The STEP System for Collaborative Case-Based Teacher Education: Design, Evaluation & Future Directions

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ABSTRACT

We report research and development work with STEP (Secondary Teacher Education Project) Web, an innovative and complex web site designed to support learning through facilitated video case discussions in secondary teacher education programs. The goal of instruction with STEP is to help pre-service teachers acquire useful scientific knowledge about cognitive psychology and other learning sciences. STEP Web is currently being used and evaluated in connection with psychological foundations courses taught for teacher education majors at UW-Madison and Rutgers University. We report user preference data on web site design and related instructional formats, and provide evidence that the STEP approach can produce transfer and flexible use of course concepts.

Keywords

Instructional Web Sites, Video Cases, Case-Based Learning, Teacher Education, Problem-Based Learning

INTRODUCTION

Case-based instruction (CBI) refers to a class of pedagogical methods in which learners acquire subject knowledge through study and analysis of cases, often experts' solutions to real-world problems. For many years, CBI has been employed extensively in both preservice and inservice teacher education with the aim of helping teachers acquire pedagogical and theoretical knowledge that is grounded in situations like those they will encounter in professional practice (e.g., Shulman, 1992; Loucks-Horsley, Hewson, Love, & Stiles, 1998; Merseth, 1996). Typically, the instructional materials used with CBI in teacher education are written narrative cases of various types, such as authentic classroom dilemmas faced by practicing teachers (e.g., Harrington, 1995). Recently, however, there has been a strong, growing trend toward preference for video cases of classroom practice, a trend partly motivated by release of videotaped lessons from the Third International Mathematics and Science Study (TIMSS; e.g., Stigler & Hiebert, 1999). Case narratives are more convenient to develop and use than video cases, and they are easier for teachers to comprehend and study. However, researchers argue that such narrative cases oversimplify, and hence misrepresent, the "buzzing confusion" of true classroom life (e.g., Grossman, 1992, p. 228; Koehler & Lehrer, 1998), and that oversimplified problem representation during learning may contribute to later flawed reasoning in practice, such as "reductive bias" (e.g., Spiro et al., 1991). Video case-based methods may be an especially important form of professional development for preservice teachers, who may have little opportunity to experiment with instructional methods in classrooms (Putnam & Borko, 2000). Since classrooms in which education majors observe and practice teach often do not represent the ideals of school reform (Shulman, 1992), video cases can help provide better models for practice and visions of what is possible. Also, preliminary evidence indicates that video case methods in preservice programs may improve reasoning, produce more reflective practitioners, and produce lasting effects (e.g., Copeland & Decker, 1996; Tochon, 1999).

Motivated by such arguments, researchers are now designing and investigating various technologies and socio-technical infrastructures for making video cases more available and learning from video-case discussions more central to teacher professional development in the United States (e.g., Barab et al., 2000; Chaney-Cullen & Duffy, 1999; Derry & the STEP Research Group, 2000; Frederiksen et al., 1999; Lampert, & Ball, 1998; Marx, Blumenfeld, Krajcik, & Soloway, 1998). Some projects have produced stand-alone multimedia systems to support teacher learning by individuals or small groups. An example is CAPPS (Casebook of Project Practices), a multimedia system that scaffolds teachers as they study and learn from video cases of classroom practice (Marx et al., 1998). Other projects are attempting to promote online case-based teacher learning. For example, Barab et al. (2000) developed a video-based Internet technology that enables teachers to upload video of their classes and remain in their classrooms while they go online to observe and discuss how teachers in other sites are implementing state standards. Stigler (personal communication) and Goldman-Segall (2001) are also developing Internet technologies to support group discussions and learning from instructional video cases. A major online commercial initiative is Teachscape (http://www.teachscape.com), described by its web site as follows:

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> Teachscape is building a national community of educators by sharing real-world examples of excellent teaching in practice, by creating opportunities for online and in-school dialogue on teaching and learning, and by integrating on-site professional development support.

Another example is STEP (http://www.wcer.wisc.edu/step; Derry & the STEP Group, 2000; The STEP Research Group, 2000), an innovative web site designed to support facilitated video case discussions in secondary teacher education programs. The site is currently being developed, used and evaluated in connection with psychological foundations courses taught for teacher education majors at UW-Madison and Rutgers University. This paper will overview the design and theoretical basis of the STEP site and related instructional procedures, report findings from evaluation studies involving its use, and briefly overview future directions, including deveopment of the STEP environment for online problem-based learning, described in another paper in this conference proceedings (Steinkuehler, Derry, Woods, & Hmelo, 2002).

THE STEP SITE

The goal of instruction with STEP is to help pre-service teachers acquire useful scientific knowledge about cognitive psychology and other learning sciences that can flexibly be applied to the design and analysis of instructional environments. Research has shown repeatedly that this type of transfer is a very difficult goal to achieve. Our premise is that high level transfer of professional teaching knowledge and skill can be attained with our approach, partly inspired by Cognitive Flexibility Theory (CFT) (e.g., Spiro, Feltovich, Jacobson & Coulson, 1991). A central argument of CFT is that many instructional approaches fail because they represent complex subject matter in an unrealistically simplified and well-structured manner. The most common kind of learning failure is reductive bias -- the tendency to over simplify approaches and solutions to complex problems encountered in the world outside of class. CFT holds that the goals of advanced knowledge acquisition in ill-structured domains must include flexible and adaptive knowledge transfer, a process whereby students spontaneously assemble an appropriate set of ideas as a basis for creating unique models of real-world problem situations. This goal requires instructional techniques that lead students to re-examine the same domain concepts on multiple occasions in the context of multiple real-world cases and problems.

Our instructional approach engages students in collaborative group problem solving supported by STEP Web, a complex network of interactive conceptual relationships among cases and ideas within the domain of learning science applied to teaching, and of tools for supporting navigation through and discussion of that domain. Thus, STEP Web represents a hypermedia network of instructional resources designed to support video CBI. These resources include:

- Cases—stories of lessons, and of student learning and development resulting from lessons, in actual classrooms—that include edited video of the classroom, expert commentary and case analyses, plus additional materials that supply information about context
- Instructional problems and projects that make use of cases and are designed to promote in-depth analysis and, through such analysis, development of knowledge about how to support student growth through instruction
- A network of case-related links to web pages and other resources discussing core concepts from cognitive psychology and other learning sciences
- An environment for supporting facilitated online asynchronous discussions of video cases (pbl online)
- Links to additional tools and resources that teachers can use to help them adapt and implement ideas acquired from study of cases

To convey knowledge complexity and promote transfer and cognitive flexibility, instructional strategies, which determine how students navigate and study the complex conceptual terrain, must encourage students to construct multiple understandings for cases and use concepts repeatedly in case analysis, in different combinations. The main strategy we are using to help meet these conditions is an adapted version of Problem Based Learning (PBL; (Barrows, 1988). PBL is a form of facilitated, small-group, student-centered instruction in which learners acquire subject matter by discussing, analyzing and reanalyzing case-based problems (e.g., redesign Mr. Smith's algebra lesson), and by conducting research to find material (e.g., psychological concepts and related instructional methods) as required for solving the problems. STEP Web is designed to be a resource for both online and face-to-face PBL in teacher education learning science courses.

Instruction with STEP Web ---An Example

In spring semester 2000, 55 students, enrolled in an educational psychology course that was the instructional centerpiece of their third semester in a four-semester secondary teacher education curriculum, were assigned to small groups of 5-7 students that studied together in a PBL format. During the semester, each student participated in two different PBL groups. Each group was assigned a case to study and a problem to solve using that case. For example, a case assigned to a group of science majors was “Students Get a Charge out of Static Electricity.” This case, presented on STEP Web as readings, videos, and inquiry materials, tells the story of an actual science unit in a public school taught by a popular teacher and representing good traditional instruction. The problem was to advise Mr. Johnson (the teacher) on how to improve the unit and to justify the group's redesign in learning-sciences language. Our expectation was that students would redesign the lesson, developing a more authentic, inquiry-based approach for the unit.

After studying the case individually on STEP Web, students met with their groups to discuss the case. A teaching assistant trained to facilitate a specific group method known as Problem Based Learning (e.g., Barrows, 1988) guided each group. In accordance with this method, groups began by identifying learning issues—things they needed to learn more about in order to solve the redesign problem. Between classes, students researched assigned learning issues, bringing varied findings to their group discussions. STEP Web was made available as the primary research tool, which was used both during and outside of class. The links and navigational tools in STEP Web scaffolded students' research while allowing them to pursue interests in depth. Research beyond the materials in STEP Web was also promoted, since links led to other library and WWW resources.

Each problem required about four weeks to complete. The TA guided students through collaborative discussions of their research, during which time they identified positive and negative aspects of the instruction in the case and proposed new instructional solutions. In the third week they posted their redesign with explanations on a web conference for peer evaluation and consultation with experts, including scientists and educational experts. After revision, a group design report was submitted and evaluated as a course requirement.

USER EVALUATIONS OF STEP WEB

The STEP implementation at UW-Madison during spring semester, 2000, represented a process of continuous user-centered design in which students provided feedback that was used to upgrade and improve STEP Web throughout the semester. Early in the semester, intensive feedback was obtained from a small number of students who volunteered to be research subjects, but on March 7th and again on April 18th, all students were surveyed to obtain their feedback and satisfaction ratings regarding the web site.

Fifty-four students returned surveys on March 7; fifty returned surveys on April 18. On these dates, 48 and 46 students respectively reported using the web site as an instructional resource for their study and PBL research. Satisfaction with STEP Web as an instructional resource was 3.9 on March 7 and 4.1 on April 18, based on a rating scale of scale of 1 - 5 (not very satisfied to very satisfied). Students' comments initiated a number of improvements and changes throughout the semester. For example, the addition of a search engine was based on students' requests. Students' satisfaction with STEP Web [also referenced as the Knowledge Web, or the KW, in comments below] increased as the site was improved and students gained experience with it. For example, one student who participated in three surveys commented:

> Feb 22: "KW - impressed me this week . . .I did not research outside of it. " (No rating requested)
>
> Mar 7: "I am getting better at navigating the KW." (Rating = 4)
>
> Apr 18: "I am starting to appreciate the knowledge web." (Rating = 5)

Other representative student comments:

> "When I finally figured out how to use it, it was great." (Rating = 5)
>
> "I like the newer KW." (Rating = 4)
>
> "Much improved!" (Rating = 4)
>
> "Some pages that could have helped weren't up." (Rating = 4)
>
> "They [web pages] were quite useful but KW needs to be more easily navigated." (Rating = 3)
>
> "I found the KW to be confusing in some of its explanations (Rating = 3)

In sum, most students in the UW-Madison course were pleased with the knowledge web by mid semester, but their comments indicated that further development and improvement is needed. Based on students' concerns, there is need to: 1. add to and improve resources on STEP Web; 2. improve navigation; and 3. provide instructional supports within the course to speed the process of learning how to use the site. We either have implemented or are currently working on these improvements.

STEP Web was also used at Rutgers University in a smaller course taught by an experienced PBL instructor. There it was positively rated despite being used at an early stage in its development. Based on fourteen students and a scale of 1 - 5 (not very satisfied to very satisfied), the web site was rated 4.6. The textbook used in the course, a best-selling educational psychology text, was rated 4.5.

EVIDENCE OF TRANSFER AND FLEXIBLE CONCEPT USE

The evaluation study at UW-Madison also produced evidence of growth in students' ability and propensity to activate and combine concepts from the learning sciences in the analysis of videotaped lessons. Also described in Siegel et al. (2001), our assessment approach was grounded in Hierarchical Schema Theory (HST; Derry, 1996), which claims that students should develop during a course in at least four different ways. One type of learning expected from a course is acquisition of new concepts, independent of how those concepts are activated and applied across contexts. Such acquisition is demonstrated if a student is able to define or use a concept correctly when expressly told to do. For example, consider the test item, "Define scaffolding and give an example." This question points directly to the concept that should be recalled and used to answer it. If a student develops only this level of performance, she has merely acquired unusable knowledge.

However, our goal was to help students acquire usable, flexible knowledge. Related to this goal, HST predicts three *additional* types of growth. Second, the course should increase students' general propensity to activate learning sciences ideas as frameworks for thinking about instructional situations. Third, not only should student teachers activate more learning science ideas in instructional situations, the activated ideas should be the most relevant and important ones for analyzing particular situations. Student teachers who activate more learning-sciences knowledge in thinking about instruction have grown to some degree, but students have developed further if they more frequently activate the ideas that more expert analyzers agree fit particular contexts. Fourth, student teachers should integrate ideas to construct coherent theoretical interpretations of situations. Concept activation supplies building blocks for this activity, but the construction of conceptual situation models requires the recalling, mapping and combining of concepts into coherent interpretations. Hence, although some growth is indicated when a course increases students' activation of appropriate concepts in instructional contexts for which those concepts are appropriate, there is greater growth if students discuss concepts within the framework of a coherent situational model. Here we report a preliminary analysis from a pretest-posttest assessment of these additional three types of course-related development predicted by HST.

Method

Of the 55 students who completed our spring 2000 course, 18 volunteers participated in this study. Two parallel versions of the test were developed, Test X and Test Y. Each version consisted of two video segments chosen from the Annenberg/CPB "Minds of Our Own" series (Schneps & Mintzes, 1997), each followed by an essay question. For example, video segment A from Test X depicted a good student completing an interview task both before and after a science lesson. The task showed that the lesson had not apparently improved the student's conceptual understanding of the flow of electricity in an electrical circuit. The student teachers in our study were asked to study the clip, reflect on it, and write a coherent statement about why the student's understanding did not improve as a result of seemingly good instruction.

A counterbalanced design was employed. That is, for the pretest (given in the beginning of the STEP course), half of the participants were assigned Test X and the other half were assigned Test Y. For the posttest (given during the last week of the course), participants were assigned the alternate test. The participants, who were paid for their time, were instructed to take home a compact disc containing the video segments, plan 45 minutes to devote to the task, and complete the entire test in one sitting. Neither test explicitly directed students to incorporate learning science concepts from the course into their answers; participants were notified that their responses would not be viewed or evaluated by their instructors.

After eliminating two subjects due to missing data, sixteen subjects remained, eight subjects in each of the two counterbalanced test conditions. Researchers who were "blind" to subjects' identities and time of testing coded and scored essays as described in the analyses below.

Activation of Course Concepts

Our first question was whether the course increased students' propensity to activate course concepts as interpretive frameworks for the videos. Researchers first identified key concepts from the course, and then determined the number of course concepts that each essay contained. Results, summarized in Table 1, indicated that students did spontaneously activate a greater number of course concepts for instructional situations presented in video cases, after the course.

Table 1. Descriptive statistics of the number of concepts included in pretest and posttest essays, by question.

	Question 1		Question 2	
	Pretest	Posttest	Pretest	Posttest
Mean	1.13	2.94	0.19	0.81
Standard Deviation	0.62	2.44	0.40	1.11
Range	0—2	0—9	0—1	0—3
N	16	16	16	16

Selective Activation of Most Relevant Concepts

Next we asked whether there was a trend toward increased activation of concepts determined, by more expert reasoners, to be particularly appropriate for the given video scenarios. Two doctoral students in Educational Psychology, who helped teach the course, took Test X and Test Y collaboratively. They identified a set of relevant concepts and selected from these the two or three most important "key concepts" for each video situation. For example, the key concepts for Text X, Segment A, were *misconceptions*, *prior knowledge*, and *tools*. Additional appropriate concepts were *hands-on learning*, *explanation-based learning*, *knowledge construction*, *zone of proximal development*, *assessment*, and *disequilibrium*. We then coded for and counted the number of appropriate and key concepts present in the student teachers' essays. We gave credit if students could either name a concept or correctly discuss it without using the exact term.

For both video segments, there was a marked pre- to posttest gain in number of situation-appropriate concepts activated. Examination of key concepts alone revealed the same trend. Gains for the most important key concepts averaged 1.38 for both questions combined; gains for the other appropriate concepts averaged 1.0. These results suggest that during the course, student teachers did develop in their tendency to selectively activate relevant learning-sciences concepts for different instructional situations.

Further examination determined that almost all key concepts identified by "experts" were also identified by student teachers following the course. Even for key concepts that were not explicitly mentioned, student teachers employed related theoretical ideas in their analyses.

Constructing Situation Models of Teaching

We also examined whether preservice teachers learned to adaptively integrate concepts into particular situational mental models of the instructional scenarios presented in the video segments. We developed a hierarchical taxonomy of plausible situational models. Each situation model was based on an underlying understanding of the interaction between teaching and learning, which can range from a simple transmission view (e.g., teaching is information transmission and learning is additive) to a more complex constructivist view (e.g., teaching is a form of assisted practice and learning is knowledge construction). We adapted our taxonomy from a heavily researched scheme developed by the Cognitively Guided Instruction project (e.g., Fennema, Carpenter, Franke, Jacobs, & Empson, 1996).

Table 2. Summary of Situation Models

Level	Situation Model in Brief
1	Teaching is showing and telling.
2	Students interpret instruction using prior knowledge.
3	Students' prior knowledge affects design of curriculum and classroom interaction.
4	Teaching is based on a developmental theory of disciplinary knowledge.

The hierarchical coding scheme included four levels of situation models of instructional contexts, briefly summarized in Table 2, as well as sublevels. At level 1, the respondent believes that for a student to learn science, a teacher has to show them or tell them (Fennema et al., 1996). A respondent at this level does not recognize the importance of students' prior conceptions. For example, a response might include a statement such as, "because the teacher never explained how to complete the task, the student never understood the concept." At level 2, the respondent begins to view disciplinary knowledge as important to learning (Fennema et al., 1996). We created several subcategories of this level, with higher sub-categories being scored as 2.5. Respondents at lower levels recognized and minimally described the importance of prior knowledge. For example, one response began, "If the teacher was able to first find out what all his students knew...," but did not go on to connect this idea to an instructional approach. Students at higher levels expressed the idea that instruction must respond to students' prior knowledge. For example, one student blamed performance on misconceptions that "were not addressed during the lesson in a direct enough way." At level 3, teachers believe that student thinking should determine the evolution of curriculum and the ways a teacher interacts with individuals (Fennema et al., 1996). The teacher needs to interact with students to create challenging situations and conceptual conflict. For this stage, the teacher specifically assesses students' prior knowledge. Respondents at this level said the reason students in the video did not understand what was being taught was not only because the teacher did not assess prior knowledge, but also because the teacher needed to maintain an interaction with the students in order to teach more effectively and challenge students. For example, one student teacher stated, " It is the teacher's job to challenge those previously held views and to engage students in an authentic process leading toward that goal and assessed in a way that tests growth in knowledge/changes in knowledge against prior misconceptions." The most sophisticated situation model in our hierarchy was level 4. At this point, the teacher holds a developmental theory of disciplinary knowledge and, based on this viewpoint, has a sense of how to teach certain ways at certain times and why. (Fennema et al., 1996).

Our data indicated that before the course, student teachers often used level 1 models in which teaching is merely the one-way transmission of information. Level 2 models, in which prior knowledge of the student is recognized, were also used, and a few higher-level 2 models were utilized as well. On the posttest, only two people used level 1 models, a few used level 2 models, the majority used higher level 2 models, and four people constructed level 3 models. None of the participants, on either assessment, developed a level 4 situational model in which teaching is based on the trajectory of students' disciplinary knowledge. Table 3 summarizes these data.

Table 3. Situation Models Results

	Pretest	Posttest
N	16	16
Mean	1.84	2.31
SD	0.54	.68
Range	1-2.5	1-3

One important aspect to note about the quality of the essays is that the students, as well as the experts, did not employ single theoretical frameworks, such as information processing or Piagetian psychology, in video case analysis, but rather flexibly applied pieces from different theories. For example, a higher-level 2 discussion might incorporate concepts of transfer and working memory from information processing theory, but also mention cognitive apprenticeship, from sociocultural theory. Such observations provide additional evidence that the course and site design are promoting the goals of cognitive flexibility theory, as we intended.

Narrative Case Vignettes versus Video Cases Online

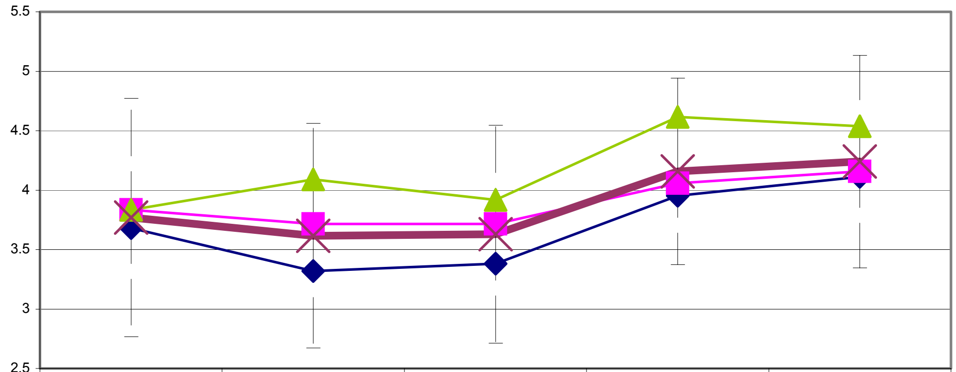
Data from the fall, 2000, implementation of the STEP course at UW-Madison were used to compare students' perceptions of lengthy PBL projects anchored to complex video cases embedded within STEP Web to brief PBL projects anchored to short case vignettes presented as written narratives. Figure 1 graphs students' ratings of PBL activities within three course sections representing different teaching certification areas. The rating scale asked students to judge the usefulness of the PBL exercise for helping them learn to teach. The data points labeled as cases 1, 3, and 4 show mean usefulness ratings for short PBL activities based on narrative case vignettes. Data points labeled Large PBL parts 1 and 2 show mean usefulness ratings at two points in time during a four-week activity based on a lengthy video case analysis. That the substantial upward shift in satisfaction at point 4 occurred for all sections at the time video cases were introduced and was maintained through the next testing period at point 5 strongly implies that students' perceptions of instructional usefulness was more favorable for the video-based PBL that is the standard instructional format for STEP courses. Thus, video case-based instruction may be preferred to the narrative case format typically used in teacher education.

CURRENT DIRECTIONS

STEP Web and its associated instructional model are complex, but results from several implementations show that the approach may be producing desired learning goals and that it is appreciated by students. Encouraged by the preliminary results reported above, we are now continuing three specific lines of work.

Expanding STEP resources, focusing specifically on the development of new and improved video-based instructional cases for five secondary teaching disciplines: mathematics, science, social studies, English and foreign language.

Figure 1
Mean Usefulness Rating
by Section/Case
[N= 68, n=59]



	Case 1	Case 3	Case 4	Large Pbl - Part 1	Large Pbl - Part 2
English/Social Studies	3.681818182	3.318181818	3.380952381	3.952380952	4.111111111
Math/Science	3.833333333	3.714285714	3.714285714	4.058823529	4.157894737
World Language	3.833333333	4.090909091	3.916666667	4.615384615	4.538461538
Class Mean	3.769230769	3.617021277	3.62962963	4.156862745	4.24

- Cognitive research that will guide design of better instructional cases and group procedures for case-based and PBL instruction in STEP Web. One interesting question in case design suggested by project collaborator Rand Spiro (personal communication; Spiro et al., 2001) is whether video instruction using computer-enhanced perceptual overlays that employ color, sound, and imagery to emphasize themes in video cases can accelerate teachers' acquisition of learning science concepts applied to classroom instruction. In collaboration with Spiro we are also planning to investigate whether such perceptual enhancements can highlight complex thematic interactions in video cases, helping learners acquire the ability to think flexibly and interpret classroom interactions from multiple perspectives.
- Research and development leading to more sophisticated conferencing tools within STEP. This line of work will enable us to offer a distributed (distance) form of problem-based learning instruction in STEP, which will permit improved course implementation on a large scale with fewer human resources. The STEP pbl environment, which has been beta tested at Rutgers, provides new users with early guidance in use of STEP Web, reducing the time required to become familiar with the complex site and its instructional procedures. The STEP pbl environment also supplies toolkits to support inexperienced facilitators and course managers. This work is described in more detail elsewhere in this proceedings (Steinkuehler et al., 2002).

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