Hypermedia Technologies for Case-based Teacher Education

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Abstract

Case-based methods of teacher education offer the promise of developing forms of knowledge useful in everyday practice. However, most implementations of case-based pedagogy for teachers rely on traditional media and means. We have been developing and assessing the utility of hypermedia-based tools for case-based learning. Along the way, we have confronted a number of design challenges, including consideration of the very nature of a case and appropriate means for anchoring case-activity to important mathematical ideas. Accordingly, we describe an evolving set of design principles for case-based instruction with hypermedia and report some of the ways in which we assess learning with these tools. We relate our development efforts to other research about case-based learning, specifically that conducted by the Cogniton and Technology Group at Vanderbilt, Magdalene Lampert and Deborah Ball at the University of Michigan and Kay McClain and Paul Cobb at Vanderbilt University.

Case-based methods for teacher education afford opportunities to develop knowledge of exemplary practices and to learn how to analyze and reflect about classroom contexts (Merseth, 1996). Mathematics educators advocate case discussions as catalysts of change, especially when the cases exemplify and problematize the growth and development of student thinking in mathematics (Barnett & Friedman, 1997; Schifter, 1996). Our interest in cases is motivated by the need to develop tools for elementary teachers that will help them understand how students think about forms of mathematics typically unfamiliar to teachers, like geometry and space or measure. Thus, our goals are to exemplify not only student thinking, but also, core mathematical ideas. To further complicate our task, the kinds of student thinking that we are most interested in promoting rely heavily on teachers' orchestration of mathematical arguments in the classroom, and on teacher skill in nurturing classroom norms related to argument, inscription (e.g., ways of representing three dimensions in two), and tools (e.g., what is a Polydronä and what is it good for?).

The multidimensional and relatively ill-structured nature of this learning task has prompted us to think hard about the nature of the cases that we wish teachers to consider and also, the nature of the medium in which the cases are presented for consideration by teachers. We have developed a small number of design principles for selection and development of cases, and also, design principles for developing learning tools for teachers. We have conducted a few of empirical studies to assess the potential of the tools developed with these design principles in mind, and from these studies, intend to make some modifications in our designs. In the sections that follow, we highlight our design principles for cases and for learning tools, respectively, and then go on to describe how these principles are realized in the design of tools for teachers. Following this description, we summarize results from studies employing single-subject methodologies to assess the effectiveness of these tools for prospective teachers. We conclude with a brief view of the work of our colleagues from Vanderbilt and the University of Michigan who are also attempting to incorporate hypermedia and case based instruction into their own professional development efforts.

Case Design

Although often considered relatively unproblematic, the nature of an effective case is far from transparent (Williams, 1992). Following from the work in professional development conducted within the mathematics education community (e.g., Fennema, Carpenter, & Franke, 1997), we develop cases of student reasoning about elementary mathematics, although the case may also exemplify other elements of teaching and learning. Within this general locus, we have developed a number of selection principles for choosing among many hours of classroom video. These selection principles were informed both by the literature and by the conduct of two empirical studies (described later) and consequently, at this point represent "lessons learned" that now guide our development efforts.

Briefly, our evolving design principles in case design call for the case to be authentic and narrative in form. The case should be long enough to establish some form of instructional corridor. The cases also should have additional supporting video to provide multiple examples (telescoping) and should help teachers come to view themselves as active agents in their students' learning. We will now look at each of these principles in greater detail (see Table 1 for summary).

Narrative

Cases tell stories about the development of "big ideas" in mathematics (Schifter & Fosnot, 1993). We select episodes with an eye toward their narrative quality: clearly identifiable actors engaging in mathematical activity related to some essential tension that is resolved during the course of this activity. The essential tensions that we are concerned with revolve around children's attempts, with the assistance of teachers, to "mathematize" some aspect of experience and thus make (more) sense of it. We provide a narrator's viewpoint in which the main story line corresponds to the prototypical development of one or more important mathematical ideas.

Authenticity of Cases

We agree with others (Brown, Collins, and Duguid, 1989) that instruction organized around authentic problems can facilitate the creation of experiences that are more similar to the kinds of informal learning that takes place in daily life. It is for this reason that all our cases are authentic, in that footage is from real classrooms with full-time professional teachers. No situations are staged for ease of filming, nor are students primed for specific responses. The authentic nature of our cases may result in footage that is less than ideal, but we believe in exchanging some quality for realism. In addition, realistic situations facilitate remembering, are more engaging, and prime the user to notice the relevance of mathematics and professional practice in everyday events (CTGV, 1997).

History of Learning

Cases can make a history of learning visible. Histories of learning are important elements of reform efforts in mathematics, partly because such histories provide means for learners to understand the evolutionary and provisional nature of mathematical thinking, and partly because constructing histories orients teachers toward establishing sociomathematical norms and associated practices in their classrooms. Thus, we tend to select episodes of teaching and learning that extend throughout a school year or that are related to other episodes that allow for ready extension. This emphasis on history is consistent with an orientation toward learning as a form of development.

Telescoping Episodes

Although the backbone of the case is a condensed narrative, we also develop "fuller bodied" episodes that provide greater detail and complexity. The case acts as an anchor (CTGV) for these related episodes. Episodes contribute toward teachers' constructing an understanding of development characterized by several branch points, rather than a simple stage-like progression. Episodes anchored to the main story line of the case provide a more varied developmental landscape than might be expected by simply following the main lines of the case narrative. The episodes can be drawn from a variety of classrooms and teachers, so that diversity around the theme in the case is exemplified. The episodes allow learners to telescope or expand upon particular elements of the case narrative.

Classrooms as Designed Environments

We consider classrooms as designed environments where teachers assist children's performance. Thus, our focus with teachers is on coming to see student learning as a form of mediated action and on coming to view themselves as designers of learning environments (Lehrer & Schauble, in press). Cases are constructed to help teachers (or prospective teachers) "unpack" potential tools for assisting student learning. These tools comprise a teacher's "design kit" (Carpenter & Lehrer, in press). Thus, we focus on cases where students invent and revise inscriptions (i.e., representations), where teachers orchestrate classroom discussions involving cycles of conjecture and justification, and where a spiral of tasks instigates cycles of student model building and revision. Generally, we like to emphasize sequences in which students make a transition from what Cobb and his colleagues refer to as "model of" a situation (mathematics invented to make meaning of a particular situation) to "model for" a variety of situations. (Others might refer to this construct as transfer, still others to trans-situational activity.)

Table 1

Design Principles Underlying Selection of Cases

Design Principle	Benefits
1. Narrative	• Development of "big ideas" • Facilitate "mathematization" • Observing prototypical development
2. Authenticity of Cases	• Realism • Facilitate remembering • Engaging • Notice relevance in everyday events
3. History of Learning	• Makes learning visible • Longitudinal timeline

	• Observation of learning development
4. Telescoping Episodes	• Provide greater detail and complexity • Incorporation of other classrooms and teachers • Expand elements of the case
5. Classrooms as Designed Environments	• View of student learning as mediated action • View of teachers as designers • Pedagogical "tool" development

Hypermedia Design

The promise of hypermedia, from the vantage point of its potential to scaffold case-based learning, consists in large measure of its capacity to represent the complexities of teaching and learning (Mereseth, 1996). Hypermedia seems well suited to the learning of complex, ill-structured domains like teaching.

However, the simple capacity to link text and video provides little guidance about appropriate document structures and interfaces. We turn to emerging research in cognitive science for insights about how to best exploit the potential of hypermedia for designing effective environments for learning. We express the relationship between learning with hypermedia and insights garnered from cognitive science as a set of six design principles, briefly summarized here (see Koehler & Lehrer, in press, for more complete descriptions).

Criss-crossing the Conceptual Landscape

Cognitive Flexibility Theory suggests that learners "criss-cross" the conceptual landscape of ill-structured domains like teaching (Spiro, Coulson, Feltovich, & Anderson, 1988). Sites in a landscape (cases, or concepts in the knowledge domain) must be revisited and conceptualized from different perspectives or "lenses." Hypermedia's node-link structure is well-suited to provide "criss-crossing" of ill-structured domains. Considered from the perspective of teachers-as-designers of learning environments, teachers need tools for representing episodes of teaching and learning from multiple points-of-view. For example, one perspective might magnify the important mathematical ideas being talked about whereas another might focus on the classroom norms established by the teacher that frame the rules of evidence guiding student discussions.

Making Structure Visible

To help teachers represent the development of student thinking about a mathematical domain, heuristic devices like benchmarks of understanding or other milestones must be represented, so that the representational landscape explicitly models students' conceptual development. Such models entail significant loss of information, but nonetheless, are important to initial (largely declarative) phases of learning (Anderson, 1995). Hypermedia devices like typed links signal readers about important features of student reasoning. For example, if learning to think about the origin of a scale is an important conceptual attainment in the development of children's understanding about measurement, then typed links can signal this aspect of understanding to readers whenever it is a feature of a classroom discussion or is embedded in a student artifact.

Make Navigation Easy

Readers have previous experience with the conventions and tools used in texts. Hypermedia systems can be designed to take advantage of this familiarity. For example, readers traditionally expect to find a table of contents to start a document. This expectation could be fulfilled in hypermedia systems as well. Likewise, readers have familiarity and experience with outlines, indexes, bookmarks, and advance organizers -- all of which may be used as navigational tools. When implemented electronically, these and related tools help readers chart a course in hyperspace by helping them find landmarks, remember their trails and goal- subgoal relationships, backtrack or retrace their steps, chose new information, and maintain connections between preceding and subsequent information. Moreover, navigational tools should be rendered in ways that display webs of association and conceptual neighborhoods, for it is just these forms of structure that can be made visible in hypermedia, but not in conventional text.

Navigation patterns are sensitive to a wide variety of individual differences. Consequently, readers need access to a wide variety of navigational tools, so that the interface is aligned with individual differences and responsive to learners' changing needs as they gain experience with the system.

Learning by Example

Goodman (1976) suggests that exemplification is a widely used mode of symbolization: the example possesses the properties that it refers to. Examples are particularly important when properties to be learned cannot be explicitly stated, or when such properties are highly related and "criss-crossed" in the manner described previously. Moreover, examples often play a central role in case-based learning (Williams, 1992) and in helping learners construct relationships (Ward & Sweller, 1990). Hypermedia systems provide opportunities to employ video and audio examples, as well as more traditional examples based on text and illustration.

Layering

"Layering" information facilitates developing and maintaining relationships among associated concepts. Black, Wright, Black, and Norman (1992) found that when definitions and the main text were presented on different screens, readers often had trouble relocating themselves in the main text. In contrast, when definitions were layered (highlighted and presented on the same screen), readers accessed definitions more often and with less difficulty. Text and video examples should also be layered as well, because examples only make sense in relation to the principles conveyed in the main text. That is, to claim that something is an "example" is to claim that it is an "example of something." For readers to make the connection between an example and a larger principle requires access to both.

Considerate Interface

Of course, principles of interface design established by instructional designers should not be forgotten when designing hypermedia tools for learning. Hypermedia systems should offer consistent visual cues to signal functionality (e.g., the purpose of buttons) and to provide feedback for reader actions (e.g., highlight buttons when they are pushed and signal screen transitions). Readers also need easy access to features and shortcuts, so that the most useful and frequently used features are visible and accessible.

Table 2

Six Design Principles of Hypermedia for Professional Development

Design Principle	Benefits
1. Criss-crossing Conceptual Landscape	• Ability to revisit cases • Multiple points of view re case
2. Making Structure Visible	• Representation of heuristics • Highlight important features of student reasoning
3. Making Navigation Easy	• Familiar conventions • Webs of associations
4. Learning by Example	• Symbolization • Explicate relationships
5. Layering	• Developing and maintaining relationships among concepts • Linking example to deep principles • Reduce working memory load
6. Considerate Interface	• Consistent visual cues

	• Feedback • Ease of access to features and shortcuts

Learning with Hypermedia Tools

We have designed and developed two hypermedia tools for helping teachers understand the growth and development of student thinking. One tool, co-designed with Matthew Koehler (Koehler & Lehrer, in press), focuses on arithmetic and exemplifies the growth of student reasoning in accordance with an analysis of problem types and strategies developed by Carpenter and Fennema's program of Cognitively Guided Instruction (Carpenter et al., in press). The other tool, co-designed with Jeff Horvath (Horvath, 1998), focuses on measurement and exemplifies the growth of student reasoning about length, area, and volume in several reform mathematics classrooms (Lehrer et al., in press). Both tools were designed according to the principles of hypermedia design discussed previously, although each was guided by different conceptions (and availability) of cases. In the sections that follow, we describe briefly how design principles were realized in each system, and illustrate use of single-subject methodologies to conduct preliminary assessments of their utilities as tools for learning.

HyperCGI

CGI presents a significant design challenge because the domain of children's arithmetic problem solving is semantically rich, and many of the elements of the domain, such as the semantics of the word problems and the strategies children use to solve them, are best understood in relation. That is, many of the concepts are constituted as conceptual landscapes, not as single elements in isolation. For example, the nature of a child's solution strategy is often a consequence of the semantics of a word problem, so that teachers select certain classes of word problems to provoke the development of certain kinds of solution strategies. We employed our hypermedia design principles to guide the development of a learning tool for teachers. Cases in this system are drawn from clinical interviews with individual children, so that cases correspond to episodes of individual problem solving.

"Criss-crossing" the landscape. The landscape of HyperCGI includes nodes devoted to the semantics of word problems (problem types), prototypical solution strategies invented by children (solution strategies), typical developmental trajectories, video episodes of children's problem solving, text examples, expert commentaries on children's actions, and information about diagnosis and assessment of students' mathematical learning. The conceptual landscape is criss-crossed by links associating different nodes in ways that outline their connections. For example, when looking at different types of arithmetic word problems, readers can readily access the types of strategies children are most likely to employ in solving them. Moreover, readers can browse the document with any of four "lenses" or viewpoints: problem-types, solution strategies, examples, and tours. Examples are represented in "Galleries" of text or video exemplars of problem types and solution strategies. Tours refer to ideal learning paths (from the perspective of Tom Carpenter, one of the architects of CGI).

Making the structure of student thinking visible. HyperCGI uses typed iconic links to clearly signal relationships. Link types are based upon the CGI model of the development of student reasoning about arithmetic, so that, for example, different icons differentiate solution strategies and problem types. A dynamic Index tool shows local structure (see Figure 1). This Index displays an alphabetical listing of all the screens in the system. Clicking on any Index entry calls up the corresponding screen. The Index can also be expanded to show connections between screens. That is, clicking once on any Index entries creates a new list that contains each connected (linked) card, and icon representing the type of that connecting link. Entries in this secondary list can also be selected to show further connections.

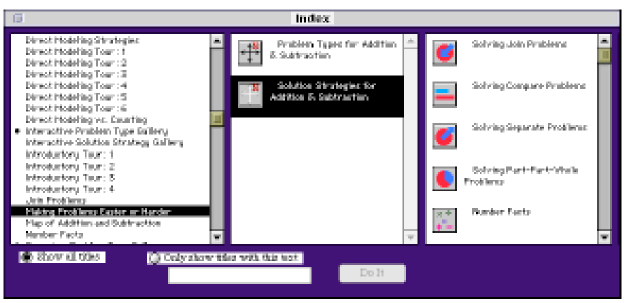
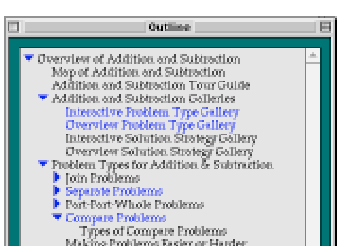


Figure 1: The Index tool for HyperCGI incorporates iconic links which signal relationships between solution strategies and problem types. These relationships are based upon research conducted on the development of student reasoning about arithmetic.

Structure is also made visible with a dynamic Outline tool (See Figure 2). The levels of the Outline can be expanded or contracted by readers, so that hierarchical structure can be viewed in varying amounts of detail.



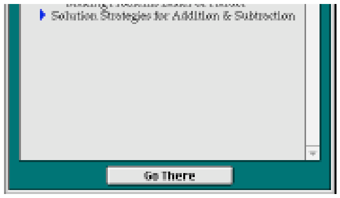
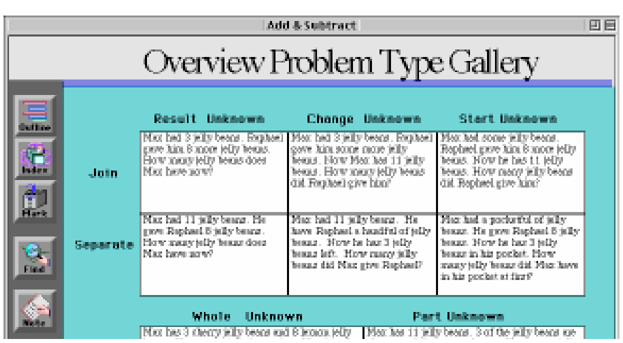


Figure 2: The Outline tool for HyperCGI allows structuring which can be controlled and manipulated by the user

Navigation. The Outline and Index serve also as navigational tools; readers can double-click on any entry to go to the target screen in the system. Next and prior buttons always allow the reader to get some next and previous screen in a predefined default linear order. HyperCGI also provides several features to help readers manage their trails or histories in hyperspace. Footprinting uses visual cues to distinguish between new and old information. Screens that have been previously visited include a blue footprint icon in the upper left-hand corner, while newly visited screens do not include this footprint. Footprinting of screens is echoed in tools, so that, for example, typed links show an overlaid blue footprint when the destination has been visited and both outline and index entries are marked if they have been visited. Furthermore, HyperCGI maintains a history of readers' trails, and provides readers opportunities to backup, or retrace their steps as needed. Consequently, the system always provides a history menu that lists the names of the most recently visited screens, allowing readers to retrace their navigational paths. Similarly, the backtrack button allows readers to retrace their paths one step at a time. Finally, bookmarks can also be created, so that readers later can recall landmarks in their exploration of hyperspace. Tours define ideal learning paths through the system, so that readers can default to an expert's view of navigation.

Learning by example. HyperCGI contains many examples of different types of word problems and video examples of children's solution strategies to these problems, drawn from clinical interviews. All videos are annotated with text, so that readers can better see the process the child used to solve the problem (in CGI language). Figure 3 displays a gallery of text examples, arranged by problem types. In this gallery, readers can see examples of each of the problem types in CGI.



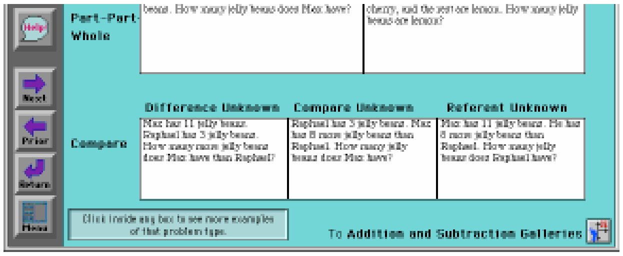


Figure 3: Readers can click on any of the boxes to get a new example of that problem type. There is a similar gallery for solution strategies, organized by problem type and children's developmental level.

Layering. Layering displays related information on the same screen as the anchoring information. In HyperCGI, all annotations (e.g., expert commentary) and video examples always are displayed in layered pop-up windows. To manage the novel terminology of CGI, when the reader clicks on an underlined word, a short definition is displayed as a memory aid (see Figure 4a). Context-sensitive balloon help provides readers with short help text for any object in the system (see Figure 4b).

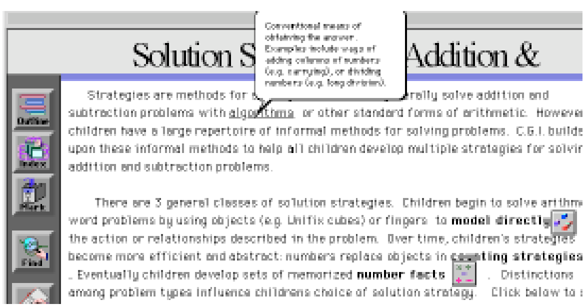


Figure 4(a): Incorporation of Balloon Help to assist in terminology within context of the text.

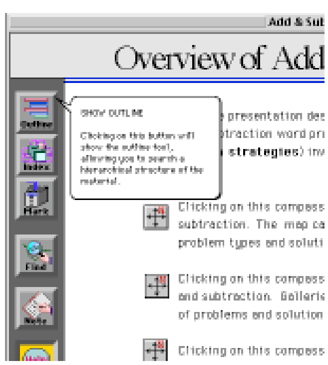


Figure 4(b): Further incorporation of Balloon Help to assist the user in explaining objects in the system.

HyperMeasure

The development of children's ideas about measurement poses significant challenges for teaching. Teachers often assume that if children can use tools like rulers, then they understand all they need to know about measure. Yet for children, tools like rulers are "transparent," meaning that their design principles are not examined or thought about. For example, when children read rulers, they often do not understand why the intervals are all equivalent or even what the partitions of the units represent. To help teachers learn about the growth and development of student reasoning about measurement, we find it useful to draw distinctions among several related "big ideas" about measure, such as the very idea of a unit, the roles played by identical and conventional units, and the construct of an origin (a zero-point) of measure (Lehrer, Jenkins, & Osana, in press). These components of measure constitute a framework for understanding children's activity and how it might change over time.

Our goal is to transform teachers' conceptions of measure from an orientation toward procedural competence to an orientation centered on the development of the mathematical ideas supporting measure. To this end, we have selected episodes from classrooms in which children solve problems in which they explore the implications of big ideas about measure. For example, in one segment children develop a unit of area measure by partitioning three different rectangular regions to determine whether or not they "cover the same space." Thus, the notion of case is one centered in classrooms instead of clinical interviews. In addition, the episodes afford an abbreviated form of history, centered in particular lessons. We have developed a hypermedia tool (see Figure 5) to help teachers learn about children's reasoning about measure, again guided by the design principles described previously (Horvath, 1998).

Figure 5: HyperMeasure Main Menu for the unit on Length and Area Measurement

"Criss-crossing" the landscape. HyperMeasure partitions the conceptual landscape of children’s reasoning about measurement into four thematic strands - Big Ideas, Cases, Tools & Notations, and Connections. These four viewpoints of the corpus are all interrelated, so that, for example, while reading about children’s ideas concerning a "big idea" like inventing units of measure, related information is available about classroom episodes in which children invent units, the tools and notations that help them reason about units, and the relationships of units to other mathematical ideas, like partitioning.

Making the structure of student thinking visible. The principles point-of-view encapsulates major benchmarks in children’s understanding of measure. Typed links signal these conceptual benchmarks as well. For example, when viewing a video episode of a classroom, typed links indicate associations with related conceptual landmarks (principles). The navigational tools also highlight conceptual relationships, especially a hierarchical outline and searchable index.

Navigation. The suite of tools developed for the previous application (HyperCGI) is also available for HyperMeasure. These include outline, index, history, and footprinting features. Video clips come with additional navigational tools so that viewers can readily access any part of the video episode.

Learning by example. HyperMeasure is replete with examples, primarily video episodes (approximately 2.5 hours in over 100 episodes) of students’ thinking and classroom activities (see Figure 6). These videos exemplify all of the information (e.g., principles of measurement, the role of tools, etc.) discussed in the system. Additionally, the cases in the Case theme are all extended episodes of children’s thinking and learning about measure. A case can be thought of as a deep, extended example. As such, the underlying pedagogical principle at work in HyperMeasure is to teach via examples.

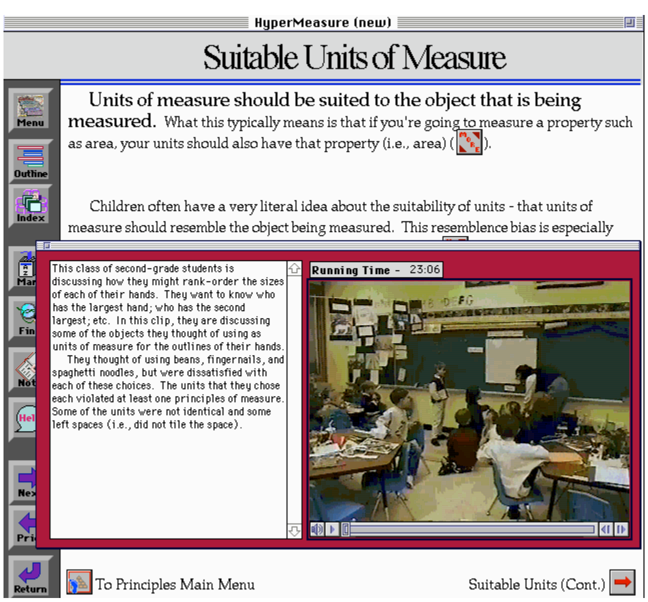


Figure 6: Video Annotations assist in viewing episodes of children's thinking and learning about measure

Layering. All annotations are implemented via pop up windows. When a user selects a video annotation typed link, a popup window appears with a brief textual description of the content of the video. The viewer can then watch the short video clip. All the while, the original anchoring text from the card is still present on the screen. In addition, all layering features available in the previous application (HyperCGI) are also available in this tool.

Assessment

The development of hypermedia systems ideally includes assessment of their potential as tools for learning. However, this step draws resources away from issues of design and development which are often perceived as more pressing. We use single-subject methodologies in order to minimize cost while obtaining reliable information about some aspects of learning. Single-subject methods rely on repeated measures of learning and of use of the hypermedia system. They work best when the measures are unobtrusive (like logs of user actions). There are a variety of designs employing single-subject methods; we have used multiple-baseline designs in which the different participants use the system for different periods of time. Learning with and without the system then constitutes the basis of comparison (see Figure 5).

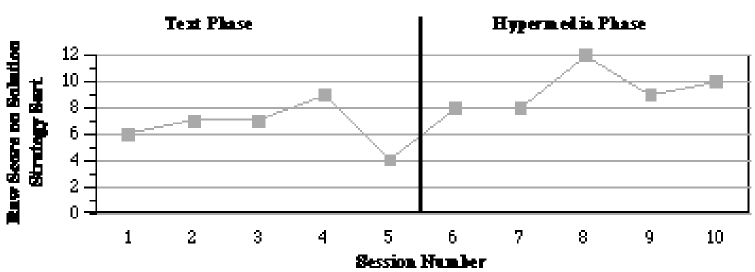


Figure 7: Here we illustrate learning about the nature of solution strategies for one participant in text and hypermedia phases (from Koehler & Lehrer, in press).

The results of these comparisons suggest that both HyperCGI and HyperMeasure are effective tools for individual learning. Analyses of user actions (log files) suggests the importance of the video exemplars in both systems (e.g., learning is associated with engagement with the examples). However, we have yet to test the systems in more communal contexts of professional development.

Informal self-report of inservice teachers (i.e., a "club" of primary grade teachers organized around discussions of HyperMeasure) suggest a significant impact on how teacher practices (e.g., teachers approach the teaching of measurement differently in their classrooms--confirmed by observations of teaching in these classrooms).

In the following section, we will present what we consider to be exciting and innovative projects by two research groups at Vanderbilt University and one at the University of Michigan. All three are attempting to fuse case-based instruction for professional development through the utilization of hypermedia systems. In addition, all three have made significant advances over the past decade in expanding theory on learning and professional practice while developing increasingly comprehensive technology-assisted projects.

Related Approaches to Technologically-Assisted Case-based Professional Development

The E-Team of CTGV

The Cognition and Technology Group at Vanderbilt's (CTGV) latest instantiation in anchored instruction (CTGV, 1990) involves uses of technology to create a new way to communicate with a wide variety of audiences, including teachers, principals, superintendents, business leaders, parents, and school board members. Their approach, developed in partnership with Little Planet Publishing, involves animated stories that feature "The E-Team: Experienced educators who encourage excellence in an electronic era" (see Figure 8).

Figure 8: The E-Team, (L-R) Exacto, Electra and Ethyl provide the user with a series of adventures as they attempt to infuse innovative teaching methodologies within a big city school system. The camp format takes advantage of identifiable genre characteristics while addressing difficult, real-world issues such as local city politics, differing curricula philosophies and the challenge of "scaling"

advances in current learning theory to classrooms nationwide.

These are entertaining, but wise characters who investigate issues in a way that is fun, informative, and efficient (in terms of the time it takes to communicate). Examples of E-Team cases that are currently under development include: Why teachers need ongoing professional development, How technology can enhance learning, Why and how to teach for understanding, and Issues in Assessment. An episode lasts from 10 to 15 minutes, maximum. The animated characters are also able to interact with "real world' characters and environments (see Figure 9).

Figure 9: In this scene, the E-Team (foreground) interacts with the Co-Directors of Vanderbilt's Learning Technology Center (L-R, Nancy Vye, John Bransford, Ted Hasselbring, and Susan Goldman) as they inquire about anchored instruction and professional development.

Case-based reasoning. The function of the E-Team cases is to serve as anchors for further discussions. Each case ends with a series of questions that can be explored in face to-face meetings, on radio and television shows, and on the Internet. The Internet site under development allows people to post their own answers to the E-team's questions, and it points people to resources that relate to each E-team episode. In addition, Internet users can suggest new resources that are relevant. Examples include web sites relevant to particular educational issues, cases of teachers using technology, and NPR radio programs that focus on issues of education and are available through their web site. At present, these resources are scattered all over the web.

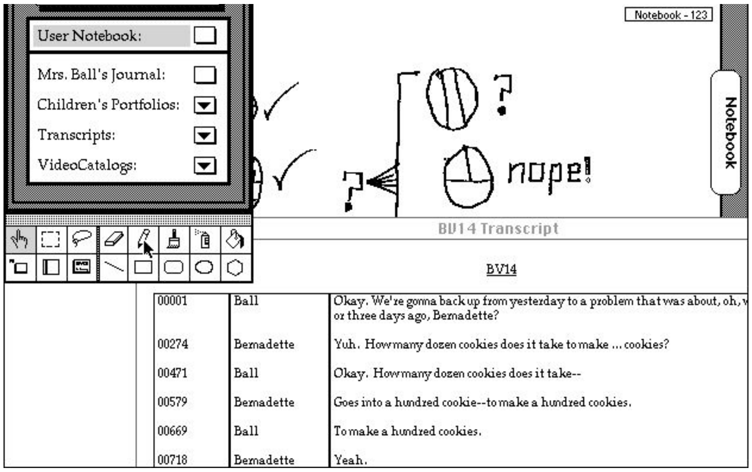
Over time, each E-team case becomes an anchor for a rich set of materials that is relevant to each episode, and that can be updated as needed. By allowing people to post E-Team cases on local sites, resources and comments can be tailored to specific schools and districts interests and needs.

E-Team episodes have been piloted with a number of groups, including teachers, parents, principles and superintendents. Reactions have been highly positive. The Vanderbilt group is currently using the E-Team to introduce audiences to their Schools For Thought project (CTGV, in press; Lamon, Secules, Petrosino, Hackett, Bransford, Goldman, 1996; Secules, Cottom, Bray, Miller, & the SFT Collaborative, 1997). The E-team investigates the project and conducts interviews with some of the principal investigators and, most important, many of the SFT teachers and students. As mentioned previously, these episodes will be accompanied by resources that are available in print and on the internet.

Case-based Documentation of Expert Teachers-
University of Michigan

Two of our colleagues at the University of Michigan, Magdalene Lampert and Deborah Ball, have been utilizing multimedia in their teacher education courses while similarly incorporating case based methods. Their aim is to develop a new pedagogy of teacher education that represents a significant change in the content, discourse, and the setting of teacher preparation programs. To accomplish these goals, they have taken advantage of hypermedia advances as well to facilitate the representation of complexity of the teacher in conducting classroom lessons and the integration of these representations within a theoretical perspective on mathematics education (Lampert, Heaton, and Ball, 1994). In so doing, they have been developing a perspective on pedagogy concerning teacher education that transforms prospective teachers into active inquiring learners instead of passive recipients of their professors' thoughts concerning how teaching should be accomplished.

Initially, data were collected in both Lampert's and Ball's elementary mathematics classrooms across the entire year: one third grade and the other, fifth grade. The video and other data (student artifacts, teacher notes, interviews) were compiled into a database with computerized cataloguing systems. From this work, they developed multimedia cases that could be used in a range of teacher education contexts to explore the practice of teaching mathematics for understanding. Lampert and Ball have digitized subsets of their massive data base, enabling a user to see and interact with the data on the computer. They then designed and constructed a hypermedia learning environment (see Figure 10), adding computerized capacities for accessing and manipulating multimedia information.



Office of Instructional Technology, University of Michigan

Figure 10: The Student Learning Environment (SLE) is a hypermedia system that links multiple data sources collected from a year's teaching in third and fifth grade classrooms. Initially developed by Deborah Ball and Kara Suzuka at Michigan State, SLE is in the process of being redesigned at the University of Michigan.

Currently, Lampert and Ball are involved in engaging university faculty and graduate students in this environment and learning about what instructors try to do and why. Lampert and Ball are also studying the use of the hypermedia environment in several teacher education classes (Office of Instructional Technology, 1996).

Video Based Teaching Experiments: A Case of Patterning & Partitioning

The approach that McClain and Cobb are taking toward producing CD-ROM based cases involves utilizing video from classrooms where they have conducted teaching experiments for extended periods of time. The daily video-recordings of each lesson from two cameras generate a wealth of resources for creating cases that are intended to provide a basis for the discussion of issues of content and pedagogy. These issues include, but are not limited to (1) classroom norms, (2) the proactive role of the teacher, (3) building on students' current understandings, and (4) the sequencing of instructional tasks to support students' mathematical development. The longitudinal cases are presented via a "timeline" of edited classroom video that is supplemented by (1) pre- and post-interviews with selected students (see Figure 11), (2) reflections from the teacher, (3) copies of students' work, and (4) a text description of the instructional sequence utilized in the project classroom (see Figure 12).

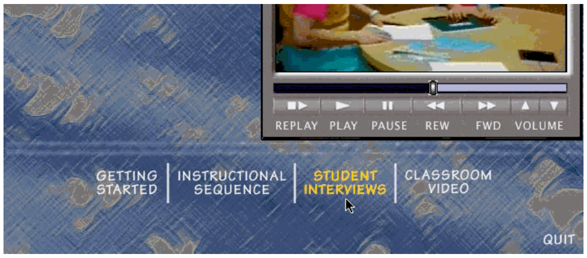


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Figure 11: Extensive pre/post interviews with selected students on the topic of Patterning and Partitioning.

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Figure 12: The user interface allows for both a text description as well as video sequences related to the specific topics of discussion, in this example, the topic is Patterning & Partitioning.

In addition, the interface of the environment is designed to include a means of supporting the user's ability to think about how one might plan a lesson sequence based on observations of the students in the video. An electronic plan book that facilitates this process is augmented with a journal that can be used for comments and reflections (See Figure 13). The interface design principles include attention to the importance of making navigation easy by providing what Lehrer calls a "considerate interface."

The primary criteria for selecting video episodes is to identify incidents from the classroom that highlight the complex nature of classroom interactions. This focus includes a focus on the role that norms play in supporting students' mathematical development.

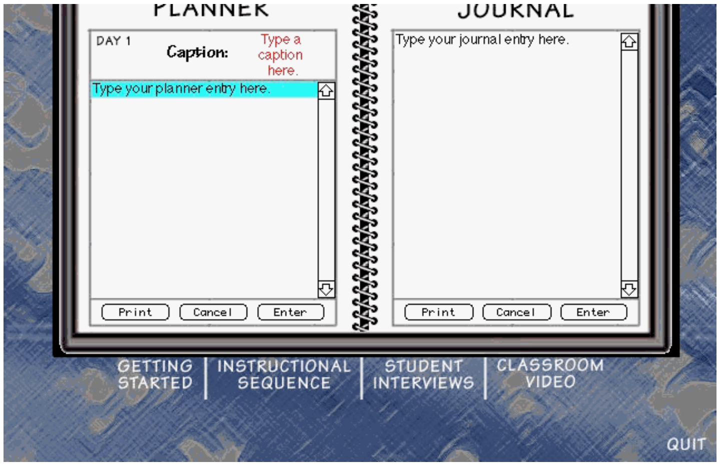

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Figure 13: Electronic Notebook facilitates opportunities for reflection and revision of instructional opportunities for pre and in service teachers.

Episodes in which students (1) engage in mathematical argumentation serve to highlight the importance of creating classrooms where students engage in productive mathematical discourse. However, this aspect of the classroom cannot be seen as standing apart from the importance of (2) the teacher's proactive role in initiating and guiding the development of norms and (3) carefully sequenced instructional tasks. Focusing on all three of these aspects of the classroom while selecting video episodes accords with Lehrer's design principles for selection of cases. The cases are "authentic" in that they come from actual classrooms, they focus on the development of mathematical "big ideas," and they provide a history of learning. Finally, they are situated in classrooms where the teacher takes a proactive role in the supporting the students' mathematical development or in designing a learning environment (Lehrer & Schauble, in press).

At present, the hypermedia environments under development are being designed for use with both pre- and in-service teachers. It is hoped that the resources can provide the basis for rich discussions with both groups of teachers, although the nature and focus of those discussions will need to be tailored to the needs of the participants.

Summary

Throughout this paper we have described an emerging set of ideas about what constitutes an effective case. Likewise, we have seen a number of other groups in the field struggle with emerging ideas about what constitutes the primary purposes of these cases. The media tools developed at Wisconsin take a focused, although targeted focus on student thinking, whereas at the other end of the spectrum, the Cognition and Technology Group at Vanderbilt addresses issues of scaling to a much larger audience. Ball and Lampert at Michigan are focusing a great deal of attention on the application of their principles to the issue of teacher education in their methodology courses, while at the same time pushing the field forward with their own theories of teacher learning. Like the Wisconsin group, McClain and Cobb at Vanderbilt focus on student thinking, but episodes are selected primarily with an eye toward describing sociocultural and sociomathematical norms. Thus, there are potentially interesting differences in emphasis across these development efforts, with unknown consequences for either preservice or inservice teacher development.

We agree with Merseth (1996) that leaders in the field of education should encourage and support multiple case development efforts while concurrently seeking diverse and creative interpretations of the genre. The challenges are only compounded when we consider the application of hypermedia to the equation But we believe, so are the rewards.

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[1] The Cognition and Technology Group at Vanderbilt (CTGV) http://peabody.vanderbilt.edu/ltc/general/

CTGV is a collaborative, multidisciplinary group of approximately 70 researchers, designers, and educators. CTGV members are currently working on a variety of projects in the areas of mathematics, science, social studies, and literacy.

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