Developmental journeys moving problem-based case learning to real-time:

Implications for teacher learning and professional development

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Introduction

This paper uses the case studies of faculty who have worked with the Center for Information Technology Education's (CITE) Corporate Scholars Solutions Project (CSS) to identify common themes and issues important to them as revealed from their experiences. Their efforts to explore possibilities for preparing the future workforce with not only the content knowledge needed for Information Technology degrees, but perhaps, more important, the skills needed to find solutions to real-time business problems, confirm that these solutions will require innovation and adaptive expertise as well as technical knowledge about IT systems.

CSS utilizes Problem based cased (PBC) pedagogy as based on learning principles from Problem Based Learning (PBL, Barrows, 1985), Case Based Reasoning (CBR, Kolodner, 1997) and the literature on how people learn (Bransford, Brown & Cocking, 1999). These learning principles have been shown to be more effective than more traditional pedagogy for producing important student outcomes (Barrows & Bennett, 1982; Vernon & Blake, 1993; Kolodner, Gray & Fasse, 2003; Albanese & Mitchell, 1993).

Our CSS Project is an example of a constructivist learning environment. Jonassen (1999) presents a description of the elements and resulting system in Constructivist Learning Environments (CLE). He includes question-based, issue-based, case-based, project-based, or problem-based learning as examples of ways CLEs might be developed. In his generic model he uses "a problem" (p.219) to stand in for these more particular instances which represent a continuum of complexity depending on how they are elaborated. In order to support a constructivist approach, the problem needs to be ill structured so that multiple perspectives, multiple solutions, and complex cognitive activity are possible. (For a complete explanation of CLEs see http://www.ed.psu.edu/-jonassen/CLE/CLE.html)

In our Corporate Scholars Solutions (CSS) project, we have used real-time business problems as the context or anchor for PBC learning environments. This aspect offers the most authentic experience since it is an actual problem playing out in an actual business community and unfolding in real-time. CLEs all assume the need for authenticity but as with most aspects of CLEs there will be a continuum of authenticity. As the authenticity increases, so too will the complexity of managing the learning environment.

In CSS projects, we ask two central questions: How do we prepare our students to innovate? How do we encourage developing expertise to move from routine efficiency to adaptive thinking? These same two questions are central to professional development models. How do we foster teacher learning, innovation in teaching, and adaptive expertise in teaching?

A description of the CSS model will be presented and used as the context for an analysis of the faculty case studies. The implications for professional development from this analysis will then be presented and framed within the larger literature on teacher learning.

Corporate Scholars Solutions Projects

Whether as individuals, as corporate entities, or as smaller productive groups (teams, communities, groups, business units), we all struggled to adapt to the economic, cognitive, and social implications of speed and globalization. We came to understand on a very practical level that learning is the strategic competence for an entity experiencing change. We quickly recognized that becoming a learning organization entails deliberate culture change. With that, we began to abandon our old instincts to reify and broadcast and to develop skills that help us cultivate new business practice. We struggled to honor local differences. And we learned to celebrate the unique power of narrative in conveying knowledge across otherwise formidable epistemic boundaries. (Brown & Gray, 2004, p.5)

We all continue to struggle with the rapid change in our world and as individuals, groups, and educators, we are all aware that learning is key to adapting and continuing to improve educational and training outcomes. In our activities at the Center for Information Technology Education, we have worked with teachers and faculty who have helped us test our efforts to reform learning environments for those exploring information technology careers (IT Academies in high school) or studying for careers in IT (2-year community colleges and 4-year universities). We also believe in the power of narrative to cross boundaries between schools and the business world. The narrative, stories, or cases, also have the power to serve as anchors or contexts for learning (Kolodner, 1997).

Our teachers are faculty members at 2- and 4-year colleges. Those in the two-year programs, or community colleges, are asked to teach 5 classes as compared to a 2-3 class load in four-year colleges. Most faculty are not trained in "pedagogy" but are experts in their fields, in our case, information technology. Many have had experience in business and industry settings and bring a wealth of knowledge about workforce issues and needs. They have been engineers, systems

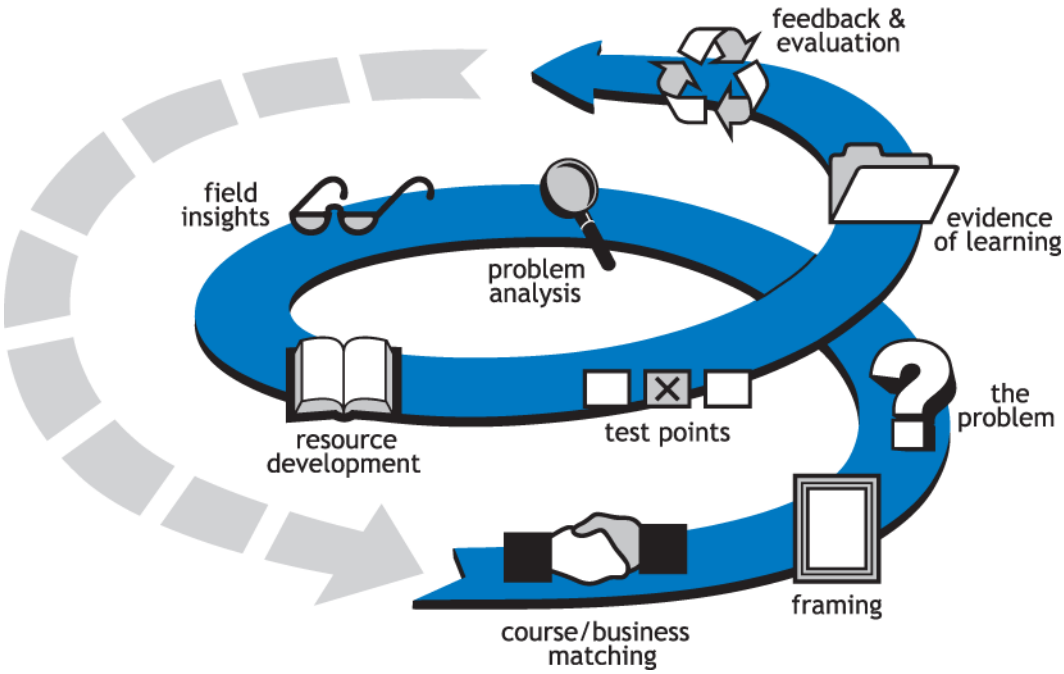
analysts, software developers, information security consultants, and GIS experts to name a few. They come to teaching as a choice and their views about teaching usually include a strong belief in the importance of application of learning in real-world settings.

Initially faculty are attracted to case based approaches because they see the merit in projects. They may have used projects in their teaching and especially for senior level courses, projects act as a capstone event for applying the knowledge learned during the course of study. Understanding more deeply the differences between short term, hypothetical project assignments and true contextual learning opportunities where cases and problems are addressed semester long and taken from the context of actual business cultures, is one of the first steps in taking on a new pedagogy. The consequences for teaching and learning practice are complex and often not immediately apparent.

Faculty need multiple opportunities to communicate their concerns and find support for their new efforts. We have found that in our workshops, faculty need time to reflect, share their experiences, and learn from each other. For a pedagogy that requires a radical shift in "control" in the classroom, it is imperative that faculty know they are making progress and that the full orchestration of a problem based learning environment comes with repeated opportunities and iteration.

It is also necessary to provide faculty with multiple opportunities to learn for themselves the conceptual assumptions that ground these new pedagogies. After 20 years of empirical work on factors that contribute to good learning outcomes, we have a research base from which to draw applications to the design of learning environments (Branford, Brown, & Cocking, 1999). IT faculty are not familiar with this research, largely from the field of cognitive psychology and the learning sciences, and they will require repeated efforts in professional development events and support during their implementation experiences to construct their own understandings around the value of the new approach to teaching and learning.

The CSS Learning Cycle



The CSS Learning Cycle was developed to address the process for taking on a real-time business problem. Since most problem based approaches do not deal with real-time problems, the first part of the cycle represent unique issues for the instructor. Ideally, faculty and business partners have time to work together prior to the beginning of the course. Essential to the success of the process are good communication skills, clear expectations for the business partner's on-going role during the course, accurate and extensive information about the context of the presenting problem, understanding of the learning outcomes, realistic expectations about student outcomes for the deliverable, and time to work through each of these. Once faculty and the business partners have met to discuss and negotiate these issues, a plan can be made to target and set up suggested dates for important milestones across the semester.

Faculty need and want to be prepared around the business partner relationship and the plan they develop together. This is essential to the "course/business matching" element in the cycle and represents the first step for the faculty in preparing for the CSS project.

The next step is to introduce the problem to the class. How the problem is presented will have a huge impact on the remainder of the semester. The business partner should introduce the problem if possible. The larger context for the problem should be included in such a presentation. If the problem is situated in the larger context, that can serve to anchor problem for the students. If faculty have prepared the students to ask relevant questions to gather more information about the problem, the discourse between the business partner and the students will be more productive. After the business partner leaves, the discourse should begin with faculty and students to frame the problem.

Framing the problem is perhaps the most important aspect of the learning cycle. "What is the problem?" should guide the discussion. Multiple perspectives on the problem should be introduced and discussion around that should ensue with a rich description of the context of the problem. When students have had a chance to grapple with the complexity of the problem and its context, the discussion should lead to a consensual definition of the problem.

Having reached a consensual description of the problem students will then be ready to analyze the problem, thus the problem analysis stage of the cycle. During this stage students generate hypotheses about possible solutions, what they need to know to arrive at a solution, where they might find more information about the learning issues they identify, and plan for gathering additional information.

Actually visiting the business setting, when possible, is an important source of information from the field. The field insights and resource development stage of the learning cycle allow students to bring together all the information they have and begin to integrate it with their previous understanding of the problem.

When students have all the information they think they need, they begin to develop solutions and test their ideas with their team and other teams in the class. There may also be additional meetings with the business partner to present their current ideas and get additional feedback and clarification from the partner.

When students have finalized their solution, they begin to organize a formal presentation to make to the business partner and others from their program or institution. This authentic audience affords feedback on their efforts.

The CSS learning cycle is not intended to be linear in enactments. Student teams, faculty, or the business partner may see a need to go back to any one of the stages to iterate or cycle through previous processes.

Using the learning cycle as a general framework for the enactment of a CSS project is the start point for the pedagogy. The intended classroom culture follows from the assumptions of a constructivist approach where students collaborate in their teams, adopt a project management approach to their efforts, self-regulate their learning the needed information to come to solutions, and communicate in a professional manner across multiple audiences - their team, other teams, the instructor, and the business partner and through multiple media - person to person, e-mail, phone calls or conference calls, and presentations.

The resulting classroom climate/culture is envisioned as one where knowledge is constructed through self-regulated learning with the support of faculty and the business partner and access to critical information through a variety of resources. Classroom and the business setting offer multiple opportunities to engage students in discourse activities that promote active learning through communication that enables knowledge sharing and problem solving. Finally, a feeling of professionalism and trust in the capabilities of the student teams is essential.

Faculty change their role from one of directing student learning to that of a project manager supporting student's self-directed learning. When needed, of course, faculty become a resource or expert in sharing "just in time" technical or business practice content knowledge. Providing formative assessment of student's developing skills in content knowledge, teamwork, communication and critical thinking skills is also part of the faculty role across the semester.

The business partner's role is critical to the success of a CSS project and their availability, knowledge sharing, and willingness to meet at identified points throughout the semester are essential.

Finally, the student's role moves from receiving information to constructing his or her own knowledge. New expectations for collaboration, communication skill, problem solving, and critical thinking are added to their need to learn content.

Analysis of the CSS Case Studies

Method

A design experiment methodology (Collins, 1999) was used to collect data on the curriculum approach including implementation issues for faculty, the business partner, and students. Excepting data reported in our yearly evaluation reports, the data for this study were qualitative in nature. In this paper, we report on the analyses of the data for faculty outcomes only.

Data sources

Primary data source, Structured Faculty Interview:

During the fall of 2005, interviews were conducted with 12 CSS faculty. Appendix A includes the questions for those. These interviews were the basis for a set of case studies for 12 CSS projects. The other data sources were consulted in writing the cases. A faculty member from the English Department at NSCC who had worked as a consultant for some of the technical

writing tasks on the CASEFILES project conducted 8 of the interviews and the senior research associate with CITE conducted 4 interviews with faculty. The English professor wrote all case studies. The resulting faculty case studies and interviews with the Deans of the respective institutions were published as "CSS Impact: Case studies of Problem-based case learning" available at http://www.cite-tn.org

Professional Development Activities:

A series was delivered focusing on the conceptual foundation for the approach (How people learn (HPL), Adaptive Expertise) and the pedagogy (Problem based learning (PBL), case based reasoning (CBR), and constructivist learning environments (CLE). Documents from these events including observations of the sessions and facilitators reflections were collected. Additionally, a video was made of a faculty panel discussion in March 2004.

Classroom Observations:

Classroom observations were also conducted and informal interviews with faculty were collected during site-visits or by phone. Final student team presentations were video-recorded and evaluations on those were collected from faculty and administrators attending.

Weekly Meetings with CSS Coordinators:

Notes from weekly phone conference calls were transcribed capturing the issues from the field. Each institution had a CSS coordinator and those individuals along with CITE's director and senior research associate participated in the weekly meetings.

Analyses

The case studies were analyzed by the first author, a research associate with CITE during 2004-2005 and a consultant during 2005-2006. Each case was analyzed in three phases. The first stage involved examining the responses to the categories of questions used in the interview: the kind of problem, the problem/content fit, impact on students, impact on teaching, and the overall affect of the reported experience. A second pass through the interviews included an examination of the comments related to the learning cycle stages. Finally, in the third pass through the interviews (and the additional data sources described above) an analysis was conducted to describe aspects of "developmental journeys" of individual faculty.

Results

The first analyses revealed that the majority, 8 of the 12 cases, were positive experiences overall. Student learning outcomes were all positive and the impact on teaching revealed a general trend for more focus on teamwork, the need for a clear understanding of the business partners' expectations, and the centrality of the fit between the course content and the business problems' affordance for learning. Three of the 12 cases were negative in overall affect. An additional case was partially negative in affect.

The next level of analysis afforded a more specific examination of the negative cases and a fuller description of the positive cases. Of the negative cases, two were in database programming classes. But, looking further at the reasons for difficulties in these two classes, it was apparent that the source of the negative impact was located in the business partner relationship. In both cases, the business partner was either unavailable or did not provide important information needed for a problem solution. A third case involved the trend for scope creep on the part of the business partner's expectations. Even though the reported experiences had an overall negative affect, student impact was still, for the most part, positive. The one exception was in one case where students refused to work in teams and several students dropped the class. In the final level of analysis, trends were noted that suggested a developmental progression for faculty that was contingent on their prior beliefs about problem based case approaches, their experiences in the workforce, and their level of comfort with project management experiences.

Discussion

Our results indicate that all our faculty had already used project based approaches in their classes. Most had brought in problems that they had encountered in their work or hypothetical problems that had been available to them. None had experienced the complexity of a real-time business problem, yet they were, for the most part, volunteers to take on this approach. The consistency of the positive experiences with CSS speaks to the faculty's willingness to trust the process. There are several themes that come out of that trust and each will be discussed below.

On the other hand, the smaller number of faculty reporting somewhat negative experiences is a more complicated story. The results from the second level of analyses revealed an important disconnect with their relationship with the business partner. The conditions under which these faculty were recruited to participate at their institution also played a role in a less than optimum experience for them.

Three major themes emerge from the overall analysis. First, the business partner relationship and its role are central to understanding faculty experience. Second, the critical role of framing the problem and allowing it to anchor the learning seems to be the foundation for success or failure with the approach. A third major issue coming out of this analysis is the developmental journey that faculty encountered as they moved from problem-based approaches to problems in real-time. Issues central to the journey included understanding the conceptual foundation for the pedagogy; managing the learning environment or "managing the engagement"; and trusting the process. To the credit of all that attempted this approach, faculty were willing to test their own understandings of the pedagogy involved and share their personal journeys. What they learned and how they are positioned to continue learning is important to framing a professional development model.

Business partner relationship

In the 12 faculty cases analyzed, the nature of the business partner relationship was central to the success of the CSS project. This is not surprising since the project was conceived to be an actual, real-time experience and not a hypothetical or second-generation case (footnote) from business, which would not require an actual relationship. This very feature distinguishes CSS from other problem-based approaches. It also represents the greatest challenge for faculty.

The most successful CSS projects had faculty who either had involvement in their own business community or who had extensive experience in their respective fields prior to teaching. These factors may have impacted the way they approached the business partner and understood the complexity of the workforce context. More upfront time was spent meeting with the business partner prior to the beginning of the class than in the case of less successful projects and they reported working well with the partner in contrast to the 3 negative experiences where the business partner did not share critical information or had differing expectations from the faculty expectations. In several cases, the faculty knew their business partners from previous experiences or as former students whom they had taught.

As faculty worked with the business partners, or not, to match the problem to their course content most felt they had a good match. The cases where the business partner relationship was not viewed positively, had on-going issues around the problem/content "fit" and in those 3 cases, those faculty were convinced that CSS projects were not appropriate for their particular class.

It appears that the foundation for success of a CSS project depends to a large extent on the business partner relationship and how the faculty engages that partnership building (or is allowed time to) process. The understandable concern that faculty have with matching their

content to the problem needs to be addressed. Some of the resistance to problem-based approaches can be accounted for around this issue. Yet those that were successful were able to see that the problem is the context for learning the content and even when some content may not have been "covered" they could see their students were better prepared for the workforce. They recognized the value of the "added" skills like teamwork and collaboration, professional expectations for communication and presentations, and problem solving in ambiguous spaces requiring critical thinking and adaptive expertise. They trusted and supported their students to construct and regulate their learning.

Excerpts from the case studies:

"The business partner engaged the student teams as extensions of the companies' technical staffs. Students were extremely motivated. They communicated with the business partner through e-mails and conference calls. The first three weeks were spent defining the scope of the project."

"The business partner, the faculty and the students worked as a team to address the problem."

"The business partner's participation was significant in the success of the class. He provided direction, guidance, and data. He made arrangements with city officials and police for students to work in the field and accompanied students when they did their field work."

"The business partner provided detailed design specifications that could be incrementally decomposed and implemented as the class learned the skills required for a particular code segment."

"Faculty would benefit from more lead time. The instructor needs time to visit on site with the business partner, to clearly define the problem in his or her own mind, to develop the problem/solution sequence, and to review with the business partner so they are in agreement about the scope."

"The business partner also highlighted for students the need to develop team skills and strong communication skills as well as technical skills. He reminded students that outsourcing is making it imperative that IT professionals have a suite of skills, both analytical and technical, but especially communication and team skills."

Framing the problem

Faculty experiencing the most success with their CSS projects all had experience using a project management approach to framing the problem or they had experience with other management structures like SDLC (Systems Development Life Cycle). Interestingly, several faculty reported adapting their approach to accommodate the unique features of the CSS project. Instead of teaching as they always had, they were willing to learn along with the students even if it felt as if they were "tap dancing." They welcomed the complexity of the problem to challenge their students but they supported the student teams by helping them develop project management strategies to frame the problem. For example, at least 8 of the 12 cases revealed that faculty had guided student teams in ways to break the problem into subparts or phases that were more readily manageable. One teacher even had students do a feasibility study as a way to establish parameters for the problem. These efforts suggest the more successful projects were dependent on what might be called faculty adaptive expertise in framing the problem. Instead of relying on a template for using problems or cases with their students, they appeared to view the real-time problem as a unique situation that called for adapting their approach. More important, they were willing to do so!

Excerpts from the case studies:

"The faculty acted in a project manager role rather than the traditional instructor role. Instructor responsibilities included scheduling several status review meetings to keep the teams on track, developing exercises on the fly to help the programming teams understand segments of the overall problem implementation process, and providing guidelines for developing project plans and for creating and delivering presentations."

"The instructor framed the business problem by using two scenarios depicting Help Desk employees responding to problems via phone; one knowledgeable and helpful, the other confused and confusing. The scenarios got the students involved in the experience and they were enthusiastic.'

Faculty developmental journeys

Understanding the conceptual foundation for the pedagogy

One of the most daunting aspects of faculty's developmental journey involves connecting the process of learning through a problem-based context with its conceptual and empirical base. Translating what we know about how people learn into practice will occur across time and with multiple opportunities to practice doing so. Even though the pedagogy can be described as a

series of suggested activities and structures and abstracted by a graphic depiction and explanation of the learning cycle, enactments will vary across faculty and their understandings about the "why" of these respective curriculum elements.

Analyzing the enactment of the CSS projects from the case studies and classroom observations reveals a variety of ways faculty approached their role and often changed it from former approaches. For the more successful projects, faculty indicated a developing understanding of the powerful role the problem played in anchoring the learning. At least one faculty member indicated an understanding of the role prior knowledge plays in constructing new knowledge and the importance of assessing that in his students.

Excerpts from the case studies:

"'I could have presented the problem the first day,' the instructor said. He waited until half way through the course to introduce the business problem because he believed students needed some basic skills in order to work through the problem. In reality working through the problem is a way for students to learn the Java syntax."

"He believes now that it is his responsibility to make students aware of the knowledge gap- the gap between what they know and what they need to know. He said, 'Previously my goal was to fill the gap.' Now his goal is to prepare students for the many knowledge gaps they will encounter in the workplace. The best way to prepare them is through letting them find out things for themselves."

"Students did not know Java programming language when they started but learned Java as they worked through the business problem."

All case studies revealed a great deal of respect for teamwork and the need for developing that skill for workforce expectations. It was not clear, however, that faculty held the understanding of the importance teamwork plays in harnessing what we know about the social nature of learning and the value of distributing expertise. In some case studies, difficulty with using teamwork may highlight the assumption that students will just figure out how to do it. The more successful efforts with teams were in classes where faculty purposefully group team members and provided support and feedback on team building skills.

Managing the learning environment or "managing the engagement"

In learning environments where a constructivist approach is taken, faculty often have to focus on some aspects more than others. Balancing teamwork, discourse activities, resource needs, the business partner's role, and keeping up with where students are in their efforts by providing formative assessment and feedback is challenging. All of that is in the context of an ill structured problem with multiple solutions possible. And, not the least of faculty concern, they are monitoring coverage of the required content for the course! As noted above, those faculty with experience using project management skills were more comfortable with their charge. Even with that, however, faculty varied in the degree of success they had with the additional elements like team work, communication and discourse, business partner relations for example. It appears that being good at all things, all the time, will come with development and opportunity to iterate. We cannot discern from this qualitative study of their experiences which elements are critical to success of the project. We can document the elements faculty felt they used successfully and what their remaining concerns are with other aspects of the balancing act - or "management of the engagement."

Excerpts from the case studies:

"The real benefit, according to the instructor, came from working in teams and making presentations - the 'soft skills.' They gained insight into the group decision making process and learned negotiation within a project team.'"

"The instructor has always done project-based approaches but has used 'canned project.' He is very positive about using real-world problems and has followed up with two other projects from the same business partner."

"They learned how to work effectively in a collaborative environment and experienced how technical projects are completed in the corporate business world. The business partners stated that the 'results of the student teams' efforts were right-on."

"He reiterated that the …course is a 'hands-on' course in which students always work on cases, but this case was very valuable because students had to 'go into the world and find the answer, where there's no answer in the book."

'"My fear was taking away from the syllabus. As it turned out, students stepped up to the challenge.' He stated that he had always taught through application; all problems must have a root in application. However, the CSS project has made him more sensitive to the practical aspects of the problem, the application issues."

"The instructor needs to have expertise in the content area in order to trust the student directed process - recognizing multiple pathways to knowledge, skills, and application."

Faculty appear to value the additional skills their students were developing throughout the project. Just as their students were developing soft skills, faculty were developing ways to foster, support, and address them in their teaching role. How we continue to prepare teachers to take on the full orchestration of managing a learning environment that focuses on complex cognitive activity and the social skills that are essential to solve problems will be an important part of professional development models. The quote below captures some of the issues inherent in the quest.

"…. these and many other soft or semi-soft skills take years to develop. People look to the schools to do the long-term work. The soft skills are difficult to teach and their transferability to new situations must always be questioned. Curriculum standards and guidelines, in echoing the business world's list of soft skills, tend to treat them as if effective means of teaching them were readily at hand. Even learning scientists often lend support to this unwarranted and facile optimism, claiming their approaches teach a range of 21st century skills, similar to those in the curriculum guidelines and in the 140,000 Web pages."

"…. Yet we must respect the demands of society for the schools to turn out people who, in addition to being proficient in these basic skills, will be prepared to learn new things, collaborate in the solution of novel problems, and produce innovations in areas that presently may not even exist. In the absence of tested methods, how do we do this? The time-honored and still the only promising way is immersion." (Bereiter and Scardamalia, 2003, p.55)

Trusting the process and addressing challenges

Working through CSS projects, faculty came to trust the process and be more comfortable with it after more than one experience. Seven of the 12 case studies include faculty who had multiple CSS projects. As a developmental approach would support, they increasingly became more expert at managing and adapting their learning environments. The challenges associated with reforming teaching were encountered in these faculty journeys and an understanding of those challenges will enhance efforts to provide teacher learning opportunities.

Windschitl (2002) identifies four categories of challenges facing teachers who move towards a constructivist approach: conceptual, pedagogical, cultural, and political. Our faculty encountered each of these. Conceptual challenges include understanding constructivism, which is a theory about learning, not teaching. Initially teachers assume that they can take a hands off approach to teaching since they naively assume that their students will work in groups and construct

their own knowledge. It is only over time that they begin to more deeply understand that their role in supporting, scaffolding, and managing the learning environment is essential (Kolodner, Gray, & Fasse, 2003). Some teachers also assume that the activities students engage in will be sufficient to ground the learning and fail to recognize the importance of discourse in helping students move to the big ideas (Hacker & Tenent, 2002). The process of internalizing a constructivist world view requires that teachers themselves be supported in their journey with opportunities to reflect on their practice and have opportunities to continue learning across time (Windschitl, 2002; Kolodner, et al, 2003).

Pedagogical challenges include recognizing students' prior conceptions and framing their experience within a context that will facilitate meaningful organization of new knowledge (Bransford, et. al, 1999); having expert knowledge of the subject domain (Windschitl, 2002; Kolodner, et. al, 2003); and managing the learning environment effectively. Our faculty were at different points in their own understandings of how to do these things. Knowing how to frame the business problem to actually allow it to become the context or the anchor for subsequent learning was central to the successful projects. Faculty who were expert in their subject matter trusted that students would be able to learn content and skills across the course of working towards solutions even with multiple start points. Knowing the content domain allowed them to move students through the process without concern for a linear step by step approach to "covering the content."

Managing the learning environment included engaging students in discourse that promoted depth of understanding; supporting and guiding collaboration and team skills; formatively assessing students' developing understandings and scaffolding; and modeling metacognition or making critical thinking, problem solving, and reasoning explicit for students. Most of our faculty were successful over time with some of these elements, but no faculty were able to initially do all of these all the time. Again, mastering this suite of skills needs to be viewed as developing over time.

Cultural challenges refer to the actual classroom climate or culture. Questioning, discourse, collaboration, knowledge building, trust and respect for multiple perspectives, and being able to learn from failure contribute to the kind of opportunities students need to develop the skills needed to find solutions. When faculty were able to create such a culture in their classes, students flourished and innovation was possible.

The political challenges to reforming teaching include emphasis on basic skills or content mastery; a general distrust for progressive reform initiatives; and misunderstandings about constructivism. Perhaps the most critical challenge is the disconnect between what we know about how people learn and methods for assessing learning.

Our faculty, for the most part, were supported by their institutions which helped to buffer the larger political challenges. Moving problem based learning to real-time will continue to be a developmental journey, both for faculty and institutions recognizing the value of translating what we know about how people learn into practice. If we know what the challenges are to that end, we can face them head on. One way to do that is to create professional development models that incorporate doing so.

Implications for Professional Development

Teacher learning is central to true reform in education. Professional development must move from one-session workshops to a true understanding of the developmental progression that teachers will experience as they continue to learn. They will require on-going support as they implement changes in their pedagogy. In fact, teacher learning needs to be the explicit goal of professional development efforts. As we have come to better understand how people learn, we are prepared to develop professional development models that incorporate the findings from research on learning and experience in reform efforts.

A growing literature on teacher learning has examined the conditions necessary for effective professional development that would foster teacher learning (Hoban, 2002; Levin, 2003); promote teachers' view of themselves as learners (Turbill, 2002; Corno & Randi, 1999); and help teachers develop adaptive expertise (Crawford, Schlager, Toyama, Riel, & Vahey, 2005).

"'What conditions will help to establish a framework for long term teacher learning to support educational change?'" (Hoban, 2002, p.42) Notable in Hoban's review of professional development models is the recognition that new understandings from research about innovative learning environments must be coupled with understandings about teachers' actual classroom contexts. Neither new information shared in workshop settings nor learning communities that encourage teacher collaboration and reflection on their practice alone is sufficient to effect change. Some form of integrated models for professional development is essential to sustaining teacher learning and educational change.

An analysis of case studies of four teachers across a 15 year period suggested that trying to understand the way teachers learn and think about pedagogy is influenced by the availability of support across time, continued experiences to be learners themselves, and opportunities to develop reflective practice and "to think metacognitively about teaching and learning, and about behavior and development" (Levin, 2003. p.276)

Teachers need opportunities to develop as self regulated learners to foster problem solving and innovation in their teaching. If the goal is to create learning environments for students to become self regulated in their knowledge construction activities then teachers will need to have experience doing the same (Corno & Randi, 1999).

Additionally, if teachers are to help students develop expertise and use it adaptively to solve problems, then teachers will need to continue their development as experts along a continuum and be willing to adapt to changing classroom demands. A recent paper by Crawford, et al (2005) examined teacher thinking during science instruction tasks and identified characteristics of adaptive expertise in teaching. These efforts will be helpful as we try to understand teacher learning.

In much of the recent thinking on teacher learning and efforts for educational reform, the role of professional development is central, critical, and absolutely essential to realizing change. The nature of the change required to create an innovative learning environment based on what we know about how people learn will vary depending on the teacher's current understanding and prior knowledge and experience with the pedagogy targeted. Findings from How people learn (Bransford, Brown, & Cocking, 1999) suggest that learners prior beliefs, experiences and understandings need to be addressed to facilitate new learning; that learning in a new area will be enhanced if new factual knowledge is conceptually organized around a context that promotes ease of retrieval for application; and that learning to monitor one's own learning processes through metacognitive activities leads to self-regulation in learning.

In our work developing Problem Based case (PBC) approaches, we have observed a need to provide on-going opportunities for teachers and faculty to learn the foundations for the pedagogy and methodology for creating a PBC learning environment and we have tried to provide anchors for these experiences to act as a meaningful context for their own learning, Perhaps most important however, we have learned that change will happen over time, with multiple opportunities to try the approach and with opportunities for teachers to reflect on their efforts and what they are learning, Finally, we have noted the importance of respecting, supporting, and documenting the appropriation of PBC as it has been enacted in a variety of settings to understand how faculty are applying what they are learning.

Based on what we have learned from our CSS faculty's experiences and what other's examining teacher learning have suggested, we propose that professional development should include the following critical elements:

- Teacher learning as central
- Developmental approach

- Taught as would teach
- Fostering innovation and adaptive expertise
- Honoring appropriation

If we use what we know about how people learn and apply that to teachers, then teacher learning will be central in professional development efforts. Taking into account teachers' prior beliefs and practices and providing a context for developing their understandings around new practices will mean allowing them to construct their knowledge over time and in a context for learning that would have them "taught as they would teach." Experiencing the effect of the pedagogy themselves, they will be better positioned to take on such practices for their students. Allowing teachers to make the practices their own and examining the outcome of their innovations will then inform new ways to look at our reform models. Expecting and honoring appropriation will also help resolve the issue of fidelity of implementation (Corno & Randi, 1999). If we can describe the ways in which teachers exhibit adaptive expertise in their teaching (Crawford, et. al, 2005) as they apply their own learning to their classroom practices, we will move closer to solutions for real-time educational challenges.

Future Research

Current research on teacher learning provides an important foundation for future research. At least two lines of inquiry are needed. First, professional development models need to be evaluated for their potential to effect teacher learning of their subject matter as well as effective pedagogy. Prior beliefs about teaching and learning should be assessed and used as a start point for supporting teacher learning. A common finding in the literature suggests that regardless of the teacher preparation program, most teachers revert to teaching as they were taught (Hoban, 2002). It will be critical to allow teachers to understand new pedagogical practice through experience being taught by those very methods. Research is needed to examine the outcomes for such efforts.

A second line of research is needed to continue the work on describing teacher learning and the conditions necessary to support helping teachers develop adaptive expertise. Describing how teachers apply their developing understandings of problem based approaches to actual classroom practice is essential. What elements of constructivist, or problem based approaches, do they appropriate and use effectively? What challenges do they encounter as they move towards reforming their practice? How do they adapt their practice to respond to local challenges? What are the cognitive and social outcomes for their students?

As Hoban (2002) has noted, teacher learning and how we support it, is central to educational reform. It remains an important task for those seeking educational reform to describe, enhance, and understand teachers' developmental journeys as they move to that end.

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Appendix A

Questions for Interviews with Faculty

Background

1. How would you characterize your teaching methods and strategies prior to this class? Were you pleased with students' learning outcomes? Were there any areas in which you wanted to see improvement?

2. What did the administration do to get you "on board"?

What happened in the class

3. Describe the class and the business problem. What were the students trying to learn (KSAs)? How was the problem formulated from the business situation - by the instructor? by the students?

4. What approach/strategies/techniques/tools did you use? Did you use the Learning Cycle?

5. Describe the role of the business partner in the case. Describe the positive aspects of the business partner's contribution. Were there any areas that could be improved?

6. How did your students respond initially to the business problem? Were they interested? Excited? Challenged? Threatened? Did they take initiative to deal with the problem(s)? What did they do? Were you satisfied with their response to the problem(s) presented?

7. Describe any teaching technique that worked especially well in getting them fully engaged with the problem(s)? Did anything work especially badly? Do you have any "lessons learned" in this regard?

Impact on students and program

8. How would you rate the quality of the students' problem solutions and recommendations that resulted?

9. Were there any particular skills or positive behaviors achieved by the students during the course? Please describe.

10. Overall, do you believe the students that came out of this class are better prepared for the workplace, compared to students in more traditional courses?

11. Do you think the use of these cases has made an impact at the program level of your institution? If so, please describe.

How your teaching has changed as a result of this experience

12. What are you doing differently?

13. What changes to the course KSAs resulted from going through this process?

14. Will you continue to use these techniques/methods/strategies in your courses? How have you modified your use of these cases since the first experience with them?

For the future . . .

15. What are the major areas in which you would like to have support to continue to use problem based/case based pedagogy?

16. What advice would you offer to other faculty embarking on this type of teaching?

17. If someone were to write a "survival guide to teaching PBCB approaches," what chapters would you suggest as critical?

18. Would you be willing to contribute your ideas and resources to such a book?