

Technology as Proteus: Digital Infrastructures that Empower Scaling Up

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The Greek sea-deity Proteus could overcome challenges by transforming among a myriad of forms (e.g., fish, bird, beast) with varied attributes and powers. Similarly, information technology can assume many forms in the service of improved educational outcomes and organizational effectiveness. Our society is still discovering powerful methods by which emerging interactive media can enable student learning, educators' professional development, efficient administration, links between schools and community, and collaborations with distant partners who provide expertise not available locally. Our case study describes the many ways that a single set of core investments in sophisticated computers and telecommunications provides leverage to enable transferring and scaling up innovations in the Milwaukee Public Schools (MPS). Research on the MPS technology infrastructure design and implementation process has developed heuristics that can generalize these protean benefits to other educational settings.

Milwaukee is typical of large urban districts in confronting many challenges to its success. Fortunately, relative political and organizational stability from about 1995-2002, based on an emerging consensus about reform strategies, made possible a sweeping set of technological initiatives. However, even before computers and telecommunications were widely implemented in the district, the concept of using sophisticated information technologies was a unifying force that helped to create a coalition of stakeholders and a common vision, increasing the district's credibility with and buy-in from the business community.

In its selection of infrastructural technologies and in its classroom uses of computers and telecommunications to aid student learning, MPS has made wise decisions that empower educational improvement on a number of levels. For example, committing to classroom placements of computers rather than isolating educational technologies into labs was an important strategic choice for promoting teacher familiarity and usage. Providing high-quality computers with reliable Internet connections in easily accessible classroom settings was vital in the effective implementation of technology-reliant curricula. Schools' commitment to spending money on equipment, training, and support influenced teachers' willingness to integrate technology into the curriculum. Linking school investments in learning technologies to parents' and communities' needs was a powerful method for creating commitment and for enhancing equity. Focusing on the career needs of students and vocational opportunities in high technology industries resonates well with families, businesses, and municipalities. The use of technology-based curricula that aid teachers underprepared in their subject domain addressed a chronic problem in urban school settings.

The district's sophisticated infrastructure is used by MPS to empower teaching/learning through a number of district initiatives: The MPS Curriculum Design Assistant (CDA) creates a collaborative environment where teachers are able to post/find lessons that support their day-to-day work in classrooms. This tool is web-based and is accessible 24-7 (http://www.milwaukee.k12.wi.us/pages/MPS/Teachers_Staff/Tech_Tools/CDA). When used in the creation mode, the CDA guides its users through lesson design options that are research proven, searchable and standards-based. State and district standards are readily available in the lesson design process, wherever and whenever the work is taking place.

The MPS Professional Support Portal (PSP) provides a single source for teachers to improve their effectiveness through multiple means of support. Implemented in stages, the first focus of the PSP is to advance and accelerate the effectiveness of new teachers, as well as to reduce the 37% attrition rate MPS experiences in the first five years after a cohort of new teachers is hired. New teachers' needs center on access to high-quality teaching and information resources, frequent interaction with expert mentors and

coaches, and ongoing peer support. In response, the portal project has created a convergence of several technology initiatives:

- The CDA provides a ready-made tool for teachers to interact about learning.
- Teachscape®, a commercial professional development process based on video case studies, provides examples of standards-based lessons being taught in urban classrooms at the elementary level (<http://ts2.teachscape.com/html/ts/public/>).
- TappedIn®, a non-profit multi-user virtual environment for professional development, provides an online social context that allows educators to build and sustain communities of practice (<http://www.tappedin.org>).

The website for the PSP is <http://mpsportal.milwaukee.k12.wi.us>. Formative design feedback from new teachers is encouraging.

Through funding from the Joyce Foundation, Chris Dede is orchestrating the availability of distant experts to assist MPS staff with design and implementation of the PSP. Using broadband telecommunications, Internet-based videoconferencing, and collaboration tools, Harvard University and EDC are providing:

- online courses customized by EDC for MPS staff in a cross-section of leadership roles across the district, centering in 2002-03 on the use of new interactive media in professional development and on data-based decision making;
- videoconference-based Harvard faculty guidance for a cohort of "rising star" MPS principals, who completed the Harvard Principal's Institute in Cambridge, MA this past summer and now are receiving feedback on their attempts to implement leading-edge practices in local settings;
- groupware- and videoconference-based collaborative design of the PSP with interface and knowledge management specialists at Harvard;
- shared development of a pilot graphical multi-user virtual environment to complement the intellectual and social interaction provided in Tapped In;
- consultations with an expert in program evaluation, helping to design metrics for assessing the complex interwoven set of activities associated with the PSP; and
- analysts who are documenting the process by which the PSP is created and implemented.

From a research perspective, the Harvard team is studying the extent to which broadband and Internet2 interactive media can support these complex activities across distance without the necessity to make frequent trips to Milwaukee.

The "expertise across distance" research funded by the Joyce Foundation is important along a number of dimensions. The aid provided is building human capacity in MPS to make the PSP successful in its design, implementation, and evaluation. Also, new teacher retention is a problem shared by many schools—especially in urban districts—that dramatically undercuts students' academic performance. Studies of the creation and implementation process of the PSP may help in adapting this innovation to replicate its strengths in other settings. In addition, strategies for the successful involvement of geographically remote experts in local improvement efforts could find widespread usage as broadband media become uniformly available.

The biggest challenge to sustaining and scaling up technology-reliant educational innovations in MPS is transitioning through changes in school board members and superintendents. In the past decade, several shifts in school board composition have created discontinuities in political direction. Related to this, from 1995 to 2003 five superintendents have led MPS, each with quite different strategies for educational improvement and dissimilar beliefs about the role of computers and telecommunications. The transition periods between superintendents cause a loss of momentum; this is followed by a need to reframe work to match their preferred agenda. The Department of Technology has weathered these transitions so far, continuing the initiatives discussed above. Being able to do so in a climate of such political and organizational instability is uncertain.

A strategy that has been especially effective at transcending these challenges has been the development of a National Technology Advisory Board. One element of MPS' PT3 grant was the creation of a National Technology Advisory Board. Two high profile national leaders, Chris Dede from Harvard and John Morgridge from Cisco, agreed to serve as Co-Chairs and in turn persuaded other national leaders in educational research and in business to join them in support of Milwaukee. The Board's discussions rapidly focused on two core issues impeding learning in MPS: the lack of active participation by district curriculum leaders in technology innovation efforts, and the high turnover among new MPS teachers. A summary report of the work of this committee can be found at <http://www.milwaukee.k12.wi.us/pt3/>.

MPS's emerging capabilities for data-driven decision making are important in achieving its goals of improved student learning outcomes and better organizational effectiveness. Technology provides many types of leverage in improving student assessment and providing formative, diagnostic information to teachers. Of equal importance, but less understood, are the ways sophisticated information systems can aggregate data to enable aligned policy-setting across different levels of a large, complex decision making system. MPS now has the technology infrastructure in place for developing a sophisticated information system to support data-driven decision-making. Creating the human and organizational capabilities to use such a system effectively is the next step. Research is needed on what types of data provide evidence that fosters scalable, sustainable strategies for improvement for practitioners and policymakers.

The MPS story illustrates how stakeholders worked together to create successful educational improvement, with computing and telecommunications fostering a shared vision and supporting partnerships. MPS is leveraging its computers and telecommunications infrastructure in multiple ways that collectively are transforming the district's operations. Too often, investments in technology are narrowly judged on just one type of capability (e.g., the Internet is in every classroom — did test scores go up?). Elaborate metrics now exist for calculating the "total cost of ownership" for information technology, but estimates of total benefit from this investment tend to dramatically underestimate the full range of potential improvements enabled by a protean district-wide infrastructure. To generalize heuristics from Milwaukee's successes to other districts, additional research is needed on the conditions for success that enabled the advances discussed above. In particular, understanding the core sources of effectiveness in MPS's innovation model is vital to preserving implementation fidelity in the mutual adaptation process for transferring this suite of strategies to new settings.