Foreseeable Demands: Tracking the Design of Online Teacher Professional Development in a State-Wide Professional Development System

Paper Presented at the MWERA Conference

October 13, 2006

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Introduction

With astonishing speed, online teacher professional development has swept into the professional education arena and continues to grow at a tremendous rate (Mandinach, 2005). All around, it seems to be the right venue at the right time, offering a myriad of benefits in times of severe fiscal constraints (Brown & Green, 2003; Carter, 2004). Online teacher professional development, or oTPD, is convenient and efficient, incorporating new, emerging technologies, online learning communities, modeling, coaching – all with the added advantage of "anytime, anywhere" participation geared to individual teacher work schedules and needs (Carter, 2004; Harlen & Doubler, 2004). In the fast-paced, media saturated world of today, oTPD is a promising newcomer with high hopes for transforming professional development from "now and then" for some to an integral part of teaching practice for all – and at a reduced price (or so it seems).

Availability, however, does not for quality make. Even as the technology for robust oTPD is at our fingertips (and ubiquitous), far less is known about how to use it to advance teacher thinking, reasoning and instructional skill through professional development (McCombs & Vakili, 2005). Barab, Kling, and Gray (2004), for example, cite how little we really know about how to build online learning communities that both inform teachers, and also help them solve practical problems of instruction. And while different configurations of oTPD (e.g., blended approaches) can compete effectively with traditional models of professional development (that is they do no harm) (Bernard, et al, 2004), less is known about actual transfer to the classroom resulting in *improved* practice – the ultimate goal of professional learning (Brown & Green, 2003; Dede, et al, 2005).

To help build the case for professional development as a worthwhile, long-term investment on the part of states, districts, schools and individual teachers, oTPD must do what traditional PD has long tried to do: help teachers learn. For this to happen, though, the online learning environment must incorporate highly interactive, meaningful, and thought provoking tasks to engage and direct teacher learners, scaffold them to higher level teaching skills, build communities of practice, and include rich collaborative e-learning tools and resources (Oliver & Herrington, 2003; Clark, 2004; King, 2002). Building such environments, however, will not be easy. It will require new relationships between content specialists and technologists; it will require new online pedagogies; it will require well-designed learning artifacts matched to science-based learning principles; and it will require imagination (Bonk, & Cummings, 1998; McCombs & Vakili, 2005; Oliver & Herrington, 2003).

Considerable research is and will be needed to ground and guide the future of oTPD, especially at the design level where the power of e-learning resources (tools, web technologies, multimedia) must connect with the learner-centered principles of constructivism for higher levels of teacher learning (APA, 1996; Bonk & Wisher, 2000; Bransford, Brown & Cocking, 2000). Strong instructional designs that best represent how people learn are key for supporting optimum matches between e-learning technologies and learning for diverse educators with different needs. A synthesis of cross-disciplinary research on human learning, the *How People Learn* (HPL) framework (Bransford, Brown & Cocking, 2000), proposes three learning principles: (a) prior understandings influence new learning; (b) new understanding requires development of factual knowledge and conceptual frameworks; and (c) self-monitoring and reflection strategies support learning with understanding. Applying these principles to instruction calls for a learning environment that is learner-centered, building on what learners already know; knowledge-centered, emphasizing authentic achievement and mastery (Newmann & Associates, 1998); assessment-centered, offering multiple means for monitoring learning progress; and community-centered, encouraging social networks and collaborative teams that support learning (Schlager & Fusco, 2004). Affording this kind of learning environment online goes to the core of the oTPD research problem and poses tremendous research challenges. We lack the instructional design theory, for example, to guide the development of learning objects so that we might test designs that work well and under what conditions (Wiley, 2001).

Our Research

Presently we are engaged in a line of oTPD formative research as a critical part of our work with the Reading First-Ohio Center for Professional Development and Technical Assistance in Effective Reading Instruction – a partnership between the Cleveland State University, John Carroll University and The University of Akron. A central goal of the state's

Reading First plan and focus of the Center is to expand professional development in scientifically research-based reading instruction.

In partnership with Teachscape, Inc., a producer of online professional development programs, the University of Akron arm of the Reading First Ohio Center developed two oTPD modules over a 2-year period (2003-2005), entitled Scaffolding in Action (SA) and Differentiating Instruction (DI). The modules were developed for use in the state's professional development program for K-3 classroom teachers, referred to as the State Institutes for Reading Instruction or SIRI. The modules represented the state's initial foray into online teacher professional development on a relatively large scale, and a formative research agenda is intended to observe and monitor the impact of oTPD. Beginning with the launch of the first online module (SA) to the present, we have conducted four field studies to examine the development, design and implementation features of these two e-learning modules as a part of state-wide professional development in reading for K-3 teachers.

Our research uses a formative research approach where the e-learning environment is the overarching unit of analysis (Newman, 1990; Reigeluth & Frick, 1999). In brief, formative research is a kind of developmental research that sets a pedagogical goal (e.g., online learning communities) and tracks what is required of materials, organization and technologies to reach that goal. Its focus is on identifying instructional design features of the environment that afford interactions toward a desired outcome, and assessing their *preferability*, that is, the extent to which design features are effective, efficient and appealing to participants in the learning environment. Sometimes referred to as "field testing" or "usability testing", the goal is to generate instructional design theory and models that support the design of higher-performing instructional resources for more powerful teaching-learning interactions.

Formative research has been used effectively to examine the organizational impact of computers (Newman, 1990), designing computer-based simulations (Shon, 1996), and educational systems design (e.g., Naugle, 1996). It seemed a well-suited method to examine our broad goal of whether the modules provide effective oTPD in an emerging state-wide professional development system for achieving effective K-3 classroom reading instruction. A set of four research questions guided the series of field studies. The current paper summarizes the results of a study that addressed the fourth research question.

- Is oTPD effective in state-wide professional development? This question addressed the launch of our first online module, Scaffolding in Action (SA), with the goal of examining how well it fared in relation to other PD venues in large-scale, state-wide implementation.
- What are the strengths of the oTPD module instructional design? Here we took an in-depth look at different instructional design dimensions of the SA module, and linked design features to a unified field theory of design.
- Is a blended approach to oTPD more powerful? To further explore the potential of oTPD for impacting teacher knowledge and engagement we tested a blended approach that included two online modules as an integral part of the professional development.
- What is the pedagogy of the oTPD module instructional design? Observing the impact of the online modules on different dimensions of the teachers' PD experience, we focused on the pedagogy of the modules to note characteristics, as well as areas to target for improvement.

What is the Pedagogy of the oTPD Instructional Design?

Our fourth field study examined the pedagogy of the two online teacher professional development (oTPD) modules – SA and DI. Our prior field studies were focused on the content of the course modules and their delivery, addressing questions of problems in implementation and impact on teacher participants in relation to knowledge, satisfaction and intent to implement. Formative research data from the initial oTPD course (SA) led to the second field study, which showed improved knowledge gains, as well strong satisfaction among participants. Neither field study, however, examined directly the instructional design features of the modules that constituted the pedagogical approach.

Yet this is a critical factor because pedagogical assumptions expressed in course activities, tools, technologies, and resources powerfully shape the participants' learning experience. Learning materials are an integral part of the learning system that constitutes instruction (Cohen, Raudenbusch & Ball, 2002), and in their own right hold instructional ideas and beliefs that can have a significant influence on instructional activity. Articulated in Cole's cultural psychology perspective (Cole, 1996), learning materials are *artifacts* that extend human capacities and mediate action. Wartofsky (1979) proposed three levels of artifacts: primary artifacts directly used in production (e.g., hammers); secondary used as representations of primary artifacts (e.g., recipes); and tertiary (e.g., processes). Applied to curriculum and instruction, artifacts include physical objects, such as pencils, microscopes and computers, and also abstractions such as lesson plans, teacher guides, and instructional models (virtual worlds).

In their role as curriculum artifacts, learning materials both afford and constrain instructional activity. On the one hand, materials afford learning activity because they trigger particular social and cultural understandings (Brown & Duguid, 1995; Gibson, 1977; Norman, 1988). Still, even as objects open up opportunities for learning, they simultaneously restrict them by imposing "terministic screens" on activity (Burke, 1966; Wertsch, 1998). That is, the very properties of the material *screen* human action by limiting or constraining it. The defining properties of a hammer, for example, constrain activity to pounding in with the head or pulling out with the claw. In curricular terms, a phonics worksheet limits activity to its content, structure and purpose.

The elements of information design of interest in this study are based on the central tenet of a constructivist perspective, that the learner's active construction of knowledge yields deep understanding. This cannot be achieved by reciting information, but requires higher order thinking, disciplinary knowledge and real world practice (Newmann & Associates, 1996). Information design involves structuring information so that it can be transformed into knowledge by the participant. Assuming a constructivist stance, e-learning tools and objects (content and activities) should promote *different types of knowledge* to mediate the development of understanding. In addition to types of knowledge, learning objects should afford *different levels of cognitive demand* for acquiring deep levels of understanding that support knowledge use in new situations (transfer). To teach for understanding, then, curricular content and activities must demand that learners use different types of knowledge (e.g., factual and conceptual knowledge) and employ a variety of cognitive processes (e.g., analyzing and creating). In instructional design terms, the patterns and meanings in information must be made visible through compelling interactions with others or with tools, so that knowledge can be constructed meaningfully (and accurately) in the learner's mind.

Dede, et al (2005), based on a 40-study corpus of empirical research on oTPD, developed a continuum of the pedagogies represented, all claiming a constructivist perspective. Pedagogies varied along a continuum of structure (less to more) and a scale of autonomy (less to more).

Some oTPD pedagogies, for example, are less structured and more autonomous, allowing more learner control of learning objects. Others are more rigid, establishing curriculum apriori (i.e., the scope and sequence of learning objects in the environment). Prior work by Teachscape, Inc. in the Seeing Math Project (http://www.concord.org) used the latter pedagogic approach, structuring teacher learning around video-based case studies of math teaching (critical concepts) and expert commentary. This curricular approach is also reflected in the pedagogy of the two Ohio oTPD modules, which utilize a more structured-less autonomous version of the constructivist perspective.

The mediating role of learning materials goes to the core of instructional design in the online environment. How e-learning tools (e.g., interactive multi-media or threaded electronic messaging) support learning is a critical design question in the expanding world of online programs and courses. In recent times, considerable attention has focused on usability design issues, such as tracking, managing and monitoring student learning, thus increasing understanding of the human-computer interaction (Clark & Mayer, 2003; Firdyiwek, 1999). But how to design e-learning contexts, rich in collaboration, multimedia and interaction that support constructivist principles of teaching and learning poses a new set of instructional design questions. Strategies for combining online learning objects into powerful instructional sequences, for example, are not clear-cut. Criteria related to granularity, i.e., the scope (size) of a learning object, are not well-articulated either, which can restrict designs and reduce the re-usability of learning objects (Wiley, 2001).

Bonk and Wisher (2000) point out that "possibilities for rich electronic learning" exist, but that there is a lack of "pedagogically sound and exciting Web courseware tools" to take advantage of these learning objects (p. 9). Faced with a proliferation of e-learning tools fast outpacing educative ideas about how to use them, the critical design problem is how to design *pedagogically-based e-learning technologies* that function to support *how people learn* in virtual learning environments (Bransford, Brown & Cocking, 2000). Design, in short, is about creating and assembling 'smart' learning objects (re-usable digital resources) for use by instructors and students in active, knowledge-rich online learning environments and communities.

In this field study, we examined these aspects of the design of the two oTPD modules created for the SIRI program (SA & DI), and also continued our formative research agenda. For this investigation, we developed an analytic method to examine pedagogic features of the modules based on Shedroff's unified field theory of design (1994) and research-based instructional principles rooted in constructivist theory (Bransford, Cocking & Brown, 2001; Clark & Mayer, 2003). We examined whether the following research questions:

- Does the *information design* of the modules support different knowledge types and cognitive processes?
- Does the *interaction design* support a constructivist learning environment?
- Does the *sensory design* support a motivating learning environment?

Sample

The study analyzed the 138 online screens, consisting of 387 paragraphs, in the two oTPD modules: 55 screens in Scaffolding and 83 in Differentiating Instruction. As defined by Teachscape (personal communication), the producer of the modules, screens contain both graphical treatment and content, and in design terms can host several pages. For example, a single screen, when printed, can span several printed pages. Page changes are signaled by content changes whereas screen changes are signaled by graphical changes accompanied by content changes.

Coding Matrix

Our research goal was to extract pedagogic features embedded in the instructional design of each module and to examine these for evidence of constructivist principles of teaching and learning, specifically the information design, interaction design, and the sensory design of the modules. To examine the information design of the modules, we turned to Bloom's Revised Taxonomy of Educational Objectives for criteria (Anderson & Krathwhol, 2001). The taxonomy framework includes four major knowledge types: factual, conceptual, procedural and meta-cognitive, and contains six categories of cognitive processes – one most closely related to retention (*Remember*) and the other five increasingly related to transfer (*Understand, Apply, Analyze, Evaluate, Create*). The four knowledge types and six cognitive process categories provided criteria for analyzing the information design of each module.

In addition to the information design elements provided by Bloom's taxonomy, we also examined the interaction design, which signals participants' level of interaction with the content. Interactivity is related to the amount of control the learner has over learning objects (tools, resources, sequence); how much choice this control includes; and opportunities to use e-learning tools to produce and create. Level of interactivity is a function of instructional goals, whether to strengthen a specific skill set (e.g., training) or to develop conceptual models for transfer to real-life problems (e.g., reading fluency instruction). This dimension was based on Clark and Mayer's (2003) description of three e-learning types of the architectures of instruction design that support learning: receptive (viewing information with limited practice opportunities), directive (learners offering frequent responses and receiving immediate feedback); and guided discovery (providing job-realistic problems and supporting resources).

The third element of the modules that we examined was the sensory design elements that garner and sustain the learner's attention to the content and learning activities. The appropriate use of media, style, and technique can result in a motivating and engaging online learning experience. Sensory details (e.g., graphics, pop-ups, color, video) must coordinate not only with one another, but also with the content, professional learning goals, and messages of the oTPD. Such aesthetics require close attention to details that can affect the meaning of the message, and consistency that can ensure a cohesive online experience. From a constructivist perspective, the sensorial design of e-learning tools and objects contributes to the communicative function of these knowledge mediators. Properties, such as graphics, procedures and illustrations help shape pedagogical schemas, scripts and routines toward a constructivist stance and enable teaching skills supportive of this activity. Recent research, in fact, has pointed to a redundancy effect in the combining of properties where concurrent narration and animation may actually split learner attention to the content, and thus hinder knowledge construction (Mayer, Heiser & Lonn, 2001) Clark and Mayer (2003) offer six principles that apply to screen design, namely multimedia (relevant graphics accompany printed or spoken words), contiguity (words and graphics presented in an integrated fashion), modality (audio is used to explain concurrent animations or graphics), redundancy (screen includes narration and identical printed text), coherence (irrelevant details, pictures, sounds, and words are omitted), and personalization (words presented in a conversational style).

Coding Procedures

The research team developed coding rules against which to rate the presence of each of the elements of the modules' screen design (i.e., the knowledge type and cognitive demand elements of information design; interaction design elements; and sensory design elements). We assigned a knowledge type and cognitive demand code for each paragraph of text and identified the highest level of knowledge type and cognitive demand for each screen. We assigned each screen one code for interaction design to signal whether the screen provided information through receptive, directive, or guided discovery methods. We coded the presence or absence of each of the six sensory design elements (multimedia, contiguity, modality, redundancy, coherence, and personalization) for each screen.

Four of the study's authors coded the level of knowledge, interaction, and presence of the sensory elements for each paragraph and screen. The group met to clarify the coding categories and to practice using those categories with a set of screens and paragraphs. Subsequent coding was done in pairs, with cross-checking among the pairs to ensure consistency in coding. After their independent coding, the two-person teams met to compare their coding results. The teams discussed the results until agreement was reached. The interrater agreement for the Differentiated Instruction module was 78% for the Scaffolding module 80% and 79% overall.

Results

Information design features. The levels of knowledge type in the two modules are illustrated in Figure 1. What is striking about the results is that approximately 50% of the text is devoted to providing directions and 50% to providing content for building knowledge. Of the text available for knowledge-construction purposes, the paragraphs contain an approximately equal amount of facts and concepts. When examining the highest level of knowledge type on each screen, approximately 30% of the screens in the DI module and 38% of the screens in the Scaffolding module focus on concepts. This blend of facts and concepts offers the learner the opportunity to learn facts and organize them into concepts, which may allow for more effective retrieval and application. Opportunities for obtaining procedural and meta-cognitive knowledge in the learning domains of scaffolding and differentiating instruction, however, appear limited.

Figure 1 Evidence of Knowledge Type in the Online Modules

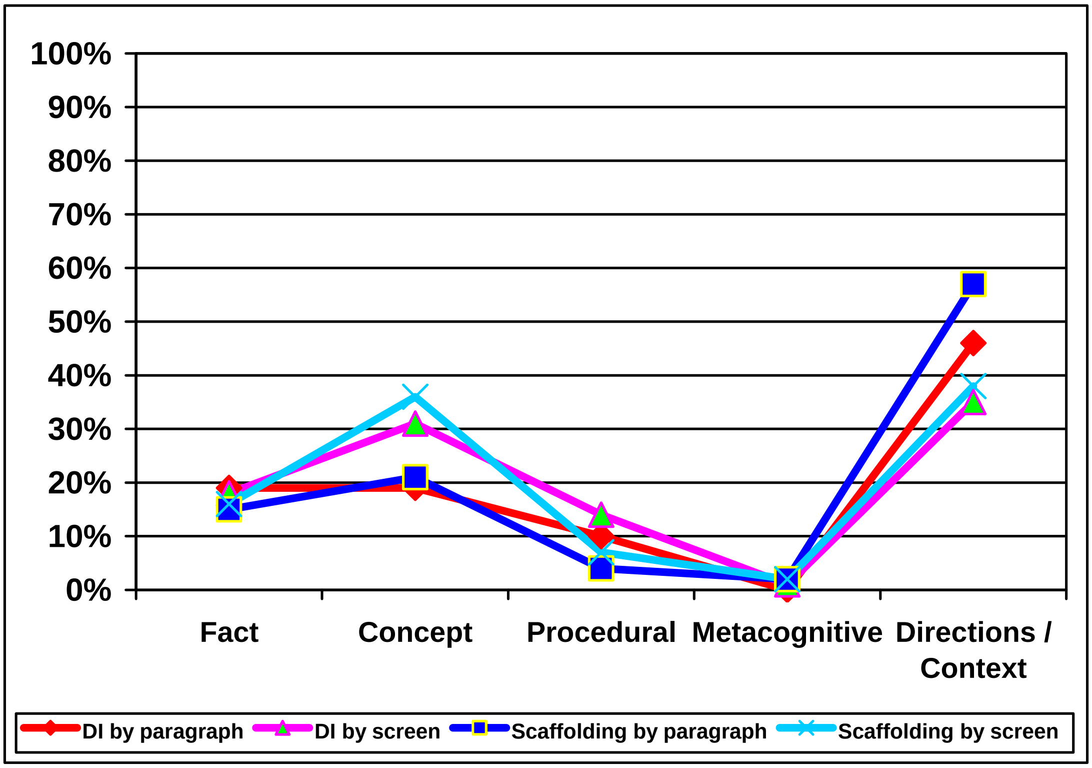
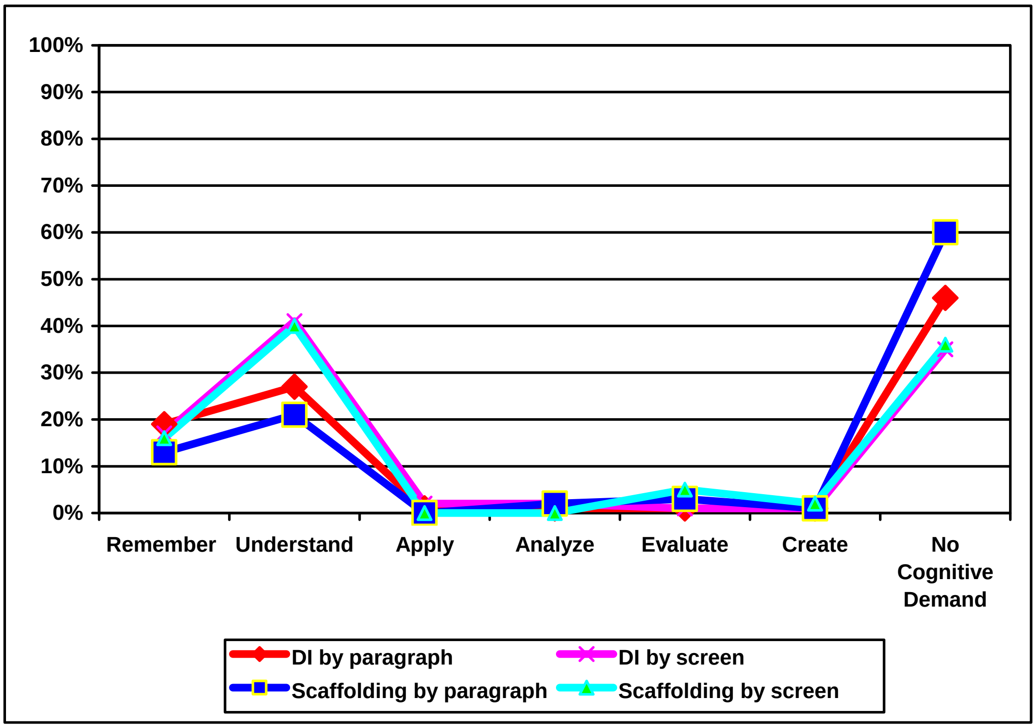


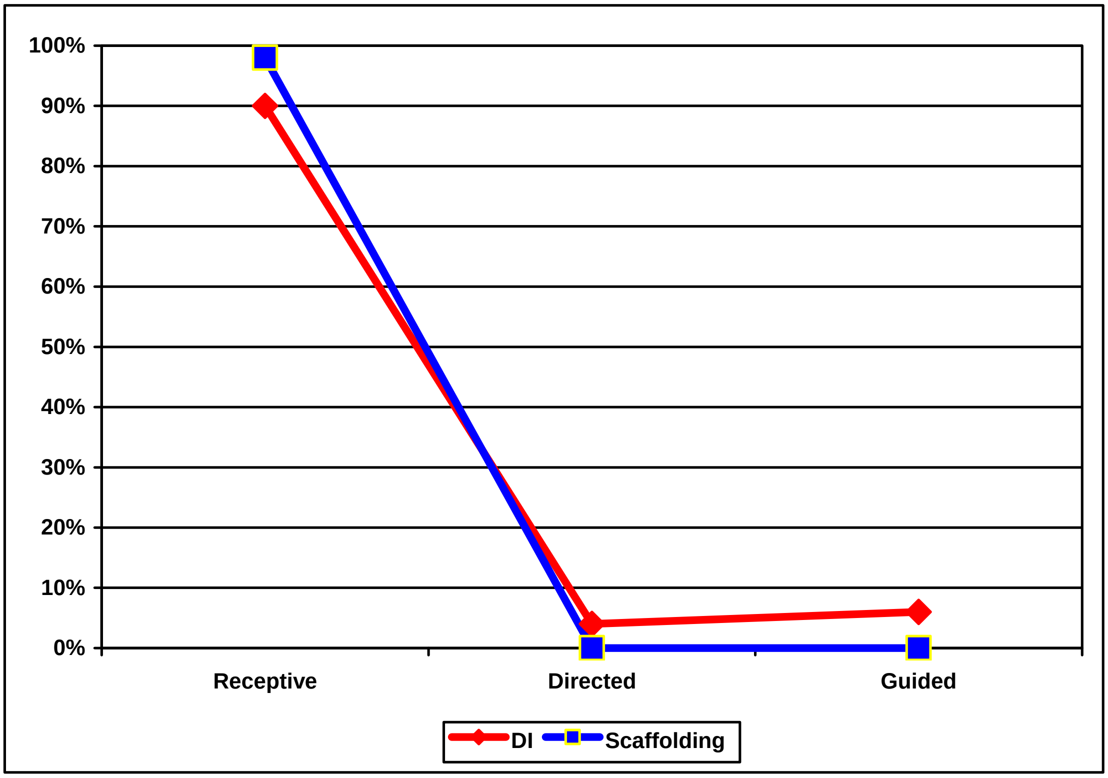
Figure 2 illustrates that the cognitive demand of the e-learning tools is related primarily to remembering and understanding, which help participants connect prior experience to new instructional ideas. Participants are asked, for example, to interpret, summarize, compare and explain content presented in learning objects (e.g., video cases). They are not offered much practice, however, in higher order teaching skills, such as applying new ideas to unfamiliar tasks, analyzing problems of practice, making judgments about instructional ideas or practices based on criteria, or creating new patterns or structures relevant to their local contexts. The design of the modules challenges participants to make new meanings yet limits knowledge construction by setting the ceiling at basic understanding, rather than analytic, evaluative and generative processes.

Figure 2 Evidence of Levels of Cognitive Demand in the Online Modules



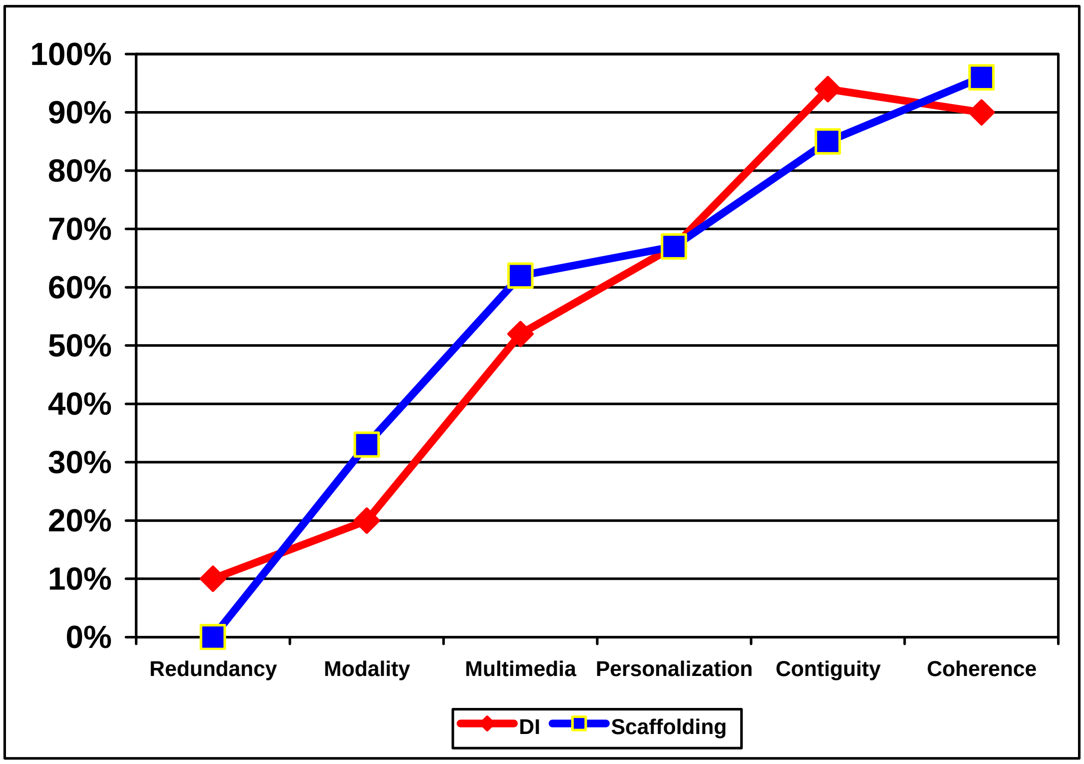
Interaction design features. Figure 3 summarizes the analysis of interaction design features along the basic types identified by Clark and Mayer (receptive, directive, and guided discovery; 2003). From a constructivist perspective these results are disappointing. What prevails is a “show and tell” instructional interaction pattern where, in large measure, information is presented without opportunities for the learner to process that information through knowledge-organizing and knowledge-building experiences. The module lacks participatory e-learning tools and objects that are the foundations of knowledge-sharing.

Figure 3 Evidence of Interaction Type in the Online Modules



Sensorial design features. The frequency of the sensorial design features of each module is illustrated in Figure 4. Both modules demonstrate a variety of sensorial details that support an appealing and engaging online learning environment. Coherence, indicated by a lack of distracting stimuli and contiguity, indicated by a coordination of media, are especially strong and are evident in over 85% of the screens. Personalization, which helps to stimulate motivation and maintain attention to the topic, occurs in about two-thirds of the screens. Multimedia, evident in 50%-60% of screens, serves to prime and guide active cognitive processing and encourage knowledge construction (Mayer, 2003). Few of the screens, however, employ audio narration to maintain interest and focus attention to the instructional message as indicated by the relatively low occurrence of the modality category. The least frequently coded element is redundancy, the concurrent use of narration and animation. Since redundancy in online learning is considered to be negative since it can be distracting to participants, the infrequent use of this element is a positive design feature. Overall, the sensorial design includes fairly strong use of five of the six principles. This pattern of coordinated sensory details and instructional goals contributes to the instructional capacity of the learning environment.

Figure 4 Evidence of Sensory Elements in the Online Modules



Differences between modules. The differences between the two modules on each of the coded elements were tested using chi square analysis. A chi-square goodness of fit test showed that the frequency of the elements was statistically significantly different only for the element of procedural knowledge type. The number of paragraphs coded as having procedural knowledge type on the Differentiated Instruction module, n = 22 (7%), was greater than the number of screens in the Scaffolding Module, n = 6, (3%), X^2 (1, N = 525) = 3.86, p = .05.

Discussion

The goal of this series of field studies was to identify the pedagogy embedded in the instructional design of two online e-learning modules that are used to provide professional development to elementary school teachers of reading. The analytic method we employed revealed key features of the comprehensiveness, approach, and engagement of the instructional method.

One of the hallmarks of the constructivist view, as a theory of knowing, is its emphasis on learning with understanding, and therefore a pedagogy of teaching for understanding. To teach for understanding, however, is difficult because it is an ambitious enterprise. It takes more effort to find out the pre-existing understandings students bring with them, to provide a firm foundation in factual knowledge for purposes of transfer, and to cultivate self-regulation in learners than to merely tell students about what they need to know and do, although "telling" may be needed at times. Thus constructivist-oriented instructional interactions, whether with materials (designed to support understanding) and/or people, are more complicated, and take not only more time, but also considerably more intellectual energy. Developing such rich opportunities is a challenge being faced in oTPD content specialists and technologists. (Oliver & Herrington, 2003; Clark, 2004; King, 2002) In terms of human energy and brain power (the resources of interaction), the economics of teaching for understanding are still not well-understood and often grossly under-estimated. Given the difficulty of using a constructivist approach in face-to-face instruction, how successful were the oTPD elements in supporting this type of learning environment?

Both online modules showed similar pedagogic features that profile a didactic pedagogy of telling and showing information rather than a constructivist process of knowledge construction and co-construction. As the data show, the emphasis is on declarative types of knowledge (facts and concepts), and low levels of cognitive demand (remember/understanding) that do not induce higher order thinking and reasoning. The architecture of instructional interaction is passive, reflecting a shallow level of participation and limited choice, control, productivity or creativity of experience in the learning environment. While the sensorial design supports learner engagement, its potentialities are not well-realized at the interface of information (content) and interaction for developing deep learning that leads to problem-solving transfer. This is to say that the combinations of sensory details are motivating and attention-holding, but not around high-level cognitive engagement. Yet we strive for oTPD experiences that are learner-centered, while they are knowledge-centered (Newman & Associates, 1998) as well as assessment-centered and collaborative (Schlager & Fusco, 2004).

Casting these results in the best light, we can take comfort in the fact that the pedagogy is likely familiar to our teacher participants, who have had prior experience in didactic face-to-face courses. The stress of negotiating the less familiar online environment may therefore be reduced, which frees attention (and thinking) to focus more intently on the content information, even though interactions are highly controlled.

But this is a rosy route that probably should not be followed for very long. To catalyze teacher learning toward the goal of improved practice for higher student achievement, oTPD must seek more rigorous instructional designs that engage teachers' minds and push for higher order reasoning around problems of practice. Considerable policy research on PD, of late, points to high quality professional development as a powerful lever of standards-based reform (e.g., Cohen & Hill, 2001; Loucks-Horsely, Hewson, Love & Stiles, 1998; Newman & Associates, 1996). High quality designs for PD, however, call for more ambitious pedagogies that are demanding for learners, who may resist the hard intellectual work deep learning requires, and equally demanding for instructional designers who must create more sophisticated interaction architectures for well-paced guided participation (Bonk, 2002; Cohen, 1988).

The emphasis on receptive knowledge transfer with lack of interaction on the part of the participants may represent an extreme of the more-structured, less-autonomous pedagogy implicit in the modules' construction modeled on the Teachscape platform. Given the overarching goals of oTPD in the multi-year SIRI project, the specific learning objects that support directive and guided discovery types of interaction in this module's learning environment are probably worth a second look as design features.

Implications

The described studies did not measure the efficiency of the professional delivery methods specifically; however, the time, effort, energy, and expense associated with delivering professional development in an e-learning environment is higher and the results of the training in terms of satisfaction, learning, and intent to apply are generally similar to face to face modalities. Contrary to the other modes of delivery described in theses studies, individualized e-learning was the only modality that did not require the students to gather in a common location for the training. Participants who engaged in the individualized e-learning accessed the course material from a variety of locations and at a variety of times. It was clearly the most flexible of the modalities; and, given the comparable efficacy and appeal of the modalities, the efficiency of the individual e-learning environment may be the most salient characteristic for differentiating these methods of delivering the scaffolding professional development.

However, despite the flexibility and apparent appeal of an oTPD solution, examining the design of an online module may provide a picture of a learning element that is not much different and perhaps even more didactic and less interactive than face-to-face instruction. Informative theoretical frameworks for guiding instructional design are sorely lacking. Much research is still needed to establish new models of online learning that tap the potential of the virtual learning environment (Tallent-Runnels, Thomas, Lan, et al, 2006). Sifting through the current research reviews on oTPD (Bernard et al, 2005; Bonk & Wisher, 2000; Dede, et al, 2005; Tallent-Runnels, et al, 2006), however, yields design foci of some strength that may serve as useful guidance for revision of the two online modules toward a stronger constructivist pedagogy. One of these is *creating online learning communities* that include design elements, such as (a) small groups organized around a specific learning goal; (b) discussion models (e.g., protocols for critical, reflective discourse and examples of 'threading' and maintaining discussion); and (c) community-building activities (e.g., articulating purpose; requiring contributions from each member; inserting questions and guidance to ensure participation).

Another is *matching design to teacher needs* for pedagogical content knowledge. In one respect this is an age-old curriculum design problem at work in a new, virtual learning environment (Zais, 1976). As Bransford, Brown & Cocking (2000) proposed, a solid three-principled framework for learning is based upon the development of factual and conceptual knowledge. It was, perhaps, an attempt to honor these principles to instruction that brought about the high level of factual and conceptual presentations in the modules. The networks and collaboration encouraged by Newman & Associates (1998) also evolved through implementation of these oTPD modules, however, the assessment-centered feature they support was less evident in the modules. More instances of immediate feedback to learners might strengthen the learning experiences. At the root is alignment, which has to do with how well elements of a system work together – and in this case, the elements of the online module as an instructional system. Design must function at the interface of information (curricular content), interaction (learning activities and assessments) and sensorial media (learner engagement). We lack the research for specifics here, but have some evidence for generalities. For example, learner control of the pace of the lesson, as well as choice as to when and where interactions will occur are strong incentives for participants (cited in Tallent-Runnels, et al, 2006). At the same time, internal pacing demands and tensions seem needed to sustain high levels of participation, along with instructor-based support systems to ensure engagement and a sense of satisfaction (cited in Tallent-Runnels, 2006). Incorporating design features (e.g., short vs long-page material & graphic organizers) to accommodate different cognitive styles of learners may improve the overall quality of instructional design (Graff, 2003).

A third focus of design, and an eminently practical one, is *making e-learning tools and objects transparent* at the user interface. To what extent, in other words, is the 'how to use' dimension of the online module self-explanatory? The design problem is twofold: to design 'smart' learning tools that are not only easily decipherable by the user as to their purpose (e.g., a text box), but also intelligent in that they interact instructively with the user (Suchman, 1994). Design elements, such as graphics and icons, aid communication of intent. Those for enlarging the capacity of tools to respond 'like a teacher' and instruct the user are harder to "build in". (expert help systems)

Limitations

The criteria selected for this study to examine the elements of content, interaction, and sensory demands have been used in other research but this full set of constructs has not been used before to analyze online learning. However, our study was not unique in its development of such a coding scheme. In judging the levels of thinking involved in online communications, Christopher, Thomas, and Tallent-Runnels (2001) devised and followed a similar system to classify units of information by following a rubric based upon Bloom's taxonomy and rating responses accordingly. They also checked interrater reliability as part of their process. Although our coding system seems appropriate and provided information to answer our research question, a more principled approach to selecting criteria (e.g., APA learner-centered principles or constructivist principles as defined in Bransford, Brown, Cocking) may have been a more appropriate system to have used in this study.

Given the study's results, future work should expand the criteria or provide a more thorough examination of direction-giving screens. Identifying ways to provide directions or context through less redundant and less wordy approaches would be useful for developers of online learning modules.

The procedure used in this study is time intensive and at this point impractical for general use in examining online instructional modules. Developing an effective sampling procedure that could be used in the field would likely be useful for online content developers. Also, reliability was moderate to low, which suggests that the coding may require considerable training.

Finally, the study did not examine the supporting materials, which, when used with the online module, might increase the content levels, cognitive demand, and interaction elements. A more holistic examination of all course content as well as of instructors' knowledge and skills in facilitating discussions and implementing the course will be important next steps.

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