3 Closing the teaching gap: assisting teachers to adapt to change

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Introduction

THERE IS A GAP BETWEEN the teaching that is needed to reach rising educational expectations and the practices that teachers are accustomed to using (Black and Wiliam, 1998b). In the US, it is increasingly recognised that achievement gains to match rising standards depend on the improvement of teaching (Lampert, 2001; National Commission on Mathematics and Science Teaching for the 21st Century, 2001; Stigler and Hiebert, 1999). This is hardly surprising, since all plausible theories of action identify teaching as the final common pathway connecting curriculum reforms to student outcomes.

How to improve teaching

Many believe that improved teaching will follow structural reforms, for example:

- higher initial salaries and differentiated pay based on merit;
- an increase in the ratio of 'content-based' to 'method-based' courses for teachers in training;
- higher academic standards in teacher preparation;
- broadening of the recruitment pool to include those from non-traditional sources, such as retired military and technical workers.

Optimism that these changes will improve teaching can only be based on the mistaken belief that these ideas are new and untried. Although they were writing about an

earlier wave of reform set in motion in the early 1980s, what Sarason and his colleagues noted then is still true today (Stigler and Hiebert, 1999):

> *…[American reformers] fail to realize that everything being said and proposed was said, proposed, and acted upon earlier as a reaction to the narcissistic wound experienced by [US] society when the Soviet Union orbited the first sputnik in 1957.*
>
> *(Sarason, 1983, p.4)*

> *…[what is] recommended for improving the preparation of teachers has been recommended countless times in the past without discernable effect, e.g., better grounding in specific subject matter and the arts and sciences generally, better supervision, more in-service and continuing education opportunities, stricter and more objective standards for judging teacher performance and competency, and greater and material recognition of superior teachers.*
>
> *(Sarason, Davidson and Blatt, 1986, pp.vii-ix)*

THE BENEFITS OF PROFESSIONAL DEVELOPMENT

Happily, many now recognise that structural reforms have limited effects unless the intended changes are implemented in classrooms, and that implementation depends on robust professional development. Teachers are receiving site-based, long-term professional development in grade-level or departmental contexts (Darling-Hammond and Sykes, 1999; Loucks-Horsley *et al.*, 1998). This training covers how to implement standards-based instruction, and how to develop and analyse student performance assessments. Some teachers are given time during the working week to collaboratively develop and try out lessons, then revise and re-teach them. Teacher response to these opportunities is positive (Garet *et al.*, 2001); this time, perhaps intended reforms may actually be implemented in classrooms.

Even with new professional development opportunities, improvements in teaching will not be easily achieved. Despite many attempts to change it, teaching in the 1990s differed little from the instructional practices described decades earlier by Rice (1893) and Stevens (1912) – who made their observations well before the era of colleges of education and the rise of progressive education, which some critics (for example, Oldenquist, 1983) blame for contemporary school problems. Hoetker and Ahlbrand (1969) found a 'remarkable stability' in the patterns of instruction described in over a century of reporting, patterns that have been condemned by successive waves of reformers, yet which survived virtually unchanged. These patterns remained so familiar and predictable in US classrooms in the 1980s that they were described as the 'default teaching script' (Cazden, 1988, p.53; Gage and Berliner, 1988, p.539).

TEACHING AS A CULTURAL ACTIVITY

This persistence and stability led many to describe teaching as a 'cultural activity' (Cuban, 1990; Feiman-Nemser and Floden, 1986; Fullan, 1991, 1993; Little and McLaughlin, 1993; Sarason, 1971; Tharp and Gallimore, 1989; Wagner, 1994). This is not good news. Anthropology teaches that cultural change lags behind environmental change (Edgerton, 1992). When an environmental perturbation occurs, the strategy of most individuals and groups is to adapt cautiously, through small experiments on the margins of cultural practice. Activities are modified just enough to

make things work – humans are *satisficers* rather than *maximizers* to use Herbert Simon's terms (Simon, 1957), and are generally happy with *just-good-enough* to get by (Edgerton, 1992). Daily routines are compromises between what is *possible* and what is desirable. Little wonder people prefer what they believe to be the most workable arrangements when change involves re-negotiating many hard-won solutions to competing pressures.

Over time, cultural activities and routines are taken for granted and become embodied in beliefs about what is right and proper. This redundancy is the basis of normative behaviours. If 'everyone does the same things' the sources of alternatives are limited.

OBSERVING CLASSROOM PRACTICE

The TIMMS Video Study

One of the major barriers to changing teaching is the narrow range of instructional practices that teachers observe as students. This point was underlined by the Third International Mathematics and Science Study (TIMSS) Video Study, which dramatically illustrated why it is so hard to introduce new teaching practices (Stigler and Hiebert, 1999). As part of TIMMS, the research team conducted a video survey of nationally representative samples in three countries (Germany, Japan, and the US). A video survey is like the more familiar variety, except random samples of lesson are videotaped in numbers sufficient to conduct statistical as well as qualitative analyses. In the TIMSS Video Study, eighth-grade mathematics lessons (for 13 and 14 year olds) were taped during regularly scheduled class periods over the course of a single school term.

After months of watching and analysing lesson videos, the TIMSS team concluded that each nation had a distinctive cultural script for teaching (Stigler and Hiebert, 1999). Although this conclusion was no surprise, the TIMSS video data put in sharp relief a very practical problem. The vivid images captured in the videos made clear how hard it will be to introduce practices aligned to the new curriculum standards: how will teachers ever be able to envisage and implement alternative practices if they seldom see any? *Seeing* that something can be completely different is one of the most effective ways of opening eyes to the ubiquity of cultural practices and creating the circumstances for change.

OBSERVATIONAL LEARNING AS PART OF THE KNOWLEDGE BASE

A general principle of behaviour change theory is that acquisition of complex competencies depends on opportunities for observational learning (Bandura, 1977). To find models, teachers turn to nearby colleagues, or to memories of their own teachers, reinforcing the normative practices that have proven so resistant to change.

Providing teachers with images of alternative practice is more than a question of sending out videotapes. Where will the images of alternative practices be found if so few use them? How can they be aligned to diverse local, regional and national curriculum standards? How will videos of teaching practice be validated as appropriate and effective? Who decides?

Powerful images of alternatives will make a difference only if they are part of a professional knowledge base for teaching. And that is something the US has never developed. Working in relative isolation, individual teachers gradually gain experience and learn what works well in their own classrooms. But their knowledge is shared in

only a haphazard manner. As much as they might benefit from the knowledge of their veteran colleagues, most teachers cannot access it and must start over, creating this knowledge anew.

Late in his career, Dewey noted that one of the saddest things about American education is that:

> *…the successes of [excellent teachers] tend to be born and die with them: beneficial consequences extend only to those pupils who have personal contact with the gifted teachers. No one can measure the waste and loss that have come from the fact that the contributions of such men and women in the past have been thus confined.*
>
> *(Dewey, 1929, p.10, with thanks to James Hiebert for this quotation)*

To swim against the tide of culture, and close the teaching gap, will require a rich, broad and validated professional knowledge base that includes vivid images of alternative practices and an environment that both encourages and supports continual improvement of teaching practice.

Designing a professional knowledge base for teaching

We recently attempted to define the characteristics of a professional knowledge base for teaching, how it can be developed, and how the work of practitioners and researchers might contribute (Hiebert, Gallimore and Stigler, 2002). Six design features for a professional knowledge base for teaching were identified. What follows is adapted from our joint efforts.

1. KNOWLEDGE LINKED WITH PRACTICE

Knowledge for teaching is useful when it is developed in response to specific problems of practice. Such knowledge can be applied directly, without translation, but only to a restricted number of situations. It is linked with practice by being grounded in the context in which teachers work and aligned to the content that they are required to teach. The processes that yield knowledge of this sort are collaborative and involve teachers in various forms of joint activities including:

- differentiating problems and developing a shared language for describing them;
- analysing classroom practice in the light of differentiated problems;
- envisaging alternative solutions;
- recursively testing alternatives in the classroom, reflecting on their effects and refining and re-teaching until they are satisfied with the consequences.

2. KNOWLEDGE THAT IS DETAILED, CONCRETE AND SPECIFIC

Knowledge linked with practice is detailed, concrete, and specific. Although the knowledge might apply more generally, it is more often directly related to particular lessons. This differs from the typically propositional knowledge of researchers, which is 'all things equal' and intended to apply to many problems and contexts. Propositional research knowledge can contribute, but it must be processed through multiple observations and replications into practitioner knowledge suited to a specific context, because in each case all things are *not* equal (Goldenberg and Gallimore, 1991).

3. KNOWLEDGE THAT IS INTEGRATED

Researchers have identified many kinds of teacher knowledge: for example, content knowledge, pedagogical knowledge and pedagogical content knowledge (Shulman, 1986; Munby, Russell and Martin, 2001). Other kinds of knowledge have been suggested, for example, *the knowledge of students* – what they know and how they learn – that accomplished teachers use to make content comprehensible to learners (Ma, 1999). All the different types of knowledge are intertwined, organised not according to *type* but rather to the *problem* that the knowledge is intended to address. Although it might be possible to identify 'content' as a teacher's knowledge deficiency, or knowledge of what students think on first exposure to a text or problem, it is not helpful to do so if the goal is to improve the teaching of something particular. Knowledge types traditionally separated by investigative analysis must be tightly integrated in order to teach a particular lesson more effectively. This knowledge is linked with practice, and integrated and organised around problems of practice.

To summarise, these first three design features describe the knowledge millions of teachers generate every day. They represent exactly the kinds of knowledge of teaching that teachers both need and want from a professional database. We argue elsewhere that, ultimately, such everyday practitioner knowledge *can* be the principal source of a professional knowledge base for teaching (Hiebert, Gallimore and Stigler, 2002). This pathway, already explored by others (for example, Hargreaves, 1998; for a review see Munby, Russell and Martin, 2001), can be viewed sceptically because practitioners' knowledge is highly personal and, under current conditions, lacks the public vetting of researchers' knowledge. However, its origins in practice provide for the first three of the six features that a professional knowledge base for teaching must include. The other three qualities, described below, transform *practitioner* knowledge into *professional* knowledge (Hiebert *et al.*, 2002).

4. PROFESSIONAL KNOWLEDGE MUST BE PUBLIC

For knowledge, practitioner-generated or otherwise, to become professional knowledge, it must be made public and be represented in such a way that it can be communicated to other members of the profession. Professional knowledge must be created with the intent of public examination, with the goal of making it shareable among teachers, open for discussion, verification, refutation, modification or improvement. Collaborations are essential because they force participants to make their knowledge public and understood by peers during its creation.

5. PROFESSIONAL KNOWLEDGE REQUIRES A MECHANISM FOR VERIFICATION AND IMPROVEMENT

To be professional, knowledge must be accurate, verifiable and continually improving. Teachers working together or with their students might generate knowledge that turns out, in the end, to undermine – rather than improve – teaching effectiveness. Local knowledge is immediate and concrete, but almost always incomplete; sometimes it is blind and insular, or even seriously wrong (Goldenberg and Gallimore, 1991).

To ensure improvement, the insularity of local contexts must be surmounted. One way to assure improvement is the mechanism of multiple observations and replications, which makes it possible over time to secure trustworthy knowledge. Practices must be tried, observed and evaluated in many contexts and the results

accumulated and shared over time and location. These are the methods individual teachers have always used to learn to teach – by observing their own practice and later revising it, according to students' feedback and progress.

An analogy can be used here to make the point. Driving through farming land in the US, it is common to see farmers' fields identified as test sites for a grain crop strain. As part of the US agricultural extension system, each year's results are fed into a database, reviewed, indexed and made available to farmers hoping to improve their crops. Many such tests have been conducted every year during the past century. The consequences have been a boon to the American people and economy.

6. PROFESSIONAL KNOWLEDGE MUST BE STORABLE AND SHAREABLE

Even public knowledge is gradually lost if there is no means of accumulating and sharing it across space and time. Practitioner knowledge exists at a particular time and in a specific place. Its life may be extended briefly if shared locally with a small number of colleagues, but this is not sufficient to create a professional knowledge base. Teachers must have a means of storing knowledge in a form that it can be accessed and used by others if it is to take on a life of its own.

Traditionally, teachers wishing to record their knowledge for others have used the most common medium: words on paper. Written records preserve ideas and allow them to be accessed by others. They can be handed across time and space. But the challenge of improving teaching leaves no reason to be optimistic that these conventional means will be sufficient. Talking and writing about teaching is never going to be enough to change the culturally-reinforced practices that were seen again and again in the TIMSS Video Studies (Stigler and Hiebert, 1999; Stigler, Gallimore and Hiebert, 2000) and in dozens of studies since the 1890s. Powerful images of alternatives – and many of them – are required if significant changes are to be achieved. If all teachers ever observe are taken-for-granted cultural teaching scripts, how can we ever hope to improve teaching? The scope of the problem can be represented with a second agricultural analogy:

> *[In the 1800s] it had taken…Coke of Norfolk, sixteen years to persuade his tenants to follow his example and [abandon broadcast planting in favour of the row-culture method], the use of which, he estimated, spread at the rate of only a mile a year. [This despite evidence that row-culture produced twice the yield.]*
>
> *(Bovill, 1962, pp.29–30)*

If opportunities to see alternatives are dependant on teachers occasionally peering into the room next door, changing practices to match new standards will also fall victim to a 'mile a year' rule. If the process takes too long, standards, assessments and other promising reforms may see their political base evaporate. We therefore need to develop a professional knowledge base for teaching that provides teachers with easy access to many alternatives outside their own culturally-constrained practices.

Internet-based technologies are a possibility: this potential was recognised in a National Commission chaired by former US Senator and astronaut John Glenn. To improve the quality of mathematics and science teaching for children aged between five and 16 years (grades K to 12), the Commission urged that:

> *… a dedicated Internet Portal must be available to teachers so they can make use of and contribute to an ever-expanding knowledge base.*
>
> *(National Commission on Mathematics and Science Teaching for the 21st Century, 2001)*

Once access and bandwidth issues are resolved, internet and multimedia technologies can potentially make a vast store of knowledge widely and easily accessible to teachers. Because it is now possible to store video and related data that can be accessed over the internet, teachers faced with teaching new topics and lessons could have immediate access to the best ideas accompanied by vivid examples of alternative practices. The content of the knowledge base will have been sifted, evaluated and verified, yielding the standard practices that distinguish the profession (Yinger, 1999).

However, the Glenn Commission sketched only broad goals for an internet approach. The immediate challenge is to consider the design of a technology solution, and by what standards to evaluate it. In the remainder of this chapter, we sketch some design ideas and hypotheses for what we believe an internet solution should include.

A design and some hypotheses for a technology-enabled professional knowledge base

To accumulate a professional knowledge base that is public, shareable and verifiable, we propose that three design components are necessary: digital libraries, user and author interfaces and real and virtual communities. Schematic representations of the system are presented in Figures 3.1 and 3.2 (page 32).

Although technology is attractive as a solution, what the Glenn Commission and many others envisage has not yet been built or tested. Therefore the following should be read as hypotheses rather than prescriptions.

1. HYPOTHESES ABOUT INTERNET-ACCESSED DIGITAL LIBRARIES

To serve the many purposes intended, we hypothesise that progress is more likely to be achieved if many libraries are built, suited to different needs, ranging from those created by a local school system to national and even international ones. From the outset, digital libraries need to be expandable and accessible over the internet using consumer technologies. Some will be developed by institutes of higher education, public and private, professional and technical organisations and commercial entities (for example, to accompany published material).

All libraries need to be indexed and, in this case, curricula are likely to provide the most natural indexing framework for many of these new kinds of libraries. Where teachers share the same curriculum and are expected to teach the same topics, professional knowledge can be indexed with the curriculum.

Lessons may be a practical way to organise and provide access to digital libraries to support improvement of teaching for a number of reasons. Lessons are:

- units of analysis that allow teachers to simplify teaching for study while retaining its essential character;
- contexts within which students' learning are woven together – goals for students' learning, attention to students' thinking, analyses of curriculum and pedagogy, and so on;

- units small enough to enable the complexity of teaching to be reduced to a manageable size.

Figure 3.1: *A schematic representation of the authoring system for Knowledge Base*

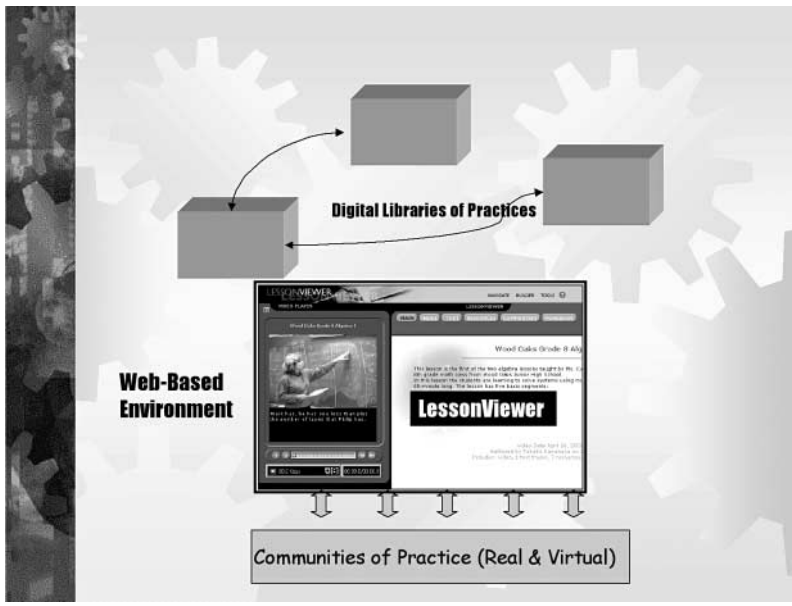
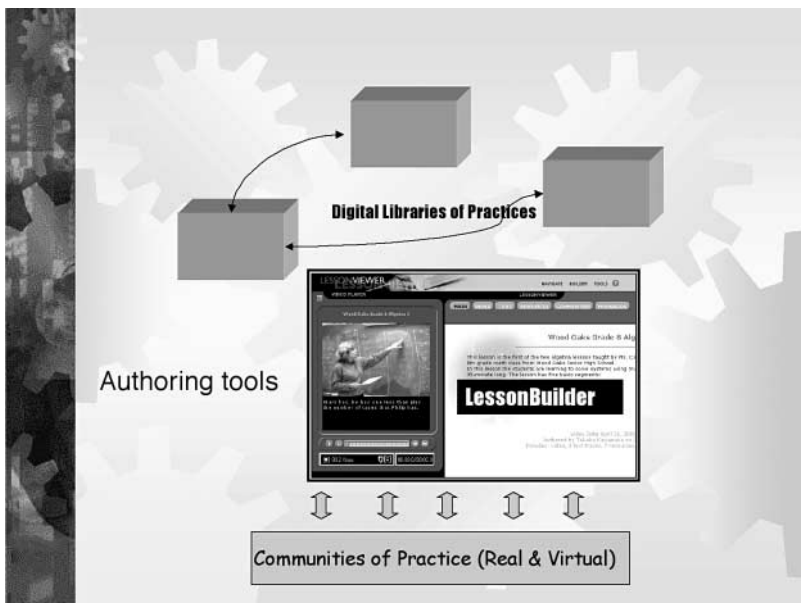


Figure 3.2: *A schematic representation of the web-based environment for Knowledge Base*



Digital libraries are likely to have more impact if they are built around vivid *images* of practice, rather than *words*. Teaching is complex and hard to capture; words may be interpreted in a variety of ways and much energy in education goes to debating the merits of different practices. The TIMSS Video Study discovered what many already knew: that the words used to talk about teaching often refer to quite different things; what one person means by 'problem solving', for example, is markedly different from what another means (Stigler and Hiebert, 1999).

Learning can be facilitated if the same ideas and concepts are exemplified in a variety of different contexts and using a range of styles. For this reason, we propose that digital libraries include a *large* collection of lesson videos – not just a small collection, and not just lessons taught by charismatic 'star' teachers, whom many admire and few can emulate. Digital libraries that are well-equipped in this way should help teachers envisage a wider range of teaching practices by allowing examination of numerous examples of practice. There is no single way to teach: good results can be obtained with a variety of methods and styles. Just as no good library stocks only a few genres, so too must a digital library of professional knowledge offer plenty of variety and contrast.

The videos in the libraries ought to include plenty of *whole* lessons, or even units of multiple lessons. Limited clips have limited credibility and impact, because the complexities of teaching have been edited out. The theory behind short clips is that teachers should imitate a demonstration and that teaching is a bundle of general pedagogical strategies; the theory that we advocate is that teachers should slow down teaching to analyse it and develop their own professional judgement.

Lesson videos should be surrounded with, and linked to, rich case materials. These should include curriculum standards, lesson plans, images of student work, assessment ideas and examples, commentaries by teachers and researchers and other resources. Images are powerful, but they need to be set in context to support teacher learning.

2. HYPOTHESES ABOUT USER AND AUTHOR INTERFACES

User interface

To help improve teaching, user interfaces that provide access to digital libraries must support *active learning* as well as easy access. Watching lesson videos can be like watching television: you may be entertained, but you won't necessarily learn much.

Teachers, alone and in groups, need an interface so that they can navigate and interact with the lessons and associated resources, enabling them actively to study and learn. The interface should link specific practices in lesson videos to all the resources in the library that are relevant to a given lesson: for example, the previously listed curriculum standards, lesson plans, images of student work, assessment ideas and examples, commentaries by teachers and researchers, and other resources.

The user interface should be designed to enhance teachers' command of the *subject matter* as well as the analysis of *pedagogy*. One way is to provide expert commentaries on lesson content, which are linked to specific parts of the lesson and to supplementary materials and resources. The system should provide for attaching to each lesson links to more information about content, or copies of relevant curriculum and instructional materials. Samples of student work should be attached to the lesson videos so that misunderstandings and errors can be part of the analysis of a lesson. The user interface should provide a way for teachers to communicate with colleagues

and expert educators about what they see in lessons, via forums and other means.

Author interface

To stock the libraries with teachers' work, the technology must make authoring of cases widely available and easy to learn. The key to a professional knowledge base is that there is not only wide access, but wide participation in its construction and, as the next section argues, in its review, improvement, and validation. The authoring interface must be inexpensive and easy to use to ensure the full participation of instructional leaders in many kinds of organisations.

It should be possible for authors to design activities for teachers to maximise their learning from study of the lesson videos and associated resources. For example, authors should be able to ask teachers to review their materials. Once they grasp the content, teachers should be able to review a video and mark places in the lesson where they observe particular points. This and similar functions will be needed to transform the digital libraries from a source that teachers are to *imitate* into one that they *study* and use to deepen their understanding and professional judgement.

3. HYPOTHESES ABOUT REAL AND VIRTUAL COMMUNITIES

It is easy enough to imagine communities of users for digital libraries and friendly interfaces. However, the long-term value of professional knowledge, enabled by technology and amplified by videos, depends on the *quality* of what is in the digital libraries: maintaining that quality will be a major challenge. However, the technology envisaged here can both be the means of making professional knowledge available and engaging wide participation in verifying its quality.

The digital libraries we envisage face a major challenge. On the one hand, we want to avoid censorship and ideological purism, on the other we want digital libraries to be repositories of professional knowledge that meet some standard criteria. To realise this, professional organisations and education authorities must work out reviewing procedures. Even at a local level this can be a daunting challenge, and will continue to be so as education struggles to develop a consensus on what constitutes 'standard practice'.

One solution rests within the technology itself. To achieve consensus on what is standard practice, a professional group needs to anchor discussions in practice, not in words about teaching. If the technology were available, it could surely make observation-based deliberations more likely, and that would be a good thing. There is evidence to suggest that when teachers and educators ground discussions of thorny controversies by referring to practice captured in videos, they become more productive and less rhetorical (Saunders and Goldenberg, 1996).

A national example of knowledge production and verification

One model that may offer some ideas for creating communities for the production and validation of professional knowledge is the Japanese system for professional development. Many Japanese elementary school teachers participate, throughout their careers, in a continuing in-service training programme built around the Lesson Study group (Fernandez *et al.*, in press; Lewis and Tsuchida, 1997, 1998; Shimahara, 1998; Shimahara and Sakai, 1995; Takemura and Shimizu, 1993; Yoshida, 1999). Small groups of teachers meet regularly, once a week for several hours, to collaboratively

plan, implement, evaluate and revise lessons. The process begins within the Lesson Study group, moves outward to include all teachers in the school, and expands to include teachers in other schools and districts as they review the materials. The knowledge gained from the year-long experience is also represented and stored in a form useful for their colleagues. Eventually those Lesson Studies that are vetted by external reviewers are published in practitioner journals for use by other teachers.

Linking teaching practices to student outcomes

The system sketched may help achieve that most elusive of goals: linking specific teaching practices to student outcomes. Digital libraries of practice give researchers and practitioners in diverse test sites access to the same visual definitions of practice. Such access can support clinical trials in many contexts, thereby enabling robust evaluation of practices through repeated observation and replication. Multiple sites might submit for review video examples of their replication efforts, offering a 'back translation' review of how well the intended changes were actually captured and implemented. Common assessment of student learning associated with practices being evaluated could also be supported by online digital libraries. This offers hope of gradually reaching a consensus on what practices are associated with different levels and kinds of student learning.

Conclusion

Will a professional knowledge base for teaching emerge from technological opportunity? Or will this, like so many promises of technology, prove to be a disappointment? It is too soon to be certain. However, after half a century of trying to disseminate research knowledge in conventional and 'comfortable' ways, it is surely time to entertain other avenues to improve teaching.

Early experience in our laboratory is promising (see www.lessonlab.com/software). Several thousand teachers in three dozen different projects are using a software platform inspired by the TIMSS Video Studies and research on professional development. Some are participating in the building of digital libraries and others are borrowing from those developed elsewhere. The TIMSS-R Video Study released in 2002 a public-use library of eighth-grade mathematics and science lessons (designed for 13 to 14 year olds). Some publishers are providing small libraries of demonstration lessons to accompany their textbooks. Local school systems are using locally-built lesson libraries to implement standards-based instruction, support in-service training programmes and induct new teachers into the profession. A few institutes of higher education are building video cases into online courses to augment traditional programmes.

The stream of activity is small at present, and many major problems have yet to be solved. Among the most challenging is the development of a consensus on what should be available in the library, and who decides what is standard practice.

Amazing technologies and digital libraries will not be enough to close the teaching gap. Like books in libraries, a professional knowledge base of teaching will do no good unless its contents are checked, watched, studied, discussed, improved, augmented and the ideas woven into existing knowledge and practice. To make

effective use of a professional knowledge base, teachers need to be part of a professional development programme that is long term and coherently integrated into ongoing reform activities in their school and district.

For digital libraries to function as envisaged, educators will need to find a way to agree on what constitutes standard practice. Standard practices, according to Al Shanker, the American union leader, distinguish a profession (Shanker, 1995); the establishment of such practices is their proper aim, provided that there is also a means of improving them over time. In medicine, failure to follow the standard practice is *malpractice*. The new technologies that are now available can help make teaching a profession defined by its knowledge base, which will allow it to improve its practices over time (Yinger, 1999). Over the past 100 years, medicine has changed greatly – not because smarter people became doctors, but because medicine found a way to accumulate and share knowledge and to update and improve it over time. If we begin now, and take advantage of the new technologies, perhaps the same will be true of teaching within the next generation.