
The field of teacher education, like other professional programs such as library science and business administration, constitutes an ill-structured domain wherein students often struggle to apply basic kinds of knowledge acquired in the classroom to complex and disparate real world cases. Traditional pre-service education programs often fail to prepare students adequately for what they will encounter in their jobs. This study examines the relative benefits of employing a hypermedia system based on the principles of Cognitive Flexibility Theory (CFT) to improve outcomes in pre-service teacher education. The experimental group was exposed to the CFT-based system, while the control group instead participated in a field experience. The study’s findings suggest that inclusion of CFT-based instructional tools, while improving students’ sense of self-efficacy as teachers, does not result in major gains when compared with field experience. While limited in focus the study lends itself well to broader applicability within other professional domains.

Headings:

Educational Technology -- Hypermedia

Educational Technology -- Interactive computer systems

Cognition -- Cognitive Flexibility

Teacher Education -- Methods of instruction
THE IMPACT OF A COGNITIVE FLEXIBILITY HYPERMEDIA SYSTEM ON PRE-SERVICE TEACHERS’ SENSE OF SELF-EFFICACY

by
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Approved by

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Background & Review of the Literature

First developed in the mid 1980s, Cognitive Flexibility Theory is a theory of learning and instruction that focuses on the following four goals:

- To help individuals gain a deeper understanding of complex subject matter
- To prepare individuals to apply critical knowledge flexibly and creatively in a wide array of real-world contexts
- To challenge individuals’ epistemological beliefs through exposure to nuanced, complex, multiple points of view
- To develop hypermedia learning environments that provide a non-linear, case-based approach to knowledge acquisition and promote the first three goals above (Spiro, Collins, Thota and Feltovich 2003)

Since its inception the theory has evolved to address the fact that today’s young learners, if they hope to succeed in our information-centric world, are increasingly required to apply knowledge in flexible ways to complex situations. Its primary application, however, remains within domains of professional practice such as medicine, engineering, business, and teaching, each of which can be defined as “ill-structured” insofar as they revolve around events or cases so diverse in nature that neither conceptual knowledge nor general principles can be uniformly applied.

Spiro et al. discuss how such ill-structured domains present particular challenges to learners making the transition from student to practitioner. Of utmost concern to Spiro
and his colleagues is the tendency towards oversimplification, or what they call reductive bias, in the early learning stages of these complex domains. They argue that such oversimplification of core concepts and introductory material, in both the manner in which these are taught and the mental representations employed to do so, severely inhibits a learner’s ability to develop deeper understanding of complex ideas and to transfer advanced knowledge to widely disparate real world cases (Spiro, Feltovich, Jacobson, and Coulson 1992). Their Cognitive Flexibility Theory aims to remedy this predicament by outlining a fundamentally different approach to instruction and knowledge acquisition, one that relies heavily on technology to provide multifaceted case-based views of conceptual complexity, overlap, and interrelatedness.

The design model for this study builds upon past research in the area of multimedia case-based instruction (M-CBI) for pre-service teachers while differing in fundamental ways. Baker (2005) provides an insightful examination of how M-CBI, when used in conjunction with field experience, ranks highly among teachers in training in terms of its ability to enhance their overall learning experience and frame in-class discussion. Her work, while it corroborates earlier research findings that indicated the perceived value of field experiences among pre-service teachers, further suggests that with an added M-CBI component, such field experiences become even more meaningful. Other researchers have found that use of M-CBI leads to students’ increased flexibility in applying their knowledge to real world settings, a skill that is central to Cognitive Flexibility Theory (Risko, Peter and McAllister 1996). Pre-service literacy teachers’ differing attitudes towards M-CBI as a learning tool were measured by Hughes et al., and this work too
suggested an inherent value in well-designed multimedia systems (Hughes, Packard and Pearson 1997).

This study differs from these earlier ones in that it examined the differences between students who participated in a field experience and those who instead utilized a custom designed Cognitive Flexibility Hypermedia (CFH) system. The CFH system was not strictly a case-based instructional medium, since it offered multiple views of key concept areas rather than focusing on one or more cases. It also was offered as a standalone component near the end of the course, with individual reflection on its usefulness captured within the online environment rather than through group discussion later in a face-to-face setting. In other words, this study hoped to determine whether there was any measurable advantage to using CFH systems *in lieu of* field experiences. While the study focused on the domain of teacher education, its applicability to other professional areas of practice that typically include field-based experience should not be overlooked.

It is important to note that the original proponents of CFT acknowledged some of its limitations. In one of their earliest longer-form explorations of the underlying theory and its applicability, the authors identify areas where the use of hypertexts (a broad term they use to describe non-linear and multidimensional computer-based systems) may not be appropriate or beneficial (Spiro and Jehng 1990). These include situations where learning centers on “attainment of superficial familiarity with concepts and facts” and mere “knowledge reproduction” (165) as opposed to advanced mastery of conceptually complex material where knowledge must be applied across diverse cases. But as Dr.
Patricia Cunningham of Eastern Illinois University pointed out over ten years ago, “In short, teacher knowledge is messy, complex, and difficult to learn. Teacher knowledge requires flexibility of application, potential for juxtaposition of seemingly disparate knowledge, and the ability to analyze critically and decide a course of purposeful action….CFT seems tailor-made to teacher education. In light of what we know about the complexity of learning to become a teacher, it is a short leap to see the applicability of CFT to teacher pedagogy” (Cunningham 1995).

Spiro and his various colleagues over the years have based much of their work on the claim that hypermedia systems are uniquely suited to supporting CFT because they can offer rapid access to nonlinear, multidimensional viewpoints of a complex case or topic. As other researchers have pointed out, however, hypermedia is often poorly designed or integrated (or both), resulting in questionable benefit (Dillon and Gabbard 1998; Dillon and Jobst 2005). The work of Dillon et al. is worth noting not because it necessarily disputes the underlying claims of CFT, but rather because it indicates how critical design and implementation are in applying its core principles. The current study hoped to address this concern by assessing the perceived usability of the custom designed hypermedia system used for the research, through both quantitative and qualitative measures. Though not intended as a rigorous comparative examination of different CFH system design models, the inclusion of usability assessment at least could be used to eliminate the possibility that the impact of the CFH system used was severely compromised by poor design.
Numerous examples of applied Cognitive Flexibility Theory do exist in the literature. In the majority of studies, empirical evidence suggests there are measurable benefits to using hypermedia systems based on CFT principles, as long as such systems are well designed and course instructors provide the necessary scaffolding to guide the learners’ experience. Even before the advent of sophisticated web-based interfaces, researchers examined the effects of multimedia case studies using specially programmed videodiscs and found compelling evidence to support the general claims of CFT (Spiro and Jehng 1990; Fitzgerald, Wilson and Semrau 1997). Fitzgerald et al. focused specifically on the impact such interactive hypermedia technologies had on pre-service teacher problem-solving abilities. One of their key findings was that the effectiveness of CFT-based instructional models “was severely restricted by ineffective methods of implementation and inadequate support for new users” (75). Similar findings were uncovered in an Australian study that compared the influence of teaching purpose and learning goals on two different multimedia tools (Baird and Love 2003). While its primary focus was the implications of these variables on multimedia design itself, this research study found that the positive impact of hypermedia case studies on pre-service teachers’ skills correlated closely with individual comfort levels using technology, as well as the quality of technical support provided.

Other research seems to corroborate this data. Prior knowledge defined as a relative measure of “domain expertise” and “system expertise” has a definite influence on the effectiveness of hypermedia learning (Mitchell, Chen and Macredie 2005). Study participants with lower domain knowledge showed greater benefit, as did those with
higher technical skills. For those individuals with lesser degrees of prior domain knowledge but who lacked system expertise, the findings still indicated a positive impact for the use of hypermedia, as long as proper guidance and support were provided.

Additional studies, though not confined to the domain of teacher education, provide further support for the efficacy of Cognitive Flexibility Theory and hypermedia-based systems versus traditional instruction. In one study conducted using 9th grade biology students, researchers found that the experimental group exposed to course material via hypermedia showed markedly higher retention rates than the control group (Yildirim, Ozden and Aksu 2001). In another, the researcher performed a meta-analysis on 35 different peer-reviewed journal articles to determine the effect size of hypermedia instruction on students’ achievement, as compared to traditional instruction (Liao 1998). The findings here showed that hypermedia-based instruction had a somewhat positive effect on achievement, but Liao notes in his discussion that variability across subject areas deserved further attention in future studies. (This particular study should be viewed within its historical context, since it was written at a time when CFT-based hypermedia tools were just coming into use.)

One more recent study articulates the need for hypermedia video ethnography case studies in teacher education (Harris, Pinnegar and Teemant 2005). The authors argue that the “pressure to prepare pre-service teachers theoretically and practically to teach culturally, linguistically, and learning diverse students” (141) requires such an approach because it is both superior to written case studies and uniquely suited to offering multiple
perspectives, authenticity, problem representation and juxtaposition of theory and practice. Here again we see the core principles of CFT being adapted within the domain of teacher education.

**Methodology and System Design**

This study compared the effectiveness of a service-learning based course component with that of a hypermedia-based module, in raising pre-service teachers’ sense of self-efficacy, based on three key areas of focus in a graduate level teacher education course. Although the course title, Introduction to Schools, implies introductory subject matter, it explores complex areas of interest within the field that lend themselves well to Cognitive Flexibility Theory. The three focus areas, each of which correlates to the factors revealed by the teacher self-efficacy survey instrument used, were:

- **Student Engagement** (objective – to appreciate the differences students bring to the classroom; to understand the benefit to all students in responding to diverse learners)
- **Instructional Strategies** (objective – to develop multiple instructional strategies and apply them to teaching)
- **Classroom Management** (objective – to identify and critique strategies for classroom management; to recognize varied influences on the classroom climate)

The course was divided into four sections, which ran concurrently during a short summer session and were taught by different instructors (doctoral students). To minimize the effects of instructor differences, participants from three sections constituted the
experimental group and students from the fourth the control group. The researcher had originally intended to divide experimental and control groups evenly, with students being drawn from two sections each. Due to a late decision on the part of the graduate instructors about which of them would lead the service-learning cohort and how many students could participate in that group, the control group out of logistical necessity was reduced to only one section. Data collected from these four sections of either type (A1-3, B) were divided into group A (experimental, n=27) and group B (control, n=14). A twelve-question survey was administered to groups A1-3 and group B on the first date of formal instruction, following a review of the syllabus and general course content by each instructor. The survey instrument used was the short form version of Tschannen-Moran and Woolfolk Hoy’s Teachers’ Sense of Efficacy Scale (2001), a 12-question survey using a nine point ordinal scale. On the final day of class, the same survey (TSES) was administered to all participants again.

In their own rigorous test studies, Tschannen-Moran and Woolfolk Hoy refined this instrument down to its 24-question long form and 12-question short form by comparing it to other well-known self-efficacy scales and by performing first and second order factor analysis on the original 32-question survey. Based on the factor analysis, they arrived at three consistent subscales based on groupings of four items each that accounted for 51% of the variance in participants’ responses: efficacy for student engagement, efficacy for instructional strategies, and efficacy for classroom management (Tschannen-Moran and Woolfolk Hoy 2001, 797). Again, these subscales correspond to some of the key concepts covered in the Introduction to Schools course and identified above as those on which this
study focused. As recommended by the creators of the TSES, factor analysis was performed on both the pre- and post-survey data to determine how closely the results corresponded to the original researchers’ subscale groupings. For this study, means were calculated then for each variable and for each of the three subscales, along with standard deviation; the pre- and post-survey data were compared to determine whether significant gains were noted in either group.

In addition to the self-efficacy scale, a second short survey designed to measure overall usability of the hypermedia system was administered to students in all three sections that comprised the experimental group. This survey was based on Nielsen’s famous heuristics for interface design and usability and addressed: visibility of system status; user control and freedom (a particularly critical aspect of CFH systems); consistency of design; flexibility and efficiency of use; and overall aesthetic appeal (Nielsen 1994). A similar scoring approach was employed for this five point ordinal scale, with the means for each survey item being calculated, along with standard deviation. Here, of course, the point was not to compare means with the control group since they had not used the hypermedia system, but rather to gauge user impressions of the system design to determine whether lack of usability may have affected negatively its impact.

Finally, a separate, more open-ended mechanism was used to gather qualitative feedback from participants in the experimental group (group A). This took the form of an integrated blog that asked students to provide their impressions of the associated hypermedia system used for the study, with the focus being on the effectiveness of the
user interface in conveying the rich complexities encountered by practicing teachers. The blog comments provided corroborating evidence as to whether the hypermedia system’s efficacy was compromised due to poor design, limited facility with technology on the part of participants, or lack of more formalized guidance in the use of the tool.

During the final week of the summer session in which the course was taught, students from group A were asked to explore further three core topics they had covered previously via face-to-face lectures, readings, and written assignments, using a rich, interactive, web-based hypermedia system custom designed for this study. This Teacher Education Advanced Cognitive Hypermedia system (TEACH) was based in large part on the theoretical work of Spiro et al. as well as the usability studies of Norman (1986) and Nielsen (2000). The researchers also had as a model to emulate the EASE History website conceived and designed by Spiro, Collins, Ramchandran, Ruggiero, and Bates at Michigan State University (2004). As stated on the frequently asked questions page of the EASE History site:

EASE stands for Experience Acceleration Supportive Environment. We want to help learners get quickly up the learning curve. EASE History’s goal, which mirrors that of the Cognitive Flexibility Theory, is to prepare learners to become more flexibly adaptive thinkers. Flexibly adaptive thinkers are well informed, open-minded, and creative. Working in EASE History, learners see that there are no simple answers or one best example; that variability exists through real world examples.

The TEACH interface was designed with similar principles in mind, combining short video vignettes with supporting texts and hyperlinks that offer multiple viewpoints of a
specific concept or theme, in this case: diversity, teacher’s rights, and school organization (see Figure 1).

Figure 1. The TEACH homepage, showing the basic layout and top-level navigation.

In order to provide a more pleasant experience to the end-user, the navigation of the TEACH interface was designed with simple top-level menus for each of the three primary topics and a one that led directly to the feedback forum, which was designed as a blog. Within each of the secondary level pages was a brief description of the core topic and links to two separate video sets (e.g., Diversity Set A - Racial Diversity in the Classroom). In the case of the feedback forum, instructions on how to post a comment were included, along with a direct link to the blog. Breadcrumbs were used throughout the site to provide additional navigational pathways, and a utility Help link on the top of every page led to a short FAQ to assist users having difficulty viewing videos or displaying pages.
Throughout the TEACH design phase, the emphasis was on usability, with a clean and simple interface that would not distract from the juxtaposed video examples and supporting materials. Limited testing was done by the researcher, his content adviser (an education faculty member), and the graduate students who would be teaching the summer course. Based on this early feedback, minor modifications were made to the TEACH interface, mainly in terms of simplification of the top-level navigation and a reduction in the number of video clips per page. (The testing revealed performance weaknesses when more than two clips were embedded on any given page.) Various approaches to incorporating contextual artifacts (charts and graphs) were explored before the researcher chose a simple, elegant mouse-over tooltip effect that worked well across multiple browsers (see Figure 2). The final result, while far less sophisticated than the EASE History interface, provided a suitably robust CFH system for the purposes of this study.

Students from each course section in group A were given up to 3 hours to use the TEACH system in a controlled lab environment, with all computers being of the same make and model and headphones provided to all participants. In lieu of being able to interact with the TEACH website, students in the control group participated in service-learning oriented site visits to a local public school. Although these few short site visits amounted to slightly more additional course hours than the 3-hour lab session for groups A1-3, they provided the researcher with an interesting comparison between self-confidence acquired through real world field experience versus immersion into a hypermedia environment based firmly on cognitive flexibility theory and user centered design standards. This is an important point since similar research studies in disciplines
other than teacher education (e.g., reference librarianship, business management) could be modeled after such an approach.

In designing the TEACH interface, the researcher initially struggled with the issue of how to gather enough video source material to create an effective learning environment. Given the difficulty of acquiring the necessary permissions to capture actual K-12 classroom footage, and due to the ever-increasing availability of educationally based video clips from secondary sources such as YouTube, the Internet Archive, and Google Video, a practical decision was made to integrate such secondary source material. In addition, the researcher benefited from the sizable video collection of one of his advisers and from commercially available DVDs. Relevant clips from the latter two sources, drawn from major motion pictures based in public school settings, provided appropriately disparate views of teachers in practice. These mass media portrayals of classroom diversity, teachers’ various roles, and school organization, were juxtaposed with documentary footage and short clips taken from the above mentioned secondary sources. This design decision was in keeping with the basic tenets of CFT as far as its emphasis on challenging learners’ preconceived notions, offering a multiplicity of views, and providing random (i.e., non-linear) access to instructional content.

Great care was taken in assembling a broadly representative sample of short video clips (under 3 minutes in almost all cases). Working alone and not having the benefit of a team of web developers or video editors, the researcher faced the daunting task of sifting through hours of potentially usable footage from these various sources, converting
relevant scenes from analog to digital format in some cases, then editing them further down to smaller chunks that could be embedded two-to-a-page in a web browser. Although the controlled lab environment assured the researcher of high bandwidth connectivity (10/100GB switched Ethernet) on a campus network, page load time was still of utmost concern, given the nature of the TEACH interface and study participants’ potential lack of patience should the system seem slow. After some initial testing with various video codecs, and based to some extent on the hardware on which the TEACH site would reside, the researcher determined that the best delivery format for the embedded video was H.264 QuickTime. The resulted in slightly larger file sizes for individual clips but higher quality playback.

In addition to the video clips the TEACH interface included charts and graphs that included supporting facts, figures, and statistics. These digital artifacts were tied directly to specific video clips to provide context and offer glimpses into the complexities of the core topics. For instance, linked to a clip that portrays a young teacher struggling with an incident of racial conflict was a chart showing the percentage of racial and ethnic distribution in K-12 public schools, by region, in 1972 versus 2005. In the section on teachers’ rights and responsibilities, juxtaposed with a classic scene from Dead Poet’s Society in which Robin Williams’ character stuns his prep school class with his unorthodox teaching methods, was a chart detailing the percentage distribution of students in middle and high school grades taught by a teacher lacking a major or certification in the field they teach. Finally, where charts were not linked to video clips, contextual prompts were provided in the form of HTML-generated “tooltips,” small pop-
up windows that posed questions related to the associated clip and intended to provoke deeper consideration by the viewer (see Figures 2 and 3).

Figure 2. An interior page on the TEACH website, showing the layout of video elements, a cognitive prompt triggered by mousing over the question mark icon, and the small chart icon that triggers a clickable HTML tooltip. Figure 3 shows an example of an actual chart generated by clicking on one of the tooltips.
Data Analysis and Findings

A total of 27 students in the experimental group (A) and 14 in the control group (B) completed all aspects of the study. The first step in the data analysis process was to perform a factor analysis on the pre- and post-survey TSES scales, as recommended by the scale’s developers. For group A and B, factor analysis using varimax rotation, default eigenvalue of 1, and the principal components method was performed, with the KMO and Bartlett test of sphericity used to determine the adequacy of the sample set for conducting such an analysis. For the experimental group, KMO indicated an adequate, if not outstanding, level of adequacy for both the pre- and post-survey data (.689 and .632,
respectively). For the control group, the KMO score was in the unusable range for the pre-survey (.282) and borderline for the post-survey (.571). In all four cases, however, Bartlett scores were .000, indicating that the data were, in fact, acceptable.

Interestingly, the post-survey data aligned more closely with Tschannen-Moran and Woolfolk Hoy’s consistently correlated factors (Efficacy in Student Engagement, Efficacy in Instructional Strategies, and Efficacy in Classroom Management) for both groups A and B than did pre-survey data. Based on their 12-question short form, four out of four factor loading items matched for the experimental group on Engagement and Strategy, while three of four items matched for Management. Three of four items matched for Engagement and Management in the post-survey data from the control group, but the third factor (Strategy) was missing entirely. The lack of factor analysis alignment with Tschannen-Moran and Woolfolk Hoy’s findings in the pre-survey data was not surprising, as they acknowledge that among pre-service teacher respondents the factor structure often becomes less distinct. This did present a challenge insofar as their recommended scoring method for TSES is to compute the unweighted means of the items that load on each factor to arrive at subscale scores for Efficacy in Student Engagement, Instructional Strategies, and Classroom Management.

Because the questions that Tschannen-Moran and Woolfolk Hoy identified as loading on each factor did not match well in the pre-survey phase, the researcher chose a two pronged approach: focus only on significant differences between mean subscale scores of groups A and B in the post-survey data; and examine differences between means of
individual questions for both groups, in pre- and post-survey data. In terms of post-survey subscale scores, the results were as follows:

<table>
<thead>
<tr>
<th></th>
<th>Student Engmt.</th>
<th>Instructional Strat.</th>
<th>Classroom Mgmt.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td><strong>Group A</strong></td>
<td>6.98</td>
<td>1.21</td>
<td>7.77</td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td>7.56</td>
<td>1.36</td>
<td>7.79</td>
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</table>

Figure 4. TSES subscale means and standard deviations (post-survey), based on a 9-point ordinal scale that asks “How much can you do?”, where 1-2 = Nothing, 3-4 = Very Little, 5-6 = Some Influence, 7-8 = Quite A Bit, and 9 = A Great Deal.

Based on these scores, it seems fair to suggest that students in the experimental group (A) rated their self-efficacy nearly as highly as their counterparts in the control group (B), especially in the area of instructional strategies where the difference between the groups was almost immeasurable. For Efficacy in Student Engagement control group participants appear to have benefited more from their field experience than those students in group A who used the TEACH system. Given that some of the video clips in TEACH dealt specifically with some of the factor loading questions for Engagement (e.g., Q2 - How much can you do to motivate students who show low interest in school work?; Q4 - How much can you do to help your students value learning?), one might conclude that a service-learning course component had greater impact on this factor than on the other two. Worth considering is how these results may have varied if the TEACH system had been compared to traditional classroom lecture format instruction, rather than field experience, given that the former remains the dominant instructional paradigm. A future research project using just such a comparative approach is currently being considered.
As for the means on individual questions, it soon became clear that participants in the control group happened to enter the study with generally higher levels of self-confidence than that of their peers in the experimental group. Mean scores were higher for the latter on just two of the TSES questions (8 and 9) at the outset of the study:

- **Q8.** How well can you establish a classroom management system with each group of students? (Group A mean = 6.96, SD = .98; Group B mean = 6.57, SD = 1.4)
- **Q9.** How much can you use a variety of assessment strategies? (Group A mean = 6.89, SD = 1.57; Group B mean = 6.29, SD = 1.73)

Post-survey data were similar in that the experimental group’s mean scores were again higher on just two items, one being question five, the other question nine once more:

- **Q5.** To what extent can you craft good questions for your students? (Group A mean = 8.15, SD = .77; Group B mean = 7.86, SD = .95)
- **Q9.** How much can you use a variety of assessment strategies? (Group A mean = 7.74, SD = .94; Group B mean = 7.50, SD = 1.09)

Because the control group had nearly uniformly higher means going into the research study, the researcher chose to examine the degree of change within the means for each item between both groups. The degree of change was greater for the control group subjects on eight of the twelve TSES short form questions. For questions 1, 4, and 8 that change was twice what it was for the experimental group, and for question 7 it was nearly four times greater. Question seven on the TSES short form asks, how much can you do to calm a student who is disruptive or noisy? As this was not one of the questions where the
The experimental group participant rated themselves higher than their control group peers at the study’s outset, the clear implication from this disproportionate change in mean is that the TEACH system failed to build pre-service teacher self-confidence in the way that field experience clearly did.

The only questions for which experimental group A’s changes in mean were higher than control group B’s were 5, 6, 10, and 12. None of these questions were ones where pre-survey data showed higher means for group A. Except for question 5, where the experimental group’s change in mean was three times greater than the control group, the degree of change for two of the other three questions was so close as to be insignificant, while the third (Q10) was greater only by .23 (see Figure 5).

![Table](Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12)

<table>
<thead>
<tr>
<th>Group</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
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<th>Q10</th>
<th>Q11</th>
<th>Q12</th>
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<td>.36</td>
<td>.86</td>
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Figure 5. Degree of change in mean between pre-survey and post-survey TSES scores.

The researcher at first thought that an explanation for these findings might be revealed by poor ratings on the TEACH usability surveys. The data, however, indicated otherwise. In general, study subjects rated TEACH highly on all survey questions. On a scale of 1 to 5, with one being “excellent,” two “good,” three “no opinion,” four “fair,” and five “poor,” the highest (i.e., worst) mean for any given item was 2.42 (SD = .99), for the ability of the system to provide feedback and instruction about what was taking place or what was
expected of the end user. While this variable represents an important construct in Norman and Nielsen’s usability literature (Norman 1986; Nielsen 1994) and Spiro et al.’s earliest CFH systems (Spiro and Jehng 1990), this mean score still fell comfortably in the “good” range. The lowest (i.e., best) mean scores were for system performance (1.81, SD = 1.2) and level of user control (2.0, SD = 1.2). Kurtosis values fell within ±1.0 on half the survey items, indicating slightly peaked distributions on three of the four items and a somewhat flatter distribution on the fourth. The remaining four items exhibited positive kurtosis values between 1 and 2, indicating higher than normal peaks in the distribution (See Figure 6).

<table>
<thead>
<tr>
<th></th>
<th>Overall graphic design</th>
<th>Overall navigability</th>
<th>Performance</th>
<th>Consistency of design</th>
<th>Level of user control</th>
<th>Ability to provide feedback</th>
<th>Ability to accommodate both novice &amp; expert</th>
<th>Communicated information about the topics</th>
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<tr>
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<td>1.313</td>
<td>0.677</td>
<td>-0.871</td>
<td>1.168</td>
</tr>
</tbody>
</table>

Figure 6. TEACH Usability Survey results (N = 26).

These data suggest an overall high level of satisfaction with the user interface among study participants in the experimental group. Qualitative data gathered in the form of blog comments generally supports these findings. Students’ blog posts were insightful and reflective, often complimentary in tone regarding the usefulness of TEACH as a learning tool. One student indicated an appreciation for the juxtaposition of content and multiplicity of views, while offering some constructive criticism:

I found the information in the charts interesting when juxtaposed with the video clips and movie images, because they allowed us to make connections between the straight
facts presented in comparison to the images we had just seen. I would like to see more connections drawn between these two perspectives, however; maybe by posing more questions that would prompt us to think critically about possible contradictions and problems in society’s representations of teachers and diverse schools.

Numerous students commented on how some of what they experienced while interacting with TEACH was a sense of ill preparedness for some of the real challenges portrayed in the video segments. Another participant wrote that the TEACH system had opened her eyes to possible strategies for confronting diversity and avoiding her own pre-existing prejudices, saying “I plan on going into urban settings and am sometimes worried that impressions I didn’t know I had of varying races/cultures will surface without my knowledge. In viewing the clips I have at least been a little bit more exposed to possible situations, and made aware of solutions to them.” Such commentary at least begins to support the argument that the TEACH system managed to achieve some of the effects that proponents of CFT believe are most worthwhile.

It should be noted that despite the blog format, there was only a single instance of one student commenting on a previous post. Since each of the three experimental group sections interacted with the TEACH system on different days, this is especially surprising. It may, however, be explained by the rather independent nature of the TEACH experience, with each study participant exploring the site on his or her own and the prompts for each area of focus being directed at the individual rather than the group. Since Cognitive Flexibility Theory finds its primary applicability at the level of the individual and not the group, this evident lack of group discussion is, in and of itself, not
an indication of weakness in the research design model. Still, it would be interesting to measure how a different qualitative feedback mechanism (such as small group follow up interviews or class discussion transcripts) might have colored the impressions of TEACH.

Conclusions

Judging from the quantitative data alone, the findings suggest that the TEACH system fell short as compared to the field experience for increasing pre-service teachers’ sense of self-efficacy. One should not overlook the possible effect of uncontrollable variables, such as influence of individual instructor’s pedagogical style, on the data. Ideally the study would have been conducted with the same instructor teaching both the experimental and the control group. The researcher further acknowledges that more than one three-hour session should have been devoted to immersion in the TEACH system, or that at least some follow-up class discussion should have been built into the research model. This would have more closely resembled the control group’s field experience since it had the opportunity to discuss the site visits after the fact. Other recently published research suggests that such follow-up discussion is enriched significantly through the use of multimedia case-based instruction (Baker 2005), so employing a similar approach here may have provided a more balanced experimental model.

Despite the consistently high ratings the TEACH system received and the general quality of the comments it generated, the researcher feels compelled to address what he acknowledges to be clear weaknesses in the custom designed CFH learning environment. First, video segments representing each focus area were fewer in number than what Spiro
and the other original theorists behind CFT would deem as ideal. Their emphasis on random access traversal of hypertexts for accelerated understanding of complex concepts relies in large part on what Spiro and Jehng called “conceptual schema assembly,” which itself hinges on “lots of little pieces of reality (mini-cases)…and a way of assembling them” (Spiro and Jehng, p.200-201). Future studies using the TEACH interface surely would benefit from the further development of it, with an increase in the number of thematically linked short video segments and more emphasis on concept-based search that would offer users multiple perspectives on each mini-case. This greater elaboration of mini-cases would align more closely with Spiro et al.’s original design for CFH systems and might result in a stronger experimental comparison between the impact of field experience course components and those based on CFT.

The use of hypermedia systems based on Cognitive Flexibility Theory has not been incorporated into the curriculum on a large scale by any well-known professional schools, whether those of education, library science, business or other disciplines. In spite of this fact, such systems remain a worthwhile subject for further research, especially in light of the fact that many of today’s university students are “digital natives” who have come of age using various new media tools and who thrive in non-linear, rapid traversal cognitive spaces (Howe and Straus 2000; Prensky 2001; Jones and Madden 2002; Oblinger and Oblinger 2005). Given the difficulty within most ill-structured domains of providing adequate pre-service training to produce truly qualified professionals who can think flexibly and synthesize and apply advanced knowledge quickly across many disparate cases, there is value in exploring new approaches to instruction that are based
on the principles of Cognitive Flexibility Theory. Though focused on the domain of teacher education, the framework presented here could easily be adapted to other domains for researchers wishing to explore the impact of CFT-based hypermedia systems.

Notes

1 http://www.easehistory.org/faqs.html
2 http://www.youtube.com
3 http://www.archive.org/index.php
4 http://video.google.com
References


