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Mathematics

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# Partitioning: Instructor Mathematics Philosophy Shaping Community College Mathematics

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*The purpose of this study was to explore the ways instructors' subject matter beliefs regarding mathematics shape their courses in a community college environment. Data were collected and analysed from instructors' philosophical definitions of mathematics and observations of teaching episodes using a constructivist grounded theory research design. Findings show instructor beliefs separate mathematics discourses into subcultures of workplace, applied and academic mathematics communities with a perceived need for future mathematics assigned to each partition. In partitioning mathematics courses, instructors need to become aware of the possible shifting of content which can be inclusive and exclusive of needed academic mathematics. The knowledge learned can be incommensurable between these disjoint subcultures and can become a barrier to the future mathematics learning needs of workers in a knowledge-based society.*

## Introduction

Globalization and rapid changes in technology have created a need for adults to update their skill sets for career advancement and to be prepared to make broad decisions about complex problems using a myriad of information (Brown, Green, & Lauder, 2001). Adults are enrolling in postsecondary institutions, and specifically mathematics courses, in response to the changing demands of the workplace and to concerns coming with the emerging knowledge economy. In the United States of America, community colleges are charged with creating the access and success to these academic pathways needed by adults (Bragg, Kim, & Barnett, 2006). Access to academic pathways combines a number of complex and often conflicting components, including preparation for college-level work, for acquiring necessary career skills, and for future learning needs. Community college faculty must provide instructional practices which support all of these components. Though this access requires mathematics knowledge, many of the instructional practices in mathematics courses limit the knowledge learned. An incomplete understanding of mathematics can prevent individuals' successful transitions between the needs of college work, workplace applications, and lifelong learning demands (Artigue, 2001; Seldon & Seldon, 2001).

Understanding community college instruction requires an understanding of the faculty's beliefs (Fennema, Carpenter, & Peterson, 1987; Schoenfeld, 1989; Thompson, 1992; Wilson & Cooney, 2003). Beliefs about teaching and learning involve a subtle interaction among various elements, including views about students, learning, and subject matter. While this is generally recognized, there is little understanding of the nature of this interaction in community colleges and how teachers' views about subject

matter content are connected to the shaping of their practice. The multiple missions assigned to the community college system create a complex teaching environment for its faculty. This issue is particularly important within community college mathematics education. Instructors are expected to shape courses to service educational programs with different and often conflicting mathematics needs.

This study explored the ways instructors' beliefs about their discipline shape the educational practice in a sub-baccalaureate college environment. The primary research question explored was "How are instructors' philosophies of mathematics shaping mathematics instruction in community colleges?" Towards this understanding the following secondary questions were asked:

- What are community college instructors' self-identified beliefs about the nature of mathematics?
- How do community college instructors view the intentions of their instruction?
- In what ways do instructors see their view of mathematics as shaping their teaching?
- In what ways do instructors see their mathematics philosophies shaping their course decisions?

Today close to half of all postsecondary enrollments are in community college institutions with the average age of students being 29 years (NCES, 2002). The increased role of technology and science in everyday life requires a deeper understanding of mathematics to interpret data for active participation in civic life and for the changes new technology brings to the workplace. A need exists to understand how instructors' philosophies of mathematics shape the instruction in these community college mathematics courses. Educational programming can be designed to better support the long-term mathematics needs of adults when all stakeholders have a better understanding regarding the shaping of instruction in workplace, application, and transfer community college courses.

## **Theoretical Framework**

The theoretical foundation used to study the process of subject matter beliefs shaping instruction in community colleges was synthesized under a constructivist conceptual framework. The literature separates constructivism into two strands, one situated within the cognitive psychology field explaining the construction of reality based on the cognitive processes in an individual (Abreu, Bishop, & Pompeu, 1997; Pehkonen & Furinghetti, 2001; Piaget, 1963) and the second situated within the sociology field of reality based on the meaning within a social group (von Glaserfeld, 1985, 1995; Vygotsky, 1978). While the distinction between individual and group contexts is important, it fails to address the influence of the negotiated knowledge of a group on the individual's constructed knowledge (Steele, 2001). As part of a social group, an individual participates in a group negotiation of radical construction and this created knowledge is negotiated by the individual to assimilate and accommodate the knowledge into their own schema (von Glaserfeld, 2006).

Literature on (a) beliefs systems from cognitive psychology, (b) Ernest's (1991) model of mathematics philosophy from mathematics education, and (c) intercultural learning from sociology structures this research. For the purposes of this study instructor beliefs are personal constructs from experience, usually created unconsciously, unique for each individual and because they are personally constructed, do not need a universal agreement to establish validity (Pehkonen & Furinghetti, 2001). Beliefs are not developed using logical thought but through experience which makes beliefs distinct from knowledge (Ponte, 1994). Knowledge is the network of beliefs, concepts, images, and intelligent abilities built through a cognitive process of experimentation, reasoning, and debate (DaPonte & Chapman, 2006). Knowledge must meet certain criteria of evidence and publicly recognized or rejected claims, whereas beliefs exist without logical consistency. Beliefs can even be held within conflicting evidence. Knowledge is context dependent. Mathematical knowledge comes from the mathematical meaning constructed from the objective mathematics definitions and from the subjective concept images and beliefs of the individual (Sfard, 2001). Mathematics understanding is constructed uniquely by each individual. Mathematics is not an absolute body of transferable procedures and concepts and is not independent of context.

Ernest's (1991) model was used as a framework to discuss the relationships between beliefs and instruction. To understand belief systems regarding the nature of mathematics, an awareness of mathematics as a philosophy is required. All philosophical systems begin through examining questions of epistemology, ontology and axiology. In this study these questions are examined within the context of mathematics. Community college instructors' epistemological (What is knowledge? How is truth of knowledge determined?), ontological (What is the relationship between knowledge and knower?), and axiological (What is the value of the knowledge?) perspectives about mathematics could be the most important beliefs underlying the teaching of mathematics (Ernest, 1991). Epistemology is the branch of philosophy that studies knowledge. An epistemology comes from a worldview (Husserl, 1931) which situates knowledge within the relationship between knowledge and the knower and the truth value of knowledge. Ontology answers questions of existence and is embedded into epistemological questions of knowing. Axiology answers the questions of value of an object and also the relationship of values to the object. Together the three branches of a mathematical philosophy reflect on a theory of mathematical being, a theory of mathematical value, and a theory of mathematical knowledge verification. The model recognizes two epistemic views of knowledge: absolutism and fallibilism. In an absolutist worldview mathematical knowledge is an objective, absolute, timeless, isolated, factual body of knowledge waiting for discovery. Implications of absolutism are mathematics as value-free, inhuman, cold, pure, abstract, remote, and rational-deductive. In contrast, a fallibilist perspective views mathematics as constructed by social process. Mathematical knowledge is dynamic, subjective, open to revision, and humanly created. Within these two epistemologies, Ernest describes three philosophies of mathematics: instrumentalist, Platonist, and problem-solving. Table 1 summarizes Ernest's translation of each philosophical foundation into a specific classroom culture.

**Table 1. Mathematics Philosophy and Classroom Culture (Ernest, 1991).**

View of the nature of mathematics	Teacher's role	Intended outcome of instruction	Use of curricular materials	Learning model
Instrumentalist	Instructor	Skills mastery with correct performance of skills	Strict following of text of scheme	Compliant behavior and mastery of skills
Platonist	Explainer	Conceptual understanding with unified knowledge	Modification of the textbook approach enriched with additional problems and activities	Reception of knowledge model
Problem-solving	Facilitator	Confident problem posing and solving	Teacher or school construction of the mathematics curriculum	Active construction of understanding of model

The concept of mathematics as a cultural milieu expands into a framework with its own knowledge, beliefs, values, customs and discourse. Mathematics is comprised of many separate domains (such as algebra, geometry and analysis), each its own subculture. If education is an intentional societal process, then the learning in each mathematic domain is the intentional learning of another culture. Conceptualized as intercultural learning, mathematics learning becomes an acculturation into a new culture, that of formal mathematics (Bishop, 1989, 2004). As a subculture of a larger society, mathematics has its own discourses and the instructor becomes an interpreter between the culture the learner brings into the classroom and the destination culture of formal mathematics (Kalathil, 2006; Prediger, 2001; Sfard, 2001). As acculturators, teachers need to know the culture of formal mathematics at a local level (course content, technology requirements, transfer requirements, and vocational certification requirements) and also globally (the relationships between topics, the structure of mathematics, and the contexts for its application).

## Methodology

This research used a constructivist grounded theory methodology (Charmaz, 2006) to study the ways beliefs about the nature of mathematics shape instruction within the ecology of community college mathematics classrooms. Evidence of this phenomenon was provided by researcher field notes; transcripts of 14 video-taped classroom observations; 2 two-hour interviews with each instructor; and instructor written statements concerning mathematics beliefs over a 16-week fall semester. Triangulation was established from instructor-generated concept maps outlining mathematics contents and course artifacts including syllabi, board drawings, handouts, and formal

assessments. These extant documents provided examples of instructional problems which identified the concept representations, mathematics content, and assessment priorities of the instructors.

## Participants

The research site was an open-access, rural Midwest community college serving a district population of 100,000. Working within a state higher education articulation policy, the community college offered career programming (vocational certificates & associate degrees in applied sciences), transfer course programming (degrees in associate of arts, associate of science, associate of fine arts, & associate of engineering science), and remedial programming (coursework in adult basic education, adult secondary education, English as a second language, & developmental education). One female and three male, full-time tenured mathematics instructors were purposefully selected demonstrating contrasting instructional styles and an example of mathematics from vocational, developmental, general studies-transfer, and application-transfer courses. Table 2 provides a chart organizing the demographics of the study's participants using pseudonyms for anonymity. Limiting the participants to full-time faculty members, without including adjunct instructors, guaranteed the participants had full understanding of the institutional policies structuring their professional practices.

**Table 2 Demographics of participants.**

Instructor pseudonym	Undergraduate degree	Graduate degree	Prior teaching experience	Professional self-identity
Morris	Associates B.S. Mathematics	M.S. Mathematics Doctoral path	University teaching assistant	Mathematician
Frank	Associates B.S. Mathematics + Secondary Certificate	M.S.Ed. Mathematics	Secondary	Mathematics educator
Jamie	B.S. Mathematics	M.S. Mathematics Doctoral path	University teaching instructor	Algebraist
J. P.	B.S. Mathematics + Secondary Certificate	M.A.T.- Mathematics	Secondary	Mathematician

## Data Collection

Pre-observation interviews (Appendix A) with the chosen instructors were audio-taped to collect demographic information and allow the participant-educators to self-identify a philosophy of mathematics. The open ended questions of the first interview were based on the three philosophical components of epistemology (What is mathematics? How do you know mathematics is true?), ontology (How is mathematics created? How is mathematical knowledge created?), and axiology (What is the value of mathematics? What is the value of mathematics knowledge?). Instructors were given the option to reflect on their beliefs by creating a concept map of mathematics within the context of the research course (see Appendix B). Video-taped observation of teaching episodes occurred within the same month in each classroom. Instructors verified the accuracy of

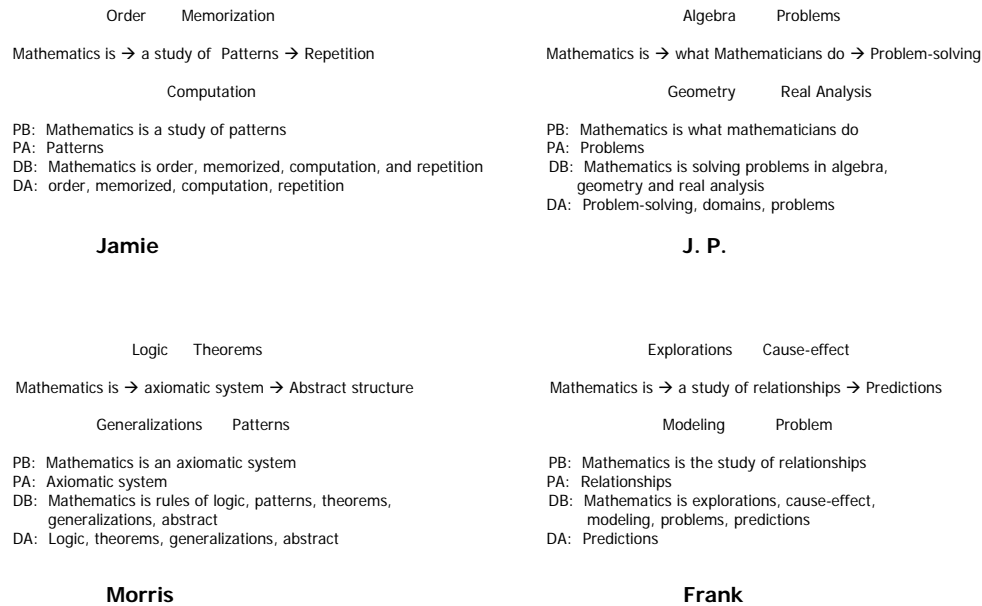
the transcripts from the first observation. Theoretical sampling for possible differences in questioning patterns required an extra observation in the two transfer classes and the addition of several questions to a second interview protocol addressing instructors' professional affiliation and instructional changes based on course track or level. Second interviews (Appendix C) provided transcript verification, instructor's description of their experiences as graduate students, professional affiliations, educational intent behind classroom behaviors, and instructors' intentions of instructional decisions. Besides elicited text from transcriptions of interviews and teaching episodes, a variety of data were collected from viewing artifacts such as: (a) field drawings of white board visuals during instruction, (b) field journal tracking research decisions, (c) class syllabi, (d) handouts, (e) quizzes and exams, (f) state policy documents governing community colleges and (g) administrative policy documents of the community college in this research. These extant texts detailed the voices of authority under which the faculty practices were structured. In addition, the data provided triangulation both for consistency and authenticity.

## Data Analysis

The transcripts of each instructor were sorted chronologically and coded for data which appeared to address the research questions. Data were separated into events, compared, and coded by similar events. Codes evolved from comparing dissimilar events using incident-to-incident coding and produced one hundred separate codes describing behaviors and actions. When possible in vivo codes from participants' special terms were used as symbolic markers of meaning. For example the category self-identification came from the in vivo code "self-identify" and the code "guiding question" came from an instructor when modeling problem-solving in class. These, and other key words used by the participants, became significant indicators of their philosophical mathematics beliefs. Memos were written throughout the research process and abstracted the codes to theoretical categories. One illustration of abstraction from researcher memos occurred after memoing identified different questioning styles. The transcripts were then coded to reflect the different questioning uses by the instructor and also between instructors. Out of these codes came categories of *factual*, *guiding* and *probing* which were eventually collapsed into the theoretical category Bridging Discourses.

Four schemata representing metaphorical images of each instructor's philosophy of mathematics (Chapman, 2002) were created (see Figure 1). The primary beliefs [PB] referred to the primary attributes [PA] which came directly from participants' responses to the interview question "What is mathematics?" The derivative attributes [DA] came from the supporting statements [DB] expanding the explanation of the primary belief. In one case J.P., the instructor of the general education mathematics course, provided the following answer:

What I can say is mathematics is what mathematicians do. It is anything you want it to be. More seriously ... I am not always sure. Just as I am not always sure what geometry is compared to algebra. To me there is a flavor to geometry and a flavor to algebra. ... Almost it is by problem. When I see a problem, I know where it fits ... it is solving problems. It is not proving things-unless you think of that as a problem.



**Figure 1. Philosophies of mathematics schemata**

These schematic philosophies were used as personal theoretical frameworks to compare, contrast, analyze, synthesize, and connect the emerging categories.

The most significant codes were focused to make analytic sense and to categorize the data. Instructor responses provided the dimensional ranges for each category and relationships between categories. The fractured data were compared, related and linked to subsume the codes into three subcategories. Two of the emerging theory's main categories, Valorizations and Voicing of Authority originated from open coding labels. The third category, Bridging Discourses, was an axial coded label. The connections of focused codes to each theoretical category influenced by the instructor's mathematics philosophy produced a core category of Partitioning. Grounded in the data from community college instructors and the literatures on socio-constructivism, acculturation and belief theories, a conception of partitioning was created.

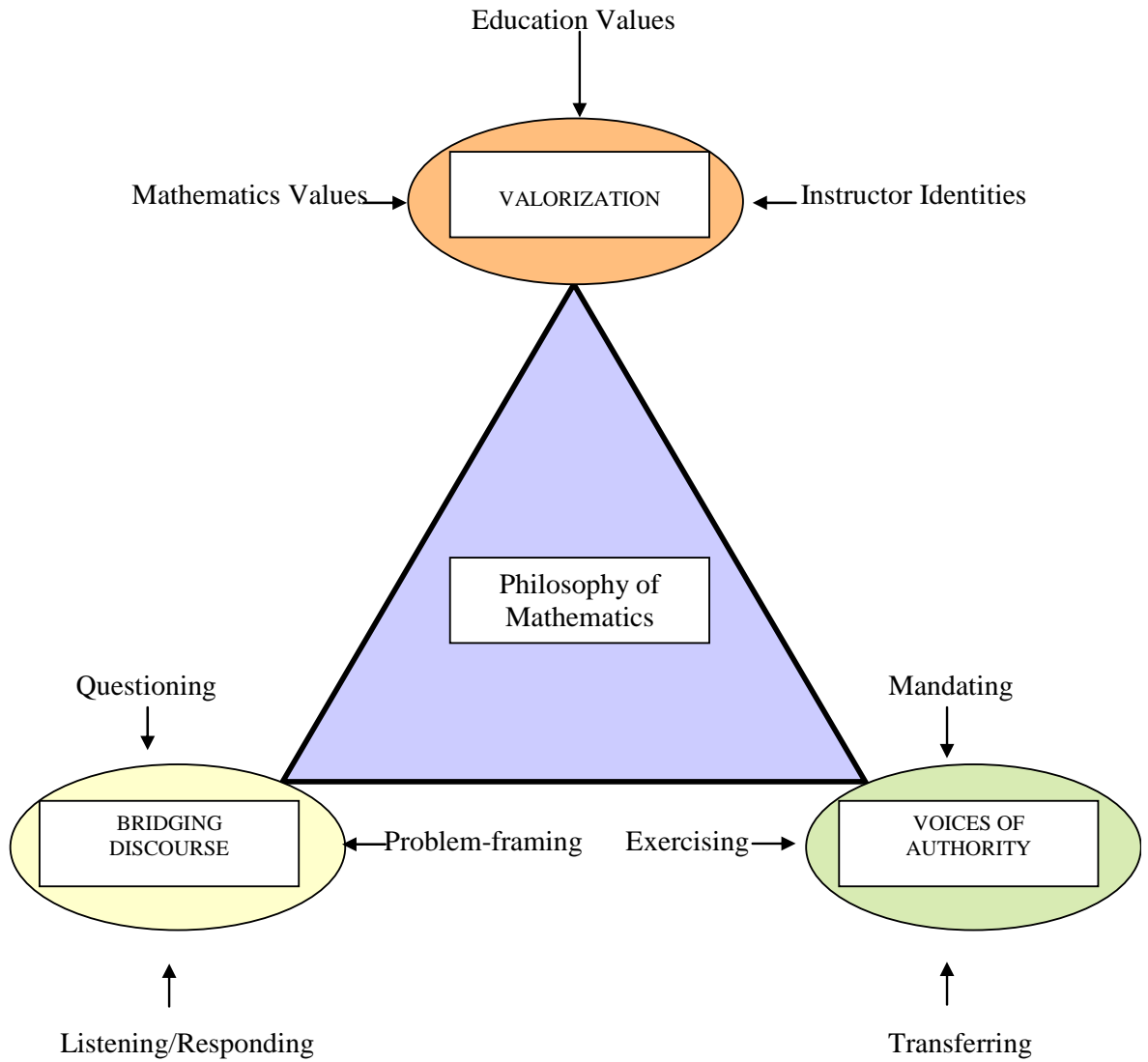
## Results

Instructors' beliefs about the nature of mathematics were filters for assigning more worth to some instructional practices over other practices. Instructors "privileged" (Wertsch, 1998) those classroom practices which aligned with their beliefs over other practices in conflict with these beliefs. By these *valorizations*, instructor's beliefs influenced the shaping of classroom discourses. Using questioning, listen-responding, and problem-framing patterns, instructors built a *bridging discourse* where the learner's prior mathematical knowledge and experiences converged with the academic community of the mathematician; as represented and filtered by instructors' philosophies of mathematics. During interviews and classroom observations, faculty specifically referenced the *voices of authority* as an intervening condition on their pedagogical decisions. There existed complex and often conflicting policies governing



degree, program, course pre-requirements, funding structures, and credentialing which structured faculty's instructional decisions.

The central phenomenon of Partitioning became the core category explaining a process of mathematics instructor's beliefs shaping instruction in mathematics courses. The mathematics definition of partitioning is "the decomposition of a set into a family of non-empty, disjoint sets where the union of the sets equals the original set" (OED, 1994). Instructors partitioned the mathematics field into incommensurable mathematical worlds. The instructors' philosophies regarding the nature of mathematics partitioned the discipline of mathematics into subcultures each with its own interpretation of the value of mathematics and way of knowing. For each subculture, instructors' beliefs assigned different worth to mathematics and created different classroom discourses. The instructors spoke of different communities inside and others outside the instructors' conception of the culture of mathematics. Members in these communities were identified as being included or excluded from the mathematics community. Some participant comments referring to the existence of disjointed worlds are "I'm an algebraist ... Stats ... I don't think is really math. I leave that to the statisticians" and "I haven't taught Nursing 107 math-for-nurses ... is arithmetic. But the only true math course I haven't taught is the Diffi-Q." Students in career technology mathematics were partitioned outside the field of mathematics as referenced by the instructor comment: "A lot of this doesn't apply to the Tech Math students. They are just a different bunch." The result of these differences is a partitioning of learners into subcultures of workplace, applied, and theoretical mathematics. In the profession of the community college mathematics educator, the content viewed as essential, the subject discipline's norms, and the discourses instructors created in the classrooms were valorizations of the instructors' philosophy of mathematics. The partitions within the instructors' perceptions of the community college course classifications, the future mathematics needs of the learners, and the professional self-identities separated mathematics learners into cultures of workplace, applied, and academic mathematics perceived as disjoint. The instructors created a partitioning process through the necessary, but alone insufficient, actions and interactions of Valorizations, Voices of Authority, and Bridging Discourses (see Figure 2).



**Figure 2. Model of Partitioning.**

## Discussion

The findings of this research suggest that community college instructors' partitionings lead to the directed acculturation of students into separate mathematics subcultures. In the author's substantive theory of partitioning, teachers become the acculturators of students into subcultures, each with its own variations on notation, vocabulary, assumptions, abstractions, applications and ways of knowing. These variations are like dialects within the language of general mathematics, and bridging discourses reformat the content for student access to the instructor-defined knowledge. Teachers minimize the differences between the mathematics and the learner by blending the learners' values, norms, and knowledge with the teacher's valorization of what are the values, outcomes, and knowledge relevant to the destination subculture. Each teacher produces a bridging discourse unique to the valorizations of their individual mathematics philosophy. Separate discourses ensue from different mathematics philosophies. Implications of a theory of partitioning to adult learning, community colleges and professional development of faculty are the difficulty in integrating the content between the partitioned subcultures of vocational and academic mathematics, the involvement of the partition between professional identities of scholar and pedagogue in the recruitment of community college personnel, and the applications of the partitioning process on the scholarly fields of higher education, adult education and mathematics education for situating research on adults' mathematics education.

In mathematics courses servicing career-technology education (CTE) programs the presumption was that students would not have a need for mathematics learning in the future and did not have a need to communicate mathematically. It could be argued these students were not learning mathematics at all but were learning to use tools provided by mathematics. The course content was an atomized variety of computational tools provided by mathematics but excluded the symbolism, notations, syntax, and connected structure of the mathematics discourse. Although the CTE mathematics course has a college-level course and the developmental mathematics was a lower numbered pre-college level sequence, the destination discourse created in the CTE mathematics course was a workplace discourse which found utility in the computational tools of mathematics. In this scenario the intent was not to build a bridging discourse to acculturate students into mathematics but into a culture which mechanically used the tools of mathematics. This philosophy was reflected in instructional practices which used lower levels of student participation, questioning-listening-responding, and problem-framing. The surface knowledge learned in CTE mathematics was incommensurable with the foundation knowledge needed for future mathematics understanding and could make mobility between mathematics sub-cultures problematic, preventing workers from acquiring needed skill updates in the future.

Policies challenge sub-baccalaureate colleges with providing workplace and occupational education. In the United States, the federal Perkins IV legislation prioritizes integrating academic discipline content into vocational courses to prepare for the undeterminable training needs occurring in workplaces. From instructors' personal mathematics philosophies are derived beliefs of who will and will not need future mathematics learning. A view of mathematics as an ideology for understanding the world can form a peripheral belief that the need for mathematical learning continues throughout the lifespan of all workers. In direct contrast, impressions of mathematics as

a collection of connected particulars partitions future mathematics needs by degree tracks. Such instructors articulated the CTE students' lack of need for future mathematics learning as justification for the weak emphasis on formal mathematics content in CTE courses. Compared to CTE students, it is believed developmental students are stronger academically and need preparation for future mathematics to complete a baccalaureate degree. These assumptions contradict the actual completion behaviors of students enrolled in developmental and CTE education programs. The national longitudinal survey, Beginning Postsecondary Students (BPS) found 36% of transfer degree students enrolled in two developmental courses drop out without attaining any college credential. The percentage increases to a dropout rate of 46% when the number of remedial courses is three or more (NCES, 1996, 2000). However, NCES found students declaring a vocational program were more likely than general education community college students to complete a degree or certificate within two years (NCES, 2000). This privileging of academic knowledge away from CTE programs, while including it in developmental and transfer programs, directs students to long-term educational commitments in programs which show an increased risk of student-dropout without any degree and few college credits (Elder & McDonald, 2006).

Problematic is the partition of career technology mathematics outside the traditional discipline of academic mathematics. When instructors partition mathematics learning, they also partition the subject's value between worth to the individual and worth to the society. This subject irrelevance paradox (Niss, 1994) promotes mathematics as publicly important while being personally irrelevant to individual learners. All associate degree programs include a mathematics requirement, many taught by mathematics department faculty. Many community college vocational faculty do not have a deep understanding of mathematics or its teaching. Yet few community college mathematics faculty understand the extent of mathematics in occupational and vocational areas (Elder & McDonald, 2006). Therefore, instruction in vocational courses teaches mathematics at a surface level. Discourse bridges founded in career technology mathematics have students training in discrete and isolated content which is disconnected from the structure of formal mathematics. Instead of learning about mathematical perspectives or inquiry methods, students are restricted to job training in the tools provided by mathematics. The assumption is that a context-rich quantitative literacy is substitutable for formal mathematics in career technology programs (Ewell, 2001).

But knowledge needed in the workplace is complex, takes time to develop and constantly changes as innovations are introduced into organizations. It would be reasonable to expect vocational students to have as great a need in the future, if not a greater need, to build upon a mathematics foundation as do students pursuing transfer degrees. Technological advances transform fields in vocational education more often and with a greater magnitude than the modifications which occur to fields in liberal education. Students pursuing transfer degrees in non-scientific-based business management are offered application-specific statistics and calculus courses. By contrast, diesel power technologists are responsible for applying complex principles from physics to expensive machinery, yet their mathematics preparation is trivialized to learning computations easily performed by common calculators. There are few routine tasks in the vocational workplace, and rapid advancements in technologies ensure more mathematics learning will be part of these workers' futures. Providing instruction in

computations made obsolete by inexpensive calculators does not prepare workers for the future shifts of skills in the workplace. Computational knowledge without conceptual understanding will not provide the formal and operational competencies for mastering new advances created by technology.

State and federal higher education policies have placed a multitude of missions and roles onto United States community colleges. Instructors are given the responsibility of balancing a multitude of diverse educational services within their subject teaching. Many of these educational services conflict with the teachers' perceptions of their subject, its knowledge and its worth. One way community college faculty negotiates these demands is by partitioning the subject they are teaching into subculture domains. In this study instructors expressed a negotiation between the emphasis placed on vocational and that placed on academic education. Students were partitioned by teachers' perceptions of a need for future building upon the subject; by the nature of the class as a vocational, applied, or theoretical representation of the subject; and by the teacher's placement of the course content as inside or outside the subject area. But it is possible to argue that workplace preparation occurs in all educational programming and that every course provides some preparation for future work. If this is so, and the general value of education in a knowledge-based society is seen as a preparation for work, what are the implications for those unable to work? Are they partitioned from education? Mathematics educators need to be aware of the partitions they create so learning outcomes can move beyond acquiring technical skills and competencies toward outcomes which change the ways people engage with work.

### **Conclusion and Implications for Further research**

In this paper, instructors' epistemological, ontological, and axiological beliefs about the discipline of mathematics were studied and found to filter what content is considered mathematics, the program context where this content is valuable, the value of this content, and most importantly, who is given access to what content knowledge. The philosophical construction of mathematics determines the mathematical needs of the different vocational, developmental and transfer learners. Philosophical beliefs concerning the nature of mathematics establish the course contents as inside or outside the discipline of mathematics. Students within these courses are perceived as either learning the discipline of mathematics or learning to use the procedures provided by mathematics. Under the constraints of political and administrative authority, the faculty beliefs concerning the nature of their academic discipline valorize certain instructional practices when creating the classroom discourses to bridge learners to the academic content. In this research, the instructors' philosophies of mathematics result in partitioning academic mathematics by course categorization into vocational, developmental, and transferable; by instructors' perceptions of the future mathematics needs of learners; and by instructors' professional self-identities using classroom discourses of essential content, pedagogical orientation, and problem-framing.

While the focus of this research is the influence of mathematics faculty's subject matter philosophies on shaping instruction in community colleges, it suggests threads for future research in the areas of higher education, adult education and mathematics education with regards to teaching and teacher belief systems. Within the field of higher education the discipline of mathematics was the focus of this study. Given the similar values and epistemic frameworks in the biological and physical sciences, does a theory

of partitioning provide explanations for the shaping of mathematics instruction occurring outside mathematics classrooms? Community colleges recruit instructors from several environments, each with specific socializations. How does the partitioning theory differ when applied to instructors recruited from secondary education, four-year institutions, and outside the field of education? Finally, mathematics has conflicting roles in adult education. On an individual level, mathematical illiteracy can be a source of disempowerment, instead of a source of empowerment. On a societal level, a lack of mathematics can marginalize subgroups within societies. In what ways does partitioning mathematics prevent subgroups' entry into occupations, denying them full social and political participation? Issues of equity within a theory of partitioning must be identified. How can a theory of partitioning contribute to the distinction between the commodity of lifelong learning and the humanist self-evident good of lifelong education? In other words, will the learners be in need of constant skill-based retraining or will they be enabled to continue with the study of academic mathematics as and when they perceive the need?

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## **Appendix A. Interview Protocol One**

Interview Protocol One

Instructor Name:

Date:

Course used in Study:

### **I. DEMOGRAPHICS**

A. Undergraduate institution and degree/major

B. Graduate institutions and degrees/majors

C. Number of years teaching mathematics at [Community] College (please label between adjunct and full-time work)

D. Courses taught at [Community] College (please label between adjunct and Full time work)

E. List all courses being taught this term

### **II. QUESTIONS**

1. What is mathematics?

2. Where does mathematical knowledge come from?

3. How is mathematical knowledge formed?

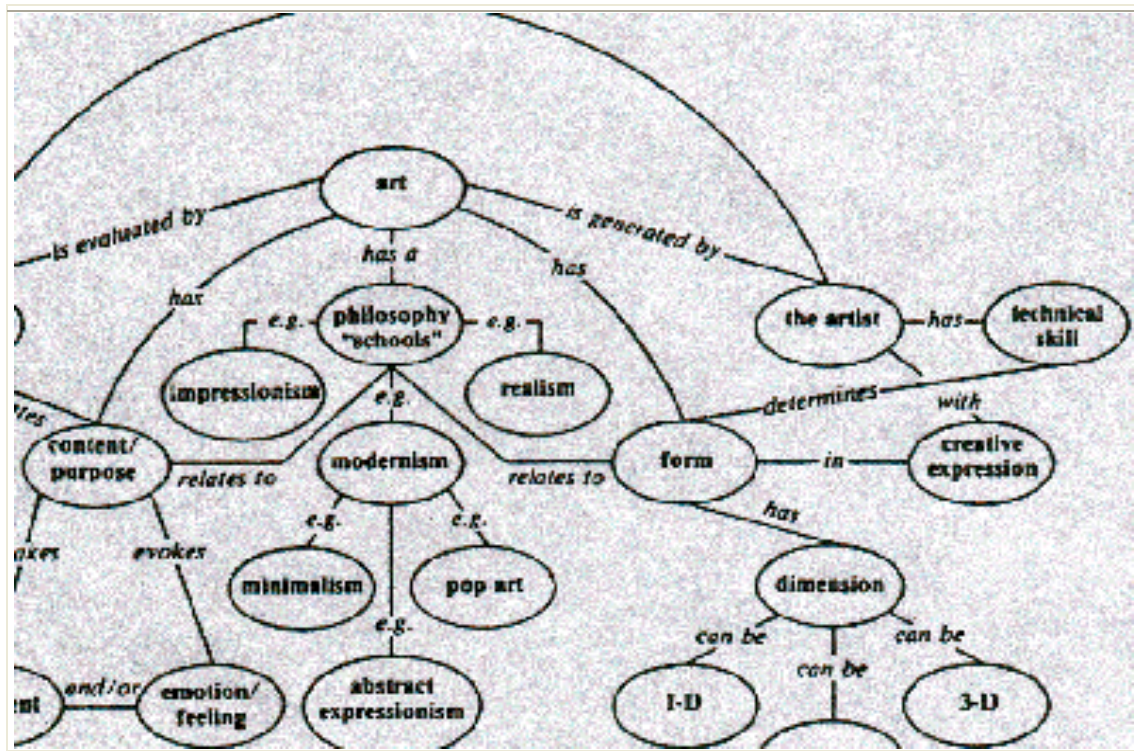
4. How do you know mathematics is true?

5. What is the value of mathematics?

## Appendix B. Concept Map Directions

Concept mapping is a method for attempting to analyze how one has a body of knowledge arranged in one's mind. I would like you to draw a concept map of the discipline of mathematics as it pertains to the course you are currently teaching. From this map I hope to get some idea of your mental structure for the subject and how the various topics, concepts, and procedures are linked.

Below is an example of a concept map employed by Novak and Gowin (1984) regarding an individual's understanding of the subject of ART.



From: Novak, J. D., & Gowin, D. B. (1984). *Learning How to Learn*. Cambridge: Cambridge University Press, p.182.

Please construct a personal concept map for Mathematics within the context of your participating course. Begin by placing the title, Mathematics, in the middle of the large chart paper and then just let the ideas associated with this title flow. Place the words associated with related ideas in clusters on the page and add lines to show connections.

## Appendix C. Interview Protocol Two

### Interview Protocol Two

Instructor:

Date:

Course Used in Study:

What attracted you to mathematics teaching?

What attracted you to the community college environment?

What does it mean for a student to understand mathematics? (general and observed class)

What do you want your students, in (observed class) to understand about mathematics?

How do students display their mathematical understanding?

Describe the way you present mathematics in your (observed) class

How does your instruction differ based on the level of the mathematics course?

How do you see your beliefs about the nature of mathematics influencing your course design?

How do you see your beliefs about the nature of mathematics influencing your instruction?

How have you been influenced by the recent reform movement in mathematics education?

How do you see the recent reform movement influencing your instruction?

In what professional organizations or conferences do you participate?

You participate in what professional development activities?

How do other courses you teach influence you in *COURSE NAME*?

What influences your selection, formation, or posing of problems in your mathematics courses?

What do you listen for in students' responses?

What do you look for in students' problem answers?