is the entire set of technology-related conditions that influence how people feel and how effectively they work and learn. The conditions range from the tangible (e.g. hardware, networks, and facilities) to the intangible (e.g. processes, skills, and values).
describes a framework for identifying barriers to technology-enhanced learning environments in teacher education programs; (2) offers data illustrating the analytical and decision-making utility of the framework, and (3) describes actions taken by one teacher education program in response to barriers identified through the analysis.

1. Background

The rapid expansion of the Internet has intensified pressures to move technology to a more central role in today's schools. Preparing teachers to work in technology-rich schools is a challenge facing every teacher education program. Unfortunately, many programs are not meeting the challenge. The Office of Technology Assessment (1995) reported on technology in teacher education and noted significant limitations, including:

1. faculty do not model technology use;  
2. students learn about technology — not with it;  
3. field experiences for preservice teachers are not designed to model the use of technology; and  
4. technology is isolated from the main curriculum and pedagogy of teacher education.

Collectively, these limitations point out the failure of teacher education programs to develop, implement, and sustain technology-enhanced learning environments. Put another way, it is unlikely these limitations will be overcome unless such environments become characteristic of teacher education programs.

Efforts to create technology-enhanced learning environments in teacher education programs are often grounded in a faculty development framework. Wedman and Strathe (1985) offered a model for faculty development in technology. The model included a context dimension, an attitude dimension, and an organizational dimension, the model's goal being to create ongoing support for faculty involved in the process of incorporating computer technology into their teaching. The Wedman and Strathe model was somewhat unique in that it included factors reaching beyond technology knowledge and skill issues. Unfortunately, the model failed to incorporate many other important factors influencing the use of technology in teacher education programs (e.g. expectations, rewards). A “performance support” perspective can help address this limitation.

Performance support can be thought of as a comprehensive set of strategies for improving performance, strategies extending beyond a training paradigm. For example, in a recent study of about 1000 firms, Huselid (1995) found that employee recruitment and selection procedures, performance management programs, incentive compensation systems, extensive employee involvement, and training combined to have a significant impact on turnover and productivity as well as short- and long-term corporate financial performance. Of significance here is the fact that training...
was identified as one strategy among many others. Extending this line of thinking, it
seems that efforts to create technology-enhanced learning environments in teacher
education programs must look beyond traditional faculty development approaches.

Models of performance support have appeared in the literature for some time. Two
decades ago, Gilbert (1978) offered a Behavior Engineering Model used for
diagnosing performance problems and planning performance improvement solu-
Problems* (now in its third edition), offered another very popular approach to per-
formance support. Several other models have surfaced in the last few years. For
example, Wedman and Graham (1998) developed the Performance Pyramid (Fig. 1)
as a means of guiding performance improvement efforts.

The premise of the Performance Pyramid is that significant accomplishments
result when three components are aligned: vision, support system, and resources. The
support system consists of six building blocks: (1) Expectations and Feedback; (2) Tools, Environment (i.e. facilities), and Processes; (3) Rewards, Recognition, and
Incentives; (4) Motivation and Self-Concept; (5) Performance Capacity, and (6)
Knowledge and Skills. If one or more blocks are missing, if the blocks are not
aligned (i.e. incompatible with each other), or if the resources are not adequate to
fuel the support structure, then accomplishments will suffer.

The Performance Pyramid has been used to guide performance improvement
interventions in industry (e.g. Dapkus, 1998), to introduce the notion of perfor-
mance support in training organizations (Wedman & Graham, 1998), and to guide
the creation of a technology infrastructure in higher education (Wedman et al.,
1998). Illustrated in the case study below, the Performance Pyramid can also guide

![Performance Pyramid](image-url)
identification of barriers to creating and implementing technology-enhanced learning environments in teacher education.

2. Case study

2.1. Context

The Performance Pyramid framework provided a means of identifying barriers to creating and implementing a technology-enhanced learning environment in the University of Missouri — Columbia teacher development program (MU-TDP). Launched in 1996, the MU-TDP was based on the notion of a “reflective practitioner” (Schon, 1984). The program consisted of four phases (University of Missouri-Columbia, 2000) where Phases 1–3 were designed to address the 10 teaching competency areas of the Missouri Standards for Teacher Education Programs (Mo-STEP). Phase 4 was an induction year intended to give support to the MU-TDP graduates for their first 2 years in the field. As a measure of performance assessment, each teacher development student maintained a portfolio organized around these teaching competencies. The program design included significant field experiences in all teacher education classes.

During the 1996–1999 timeframe, an approximately 60 faculty worked in the MU-TDP. Of these, less than one-third were tenure-track faculty; the majority of the instruction was provided by clinical faculty, consisting of a mix of full-time graduate students and classroom teachers “on loan” from schools across the state. Neither technology skills nor a pro-technology attitude were required in order to be a member of the MU-TDP faculty.

Annually, approximately 1100 undergraduate students were enrolled in the MU-TDP. In terms of academic potential, these students were very talented; the average ACT score was 25.1 compared to a campus average of 24.9 (University of Missouri — Columbia Enrollment Services-Registration, 1999) and a national average of 21.0 (ACT, 2000). The vast majority of the MU-TDP students were from Missouri and aspired to teach in Missouri schools.

In terms of technology resources, all MU-TDP faculty had modern desktop computers. Students had access to numerous computer labs on campus, and approximately 500 of the teacher development students had laptop computers provided by the university as part of a 2-year experimental program. Most teacher education classes were conducted in a 70-year-old building originally designed as a laboratory school located in the heart of the campus. All instructional spaces provided at least two ports to the campus backbone network. Mobile computers with projection systems were available, as were support personnel to deal with technical problems.

Between 1996 and 1999, the MU-TDP invested over $4,000,000 in technology-related products, services, and facilities. While much of the investment was in the form of one-time dollars, nearly $400,000 of rate (i.e. on-going) money was reallocated to provide the long-term financial base needed to fund the technology infrastructure. Unfortunately, there was concern that the investment had not produced...
the hoped-for level of systemic change; technology integration in the program was considered to be sporadic and required considerable diligence on the part of a few key individuals. Described below, a two-phase self-study was initiated to help identify and understand the barriers to a technology-enhanced learning environment.

2.2. Self-study

The self-study involved 23 teacher education faculty members; 87% were clinical faculty and 13% tenure track faculty. The first phase of the self-study used a survey instrument based on the Performance Pyramid model. The 15-item instrument included statements designed to identify potential barriers to the faculty’s use of technology. For example, one item stated: “The physical environment makes it easy for me to use technology in the teacher development program.” The faculty were asked to respond to these items, marking either “True,” “False” or “Unsure.” The faculty were also asked how frequently they used technology in their teaching and if the technology was helpful in achieving the goals of the teacher development program. The surveys were scored, frequencies and percentages were calculated, and potential barriers were identified. A barrier was considered to be any item in which approximately 50% or more of the responses were other than “True” (i.e. “Unsure” or “False”).

In the second phase of the self-study, the faculty were interviewed using a protocol based on the Performance Pyramid. The interview consisted of 21 questions, addressing such issues as expectations (“What is your role relative to the technology component in the teacher development program?”), environment (“Are the classroom environments you teach in set up to help you be successful with the technology component of the teacher development program? How so?”), and other factors contained in the Performance Pyramid. The interview results were sorted into categories based on the Performance Pyramid framework.

2.3. Results

Of the 23 faculty completing the survey, 17 (74%) indicated they used technology “Daily” in their teaching; the remaining six (26%) indicated they used technology “1–2 times per week.” Furthermore, 20 participants (87%) indicated that using technology was “Essential” or “Very Helpful” in achieving their teaching goals while the remaining three (13%) indicated that technology was “Somewhat Helpful.” Unfortunately, this high level of technology endorsement occurred in the midst of several barriers.

As summarized in Table 1, the survey identified five factors as barriers to technology use. Specifically, only half of the faculty (52%) reported they had received explicit expectations regarding the use of technology in their teaching. Less than one-quarter (22%) indicated they received regular and helpful feedback about how

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2 Technology use included non-classroom applications (e.g. listservs) as well as classroom applications (e.g. digital presentations).
<table>
<thead>
<tr>
<th>Barriers</th>
<th>Survey results</th>
<th>Interview trends</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Expectations</strong> (receives explicit expectations on the use of technology)</td>
<td>True 52%</td>
<td>Consistent with survey in that the expectations are inconsistent. No common understanding of expectations</td>
</tr>
<tr>
<td></td>
<td>False 31%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unsure 17%</td>
<td></td>
</tr>
<tr>
<td><strong>Feedback</strong> (receives regular and helpful feedback about how well expectations on technology use are being met)</td>
<td>True 22%</td>
<td>Faculty rely heavily on student feedback (6 of 9). Student feedback is a mix of student attitudes and student performance</td>
</tr>
<tr>
<td></td>
<td>False 57%</td>
<td>Very limited use of data from non-student sources (e.g. peer review, dept. chair)</td>
</tr>
<tr>
<td></td>
<td>Unsure 17%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NR 4%</td>
<td></td>
</tr>
<tr>
<td><strong>Tools, processes and facilities</strong> (receives ready access to technology; timely technical support is available; physical environment makes it easy to use technology)</td>
<td>True 39%</td>
<td>Classrooms do not support technology use</td>
</tr>
<tr>
<td></td>
<td>False 48%</td>
<td>Proximity to a support group increases satisfaction with teaching environment</td>
</tr>
<tr>
<td></td>
<td>Unsure 13%</td>
<td>Time is a factor that influences satisfaction with physical environment (e.g. time to set up room)</td>
</tr>
<tr>
<td><strong>Rewards and incentives</strong> (receives extrinsic motivation for using technology)</td>
<td>True 22%</td>
<td>Some rewards (4 of 9) were altruistic; others were truly for self (5 of 9)</td>
</tr>
<tr>
<td></td>
<td>False 26%</td>
<td>None of the rewards involved the university’s reward system (e.g. pay raise, formal recognition)</td>
</tr>
<tr>
<td></td>
<td>Unsure 43%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NR 9%</td>
<td></td>
</tr>
<tr>
<td><strong>Knowledge and skills</strong> (possesses technical and instructional knowledge and skills needed to use technology)</td>
<td>True 48%</td>
<td>Most faculty (6 of 8) expressed knowledge and skill needs focused on technology, not on its use</td>
</tr>
<tr>
<td></td>
<td>False 22%</td>
<td>Administrators need a wide mix of knowledge and skills, including technology basics and use (5 of 9) plus technology leadership (6 of 9) (e.g. modeling; goal setting)</td>
</tr>
<tr>
<td></td>
<td>Unsure 30%</td>
<td>Students need software skills, internet skills, and basic computer skills. No mention of teaching skills related to technology</td>
</tr>
</tbody>
</table>

* NR, no response.
well they were meeting expectations regarding technology use. Only two-fifths (39%) indicated the available tools, processes, and environment adequately supported technology use in teaching and only one-fifth (22%) reported that rewards and incentives were in place to encourage technology use. And, in spite of numerous training sessions, only half the faculty believed they possessed the technical and instructional knowledge and skills needed to use technology.

The trends identified in the interview data were consistent with the survey findings. When asked, “What do you believe you are expected to do with technology in the teacher development program?” most interviewees were able to respond, but their responses were very inconsistent, indicating a lack of a shared set of expectations. In terms of receiving feedback, the interviewees reported they relied on student feedback with very limited feedback from peers or supervisors. Interviewees also indicated that adequate technology environments were limited to a few computer labs; there were numerous complaints that the general classrooms did not support technology use due to wiring (electrical and data) limitations coupled with lighting and climate control problems. Classrooms that were not located near the technical support group were particularly problematic due to the additional time and effort required to set up a classroom for technology use. Interviewees also reported the only rewards for using technology in teaching were from sources other than the university’s formal reward system. While most faculty felt their knowledge and skill needs were primarily technical in nature, several added that university administrators needed technology-related leadership skills (e.g. modeling, goal setting).

3. Discussion, implications, and actions

The survey and interview results reported above were similar to results found by Dean, Dean, and Rebalsky (1996) in their study of employee perceptions of workplace factors influencing performance. Two-thirds of the participants (N=857) believed the environmental factors of information (e.g. expectations, feedback), resources (e.g. tools, processes), and incentives needed improving if their own performance was to improve. These trends carried across all sub-groups, including staff-level employees, managers, professional society members, graduate students, and teachers. Taken in conjunction with our findings, the Dean et al. study underscores the importance of a comprehensive perspective for identifying performance barriers.

The survey and interview results had significant implications for the MU-TDP. For example, expectations regarding technology utilization were needed along with feedback mechanisms to provide faculty with the information they needed to change their instructional practices. Also, a rewards and incentives program related to technology use in teacher development was needed. Additionally, the environmental constraints identified in the study needed to be removed, paralleled with improved access to technology resources and technical support. And new approaches to developing faculty and administrator technology-related knowledge and skills were needed. As described below, significant progress has been made on all fronts, leading to a technology-enhanced learning environment.
3.1. Expectations

Explicit expectations related to technology use in the MU-TDP were developed and implemented during the 1999–2000 academic year. A conceptual framework referred to as the “Technology Learning Cycle” (University of Missouri — Columbia, 1999) was created to communicate the process of becoming a technology using teacher and teacher educator. Briefly, the process consists of five phases: Awareness, Exploration and Selection, Learning, Application, and Reflection and Sharing. In terms of expectations, all teacher development faculty were expected to model the process for at least one innovative technology application per semester. The faculty member was responsible for selecting which technology application to learn and model, the recognition being that what is innovative to one faculty member may be “old-hat” to another. The underlying assumption here is that faculty will become life-long learners in terms of technology applications in teaching and learning, and model this quality in their own teaching.

3.2. Feedback

Each time a faculty member selected an innovative technology application to model, a “best practice” checklist was developed associated with the selected technology. The checklist was developed as a collaborative effort involving the faculty member and a technology integration specialist. The specialist then used the checklist as a guide for monitoring how well the faculty member performed in terms of modeling the selected technology application, culminating in a feedback session with the faculty member, focusing on how well the faculty member met the criteria established for the application. Additionally, a total-quality management process was created to monitor student achievement of technology standards based on the National Standards for Technology in Teacher Preparation by the ISTE Accreditation and Standards Committee (ISTE, 2000).

3.3. Rewards and incentives

Department chairs played a key role in terms of addressing the lack of rewards and incentives for technology use. Department chairs with faculty in the MU-TDP implemented the practice of including technology use in the end-of-year merit review process. Additionally, faculty who modeled technology use in their teaching had access to funds to purchase learning support materials having a technology component. These faculty were also given priority in terms of upgrades for their desktop computer.

3.4. Environment

The MU-TDP was fortunate in that the primary facility housing the program was scheduled for an $8.3M renovation. Virtually all vestiges of the old laboratory school were replaced with new resources and environmental features selected to
support technology use in the teacher preparation process. Lighting and climate controls, high-speed data connections, and flexible learning spaces of many shapes and sizes comprised a technology-rich environment with technical support only a few yards away. Additionally, all instructional spaces were physically adjacent to a multi-media resource area — the Reflector — a 14,000-feet$^2$ facility housing approximately 100 workstations in addition to a large collection of digital and non-digital learning resources used in the MU-TDP.

During this same time period, online learning environments became more commonplace in the MU-TDP. Faculty had ready access to products from Blackboard and WebCT, along with the technical support needed to ensure optimal performance of these tools. Additionally, the use of Internet video began to increase between the MU-TDP and selected school sites, creating opportunities for virtual field experiences for teacher development students.

3.5. Knowledge and skills

Consistent with the expectation that faculty and administrators model the use of innovative technology applications, a new process for knowledge and skill development was implemented. Referred to as the SWAT Team (Student Wizards Assisting Teachers), technologically-advanced undergraduates were teamed with teacher development faculty, the goal being to provide just-in-time training on an individual basis, tailored to the unique needs of each faculty member. Coupled with a conceptual shift from a techno-centric to a learning-centric view of technology-related knowledge and skills, the SWAT Team approach was replicated in other academic units across the MU campus, an indication of the intuitive appeal of the approach.

4. Conclusion

Many efforts to create and implement technology-enhanced learning environments in teacher education programs are limited to faculty development approaches aimed at improving faculty members’ knowledge and skills related to technology. While an important consideration, such efforts will fail to overcome the limitations identified by the Office of Technology Assessment since other factors (e.g. expectations, environment, etc.) are also at work.

Clearly, identifying the barriers to technology-enhanced learning environments is only the first step in their removal. And just as clearly, it is unlikely that the barriers can be removed without a financial investment. The MU-TDP was fortunate in this respect. In addition to internal reallocation of funds, external funding was secured through a US Department of Education (2000) grant — Preparing Tomorrow’s Teachers to Use Technology — to launch a large-scale effort to increase technology use in teacher education. And a state-level appropriation made it possible to transform an out-of-date building into an environment designed to support technology utilization and integration.
The Performance Pyramid provided a means of identifying a broad set of inter-related factors that were functioning as barriers to technology-enhanced learning in the MU-TDP. Other factors might also have been barriers. For example, when the current study was conducted, the Performance Pyramid did not include the notion of “organizational culture”. Organizational culture deals with such considerations as the values, mores, and communication networks in an organization. The data suggest that organizational culture factors may have indeed been functioning. Specifically, the lack of feedback from non-student sources may have been an indicator of a potential hesitancy in this organization for colleagues to provide direct feedback on each other’s teaching practices. If indeed such was the case, then this hesitancy may have been one of the mores of the organization, which in turn created a barrier to building a technology-enhanced learning environment.

Future research will include an assessment of organizational culture factors and potentially other factors influencing the overall environment. What is important here is that a systemic perspective was used, a perspective broad enough to guide the creation and implementation of a technology-enhanced learning environment for teacher development.

References