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TEACHER BELIEFS: THE IMPACT OF THE DESIGN OF CONSTRUCTIVIST LEARNING ENVIRONMENTS ON INSTRUCTOR EPISTEMOLOGIES

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ABSTRACT. Promoting student epistemological development is seen as a goal of higher education. Further, the epistemological beliefs of instructors have been shown to affect their teaching beliefs and behaviors. Some argue that only when instructors are epistemologically advanced will they be able to engage in pedagogical activities that encourage student epistemological development. This study examines the impact of the design of constructivist learning environments on university instructors' epistemological belief systems. Constructivist learning environments are technology-based environments that present learners with authentic problems, that are supported by cases similar to the problem being posed, and learning-support strategies such as modeling, coaching, and scaffolding. Instructors' epistemologies might be impacted by engaging in constructivist learning environment design because the process requires instructors to think about their discipline in non-traditional ways. Results of this qualitative inquiry suggests that instructors who are in a zone of 'readiness' for intellectual growth could experience epistemological growth from this experience.

KEY WORDS: constructivism, constructivist learning environments, epistemological beliefs, epistemology, higher education, teacher beliefs

1. INTRODUCTION

College student research based upon epistemological development schemes is quite common. These studies have shown that certain pedagogical interventions (e.g. scaffolding, modeling) can positively impact student epistemological development (Jacobson & Spiro, 1995; Marra, Palmer & Litzinger, 2000; Pavelich & Moore, 1996; Stephenson & Hunt, 1977). In parallel, researchers have argued that instructor epistemological development levels can influence teaching behaviors and thus student learning and epistemological development (Fosnot, 1996; Hashweh, 1996; Windschitl, 2002). However, the use of an epistemological paradigm to explore instructors' belief structures about teaching, learning and knowledge has been addressed only to a limited extent (Howard, McGee, Schwartz & Purcell, 2000).

Prior student research has sought to determine the impact of certain instructional interventions on student epistemological development. Likewise, this study examined the impact of a pedagogical development

experience – the design of constructivist learning environments – on university teachers' epistemological belief systems. Constructivist learning environments are technology-based environments that present learners with authentic/complex problems that are supported by cases similar to the problem being posed, cognitive tools, and learning-support strategies such as modeling, coaching, and scaffolding (Jonassen, Marra & Palmer, 2003). Instructors' beliefs or epistemologies can be influenced by engaging in constructivist learning environment design because the process requires instructors to think about their discipline in non-traditional ways. Evidence of instructor beliefs is gathered through interviews conducted at the completion of constructivist learning environment design and analyzed via analysis of instructor case studies (Miles & Huberman, 1994) as evidenced by interviews.

2. THEORETICAL AND RESEARCH FOUNDATIONS

2.1. *Teacher Beliefs*

Historically, researchers have studied college teacher belief systems to ascertain the impact of these beliefs on teacher behaviors. College teachers are usually adequately prepared to be researchers but often have had little formal teaching preparation (Boice, 1992). In order to develop academics into 'excellent teachers', the academic community needs to understand how teachers' current belief systems developed and what factors or events could influence beliefs and teacher actions (Kane, Sandretto & Heath, 2002). Other researchers echo this view indicating that given the frequent application of constructivist learning paradigms and thus the inclusion of the learner as an active participant, professional development activities designed to positively impact teacher behaviors must take teachers' current belief systems into account (McAlpine & Weston, 2000 as cited in Kane et al., 2002; Putnam & Borko, 1997).

In their review of the research literature on college teacher beliefs and practices, Kane et al. (2002) draw attention to the need for gathering data not only on teacher beliefs but also on how those beliefs are translated into teacher actions. Argyris and Schon's theories of action (1974) framework provides a valuable lens for studies that address teachers' beliefs and, in some cases, actual teaching actions; however, these studies do not address the factors that promote changes in teachers' beliefs or actions (see Kane et al., 2002). An exception is Tillema's (1995) work that found that the simple presentation of new information that typically occurs in 'inservice' activities had little impact on teacher beliefs.

Engaging instructor members in new pedagogical methods as a means of affecting beliefs and behaviors has also been attempted, but overall there has

been very little research in this area. Dahlgren, Castensson, and Dahlgren (1998) conducted research on how the use of problem-based learning environments influenced how instructors view themselves as teachers, and Major and Palmer (2002) are currently examining the impact of the use of problem-based learning on instructors' beliefs about teaching and learning. This study's examination of the impact of constructivist learning environment design on one significant type of teacher beliefs – their epistemological beliefs – will add to this literature base.

2.2. Epistemological Development

Epistemology pertains to the origins, foundations, limits and validity of knowledge (Oxford, 1997). Epistemological development, also known as intellectual development, describes one's beliefs about the meaning of knowledge and truth and how those beliefs change over time (Hofer & Pintrich, 1997). There are several theories for describing learners' levels of epistemological development, including epistemological reflection (Baxter-Magolda, 1987), reflective judgment (King & Kitchener, 1994), and Perry's levels of intellectual development (Perry, 1970).

Although theories differ in detail and scope, they suggest a common pattern of development that progresses from simple, black-white thinking through to an exploration of multiple perspectives, to complex, relativistic thinking. Underlying this gradual development in thinking is a dramatic change in a person's epistemology from a view of knowledge as a collection of known facts toward a perspective that sees knowledge as contextual and evolving. William Perry's (1970) scheme of intellectual development was developed during the late 1950s based upon interviews with approximately 100 Harvard University students and describes nine stages (positions) through which students move during their intellectual development. As a sample of an epistemological theory, Perry's scheme of intellectual development is summarized in Table I. The Perry scheme has been used as a research paradigm in many disciplines and has shown that pedagogical events such as scaffolding can affect student epistemological development (Jacobson & Spiro, 1995; Marra et al., 2000; Pavelich & Moore, 1996; Stephenson & Hunt, 1977) and, conversely, that students' epistemological levels can influence the success of certain non-traditional pedagogical activities (Jonassen et al., 2003; Widick & Simpson, 1978). Readers can refer to Hofer and Pintrich (1997) for a review of the prominent epistemological developmental theories including the Perry model.

Although epistemological research generally has been applied to students' development through the college years (e.g. Bendixen & Hartley, 2003; Marra et al., 2000; Pavelich & Moore, 1996; Stephenson & Hunt, 1977), some researchers are beginning to examine the epistemological

TABLE I
Perry's Scheme of Epistemological Development

Perry position	Knowledge	Learning
1. Basic dualism (hypothetical)	Knowledge is right or wrong, and is a collection of facts.	Students receive right answers from authority.
2. Multiplicity pre-legitimate	Knowledge is generally right or wrong. Complexity or uncertainty is either an error or a teaching tool.	Authorities are the source of right answers or give us problems so we can learn to find the truth.
3. Multiplicity legitimate but subordinate	Knowledge is right or wrong, and some knowledge is unknown temporarily.	Authority is the source of answers or the source of methods to find the answers.
4. Multiplicity	Some knowledge is right or wrong, but most is not yet known. Where authorities do not know, everyone is entitled to his/her own opinion.	Authorities are the source of ways to think.
5. Contextual relativism	Most knowledge is contextual and can be judged qualitatively.	Students learn methods and criteria of their discipline. Metacognition begins.
6. Commitment foreseen	Knowledge is not absolute but student accepts responsibility for making judgments.	Students accept responsibility for making a commitment based on their values.
7, 8, 9. Commitment within relativism	Commitments are made within a relativistic world as an affirmation of one's own identity.	Choices made in the face of legitimate alternatives and after experiencing genuine doubt.

implications for teaching excellence and ultimately on student learning (Jonassen et al., 2003; Windschitl, 2002). Recently, Howard and his colleagues (2000) found that preservice teachers who participated in a 4-week training session on constructivist pedagogical approaches showed significant growth on three factors measuring aspects of epistemological development. Other research has shown that teacher epistemological beliefs can affect their overall teaching strategies (Hashweh, 1996; Martens, 1992), how they approach curricular changes (Prawat, 1992), actual student behaviors such as reading practices (Anders & Evans, 1994) and higher-level thinking skills (Maor & Taylor, 1995).

The argument is that a teacher's conception of what knowledge is and where it comes from – that is, their epistemological beliefs – will necessarily have an impact on how one teaches (Brindley, 2000; Windschitl, 2002). The next section explores constructivism and constructivist learning environments, and discusses the epistemological entailments for teachers of using constructivism and the potential impact on

teachers' epistemological beliefs from working with constructivist learning environments.

2.3. *Constructivism and Constructivist Learning Environments*

Constructivism refers to the philosophical belief that people construct their own understanding of reality (Duffy & Cunningham, 1996; Fosnot, 1996; Jonassen, 1991; Jonassen, Peck & Wilson, 1999; Oxford, 1997). From a learning perspective, constructivism tells us that meaning making is intimately connected with experience. Constructivist learning environments are technology-based environments that present learners with authentic or complex problems or projects that are supported by cases similar to the problem being posed, information resources, cognitive tools, and learning-support strategies such as modeling, coaching, and scaffolding (Jonassen et al., 2003). Constructivist learning environments are student-centered and learner-controlled, emphasizing student responsibility and initiative in determining learning goals and regulating their performance toward those goals, not just determining the path through a prescribed set of learning activities. Constructivist learning environments operate on a different set of assumptions about learning than traditional classroom pedagogies, thus creating implications both for the teaching beliefs and actions of educators adopting constructivist learning environments. Windschitl (2002) defines four categories of dilemmas (see Table II) that educators face when implementing constructivism: conceptual, pedagogical, cultural and political.

Windschitl's (2002) conceptual dilemma is concerned with teachers' understanding what constructivism is and internalizing and reconciling that understanding with their own teaching belief systems. This review only addresses the conceptual dilemma as this study does not address the implementation of constructivist learning environments – which is the focus of the other three dilemmas. To overcome the conceptual dilemma, teachers need to reconcile their own beliefs about teaching, learning and

TABLE II
Windschitl's Dilemmas for Implementing Constructivism

Area	Dilemma
Conceptual	Reconciling <i>belief</i> systems with constructivism's underlying assumptions regarding learning and knowing.
Pedagogical	Adapting, changing pedagogical strategies to be learner-centered.
Cultural	Defining and implementing a classroom culture consistent with constructivism and one's own beliefs.
Political	Reconciling constructivist activities with stakeholders such as administrators, parents and lawmakers.

knowledge – that is, their epistemology – with the underlying epistemological assumptions of constructivism. The epistemological underpinnings of constructivism are founded on the idea that knowledge is *not* based on a set of unambiguous or universal ‘truths’; instead one knows the world through interactions between the knower and the world’s phenomenon (von Glasersfeld, 1987, as cited by Windschitl, 2002). This view is in stark contrast to objectivist views of knowing in which knowledge is an unchanging object that can be transferred from the teacher to the learner (Jonassen, 1991). Transmission modes of instruction, such as lecture, are congruent with objectivism whereas constructivist learning environments are an example of a learning activity congruent with constructivism.

Windschitl therefore argues that, based on prior research results (Pope & Gilbert, 1983; Pope & Scott, 1984), a teacher with an objectivist-oriented epistemology might see lecturing as a sound pedagogical strategy to transmit knowledge to students. As an example, Smith and Neale (1989, as cited in Windschitl, 2002) found a negative relationship between holding an objectivist view of science and encouraging of learners’ ideas and explanations during class time. Similarly, other research found that, when asked to address ideas that are incompatible with their existing beliefs about teaching and learning, preservice teachers might alter the new ideas so they will not conflict with their existing views (Bird, Anderson, Sullivan & Swidler, 1993; Schommer, 1990). Conversely, Windschitl argues that an underlying constructivist-oriented epistemology is a necessary but not sufficient condition for a teacher to attempt to design and implement constructivist principles in the classroom.

This study lies at the intersection of one type of teacher/instructor beliefs – epistemological beliefs – and the implications for these beliefs for implementing constructivist practices such as constructivist learning environments. The researchers used semi-structured interviews to both make explicit instructors’ tacit beliefs about teaching and learning while gathering indicators of their level of epistemological development, all in the context of instructors engaging in a project to design and develop constructivist learning environments. Rather than focusing on subject matter content, the instructors, in their role as subject matter experts, were challenged to consider their disciplines from the perspective of accommodating multiple perspectives, authentic tasks and task-oriented supports, problem-solving outcomes, and learner-centered activities. As such, this study explored whether the process of designing constructivist learning environments – a process that requires that instructors think about knowledge and teaching in non-traditional ways – can provide instructors with an *epistemological stimulant* similar to the curricular and extracurricular experiences that have been found to encourage epistemic growth in students (e.g. Marra et al., 2000; Stephenson & Hunt, 1977). If instructors develop

more complex understandings of what it means to know, this could in turn enable them to adopt pedagogical methods that would similarly encourage epistemic growth in their students.

3. METHODS

3.1. *Participants*

Participants were seven instructors at a large USA mid-western university. These participants worked with instructional design graduate students who were completing a course in constructivist learning environment design, to develop constructivist learning environments for a course taught by the instructor. The professor in the constructivist learning environment course selected the seven college teachers from a larger pool of instructors based on the suitability of their course projects to the goals of constructivist learning environments and for their diversity of disciplinary areas. Participants served as subject matter experts while the graduate students created environments to support the instructors' courses. The instructors are described below. (However, information about the participants' sex is randomized to preserve anonymity.)

- FM1 (first instructor): Assistant professor of occupational therapy. The target course was a new, continuing education course for inservice occupational therapists focusing on care for dying patients.
- FM2 (second instructor): Instructor of occupational therapy. Co-teaches target course with FM1.
- FM3 (third instructor): Associate professor of religious studies. Targeted course was an Introduction to the New Testament and the Gospels. The constructivist learning environment focused on a hermeneutic analysis of the gospels.
- FM4 (fourth instructor): Associate professor of economics teaching a large lecture-based introductory course in micro-economics for non-majors. The constructivist learning environment focused on predicting qualitative changes in the supply-demand curves resulting from economic interventions.
- FM5 (fifth instructor): Associate professor of biochemistry teaching a biotechnology course for non-majors completing a final science requirement.
- FM6 (sixth instructor): Instructor of biochemistry co-teaching the biotechnology course with FM5.
- FM7 (seventh instructor): Experienced associate professor of geography teaching an introductory geography course for first-year and second-year students focusing on the use of alternative maps.

3.2. *Procedures*

Constructivist learning environment design and development occurred as a required course project for a graduate course on constructivist learning environment theory and design. The constructivist learning environment course professor met with the individual graduate student/instructor groups once per week for the first 4–5 weeks to scaffold the graduate students' analysis skills and ensure that the groups were effectively collaborating with the college teachers to produce high quality constructivist learning environments. For the next 10 weeks, the graduate students met with the teachers at least once per week to design the problem scenarios and the learning support systems surrounding those projects. The graduate students implemented those scenarios in web-based, interactive learning environments using principles of constructivist learning environments. At the conclusion of the semester, the graduate students demonstrated their projects for the remainder of the class and the instructor participants. At that time, instructors had not yet had an opportunity to use the just-completed constructivist learning environment.

3.3. *Data Collection*

At the project's completion, the course professor conducted an individual semi-structured interview with all instructor participants with the exception of FM5 and FM6, who were interviewed jointly due to scheduling constraints. The interview was a modified version of one used to gather data for the Perry scheme. Although data to determine Perry ratings might have been obtained via other data collection methods (see Moore, 1994), semi-structured interviews are a proven method (Marra et al., 2000; Moore, 1994). The author and the constructivist learning environment course professor recognize that a pre-intervention interview would have strengthened the methodology, but these interviews were not possible due to scheduling conflicts with the instructor participants.

The interview protocol consisted of open-ended questions about the instructors' opinions concerning the ideal college course, their understanding of what it means to learn, their definitions of knowledge and truth, how they approach teaching, and the impact of the constructivist learning environment project on their beliefs and actions about teaching and learning. On completion, the tape-recorded interviews were transcribed for analysis.

3.4. *Data Analysis*

Prior to coding the verbatim transcripts, the author created several coding categories relevant to this inquiry and based upon the interview protocol

including: beliefs and actions about teaching and learning (pedagogy), knowledge and truth, and project impact. The pedagogy category was defined as any statement concerned with teaching beliefs and teaching actions (in particular in reference to the target course). The knowledge and truth category was used to code any statement describing the participant's understanding of what knowledge or truth is, or the nature of knowledge or truth relative to teaching and learning. The project impact category was used to code any statement concerning the impact of the constructivist learning environment design project on the teacher participant.

The author and the constructivist learning environment course professor coded each interview separately at the phrase level (Weber, 1990) and then compared their coding of each interview. The coders' individual coding agreed 75% of the time – meaning that both coded the same text passages using the categories previously described. In most cases of disagreement, the author coded more text passages than the constructivist learning environment course professor, but these were passages that predominantly reiterated a previously-coded theme for that interviewee. In discussions of these coding variations, the coders resolved all coding differences. The results presented reflect these resolutions.

4. RESULTS/DISCUSSION

4.1. *Pedagogy and Teaching Beliefs*

Instructor participants' statements about pedagogy are summarized in Table III. For purposes of later discussion, some subcategories are marked with an asterisk to denote their *potential* for being in alignment with a constructivist pedagogical philosophy. Table III is broken down into the main categories that emerged from the interviews and then, within each category, participant's positions are shown for each category.

The desired learning outcomes for the targeted course category show the variability in the participants. Instructor participants mentioned both application of knowledge and problem solving, as well as affective learning outcomes. In Occupational Therapy, FM1 indicated that he was striving for both of these types of outcomes.

We hope that they will actually be more comfortable and approach serving people who are dying rather than avoiding that kind of practice. So we hope that they will . . . have a comfort level to engage in it with some basic knowledge and know where the resources are. Well I would like them to be able to. Yes, I can see hospice patients and evaluate them. I have the tools to evaluate them, I have these tools to treat them, and I will do so. So they will actually have an impact on that patient's life.

TABLE III
Pedagogical Beliefs, Actions and Roles of Instructor Participants

Categories/subcategories	Instructors
Desired learning outcomes for targeted course	
Metacognitive/knowledge processing ^a	FM3, FM7
Argumentation ^a	FM5
Application of knowledge and skills; problem solving	FM1, FM2, FM4, FM7
Affective/attitudes	FM1, FM2, FM6, FM7
Knowledge	FM3, FM4
Role of teacher	
Coach/facilitator ^a	FM1, FM2, FM7
Other	FM1, FM3, FM4
Not explicitly mentioned	FM5, FM6
Pedagogical strategies used	
Lecture	FM4
Discussions ^a	FM1, FM3
Uncomfortable with open free-form discussions	FM5
Student-centered strategies ^a	FM2, FM7
Not described	FM6

^aDenotes subcategory potentially in alignment with adoption of constructivism.

FM6 was also interested in student attitudes toward her discipline as she indicated that she'd like students to see that "science isn't a big, bad, scary thing; they really do this all the time . . .". Notably, only FM5 mentioned argumentation ("arguing from evidence and the kind of evidence we want in this particular class") as a desired goal. FM3, however hints at this type of outcome when he says that he would like his students in religious studies to "wrestle" with the ambiguous issues in religious studies.

Also notable was that only FM3 and FM4 mentioned acquiring simple content knowledge as a learning outcome. Lastly, concerning targeted course outcomes, FM3 and FM7 were both interested in students becoming more adept at the *process* of learning and knowing. FM3 describes this in terms of working on the methods of learning:

I'd like to include some work on method and see if I can get students, primarily first and second year students, working on method.

In general, the participants' statements about their roles as a teacher were congruent to their stated learning outcomes and their descriptions of pedagogical strategies used. For instance, FM1 and FM2 describe themselves as implementing a 'coach' role in which they guide discussions and other student-centered strategies. FM2 says that she has "not lectured in the last

ten years". FM7 also describes herself as a coach and implements project-based learning activities in her geography courses. FM4's statements about teacher roles and pedagogical strategies are also congruent with one another, although they represent a different set of beliefs and actions about teaching. He doesn't talk about his role as a teacher explicitly, but rather indicates that choices about learning are entirely up to the student.

The student has to make a decision about what they are going to do. Is this course relevant to the rest of their lives? And lots of students don't do that but I would hope that they would actually . . .

Table III also shows a subsequent coding of some subcategories as being potentially in alignment with adopting a constructivist framework in the classroom. The coders used this strategy based on the argument from Windschitl (2002) that certain belief systems must be in place as a necessary but not sufficient condition for adopting constructivism. Thus the denoted subcategories, marked with an asterisk (e.g. metacognitive, knowledge processing and argumentation learning outcomes) all embody aspects of the constructivist paradigm such as processing knowledge in societal contexts or placing learning in the hands of the learner via student-centered activities. The data show that all instructor participants indicated some pedagogical strategy that is open to constructivism.

4.2. *Knowledge and Truth*

The instructors' comments about knowledge and truth are the main source of data for ascertaining their underlying epistemological belief systems. The underlying epistemological foundations of the instructor participants' statements about knowledge and truth can be summarized along two dimensions in terms of how the instructor: (1) views truth and knowledge in his or her 'home' discipline (e.g. for FM1 and FM2, occupational therapy); and (2) views truth and knowledge in other disciplines that are significantly different than the 'home' discipline. The following is an example of the interview question posed to FM5, who co-taught the biotechnology course, to ascertain his views about knowledge in other disciplines. "Do you view truth and knowledge in other disciplines – such as literature or history – differently than you do in your own discipline?" Table IV summarizes the instructors' views along the two dimensions.

The second row in Table IV – for which truth is fixed in one's home discipline but not in different disciplines – includes FM4–FM6. As an example of this type of position, FM5 discusses knowledge and truth in his home discipline of biotechnology (as 'science' in the following quotation) as compared to art:

TABLE IV

Instructors' Views on Truth and Knowledge: 'Home' Discipline Versus 'Different' Disciplines

Group	Instructors' views on truth		Instructors
	'Home' discipline	'Different' disciplines	
I	Universal truths	Universal truths	None
II	Universal truths	No universal truths	FM4, FM5, FM6
III	No universal truths	Universal truths	FM1, FM2
IV	No universal truths	No universal truths	FM3, FM7

In science, we try to explicitly build a mental model that reflects physical reality. In what I regard as art-based disciplines, it's sort of the other way around. What you do as an artist is to make a physical manifestation of your imagination. So, it's the other side. . . .

The first part of his statement indicates that he sees knowledge and truth differently in the two areas – science tries to reflect reality (which is the truth) and an artist makes a reality out of his imagination (which is not a universal truth).

The second row in Table IV is also noteworthy in that it indicates a view of knowledge in the home discipline as being comprised of universal or absolute truths. According to Windschitl (2002), an implication of this view could be that such instructors would have difficulty in overcoming the conceptual dilemma of implementing constructivism while holding this relatively simple epistemological position.

The third row, for which truth is 'known' in other disciplines but variable in one's home discipline, FM1 clearly contrasts his discipline with others:

I think probably in OT that, well, we have an intuitive knowing of those truths. To articulate it to the rest of the world is harder. In chemistry, you can lay out that periodic table and say this is what we know. And this is what we have discovered and hope to discover. In OT, you can say that this is what we know about human beings' function, and what enhances their rights and what limits their rights. And we are about finding the ways to help people to enhance their lives through physical and emotional and spiritual activities.

In contrast, FM4 made firm and clear statements about both the absolute truths and views in his home discipline of economics:

On the micro-economic side, the graduate students and the faculty in their professional level probably won't see anybody disagreeing with them. Everything is laid out. It is very structured . . .

And when asked about truths in other disciplines, he responded that "I could find multiple truths too that were valid for different people in my

perception”, indicating his perception that multiple truths can exist in other disciplines.

FM3 and FM7 were the only participants to indicate that truth and knowledge vary contextually – indicating relatively advanced levels of epistemological development – regardless of disciplinary context. Here, FM3 describes his beliefs about truth and knowledge both in his home discipline of religious studies and compares it to the contrasting discipline of science:

[There is a] kind of truth that they’re operating on or that they’re working on. We [in religious studies] try not to do that. . . . I lean that way. I think that really a sophisticated approach to say, science or something, would say the same thing. Truth is very difficult to get at. I think it’s easier in the sciences to overlook those issues and take a mechanistic approach. It’s easy in ours too, I guess.

He clearly expresses that he sees truth as variable and contextual in both areas.

4.3. *Impact of the Project*

The instructors reported varied impacts of the constructivist learning environment design process on their beliefs about knowledge and learning, and/or their beliefs about or their actions towards teaching. Table V lists these impacts and the instructors who reported each.

Of particular note in Table V are categories 3, 4 and 5 as they provide evidence that the project influenced some aspect of the teaching or learning process that could have an impact on student learning – which is arguably a goal of encouraging epistemic development and use of constructivist strategies amongst teachers.

Four instructors said that the project had impacted on how they approached class planning or implementation of pedagogical actions (category 3). The OT instructors indicated that they had introduced group

TABLE V
Impacts of Design Project on Instructor Participants

Impact category	Instructors
1. No changes in teaching beliefs	FM3
2. Expects impact on how students behave when interacting with classroom learning environment	FM5, FM6
3. Impacted class planning or pedagogical actions	FM1, FM2, FM3, FM7
4. Impact on instructors’ teaching beliefs	FM1, FM2, FM4, FM6
5. Actual changes in student performance	FM7
6. Positively impressed by working with graduate students	FM1–FM7

work into their courses as a by-product of their work on the constructivist learning environment – and this occurred even though they had not yet implemented the constructivist learning environment in their courses. And, although FM3 stated that the project had not changed his views about teaching beliefs (category 1), he indicated that the process had affected his ideas about his goals for the target course:

It taught me to explore the direction in which I want to go with this course. They [the graduate students] have come up with different ideas to challenge me on things that I could do in the course.

FM7 had a similar experience stating:

Your students have made me realize that there's real value in defining what the objectives are and what am I going to assess them on. I never really spent very much time on that.

Even more significantly, FM7 reported that the project had influenced student performance (category 5 from Table V) during the semester when project design took place. When asked whether the project had affected her teaching practices, she responded with a resounding “Absolutely!”, explaining that, because of the project, she had introduced project rubrics into his current semester's course. She further described that the students' projects “were far better than in previous years . . . because, instead of the students shooting at a moving target, they knew exactly what I was going to grade”.

The OT (FM1 and FM2) and one of the biochemistry instructors (FM6) were the participants who reported that the project had directly impacted their views on what it means to teach and their overall teaching beliefs. Both FM1 and FM2 commented on their growing understanding that teaching and learning can be more effective when embedded in meaningful contexts in which students actually *need* to access the learning materials in order to accomplish some sort of meaningful goal. For instance, FM1 stated that “well, we learned about situated cognition. . . .”, and FM2 described the impact of hearing about this concept as well:

[W]hat you said earlier on is that people don't really learn and remember something until it is time to use it.

FM2 showed a further understanding of this concept when she described how the students in her online course did not access the online ‘lecture’ materials until they had a meaningful problem to solve:

So I said, okay, icon on the homepage. But then I gave them a final, which was a case. And when I gave it to them, I said that I will be looking for material from the online lectures in your answers to this case. And that seemed to stimulate them.

FM6 described her changes around the idea of a deeper understanding of the variations in how students learn.

Right. Just realizing . . . that there are so many different ways that students learn. Being a student for almost all of my life – and typically around people who are like you, for a long time, I assumed that everybody learned in the way that I did.

FM4's revelations were somewhat subtler. He said that he realized that "students come at truth in different ways" and bring different quantitative skills to the course – and that the constructivist learning environment needed to "explore ways to develop tools" to respond to these varying student needs.

4.4. *Discussion*

Although this study was intended to examine the impact of a constructivist learning environment design experience on instructors' epistemological views, the results point to a circular relationship between the constructs. It appears that only instructors who are just on the brink of embracing constructivist principles and the underlying epistemology it entails – or in a 'zone' of readiness – can be influenced epistemologically by engaging in constructivist learning environment design. The results point to FM1 and FM2 existing in this 'zone'.

The 'zone' of readiness is comparable if not a specific example of Vygotsky's zone of proximal development (1978). Vygotsky's zone of proximal development asserts that, for learners to develop mental functions, they must be fostered and supported in collaborative activities in which learners engage in challenging tasks with the assistance of others who are more advanced. This assistance allows learners to gradually internalize the tasks and strategies used by the more advanced collaborator and later accomplish the task on their own (Windschitl, 2002). One likewise can argue that, for instructors to develop epistemologically in the context of participating in the design of a constructivist learning environment, they must not only be supported by those who are more advanced in this realm – in this case, the constructivist learning environment course professor and the graduate student team – but they must also be sufficiently, but not overly, epistemologically advanced themselves to be affected by the design process. The results reported in Tables III–V support this assertion.

Regarding pedagogy, all seven instructors expressed pedagogical beliefs or employed teaching strategies that denote the possibility of a constructivist philosophy (see Table III). At first glance, then, it might appear that all instructors might be in the 'zone' where they could be impacted in significant ways by their engagement in the constructivist learning environment design process. However, the fact that all instructors in this study

volunteered to participate in constructivist learning environment design is already a strong indicator of their willingness to engage in or express constructivists beliefs to some degree. Further, when the pedagogy category results are combined with the other two major coding categories, a different picture emerges.

From Table V, regarding the impact of the constructivist learning environment design process on instructors, categories 3, 4 and 5 are significant as they provide evidence that the project influenced some aspect of the teaching or learning process. These subcategories include all but one participant; only FM5 is not represented. Note, however, that FM1 and FM2 are the only two participants to be represented twice amongst these subcategories.

A re-examination of Table IV on epistemological beliefs reveals a strong indicator that could support the 'zone' conclusion. Of the four groups represented in Table IV, group IV, for which one sees truth as relative in all disciplines, represents the most advanced epistemological orientation and thus, arguably, the one most in line with adopting and implementing a constructivist paradigm. Only FM3 and FM7 exhibited these beliefs. FM1 and FM2 exhibited a relatively advanced epistemology in their own disciplines, but not in others (group III). The remaining participants were in group II for which absolute truth exists in their disciplines, but perhaps not in others.

Recall from Windschitl (2002) that epistemological views in alignment with constructivism are necessary for adopting constructivist implementations. Arguably, groups III and IV would be considered in alignment; IV is the most advanced epistemology of the four groups and could easily be reconciled with the student-centered, socially-negotiated terms of constructivist learning. Group III, while not as advanced, allows for the potential of implementing constructivism in instructors' home disciplines. Group II is not in alignment with constructivism as knowledge and truth are still seen as absolutes in one's own discipline. If one accepts this line of reasoning, then FM1, FM2, FM3 and FM7 are all possible candidates for the zone of proximal development.

FM3 and FM7 are eliminated, however, based on a more critical examination of their discussion of the impact of the constructivist learning environment design project, the overall tone of their interviews and, finally, their years of experience in their home disciplines. From Table V, one sees FM3 and FM7 reported impacts coded as categories 3 and 5 – impact on actions and impact on students: neither reported that the experience had actually impacted their beliefs about teaching and learning – and thus their underlying epistemology. Certainly the author does not discount these impacts – these instructors actually changed what they were doing in their courses, perhaps due to their constructivist learning environment design

experience. However, from analyzing their interviews, combined with the fact that they did not report changes in beliefs, it would appear that these instructors *already* held beliefs that were in alignment with constructivist principles prior to their participation in this activity.

Thus, from the four instructor participants who exhibited a belief system in alignment with constructivist principles (Category III from Table V), it would appear that only FM1 and FM2 were in the zone of proximal development, as only these two show both an epistemological framework in alignment with constructivist belief systems *and* expressed that the constructivist learning environment design project impacted their beliefs about teaching and learning (Table V). FM3 and FM7 were already so advanced epistemologically that their collaborators were not sufficiently more advanced than they were to be able to encourage further epistemological development. Ultimately, these instructors were not sufficiently challenged by the activity to have a noticeable impact on their epistemological views.

In contrast, FM5 and FM6 were not sufficiently advanced or ready to be engaged by the constructivist learning environment design process. However their case is interesting because a further application of the Vygotsky metaphor argues that a slightly different task that was 'nearer' to where FM5 and FM6 started epistemologically could have had an impact on their epistemological views. An example might be developing, with the guidance of an instructor who routinely implements constructivist learning activities, a smaller, more-contained constructivist-based pedagogical activity for a specific biochemistry learning outcome.

4.5. *Limitations/Future Work*

Having proposed the above interpretations, the author recognizes the limitations of the analysis and suggests the following ways in which future research might build upon and strengthen these findings.

The sample of instructors consisted of those who were necessarily open to new pedagogical activities. Regardless, even with this self-selected sample, the results still show differences in terms of how the constructivist learning environment design experience influenced the instructors. The results indicate that only certain instructors who are 'epistemologically ready' can experience epistemological benefits of constructivist learning environment design. Research with students has shown that the use of certain scaffolding mechanisms can help students to advance epistemologically regardless of their initial epistemological state (Marra et al., 2000; Stephenson & Hunt, 1977). Future constructivist learning environment development activities should include appropriate scaffolds, such as opportunities for reflection and 'apprenticeships' with instructors who use constructivist practices, to test whether these strategies can increase the effectiveness of constructivist

learning environment design activity. Additionally, a future study would certainly be strengthened by using a pre/post intervention interview design. Unfortunately, due to instructors' schedules, this was not possible for this study.

5. CONCLUSIONS

This study explored the impact of instructors being engaged in the design of a constructivist learning environment in terms of their beliefs about teaching and learning and their epistemological beliefs. This study's results suggest that instructors' participation in the design of constructivist learning environments, for instructors in a readiness zone similar to the zone of proximal development, can influence their views about teaching, learning and knowledge – their epistemology. Constructivist learning environment design can promote such changes in thinking because it requires instructors to think about teaching in non-traditional ways (e.g. performance of authentic tasks, and student-centered support rather than instructor-supplied solutions). The potential impact of this inquiry is that, if college teachers' *beliefs about* knowledge and learning and teaching become more complex (their epistemologies), they are more likely to communicate these complexities to their students and thus promote student epistemological development (Brindley, 2000; Howard et al., 2000). Further, the need for such interventions that can positively influence teacher epistemologies and behaviors is underscored by prior research that has found that preservice teacher education programs do not adequately address learners' existing epistemological beliefs and, thus, do little to challenge relatively simple epistemologies or promote more complex ones (Fosnot, 1996 as cited in Brindley, 2000).

Jonassen et al. (2003) argue that students bring established 'scripts' for what to expect in higher education that include listening to lectures, predicting what ideas will be examined on the test, cramming information into working memory, and completing examinations before forgetting most of what was studied. These scripts can act as a lens through which they see and experience learning activities. When students' learning scripts are based on traditional, transmission modes of education, they might not experience the full benefits of constructivist learning environments or might even respond negatively to them.

It seems likely that instructors also develop 'scripts' for what it means to teach. And, similar to students whose experience of constructivist learning environments might be impacted by their existing epistemological beliefs, the instructors in this study experienced the potential impacts on pedagogy and teaching beliefs of designing a constructivist learning environment to different extents. Specifically, only those who were in an *advanced enough*

stage epistemologically (category III from Table IV, FM1 and FM2) – but not too advanced – experienced actual changes in their teaching beliefs during project participation.

To conclude, one might compare these findings to a coach telling a developing tennis player: “Your game will improve if you play against folk who are better than you.” These results support this idea but only when ‘better’ is within a certain ‘zone’. Specifically, the coach probably didn’t intend for the novice to play against Wimbledon champions – likewise, instructors might benefit epistemologically from participating in a constructivist learning environment design activity, but only if their pre-existing epistemological framework is in a zone of readiness to be challenged by the assumptions and demands of designing constructivist learning environments.

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