A QUALITATIVE INQUIRY EXPLORING AFFECTIVE CHARACTERISTICS OF DEVELOPMENTAL MATHEMATICS STUDENTS

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“If I have seen further it is by standing on ye shoulders of Giants.”
(I. Newton, personal communication, February 6, 1675)

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Abstract

Across the United States, initiatives have been undertaken to address the concerning numbers of academically underprepared students who enroll in community colleges with the need for developmental mathematics coursework. Practically all assessment done to understand the needs of developmental education students is cognitive and few efforts are made to assess students' affective characteristics, which include student attitudes, locus of control, anxiety, and self-efficacy.

The purpose of this qualitative, collective case study was to seek understanding of the affective characteristics of developmental mathematics students and how these characteristics influence completion of their prescribed mathematics coursework within a developmental education program at a community college in the state of Hawai‘i. Two cases of developmental learners were explored, including students who completed the prescribed sequence of courses (completers) on the first attempt and those who withdrew from, failed or otherwise did not complete the developmental mathematics course(s) on the first attempt (repeaters). The third case consisted of fulltime developmental education faculty members, including educators, counselors, and administrators (developmental faculty case).

The design of this research study was framed under the lens of Albert Bandura’s self-efficacy theory, based on the notion that achievement is dependent on interactions between a person’s behaviors, personal factors, and their environment. Through the use of open-ended interview questions, utilizing a semi-structured interview protocol, quality responses reflecting the lived experiences of the participants were obtained. The perspectives of 10 research
participants produced findings about how attitudes are formed by prior experiences in mathematics, often times adopting a utilitarian function from pleasurable or painful experiences; how locus of control is often influenced by motivation, such that irrelevant coursework spawns amotivation, while engagement fosters intrinsic curiosity; how math anxiety can be incapacitating; how low mathematical self-efficacy perceptions are deeply entrenched, but can be delicately rebuilt with the encouragement of faculty and how the developmental educator is considered a cornerstone for student learning. This study contributes to the body of literature in developmental education and may be used to assist educators, counselors, and administrators to develop more effective learning communities that support the affective characteristics of the students they serve.
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CHAPTER 1. INTRODUCTION

Background of the Study

Across the United States, initiatives have been undertaken to address the concerning numbers of academically underprepared students who enroll in community colleges with the need for developmental coursework. The rate by which these students matriculate into college-level courses and proceed on to transfer or graduate is alarmingly low. One initiative aimed at reversing this trend, Achieving the Dream: Community Colleges Count, is currently being pursued in 35 states and the District of Columbia, in over 200 community colleges (www.achievingthedream.org). Achieving the Dream requires participating institutions to track and analyze student outcomes among several cohorts, especially in gatekeeper courses, so that colleges nationwide may use the data to inform decision making. Community colleges participating in Achieving the Dream are using these data to identify barriers to student achievement and opportunities for improvement and then prioritize actions to implement and further evaluate.

The data that have most recently been collected and disseminated by the Community College Survey of Student Engagement (CCSSE) and the Survey of Entering Student Engagement (SENSE) reflect that overall numbers of students referred to developmental education are concerning, as respectively, 72% and 66% of survey respondents reported that their placement tests indicated the need for developmental coursework in at least one area (Center for Community College Student Engagement, 2012).
Previous national studies, including the Spellings' Commission Report (Department of Education, 2006) and Measuring Up 2008 (National Center for Public Policy & Higher Education, 2008), reported on key areas where colleges and universities must focus their attention in the future to place American higher education back in its former position as the world economic leader. Both documents indicated that student academic under preparedness for college is a major hurdle to student success in community colleges and universities, and that this area requires a high level of evaluation and action. The issue of academic under preparedness is particularly apparent at the community college level, as these colleges have an open-access, or open-door, policy (Cohen & Brawer, 2008).

Statement of the Problem

According to the National Center of Education Statistics (2008), nearly 35% of students who enter a public 2-year college enroll in developmental mathematics courses. These students include recent high school graduates, retirees, baby boomers, and returning adult learners who have previous college-level work. This diversity of backgrounds shapes how a community college meets the educational needs of the students. William Armstrong (2000) explains, “The open-access philosophy of community colleges practically ensures that the students served will differ in their experiences, education levels and socioeconomic status” (p. 681). With the open-access policy of many community colleges in the United States, a majority of students enter college with a need for developmental education (Bailey, T. R., Jeong, D.W, & Cho, S.W., 2010), but evidence of its effectiveness in preparing students for college level mathematics toward the completion of a degree is unclear. Some studies indicate that
remediation reduces student attrition (Bettinger & Long, 2009; Lesik, 2007), while other studies find that students in remediation earn fewer college-level credits and are less likely to complete a degree due to the extended time required and financial obligations of taking developmental courses (Boatman & Long, 2010; Calcagno & Long, 2008). It is concerning that developmental education, especially developmental mathematics, is attributed with low levels of course completion. Among the community colleges participating in the Achieving the Dream: Community Colleges Count initiative (www.achievingthedream.org), only one third of students who were referred to developmental mathematics courses completed the recommended sequence of developmental courses (Bailey et al., 2010). Furthermore, of the students who enrolled in the developmental education courses, only 20% actually completed a required college-level math course following their developmental course (Bailey et al., 2010).

Failing to complete the developmental mathematics sequence and then the required college-level mathematics courses prevents students from their goal of earning a college degree and pursuing certain professions (Rivera-Batiz, 1992). Some research indicates that failing to complete developmental education results in more dire outcomes, including low wage jobs, welfare participation and even incarceration (Waycaster, 2001). Given these negative consequences of failing to complete developmental mathematics, it is critical to identify potential ways to improve developmental students’ math success.

Practically all assessment done in U.S. colleges and universities to understand the needs of developmental education students is cognitive and few efforts are made to assess students’ affective characteristics, which include student attitudes, locus of control, anxiety, and self-
efficacy (Anderson & Bourke, 2000). According to a recent study by Gerlaugh, Thompson, Boylan, and Davis (2007), even though almost all community colleges assess students' cognitive skills, only 7% assess students' affective characteristics. This lack of information presents a serious weakness in understanding the non-cognitive needs of developmental students; data that could be used to inform the education, advising, assessment, placement and student support services. Furthermore, Bloom (1976) estimates that as much as 25% of student performance is determined by affective characteristics and Nolting (2007) argues that performance in mathematics has almost as much to do with students' attitudes and beliefs as it has to do with their mathematical knowledge. Weinstein, Dierkling, Husman, Roska, and Powdrill (1998) argue that student success is dependent not only upon cognitive study strategies, but also the affective will to employ them. Saxon, Levine-Brown, and Boylan (2008) affirm that the affective characteristics of developmental students represent an important component of success. Anderson and Bourke (2000) posit that affective characteristics are “important as a means of education, as ends of education, and as barometers of education-in-progress” (p.16).

The exploration and understanding of these affective characteristics of developmental mathematics students is essential to providing the supplemental assistance needed during the process of remediation. In an effort to improve the effectiveness of developmental education, research with regard to the affective characteristics of developmental education students and they influence achievement in mathematics, as heard from student and faculty perspectives, is imperative.
Purpose of the Study

The purpose of this qualitative inquiry was to seek understanding of the affective characteristics of developmental mathematics students and how these characteristics influence completion of their prescribed mathematics coursework, as examined through the perspectives of both students and faculty. To that end, this study employed a collective case study approach to explore specific affective characteristics of students, including attitudes, locus of control, anxiety, and self-efficacy (Anderson & Bourke, 2000). Two populations of developmental learners were explored: students who completed the prescribed developmental sequence of courses (completers) on the first attempt and those who withdrew from, failed or otherwise did not complete the developmental mathematics course(s) on the first attempt (repeaters).

To complement the experiences of developmental students, developmental mathematics faculty, including educators, counselors, and administrators, were interviewed to explore their understanding of the affective characteristics of their students. It is important to investigate the perceptions and experiences of faculty, who work in conjunction with developmental students, as they are a critical component of the developmental education experience and should be considered equally in the population selected for participation in the study (Merriam, 2009).

The information garnered from each population is expected to inform developmental students about their own affective characteristics and influence the future development of sophisticated learning plans for developmental mathematics students by the faculty who serve them.
Differences between Developmental and Remedial Education

Although some scholars choose to use the terms *developmental education* and *remedial education* interchangeably (Hathcock, 2011; McHugh, 2011; Roueche & Roueche, 1999), the researcher chose to differentiate the terms for this study based upon his own beliefs and conceptual framework and also drawing from the compelling literature of other researchers in the field. As defined by Arendale (2005), remedial education historically focused on the “...skill deficits of students and educational approaches that addressed these identified needs” (p. 68). Rambish (2011) further explains that remedial education looks at students only in terms of their deficits and that remedial courses “...are courses which target only students’ weaknesses in a particular skill” (p. 14). Several authors indicate that the word *remedial* has taken on a negative connotation over the years (McHugh, 2011; Rambish, 2011).

On the other hand, developmental education seeks a more holistic approach. According to the National Association for Developmental Education (2013):

Developmental education is a field of practice and research within higher education with a theoretical foundation in developmental psychology and learning theory. It promotes the cognitive and affective growth of all postsecondary learners, at all levels of the learning continuum. Developmental education programs and services commonly address academic preparedness, diagnostic assessment and placement, development of general and discipline-specific learning strategies, and affective barriers to learning.

For this research study, the term *developmental education* is used to describe the educational process that academically unprepared students experience during their transition to college level courses. *Remedial education* is used in reference to an author’s
specific usage of the term or to preserve historical context. To be fair to both traditions, the researcher intends no positive or negative connotations for either term.

Theoretical Framework

The research study was guided by Bandura’s (1997) theory of self-efficacy and used as a lens to examine the research questions and assist the researcher in exploring and understanding affective characteristics of developmental mathematics students. Self-efficacy is defined as “the belief in one’s capabilities to organize and execute the courses of action required to manage prospective situations. Efficacy beliefs influence how people think, feel, motivate themselves, and act” (Bandura, 1995, p. 2). Bandura later elaborated that “self-efficacy refers to belief in one’s power to produce given levels of attainment. A self-efficacy assessment, therefore, includes both the affirmation of capability and the strength of that belief” (p. 382).

Self-efficacy Theory

Self-efficacy is steeped in the traditions of social cognitive theory, which is based on the notion that achievement is dependent on interactions between a person’s behaviors, personal factors, and the environment (Bandura, 1986; Bandura, 1997). Beliefs, expectations, and feelings influence the relationship between personal factors and demonstrated behaviors. Hall and Ponton (2005) suggested that an important personal factor is self-efficacy, and “self-efficacy serves as a primary determinant of how individuals make choices, expend effort to achieve goals and persevere through the completion of these goals” (p. 27). Bandura (1997)
found that self-efficacy influences persistence, completion, coursework and career choice, resilience, effort, and achievement. According to Bandura (1997), if students believe in their own learning capabilities, invest more effort, work harder, persist longer, participate more readily, and achieve at a higher level, they are considered to be efficacious. Efficacious students tend to view challenging problems as tasks to be mastered rather than avoided, exhibit an intrinsic motivation for the activities in which they participate instead of viewing them as beyond their capabilities, form a stronger sense of commitment to their interests and activities and recover quickly from setbacks and failures.

Four Sources of Influence to Develop Self-efficacy

According to Bandura (1997), self-efficacy is founded upon four pillars. The first source to influence a person’s self-efficacy is through accomplishments, such as past achievements or performances. The second way that self-efficacy develops is through the modeling of others, including vicarious learning experiences (Bandura, 1997). Bandura further elaborates that self-efficacy developed through vicarious learning originates from the observation and interpretation of others. Students learn by watching others and by making use of past experiences for future application of vicarious knowledge acquired. The third way self-efficacy can be influenced is by social or verbal persuasion (Bandura, 1997). Social or verbal persuasion is a means of strengthening students’ beliefs that they possess the capabilities to achieve what they seek (Bandura, 1997). If this persuasion is positive, greater academic success results (Bandura, 1994). “Most adults can recall something that was said to them (or done to/for them) during their childhood that had a profound effect on their confidence throughout the
rest of their life” (Pajares, 2002, p. 10). On the other hand, if students are not exposed to social persuasion, they tend to harbor self-doubts and dwell on personal shortcomings when challenges or difficulties arise (Bandura, 1997). Finally, physiological factors and affective states (e.g., anxiety and stress) are the fourth influence on self-efficacy (Bandura, 1997). Bandura believes that stress and anxiety affect the amount of self-efficacy attained.

Self-efficacy theory is closely intertwined with the research questions of this study. One of the goals of this study was to understand the affective characteristics of developmental mathematics students, which include attitudes, locus of control, anxiety, and self-efficacy. Student attitudes and values are shaped in part by social persuasion and vicarious learning experiences. Locus of control, or the assignment of responsibility, can be viewed as a precursor to self-efficacy, as a primary determinant of how individuals make choices or expend effort. Anxiety and stress are primary sources of deterring self-efficacy and also at the forefront of the affective state of many developmental mathematics students.

Affective Characteristics

The purpose of this research was to assess the affective characteristics of developmental mathematics students from both student and faculty perspectives. In order to do so, each affective characteristic under investigation had to be clearly defined prior to the research commencing. These definitions were made as precise as possible by specifying the defining features of each affective characteristic (e.g., attitude) and the target to which it is directed (e.g., mathematics). Two types of definitions were important in the context of affective assessment: conceptual definitions and operational definitions. Conceptual definitions
are “concerned with the abstract meaning of an affective characteristic” (Anderson & Bourke, 2000, p.27) and defined in terms of their important aspects or critical features, while operational definitions refer to “clear, precise definitions and instructions about how to observe and/or measure the variables under study” (Ferrante, 2008, p.48) and are defined in terms of intensity, direction and target. It was important to clearly and precisely define each affective characteristic under study to provide a basis for discussion and debate among educators and non-educators. As Anderson and Bourke (2000) argue “Even though people may disagree with the definition, they nonetheless have a common understanding of the meaning of the characteristic as used in the particular context” (p. 25). A common understanding of the definitions was necessary so that the results of the research are meaningful, useful, transferrable and repeatable.

The researcher in this study was particularly careful not to impose his own operational definitions of variables, or in this case, affective characteristics, on the participants (Silverman, 2011). Rather, the researcher made every effort to let the meaning emerge from the participants. Qualitative research is well suited, in this regard, that it can adjust to the case or cases under exploration. Jenks (1998) elaborates “the quantitative desire to establish ‘operational’ definitions at an early stage of social research can be an arbitrary process which deflects attention away from the everyday sense-making procedures of people in specific milieu” (p. 90). Therefore, operational definitions for each of the affective characteristics are provided with the hope that they are be precise enough to be replicated and perhaps measured in future quantitative studies, but were not applied in this qualitative study.
To operationally define each of the affective characteristics used in this research study, it was necessary to specify the *intensity, direction* and *target* of each. According to Anderson and Bourke (2000) “*Intensity* refers to the degree or strength of the feelings... *Direction* is concerned with the positive or negative orientation of the feelings... *Target* refers to the object, activity or idea toward which the feeling is directed” (p. 4-6). Specifying each of the three criteria was done in order to establish a baseline for indicating if the affective characteristic was observed among developmental mathematics and provided a baseline for measuring it in future quantitative studies. What follows next is a presentation of conceptual and operational definitions for each of the four affective characteristics that were explored among developmental mathematics students in this study.

**Attitude**

As Fishbein and Ajzen (1975) conceptually defined, *attitude* refers to a “learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object” (p. 6). Attitudes are learned and attached these feelings to particular targets. Anderson and Bourke (2000) claim that the “feelings themselves may or may not be learned. What is learned, however, is the attachment of the feelings to the particular targets” (p. 32).

As an operational definition for attitude, the three criteria for intensity, direction and target are specified. Attitude, in general, is considered an affective characteristic of moderate to high intensity (Anderson & Bourke, 2000). Despite the fact that a range of intensity is possible, for a characteristic to be high intensity, it must impel a person to seek out things or influence a person to behave in a certain way. The direction (or scale) of an attitude can be
either favorable or unfavorable (Anderson & Bourke, 2000). The direction scale ranges from negative values (unfavorable) to positive values (favorable). The target of an attitude is generally an object. For this research study, the target under exploration was attitude regarding mathematics. This spectrum is indicated in the following operational definition of the attitude characteristic.

![Operational Definition of Attitude](image)

**Locus of Control**

According to Messick (1979), *locus of control* is conceptually defined as the extent to which individuals tend to accept responsibility for their own behavior, the results of their behavior, or both. Messick further elaborated that locus of control contrasts “individuals who think of themselves as responsible for their own behavior (internals) against individuals who attribute responsibility to the force of circumstances or powerful others or luck (externals)” (p. 285). From this definition, we can conceptually understand locus of control as a decision to either accept or deny responsibility for a person’s actions or their consequences. An individual’s locus of control answers the question: Were the results or consequences the result of what I did or did they result from factors out of my control?
To operationally define locus of control, the researcher utilized three criteria for intensity, direction and target. The target of locus of control is the behavior of people and, generally, the results or consequences of the behavior (Anderson & Bourke, 2000). The direction generally follows a binary relationship, rather than a Likert scale, as it is either external (e.g., believing others are responsible) or internal (e.g., believing you are responsible). According to Anderson and Bourke (2000):

The intensity of locus of control is difficult to estimate. Because the target is the person’s behavior and the consequence or result of that behavior, the intensity is likely to be moderately high, particularly for individuals with an internal locus of control. For those with an external locus of control, the intensity may be somewhat lower. (p. 34)

This spectrum is indicated in the following operational definition of the locus of control affective characteristic.

![Operational Definition of Locus of Control](image)

**Anxiety**

Hall and Lindzey (1970) conceptually define anxiety as “the experience of tension that results from real or imaginary threats to one’s security” (p. 145). Furthermore, anxiety is
feeling unrealistic fear, worry, and uneasiness, usually generalized and unfocused (Bouras & Holt, 2007). Anxiety is considered to be an unusual affective characteristic in that people can have too much or too little anxiety. For example, being overly relaxed on a mathematics exam (low anxiety) to the point of complacency may be as harmful as being overly stressed (high anxiety) to the point of incapacitation (Anderson & Bourke, 2000). It is argued that just the right amount of anxiety is necessary for a student to perform to the best of their abilities in a testing situation (Anderson & Bourke, 2000).

In the operational definition of anxiety, Anderson and Bourke (2000) describe the target as a real or imaginary threat to one’s security. In this research study, the specific target of anxiety is the subject of mathematics, which was stated in the research questions and addressed in the interview schedule. Anderson and Bourke (2000) reinforce this claim in their statement “Within the school context, mathematics and tests are considered major targets of anxiety” (p. 36). As expected, anxiety is a high intensity affective characteristic, as exemplified by the use of the term “tension” in the conceptual definition. The direction of anxiety can be a range from “relaxed” to “tense” (Anderson & Bourke, 2000). On a quantitative instrument, the continuum for anxiety would range from 0 (very relaxed) to positive values (tense or very tense), as a negative value for anxiety would not fit the characteristic. This spectrum is indicated in the following operational definition of the anxiety characteristic.
Self-efficacy

Self-efficacy is conceptually defined as “the belief in one’s capabilities to organize and execute the courses of action required to manage prospective situations. Efficacy beliefs influence how people think, feel, motivate themselves, and act” (Bandura, 1995, p. 2). Bandura later elaborated that “self-efficacy refers to belief in one’s power to produce given levels of attainment. A self-efficacy assessment, therefore, includes both the affirmation of capability and the strength of that belief” (p. 382). In a college setting, students tend to invest considerable time on tasks they believe they are capable of learning or succeeding with. Students in this domain tend to develop an “I can do that” sense of self-efficacy. On the contrary, when a student perceives a task as too difficult, it is a typical response to develop the “I can’t do that” prerogative (Anderson & Bourke, 2000). As these classifications suggest, self-efficacy is a learned characteristic. As Anderson and Bourke (2000) state, “A predominance of successes likely leads to self-efficacy, whereas a predominance of failures likely leads to its negative counterpart, learned helplessness” (p. 35).
In the operational definition of self-efficacy, Anderson and Bourke (2000) describe the target as a task, a subject, an instructional objective and the like. They claim the direction “is best captured by I can versus I can’t” (p. 35) and that, in general, self-efficacy is considered a moderately high intensity affective characteristic and argue that self-efficacy is learned over time as the student experiences a set of successes and failures. In this research study, the specific target of self-efficacy is the subject of mathematics, which, like the anxiety characteristic, is stated in the research questions and addressed in the interview protocol (Creswell, 2013). On a quantitative instrument, the continuum for self-efficacy would range from negative values (Very diffident in ability) to positive values (Very confident in ability). This spectrum is indicated in the following operational definition of the self-efficacy characteristic.

![Operational Definition of Self-Efficacy](image)

**Operational Definition of Self-Efficacy**
(Paulding, 2013) adapted from (Anderson & Bourke, 2000)

Relationships among Affective Lenses

Humans possess a variety of characteristics, or attributes or qualities that represent their typical ways of thinking, acting and feeling in a wide variety of scenarios. These characteristics are often classified into three major categories. The first category, *cognitive characteristics*, corresponds with typical ways of thinking. The second, *psychomotor*
characteristics, is related with typical ways of acting and the third, affective characteristics, includes typical ways of feeling. As Anderson and Bourke (2000) state, “affective characteristics can be thought of as the feelings and emotions that are characteristic of people, that is, qualities that represent people’s typical ways of feeling or expressing emotion” (p. 4).

All affective characteristics are related under a common thread of describing qualities of a person that represent his or her typical ways of feeling or emoting. The word “typical” is important because the emotional states of humans vary on a daily and situational basis. However, despite the variability, Anderson and Bourke (2000) claim that people do have typical ways of feeling. Further, affective characteristics share the relationship of meeting two general criteria in order to be considered “affective”. First, a characteristic must be typical of the feelings or emotions of the person and second, these feelings or emotions must exhibit intensity, direction and target, as defined in the preceding operational definitions section.

For this research study, the attitude, anxiety and self-efficacy affective characteristics are related through a common target: mathematics. A characteristic’s target is the object, activity or idea toward which the feeling is directed. The purpose of this research is to explore the affective characteristics of developmental mathematics students; therefore, an appropriate target for these three characteristics is mathematics. It should be noted that locus of control is not included in this relationship, as the target of this characteristic is a person’s behaviors, the results of the behavior, or its consequences (Messick, 1979). The broad target of “mathematics” for the other three, rather than “developmental mathematics” is a specific design of the research, as it is likely that attitude, anxiety and self-efficacy beliefs are formed,
sometimes entrenched, long before a student enters developmental mathematics at the community college level.

Several of the affective characteristics are related through their intensity, which indicates the degree or strength of the feelings (Anderson & Bourke, 2000). For example, attitude, anxiety and self-efficacy characteristics are considered to be of moderately high or high intensity (Anderson & Bourke, 2000). Finally, the characteristics of attitude, locus of control, and self-efficacy tend to be learned, whereas anxiety tends to be intrinsic (Anderson & Bourke, 2000).

Usefulness of Affective Characteristics for Students

Anderson and Bourke (2000) believe that affective characteristics are “important as a means of education, as ends of education, and as barometers of education-in-progress” (p.16). As a means of education, affective characteristics facilitate desired goals or outcomes of the schooling process. As ends in themselves, they are the desired goals of the schooling process. As an education-in-progress metric, affective characteristics influence the way in which students perceive and make sense of their schools and classrooms (Anderson & Bourke, 2000).

In a holistic view, understanding the affect of our students is likely to enable the design of more successful school and classroom environments in addition to strengthening the relationships among students and faculty members. On an individual basis, this understanding can allow for the identification of students who have not developed these characteristics to their potential, or even those whose affective characteristics present a hindrance from succeeding in their classes or participating fully in school. Furthermore, when students become
aware of or assess their own affective characteristics, they undergo a process of self-discovery during is essential to providing the supplemental assistance needed during the course of developmental mathematics. In an effort to improve the effectiveness of developmental education, research with regard to the affective characteristics of developmental education students and they influence achievement in mathematics, as heard from student and faculty perspectives, is imperative.

Research Questions

Two research questions served as central guides for this study. They were selected to fill a significant void in the body of literature and called for further investigation by prominent researchers in the field of developmental mathematics (Saxon et al., 2008). Following each research question is a set of four sub-questions, which address specific affective characteristics (Anderson & Bourke, 2000) from student and faculty perspectives.

1) How do developmental mathematics students assess their own affective characteristics?
   a. What are student attitudes towards mathematics?
   b. To what extent do students accept responsibility for their own academic behavior?
   c. To what extent do students experience anxiety toward mathematics?
   d. How do students perceive their own self-efficacy towards mathematics?

2) How do developmental mathematics faculty perceive the affective characteristics of their students?
   a. How do faculty view the attitudes of their students towards mathematics?
   b. What do faculty believe about how students accept responsibility for their own behavior?
   c. What do faculty believe about mathematics anxiety among their students?
   d. How do faculty perceive the self-efficacy of their students?
Definition of Terms

*Academic Success:* For this study, this term refers to completion of a developmental course and progression to the next level of coursework.

*Affective Characteristics:* can be thought of as “the feelings and emotions that are characteristic of people, that is, qualities that represent people’s typical ways of feeling or expressing emotion” (Anderson & Bourke, 2000, p. 4).

*Anxiety:* is defined as “the experience of tension that results from real or imaginary threats to one’s security” (Hall & Lindzey, 1970, p. 145).

*Attitudes:* refer to a “learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object” (Fishbein & Ajzen, 1975, p.6)

*Case:* is the unit of analysis in a case study. It involves the study of a specific case within a real-life, contemporary context or setting (Yin, 2009). The case might be an event, a process, a program, or several people (Stake, 1995).

*Case Study:* This type of research involves the study of a case within a real-life, contemporary context or setting (Yin, 2009).

*Centralized Program:* In the context of remedial education, a centralized program is a separate site that provides remedial courses and services, as opposed to individual academic departments (Roueche & Snow, 1977).

*Collective Case Study:* consists of multiple cases. It might be either intrinsic or instrumental, but its defining feature is that the researcher examines several cases (e.g., multiple case studies) (Stake, 1995).

*Cross-Case Analysis:* This form of analysis applies to a collective case (Stake, 1995; Yin, 2009) in which the researcher examines more than one case. It involves examining themes across cases to discern themes that are common and different to all cases. It is an analysis step that typically follows within-case analysis when the researcher studies multiple cases.

*Developmental Mathematics:* This term is defined as courses offered at colleges that are intended to prepare students for college-level mathematics. It is used interchangeably with the term remedial.

*Developmental Student:* Any student that is academically underprepared for college-level courses.
Institution: For the purposes of this study, an institution is a Western two-year community college.

Locus of Control: According to Messick (1979), locus of control is the extent to which individuals tend to accept responsibility for their own behavior, the results of their behavior, or both. Locus of control compares “individuals who think of themselves as responsible for their own behavior (internals) against individuals who attribute responsibility to the force of circumstances or powerful others or luck (externals)” (p. 285).

Perceptions: The process of putting sensations together into a usable mental representation of the environment; it involves organizing, ignoring, and interpreting sensations. According to Online Etymology Dictionary (2001) perception is the process of attaining awareness or understanding of sensory information.

Qualitative Research: a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures; collecting data in the participants’ setting; analyzing the data inductively, building from particulars to general themes; and making interpretations of the meaning of the data (Creswell, 2014)

Self-Efficacy: a “person’s belief in his or her capability of performing behavior required to reach a goal” (Weiner, 1992, p. 861).

Value: According to Getzels (1966), a value is a “conception of the desirable – that is, of what ought to be desired, not what is actually desired – which influences the selection of behavior” (p. 98).

Within-Site: When a single geographical location is selected as the “case”, it is considered to be a “within-site” study (Creswell, 2013a).
CHAPTER 2. LITERATURE REVIEW

Introduction

In this literature review, the researcher sought to uncover what is already known about developmental education from a brief historical perspective. This history was then used to segue into current promising practices identified by research. Finally, this cumulative information was used to help select the methods and instruments used to conduct the investigation into future improvements in the field.

The literature review in this chapter has been arranged in the following manner. The first topic is a brief history of developmental education, followed by a current overview of promising practices in developmental education, as indicated by prominent researchers in the field. In this section, the literature review is broadly separated into two main parts. The first part reviews the literature that deals with practices of developmental programs, whereas the next part reviews the literature that deals more with practices for developmental students. The topics that relate to the overall programs are the philosophy, the commitment to developmental education, having centralized programs, mandatory placement, new student orientation, counseling, and flexibility. The topics that relate more to the individual student include the areas of tutoring, self-efficacy, math anxiety, and study skills.

A Brief History of Developmental Education

Developmental education is perhaps as old as higher education in America, dating back to the 1630s when Harvard College provided tutors in Latin for incoming students (Stephens,
The term remedial education was first introduced at the University of Wisconsin in 1849, with remedial courses in reading, writing, and arithmetic (Stephens, 2003). In 1907, the majority of students entering Harvard, Yale, Columbia and Princeton did not meet the entrance requirements (Stephens, 2003). By 1915, a report to the U.S. Commissioner of Education indicated that 350 of the nation’s colleges had preparatory departments, which are considered to be the precursors to developmental education departments (Stephens, 2003). Later in the 20th century, community colleges began to take over the primary role of remedial education, but many 4-year institutions still kept some remnants of their remedial programs. It was within these community colleges that the remedial programs expanded as the college population grew as a result of the open door policy provided for by the Higher Education Act of 1965. By the 1980s, placement testing was legislatively mandated and most states discovered that about 30% to 40% of first-year community college students needed remediation in at least one of the areas of reading, writing, or mathematics. This percentage was reported again in 1996, when a survey conducted by the National Center for Education Statistics (NCES) found that 41% of first-year community college students needed remediation (NCES, 1996). In 2007, this study was again repeated by the NCES and found a slight increase to 43.6% of students needing remediation (NCES, 2007).

The Cost of Developmental Education

One topic that is mentioned often in the review of the literature on developmental education is the cost. The estimates for the annual cost of providing developmental education vary between $1 billion and $2 billion. This equates to about 1% of the overall budget of $115
billion from combined sources of higher education revenue through state allocations, federal support and student tuition (Breneman & Haarlow, 1998). Other studies (Saxon and Boylan, 2001) have found that it was difficult to get an accurate figure on the cost of remediation as states have inconsistent methods of reporting these costs. The data that they looked at for cost calculation changed over time, so the estimates were only accurate for a discrete point in time. However, despite the fluctuations in cost, Saxon and Boylan ensure that “remediation is a relatively small expense in higher education, especially given the size of the population that benefits from it” (Saxon & Boylan, 2001, p. 2). Given that about 43% of community college students and 30% of university students are engaged in remedial courses (NCES, 2007) and that it is estimated that 1% of the overall budget of colleges and universities is spent on remedial courses, it appears that a relatively small amount is being spent to benefit a large group of students.

Promising Practices in Developmental Education

The University of Texas at Austin was responsible for conducting much of the early research on the effective techniques for providing developmental education. Specifically, the work of John Roueche and colleagues, Roueche and Wheeler (1973); Roueche and Kirk (1974); Roueche and Snow (1977) far outpaced other researchers during the same time period. A review of the literature on this subject indicated that between 1968 and 1978, Roueche and his colleagues published more books and articles on remedial education than all the other authors in the field combined. Since that time, major contributions to the literature were provided by Casazza and Silverman (1996), Maxwell (1997) and Boylan and Saxon (1997, 1998, 2002, 2008).
Any discussion of effective techniques or “promising” practices in developmental education must pay respect to early work of Roueche and his colleagues and then be updated with current findings of the many significant researchers in the field of developmental education.

In much of the early literature, researchers identify “best practices” for developmental education, but for the purposes of this study, the researcher has chosen to substitute the usage of phrase “best practice” with “promising practice”, as each practice mentioned is not intended to suggest that it is superior than another. More simply, the term “promising” implies that the practice has demonstrated, or is expected to yield, positive results of one sort or another. This terminology is also supported in recent literature and reports such as those produced by the Center for Community College Student Engagement (2012) and the Achieving the Dream Initiative (2011). After reviewing the body of literature on “best” or “promising” practices in developmental education, it was found that most researchers tend to classify the practices into two broad categories: those recommended for developmental education programs and those for developmental education students.

Developmental Education Programs

Clearly defined philosophy: Early studies of remediation recommend that successful programs should have a clearly defined philosophy, as well as clearly specified goals and objectives (Roueche & Snow, 1977). Later work by Casazza and Silverman (1996) and Boylan and Saxon (1998) reinforced this finding. The presence of an overarching program philosophy coupled with program goals and objectives based on this philosophy tended to define successful programs. This finding has been incorporated into the guidelines of professional
associations for program certification. Certification guidelines established by the National Association for Developmental Education (Clark-Thayer, 1995) require that programs seeking certification include a copy of their program philosophy and describe the program goals and objectives based on this philosophy as part of the requirements for obtaining certification.

A commitment to developmental education: Roueche and Roueche (1993, 1999) argued that an institution-wide commitment to developmental education was a key factor in the success of community college remediation. An institution-wide commitment to the benefits and value of remediation was highlighted through public support for remediation by administrators, a financial commitment of resources for remediation and an institution-wide belief of remediation as a mainstream activity for the community college. In their study of Texas colleges and universities, Boylan and Saxon (1998) found that remedial programs integrated into the academic mainstream of the institution had higher pass rates in remedial courses and were more successful in retaining students than programs that were not integrated. As an institution-wide commitment, developmental education should be a part of the institution’s long range plans and be included in the mission statement and other publications of the college (Boylan, 2002).

Centralized programs: Roueche and his colleagues recommended that remedial courses and services should be provided by a separate and centralized program as opposed to individual academic departments (Roueche & Kirk, 1974; Roueche & Snow, 1977). Students involved in centralized remedial programs were found more likely to pass their remedial courses and more likely to be retained for longer periods of time than students participating in decentralized programs. However, the best practice recommendation for centralized programs is somewhat
muddied with recent analysis which suggests it is not a centralized program structure alone that provides for success, but rather the smoothness of the coordination and communication among the faculty within a centralized program (Boylan et al., 1997). Some research suggests that decentralized programs may be just as effective as centralized programs as long as there is strong coordination of developmental education and plenty of communication among those who teach developmental courses (Boylan et al., 1997).

**Mandatory placement:** Mandatory assessment and placement of students in remedial courses has also been identified as a characteristic of successful remediation programs (Rouche & Rouche, 1993; Rouche & Snow, 1977). Other authors have continued to promote the use of mandatory assessment and placement (Casazza & Silverman, 1996). The early identification of those students at risk of failure was found to be associated with successful remediation (Adelman, 1999).

When placement is voluntary instead of mandatory, a large number of underprepared students with the greatest need for developmental coursework fail to enroll in, or completely avoid, the courses. The students participating in developmental courses under a voluntary placement system naturally tend to be more motivated or to recognize the need for developing their skills before enrolling in curriculum courses. In contrast, when placement is mandatory, a higher percentage of academically weaker and less motivated students take developmental courses. Cross (1976) pointed out that fewer than 10% of those needing remediation are likely to survive in college without it. Even though large numbers of the weakest students will become victims of attrition under systems of mandatory placement, more will succeed than if they had not received any remediation at all.
**Orientation for students:** Community college remedial programs have recently begun providing organized college orientation seminars for their students. Although freshmen orientation was initially developed for university students, this concept has since been successfully implemented at many community colleges (Upcraft & Gardner, 1989). Since many community college students were likely to be the first generation of their family to attend college, they tended to be unfamiliar with the expectations of a college education. College orientation courses were useful for helping students learn what was expected of them and assisting them in adjusting to the college environment. Recent research (Gardner, 1998) has shown that underprepared students participating in ongoing orientation courses were much more likely to be retained in the community college than students who did not participate in these courses.

**Counseling component:** Early research also found that successful remedial education programs had a strong counseling component (Roueche & Snow, 1977). This relationship between an emphasis on personal counseling for students and successful remediation was supported in later research by Boylan et al. (1992) and Casazza and Silverman (1996).

This research indicated that counseling by itself was not sufficient to seriously affect student success. In order for counseling to be successful with remedial students it had to (a) be integrated into the overall structure of the remedial program; (b) be based on the goals and objectives of the program; (c) be undertaken early in the semester; (d) be based on sound principles of student development theory; and (e) be carried out by counselors specifically trained to work with developmental students (Casazza & Silverman, 1996).
**Flexibility:** McCabe (2003) noted “an effective assessment and placement program, however, requires flexibility” (p. 144). He gave the example of Santa Fe Community College in Florida that allows students to be reassessed on the first day of class in order to confirm that the students have been placed in the correct level of math class. Students who have been misassigned are reassigned. Boylan (2002) also claimed that allowing reassessment is necessary because no test can be 100% accurate, and so it is important to allow students an opportunity to challenge placement because students will feel that they have had “a fair chance to demonstrate their abilities” (p. 38).

**Developmental Mathematics Students**

**Tutoring:** The importance of tutoring remedial students has been widely discussed in the literature. Early studies of remediation suggest that tutoring is an important component of successful programs for underprepared students (Roueche & Snow, 1977). Maxwell (1997) argued that research findings on the impact of tutoring on underprepared students are mixed with no conclusive results being found. Boylan et al. (1992) found that there was no difference in the performance of students participating in remedial programs whether they received tutoring or not, unless the tutoring program included a strong tutor training component. It seems that the overall effectiveness of tutoring is strongly influenced by the quality and the amount of training received by the tutors who provide the tutoring. This is particularly true when the tutees are underprepared students. Boylan (2002) recommended that all tutors undergo the College Reading and Learning Association Tutor Training Certification Program as a way to move beyond the typical procedures and record keeping that commonly makes up most
tutor training. Casazza and Silverman (1996) argued that successful tutor training programs include “learning theory, metacognition, motivation, counseling/interviewing, group dynamics, and adult learning models” (p. 110).

**Self-efficacy and math anxiety:** Math anxiety is described as a feeling of dread or despair that is experienced when a person attempts to understand and/or solve mathematics problems. Maxwell (1997) states that the fear of math and lack of self-efficacy can have a negative impact on student performance. “Researchers have found that high-risk students with low self-efficacy fail to learn even under optimal conditions” (Maxwell, 1997, p. 143). Math anxiety and poor performance in previous math courses can combine to create a downward spiral of performance in future mathematics courses.

Attitudes toward mathematics can enhance or inhibit learning, influence confidence in learning mathematics, impact the perception of the usefulness of mathematics, and create mathematics anxiety. Depending on the degree of mathematics anxiety, such fears can develop into “learned helplessness,” the belief that one is unable to do mathematics at all. (AMATYC, 2006, p. 15). AMATYC (2006) recommended that instructors understand the influence that a student’s attitude can have on that student’s ability to perform well in class. By offering students the ability to be successful in an area in which they have had little or no prior success, can help create a greater sense of self-efficacy, which, in turn, can create more successful college experiences for students.

**Study skills:** Researchers have found that students often have difficulty transferring skills from stand-alone “study skills” courses into other mainstream courses, such as mathematics. Maxwell (1997) noted that no matter what strategies for learning have been tried in the
classroom, students often revert to memorization and continue to fail math courses. The NADE Mathematics Special Professional Interest Network (2003) recommended that study skills should be taught as an integral part of the academic course. Boylan et al. (1997) found that integrating classroom and laboratory instruction was associated with student success in developmental courses. When classrooms and laboratories were integrated, instructors and laboratory personnel worked together to insure course objectives were directly supported by laboratory activities. Boylan and Saxon (1998) found that the integration of classroom and laboratory instruction in this manner was also related to student success on a state-mandated achievement test in Texas.

The use of full-time and part-time (adjunct) faculty: All researchers recommend employing full-time instructors to teach developmental coursework. In addition, researchers recommend hiring instructors who have been trained to work with adult students and underprepared students, as well as those instructors who have a strong background in educational theory, learning theories, English as a second language (ESL), curriculum development, or instructional design (Boylan, 2002; Boylan & Saxon 1998; McCabe, 2003; Roueche & Roueche, 1993; Roueche & Roueche, 1999).

While Maxwell (1997) stated that students who take developmental mathematics courses with adjunct faculty do not perform as well in other non-developmental math courses as those who took the course with a full-time instructor, other studies show no significant difference between the performance of students who took courses with adjunct faculty and those who took courses with full-time faculty. A difference was noted only when 70% or more of the courses were taught by adjunct faculty (Boylan, 2002). When institutions do use adjunct
faculty, they should receive training regarding the department’s grading policies and expectations, learning styles, technology available for supplemental instruction, and the academic support available on campus (Maxwell, 1997; Boylan, 2002). Boylan (2002) further recommended that senior faculty provide mentoring for adjunct faculty, adjunct faculty should attend all developmental education and departmental meetings if possible.

Contemporary Perspective of Developmental Mathematics

The nation is facing an epidemic in its community colleges: more and more students are attending community colleges, but the majority of students are not prepared for college-level mathematics. By many accounts, the majority of students entering community colleges are placed (based on placement test performance) into developmental mathematics courses (Adelman, 1985; Bailey et al., 2005). The data that have most recently been collected and disseminated nationwide by the Community College Survey of Student Engagement (CCSSE) and the Survey of Entering Student Engagement (SENSE) reflect that overall numbers of students referred to developmental education are concerning, as respectively, 72% and 66% of survey respondents reported that their placement tests indicated the need for developmental coursework in at least one area (Center for Community College Student Engagement, 2012). The organization of developmental mathematics differs from school to school, but most colleges have a sequence of developmental mathematics courses that starts with basic arithmetic, then goes on to pre-algebra, elementary algebra, and finally intermediate algebra, all of which must be passed before a student can enroll in a transfer-level college mathematics course. Because the way mathematics has traditionally been taught is sequential, the
implications for students who are placed in the lower-level courses can be quite severe. A student placed in basic arithmetic may face two full years of developmental mathematics classes before he or she can take a college-level course. This might not be so bad if they succeeded in the two-year endeavor, but the data show that most do not. Students tend to get discouraged and drop out entirely, or they are systematically removed by failing to pass from one course to the next (Bailey, 2009). Viewed under this perspective, developmental mathematics becomes a primary barrier for students ever being able to complete a post-secondary degree, which has significant consequences for their future. Developmental mathematics is intended to be a bridge between secondary and collegiate mathematics, but in the majority of instances it serves as a gatekeeper.

According to the National Association for Developmental Education (NADE, 2013):

Developmental education is a field of practice and research within higher education with a theoretical foundation in developmental psychology and learning theory. It promotes the cognitive and affective growth of all postsecondary learners, at all levels of the learning continuum. Developmental education programs and services commonly address academic preparedness, diagnostic assessment and placement, development of general and discipline-specific learning strategies, and affective barriers to learning.

Self-efficacy Theory

Using the theoretical framework of self-efficacy, this section compares and contrasts the Baby Boomer generation of adult learners, for which self-efficacy theory was initially proposed, with the current Millennial generation of learners, examine assumptions about the Millennial generation, while linking principles of self-efficacy theory to meet the needs of this generation. Albert Bandura developed a theory of self-efficacy as Baby Boomers came of age that is
compelling and seems to reflect the aspirations of this generation. However, in the context of this research study which includes participants of a later genesis, it is imperative to answer the question: does the self-efficacy theory of Bandura still apply to the generation now attending community college, the so-called Generation Y or Millennials?

**The Baby Boomer Generation**

At the time Bandura was researching self-efficacy theory in the 1960’s and 70’s, baby boomers were beginning to take on adult roles. The sheer population of this generation has generated a plethora of studies, articles and examinations among academics about the baby boomers. Hicks and Hicks (1999) covered this topic in literature that explores generational differences and influences, with an emphasis on the cultural values and attitudes of the generation. The Boomer generation is described in stark contrast to their parents as consumerist, of permissive morality, and wanting instant gratification (Hicks & Hicks, 1999). Other descriptions of this generation include optimistic, process oriented, and having an appreciation for convenience (Hicks & Hicks, 1999).

This generation also came of age at a time when public education, from elementary through college was considered to be important and expected (Trow, 1999). There was a significant increase in postsecondary education, especially among community colleges. The statistics from 1972 – 1982 (as Boomers came of age) are particularly telling in terms of adult education. Most of the growth was among those 25 and older, with 35 years and older with 77% and 25 to 34 a 70% increase, as compared to 35% overall increase in student enrollments. During this same period, there was also two-third increase in female students and a remarkable
increase of 85% of minority students. Another telling change during this period was the change from grants to loans as a source of support. In 1975, loans were 21% of student support, by 1984 loans provided 66% support (Trow, 1999). Education became increasingly specialized, with education purpose divided between research, teaching, liberal arts and vocational studies (Trow, 1999).

During the 1960’s, the federal and state level legislation increased funding for vocational education, benefiting community colleges (Trow, 1999). Boomers grew up in a time of prosperity and stable economic circumstances, with increased movement to suburban living. At this point, many families could still afford a one-income household. Later boomers (born mid-50’s to mid-60’s) experienced changes, with increase in divorce rates and mothers having to go to work (Trow, 1999). These emerging trends found in the Boomer generation continued to increase in prevalence and reached a peak for the current generation of adult learners, the Millennials.

**The Millennial Generation**

Millennials are defined as the generation born approximately 1980 to 2001. This is also a large cohort, at over 80 million, which matches or exceeds the size of the baby boomer generation (Pew Research, 2008). According to Oblinger (2003), this generation, enjoys group activity, retains close relationships with parents, does more homework, takes pride in being smart, is attracted to technology, and is quite ethnically diverse. Some have remarked on this generation’s expectations and sense of entitlement. Being goal oriented, they are willing to accept as much help and support to achieve success (Oblinger, 2003). It is important to note
that these summaries of generational characteristics should be viewed as summaries and do not necessarily reflect individual differences.

As Millennials have come of college age, more postsecondary choices in learning institutions have become available, yet ability or access to education funding education has become an increasing concern (Oblinger, 2003). Technology, with the growth of online education (in a hybrid or completely online format) has brought new opportunities and challenges for educators. Community college degrees have expanded beyond specialized vocational programs to accredited advanced degrees in a range of fields and require a modern range of technology to support the increased offering of courses and the Millenial learners who enroll in them.

What can be taken away from this summary is that Millenial students exhibit an interesting combination of parental respect and family ties with a comfort level with diverse technology. Oblinger (2003) notes that this generation does not look at computers as “technology”, but as a natural part of life. Understanding this attitude may be difficult for educators who may still be trying to learn and adapt to new technology.

**Meeting Self-efficacy Needs of the Millennial Generation**

Self-efficacy theory is steeped in the traditions of social cognitive theory, which is based on the notion that achievement is dependent on interactions between a person’s behaviors, personal factors, and the environment (Bandura, 1977; Bandura, 1986; Bandura, 1997). According to Bandura (1997), self-efficacy is derived from four sources. The first source that influences a person’s self-efficacy is through performance accomplishments (e.g., past
achievements). The second way that self-efficacy develops is through vicarious learning experiences (e.g., modeling of others) (Bandura, 1997). Bandura further elaborates that self-efficacy developed through vicarious learning originates from the observation and interpretation of others. Students learn by watching others and by making use of past experiences for future application of vicarious knowledge acquired. The third way self-efficacy can be influenced is by social or verbal persuasion (Bandura, 1997). Social or verbal persuasion is a means of strengthening students’ beliefs that they possess the capabilities to achieve what they seek (Bandura, 1997). If this persuasion is positive, greater academic success results (Bandura, 1994). On the other hand, if students are not exposed to social persuasion, they tend to harbor self-doubts and dwell on personal shortcomings when challenges or difficulties arise (Bandura, 1997). Finally, physiological factors and affective states (e.g., anxiety and stress) are the fourth influence on self-efficacy (Bandura, 1997). Bandura believes that stress and anxiety negatively affect the amount of self-efficacy attained.

With respect to the Millennial generation, Bandura’s theory of self-efficacy is well matched to this linked-in population of students. Having grown up around an array of communication technologies (such as smart phones, social networks and email) these students may have a habit of multi-tasking and therefore may exhibit shorter attention spans (Elam, Stratton, & Gibson, 2007). Millennials students have high expectations for a learning environment, no matter if it’s by computer or in person. The key is interactivity, whether it on computer or in class. They need the feeling of connection and feedback, and they want this quickly (Elam, Stratton, & Gibson, 2007). The self-efficacy implications of connection and immediate feedback are of particular importance for developmental mathematics educators to
recognize. Since the first source of developing self-efficacy is through performance accomplishments (Bandura, 1997), educators should design learning activities that provide quick, if not immediate feedback. This could be fostered through computer learning activities (the emporium model), mini-projects, or having peer mentors or teaching assistants in the class to quicken the feedback cycle.

Millenials also prefer interaction in groups and the active support of instructors (Elam, Stratton, & Gibson, 2007). They have developed skills in teamwork, creating social networks (albeit electronically) and organization (Elam, Stratton, & Gibson, 2007). In a revealing series of focus group studies by Sweeny (2006), Millennial students shared they don’t necessarily prefer online classes and enjoy in person classes if the instruction is engaging, active and not a “boring lecture”. Some students did not like online because responses were too slow. Students expect organization and compelling engagement whether it is in the classroom or online. The self-efficacy implications of vicarious learning through the observation and interpretation of others (Bandura, 1997) are critical in this regard. Developmental mathematics educators should consider incorporating group projects that promote the teamwork and social networking skills of the Millennial generation. Lessons should be designed so that lecture is minimized and group activities are emphasized around engaging and active tasks. It seems imperative to foster the process of students observing and interpreting others in the class, not merely mimicking the actions of the teacher.

Millenials have had more sophisticated technology at home than at school, and may reasonably believe they have better grasp of technology than their parents or teachers (Dede,
With the ingrained use of technology, Millennials are used to learning in an associative, modular, non-linear style, and are able to combine different information in new ways (Dede, 2004). These students are exposed to a diverse variety of media in which to learn, and prefer visual and audio learning, with a focus on activity and achievement (Dede, 2004). A revealing series of focus groups by Sweeney (2006) showed that Millennial students enjoy in person classes if the instruction is engaging, active and not a “boring lecture”, and don’t necessarily prefer online classes. Some students did not like online because responses were too slow. Students expect organization and compelling engagement whether it is online or in the classroom. This may be one of the facets where self-efficacy educators can have direct impact upon developmental mathematics students. According to Bandura (1997), social or verbal persuasion is a means of strengthening students’ beliefs that they possess the capabilities to achieve what they seek. Therefore, engaging instructors, versed in technology are well positioned to increase students’ self-efficacy through encouragement, positive reinforcement and by designing learning activities around the multimedia needs of their students. In this sense, self-efficacy theory is generationally perennial: caring instructors, with passion and deep knowledge of their discipline are likely to foster the creation of efficacious students, regardless of their epoch.

Summary

Much has been written about developmental education in the last 30 years. Many researchers have carried out studies on the various aspects of remedial and developmental education, and this has contributed greatly to our understanding of what works in
developmental education, summarized into a collection of promising practices for
developmental programs and for their students. Having a clearly defined philosophy should be
a key component of any developmental education program. It is also clear from the research
that there should be mandatory testing and placement of students, a system-wide commitment
to developmental education, and a well-trained, full-time faculty who are capable of providing
a variety of instructional methods. Students in developmental education need assistance in
areas such as counseling, orientation, study skills, and structure. More recent researchers have
focused on the problems of math anxiety and self-efficacy. Much has been discovered in the
last few years and researchers continue to provide information that leads to a better
understanding of developmental education.
CHAPTER 3. METHODOLOGY

Introduction

The purpose of this qualitative inquiry is to seek understanding of the affective characteristics of developmental mathematics students and how these characteristics influence completion of their prescribed coursework in mathematics, as examined through the perspectives of both students and the faculty members who serve them. With the intention of exploring the context of those characteristics and experiences, it was determined that a qualitative methodology was appropriate. The qualitative research tradition can be used to understand a wide range of human experiences, activities and perspectives (Creswell, 2013a). The traditions include narrative studies, phenomenological studies, grounded theory, ethnographic studies, critical research studies and qualitative cases studies (Creswell, 2013a; Plano Clark & Creswell, 2010; Merriam, 2009).

This qualitative research study utilized a collective case study methodology. Interviews were used as the primary data sources for this research and supplemented further with artifact analysis and narrative data of the experiences and perspectives of developmental mathematics students and faculty members. The participants in this study consisted of a total of six developmental mathematics students; three from each group of completer and repeater students, as specified in the definition of terms. In addition, the researcher triangulated student perspectives with the interviews from four full-time developmental mathematics faculty members, who spanned the roles of instructor, counselor and administrator. The researcher conducted these interviews in a face-to-face manner using both a digital recorder
and notepad to record the interviews. This method is based on the recommendations put forth by Gubrium and Holstein (2003). If the goal of any research is to understand the meaning that people make of their experiences, then conducting interviews is a necessary way of achieving that goal (Merriam, 2009).

Research Design

The term *qualitative research* is often used in reference to a wide variety of techniques, tools, approaches, and goals of social inquiry. To a mathematics instructor, the idea of implementing “qualitative” research seems rebellious to the discipline itself; yet, the researcher has become convinced of the potential rewards of engaging in such methods. Qualitative research “fit” this study more appropriately to fully explore the experiences of developmental students and faculty and allowed the richness and depth of their perspectives to emerge (Merriam, 2009). For this particular research, a case study approach was selected to explore the perspectives and experiences of developmental mathematics students and faculty. Creswell (2013a) stated that case studies are a qualitative approach, “in which the investigator explores a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information and reports a case description and case themes” (p. 97). In this research, the multiple cases were composed from developmental mathematics students and faculty members. Three categories of cases were defined and comprised of students who have successfully completed the developmental sequence of courses (*completer*) and a grouping for students who have withdrawn from or been unsuccessful with developmental mathematics
courses (repeater). The third case consisted of full-time developmental mathematics faculty members, including educators, counselors, and administrators.

Strengths of Qualitative Research

Qualitative methods tend to be rich in narrative, description and a discussion of the process, rather than providing a numerical outcome. For Creswell (2013), the strengths of qualitative research include: it is useful for describing complex phenomena, it is usually collected in naturalistic settings, it is responsive to local conditions and the needs of those studied and those who are informed by the study, the perspectives of the participants lend insight into how and why phenomena occur. Merriam (2009) characterizes qualitative research as understanding the meaning people have constructed from their experiences, in which the researcher is the primary instrument for data collection and analysis. It usually involves fieldwork as primarily employing an inductive research strategy focusing on process, meaning and understanding resulting in a richly descriptive report.

One of the strengths of qualitative research is its ability to provide complex textual and multimedia descriptions of how people experience a phenomenon (Merriam, 2009; Creswell, 2013). It provides information about the “human” side of an issue, including perceptions, beliefs, opinions, emotions, behavior and relationships of individuals (Maxwell, 2013). Although findings from qualitative data can often be extended to people with characteristics similar to those in the study population, the strength of qualitative research involves gaining a rich and complex understanding of a specific social phenomenon, rather than generalizing data to other geographical areas or populations.
Another of the strengths of qualitative methods, especially in exploratory research (Merriam, 2009), is the use of open-ended questions and probing to provide participants the opportunity to respond in their own words, rather than forcing them to choose from fixed responses or categories, as quantitative methods do. Open-ended questions have the ability to evoke responses that are meaningful and salient to the participant, perhaps unanticipated by the researcher, and rich and explanatory in nature (Merriam, 2009). Finally, qualitative methods allow the researcher the flexibility to probe participant responses, especially for the purpose of asking why or how (Gubrium & Holstein, 2003). The researcher listens carefully to what participants say, interacts with them according to their individual personalities and styles, and use “probes” to encourage them to elaborate on their answers.

The paradigm of qualitative research accepts that there are many different ways of understanding and of making sense of the world (Merriam, 2009). It attempts to understand the participants in their naturalistic setting and is primarily concerned with meaning making and explaining the social aspects and phenomena in the world (Creswell, 2013).

Limitations of Qualitative Research

A limitation of qualitative inquiry, coming from the positivist perspective, is that its context-rich, emotion laden, narrative-filled reports contain too much “fluff” and not enough “hard” evidence (Krantz, 1995). Additionally, since the researcher is actively involved in the study and is likely passionate about either who is being studied or the context of the study, the researcher can be a source of bias and can perhaps lead to an inability to see other explanations or discrepant evidence about what is taking place (Krantz, 1995).
Additionally, since qualitative research focuses on a small population or number of cases, it is criticized for its inability to generalize findings or include a broader range of information in the data analysis. Critics of the qualitative paradigm warn that researchers might express personal opinion more than report accurate findings from the study and choose to be selective in what they report as results (Tashakkori & Teddlie, 1998).

In terms of limitations to practicality, the richer and more insightful the qualitative research, the more time consuming it becomes (Atkinson & Delamont, 2006). Qualitative data gathering is a complex process and involves many opportunities for human error and bias, unlike some quantitative methods that minimize the human affect by inputting numerical data into a software program.

Due to its interpretive nature, errors can occur in all stages of qualitative research. For example, since text and language is the root of qualitative research, meaning is incredibly important. Having well defined conceptual and perhaps operational definitions is of great importance because a certain term or phrase might mean one thing to one participant in a study but mean another thing to another participant, and it also might mean something entirely different to the researcher (Gall, Gall & Borg, 2003).

Finally, in qualitative research, the problem of adequate validity or reliability is a major criticism. Because of the subjective nature of qualitative data and its origin in single contexts or bounded systems, it is difficult to apply conventional, quantitative standards of reliability and validity. In response, qualitative researchers (Guba & Lincoln, 1985; Merriam, 2009; Creswell, 2013a) have defined their own means of ensuring qualitative rigor and identifying a set of
qualitative “validation strategies” (Creswell, 2013a). Standards of rigor and validation strategies of qualitative research are discussed in greater detail later in this chapter.

Collective Case Study Methodology

A qualitative case study allows the researcher to recognize multiple realities by exploring the perspectives of researcher, students, and faculty members, which may or may not be in agreement (Creswell, 2013a). Multiple perspectives, methods, and sources of information add richness, depth, and insight to the analysis (Creswell, 2013a). In essence, a case study design allows the researcher to explore the details and meanings of experiences instead of testing a hypothesis, which is typically a product of quantitative research (Creswell, 2013a). Instead the researcher attempts to identify important patterns or themes in the data (Creswell, 2013). In accordance with Stake’s (2006) recommendations for a case study, this study provides a detailed description of each case and the setting for the research. The setting is important because it allows the researcher to explore the details and meaning of students’ experiences and to analyze this information in the context of a developmental mathematics program.

The rationale for choosing a case study approach was based on a review of the literature, congruence with the theory of self-efficacy and evaluating each qualitative approach based on its ability to accomplish the researcher’s goals. The case study methodology provided a deeper investigation into questions addressed by this research and the nature of the research problem as it “offers a means of investigating complex social units consisting of multiple variables of potential importance in understanding the phenomenon” (Merriam, 2009, p. 50).
This study was an investigation into the experiences of the participants, an opportunity to expand the scope of the researcher’s own understanding and the body of literature as a whole.

A clear association exists between the qualitative case study design and the researcher’s interest in studying the affective characteristics of developmental mathematics students within a developmental education program at a public community college. Although numerous studies can pinpoint cognitive factors contributing to the need for developmental education with precise empirical data, the researcher felt that a qualitative approach, centric on the student voice, on a case-by-case basis, will yield richer and deeper data than that of a quantitative approach. It is the researcher’s belief that the field has not delved deep enough into the affective side of mathematics and a qualitative case study is the tool that can expose a great deal of depth in description and analysis.

Justification for Case Study Approach

As a research method, a case study approach is used in many situations to contribute to the body of knowledge of individual, group, social, political and related phenomena (Maxwell, 2013). Case studies have been applied to fields such as education, psychology, sociology, business, nursing, social work and anthropology (Yin, 2013). Case study methodology is a qualitative approach to research that concentrates on the study of phenomena within real-life contexts (Creswell, 2013; Merriam, 2009; Yin, 2013). This approach focuses on collecting in-depth information using multiple sources of evidence to understand the complexities embedded within a phenomenon (Stake, 1995; Yin, 2013). Stake (1995) further articulates that case study methodology allows for the understanding of the often ignored or misunderstood
complexities that are inherent within given contexts. Consistent with the paradigm of qualitative inquiry, case study affords for rich, holistic description and critical perspective on a phenomenon (Merriam, 2009).

With regard to this research study, a clear association exists between the case study design and the purpose of the research, which was to investigate the affective characteristics of developmental mathematics students within a developmental education program at a public community college. Although numerous studies can pinpoint cognitive factors contributing to the need for developmental education with precise empirical data, the research questions concerning the affective characteristics gravitated strongly toward a qualitative approach, centric on the student voice, on a case-by-case basis. The rich, thick descriptions of each case (developmental mathematics students and faculty), yielded deeper and more telling data than that of a quantitative approach.

There are several reasons why case study methodology was ideally suited for this research study. First, case study afforded an in-depth exploration of the affective characteristics of developmental mathematics students and faculty, and thus, provided a critical understanding of an area that is sparse in the body of literature. Second, this understanding was generated within the naturalistic setting of the developmental mathematics center at the community college site, which afforded a more detailed and contextualized representation of student and faculty attitudes and perceptions regarding developmental mathematics education. Indeed, this was important to understand, as the literature has consistently shown that performance in mathematics is attributed to affective characteristics in
addition to, and sometimes equaling, cognitive characteristics (Nolting, 2007; Saxon, Levine-
study methodology allowed for the collection of evidence via multiple sources of data. The
forms of data that were utilized in this research study include physical artifacts, interviews and
field notes (Yin, 2013). Multiple data sources afforded the researcher the capacity to capture
the affective characteristics of developmental mathematics students from multiple
perspectives (Merriam, 2009).

Alignment and Justification of Data Collection and Analysis

According to Yin (2013), qualitative case study research draws upon multiple sources of
information, such as documents, archival records, interviews, direct observations, participant
observation, and physical artifacts. Maxwell (2013) also promotes the practice of using
multiple data collection methods to build evidence against threats to validity and argues that
“This strategy reduces the risk that your conclusions will reflect only the biases of a specific
method, and allows you to gain a more secure understanding of the issues you are
investigating” (p. 102). For this research study, field notes, interviews and physical artifacts
were used to construct what Creswell (2013a) calls a “layering of themes”.

Interviews

In-depth interviews are one of the most common qualitative data collection methods.
As Merriam (2009) states “In all forms of qualitative research, some and occasional all of the
data are collected through interviews” (p. 87). Interviewing is necessary when we cannot
observe behavior, feelings, or how people interpret the world around them (Merriam, 2009). Patton (2002) adds that “We interview people to find out from them those things we cannot directly observe...The purpose of interviewing, then, is to allow us to enter the other person’s perspective” (pp. 340-341).

The in-depth interview is a technique designed to elicit a vivid picture of the participant’s perspective on the research topic. In this research, the interview approach was particularly attuned to uncover feelings and perspectives that could not otherwise be observed. For example, the affective characteristics of attitude, locus of control, anxiety and self-efficacy are nearly impossible to observe directly due to their nature as typical ways of ‘feeling’ or ‘emotion’ (Anderson & Bourke, 2000). Although popular in case studies, a direct observation (Yin, 2009) by the researcher of student participants in the classroom setting would yield little data regarding their affective qualities. Without conducting an in-depth interview, in which each participant can share his or her own personal perspective, the researcher would be constrained to infer the direction, intensity and target of these characteristics, introducing observer bias into the report (Maxwell, 2013). Instead of wantonly inferring data, interviews enable the person being interviewed to be the expert and interpret their own insights and perspectives (Merriam, 2009).

Furthermore, Merriam advocates that “it is also necessary to interview when we are interested in past events that are impossible to replicate” (p. 88). In this collective case study, two of the cases are completer and repeater students. As defined previously, completer students are those who have successfully passed their prescribed sequence of developmental
mathematics courses during the first iteration. *Repeater students* are those who withdrew from, failed, or repeated their developmental courses. Their experiences in developmental mathematics cannot be replicated, so it is particularly appropriate to explore the affective characteristics of these students with the main purpose of acutely understanding the perspectives of these students.

**Physical Artifacts**

Another source of evidence in qualitative, case study research is a physical artifact, which includes a tool or instrument, a work of art, a technological device, or some other physical evidence (Yin, 2013). According to Yin (2013), “Such artifacts may be collected or observed as part of a case study and have been used extensively in anthropological research” (p. 117). In anthropological studies, observations are generally made about the instruments of everyday living to draw conclusions about the way a people lived (Merriam, 2009). In this case study research, physical artifacts were utilized in a different slightly different fashion than anthropologists, primarily because the cases under study are still living. As part of this research, participants were asked to bring in between 3 and 5 physical artifacts to represent or symbolize them personally and describe who they are as an individual. Each participant was encouraged to bring at least one of the physical artifacts to represent their relationship with or how they feel about mathematics.

In addition to their utility as a medium that relaxes a formal atmosphere, physical artifacts are also regarded as cues in the social and physical environment in which people operate and are likely to initiate a sense or meaning-making process (Weick 1995). Artifacts
provide people with points of reference and can be viewed as "seeds" that evoke open-ended and ongoing interpretations (Weick, 1995). In addition, Gallman (2009) states that the appropriate usage of artifacts and other arts based research “provides uniquely deepened understanding, accessibility, and deep connection” (p. 135).

The purpose of my research study is to seek understanding of the affective characteristics of developmental mathematics students and how these characteristics influence completion of their prescribed coursework in mathematics. Since the discussion of affective characteristics includes attitudes, locus of control, anxiety and self-efficacy, the conversation is likely to focus on emotion and feeling, which is often times, especially for students, difficult to express. The use of physical artifacts is expected to serve as an introductory rapport building activity. As supported by Gallman (2009), the use of physical artifacts can be used to provide deepened understanding and connection. The sharing of physical artifacts was useful in establishing rapport, connecting with each participant on an emotional level and for soften the barriers of entry to discussing feelings and affective states, especially pertaining to the goals of this research.

Data Analysis

Although this section is delineated from data collection, it is important to note that that data analysis and collection should be a simultaneous process in qualitative research. As Merriam (2009) suggests “A qualitative design is emergent. The researcher does not know ahead of time...where to look next unless data are analyzed as they are being collected...The process of data collection and analysis is recursive and dynamic” (p. 169). Creswell (2013a)
affirms a similar sentiment “The process of data collection, data analysis, and report writing are not distinct steps in the process - they are interrelated and often go on simultaneously in a research project” (p. 182).

This study employed the constant comparative method of data analysis, which involved comparing one segment of data with another to determine similarities and differences. Data were grouped together on a similar dimension. The dimension was tentatively given a name; it then became a category. The overall intent of the constant comparative method of data analysis is to identify patterns in the data (Merriam, 2009, p. 30).

**Within-Case Analysis**

In a collective-case study research design, a typical format is to first provide a detailed description of each case and the themes present within the case, called a *within-case analysis* (Creswell, 2013a). This is a process that allows the unique themes of each case to emerge before the investigator looks to generalize patterns and themes across cases (Yin, 2013). In addition it gives an investigator a rich familiarity with each case which, in turn, accelerates cross-case comparison.

In this research study, analysis of physical artifacts, field notes and transcribed interviews were coded immediately following data collection. Codes were inductively generated using the “grounded” approach of Glaser (1965) and emerged from the participants’ experiences and perspectives of developmental mathematics from an affective stance. At the within-case level, the data revealed emergent categories addressing the research goals to explore attitudes, locus of control, anxiety and self-efficacy, albeit at the level of a single case.
Since the data collection included artifacts, field notes and interviews, the researcher sought out multiple forms of evidence to support each category and theme creation. Discrepant evidence was also recorded and presented to committee members and “critical friends” in peer debriefing sessions for alternate explanations. Further questions and possible paths of inquiry were devised to answer the questions which emerged from the initial analysis.

In the final phase of within-case data analysis, each interview was reread with the goal of creating individual interview summaries. These summaries allowed the researcher to observe threads that ran across several interviews and to extract quotes used as examples when writing up the findings. The compilation of quotes for each code were used to notice trends and contrasts. Finally, the data were reviewed to compare student perspectives with faculty perspectives of the same affective characteristics, as well as to look at whether what the faculty member believes about the students aligns with what the students perceive.

**Cross-Case Analysis**

Cross-case analysis provides a thematic analysis across all cases (Creswell, 2013). According to Yin (2013), “The technique is especially relevant if...a case study consists of at least two cases...The analysis is likely to be easier and the findings likely to be more robust than having only a single case” (p. 164). During cross-case analysis, the researcher constructed a conceptual framework (Miles and Huberman, 1984) by identifying and categorizing the demonstrative themes of the affective characteristics of developmental mathematics students. Each theme was broken into factors and displayed in a matrix or in text to illustrate the relationships among them.
In the next step of cross-case analysis, the researcher sought out patterns and themes by the construction of cross-case displays and matrices. Plausible explanations and metaphors emerged as the variables are related, split and factored (Miles and Huberman, 1984). The goal of cross-case analysis in this study was to build a logical chain of evidence and construct a coherent explanation, while comparing against rival explanations or negative evidence. In order to check for validation, research participants were asked for feedback on the accuracy of transcriptions and generated theory during the member check processes described in the standards of rigor section.

Selection of Interview Questions

In this qualitative study, the researcher conducted face-to-face interviews with participants involving semi-structured and generally open-ended questions. Merriam (2009) contends that “Less structured formats assume that individual respondents define the world in unique ways. Your questions need to be more open-ended. A less structured alternative is the semi-structured interview” (p. 90). In this research study, a semi-structured interview format was selected to qualitatively explore the affective characteristics of developmental mathematics students. This format provided an exploratory approach, which allowed “the researcher to respond to the situation at hand, to the emerging worldview of the respondent, and to new ideas on the topic” (Merriam, 2009, p. 90). In a semi-structured interview, questions are more flexibly worded and the interview is a mix of more and less structured questions. In a semi-structured interview, neither the exact wording nor the order of questions needs to be predetermined, but the interview is usually guided by a list of questions or issues to
be explored (Merriam, 2009). Generally, the initial list of questions or issues, known as the interview protocol (Creswell, 2013; Plano Clark & Creswell, 2010; Kvale & Brinkmann, 2009) or interview guide (Merriam, 2009), is a form with approximately five to seven open ended questions with ample space to write responses to the interviewee’s comments (Creswell, 2013). Asking good interview questions takes practice and many potential interview questions are reworded, added, or thrown out entirely during the pilot study (Merriam, 2009). Fortunately, Creswell (2013a) informed this research with some guiding parameters to design the interview questions:

How are questions developed? The questions are often the sub questions in the research study, phrased in a way that interviewees can understand. These might be seen as the core of the interview protocol, bounded on the front end by questions to invite the interviewee to open up and talk and located at the end by questions about “Whom should I talk to in order to learn more?” or comments thanking the participants for their time (p. 164).

This research study employed Creswell’s format of selecting questions for the interview protocol, extracted simply from the research sub questions. However, the content of each interview question was adapted from well-established survey items in instruments created to assess the affective characteristics of students (Levine-Brown, Bonham, Saxton & Boylan, 2009).

In the remainder of this section, through the body of literature and validated survey instruments, the rationale for how each of the 12 questions were selected for the interview protocol is substantiated.

Question #1) When was the last time you took a developmental mathematics course?
Question # 2) Describe your initial reaction and thoughts when you found out “You have to take a developmental mathematics course.”

The first two questions of the interview protocol were developed according to the guide proposed by Creswell (2013a) which suggests that front end questions invite the interviewee to open up and talk. In addition, Merriam (2009) and Patton (2002) describe several types of questions to stimulate responses from an interviewee. One of these types is called experience and behavior questions, which gets at “the things a person does or did, his or her behaviors, actions and activities” (Merriam, 2009, p. 97). Both questions one and two are considered as the behavior and experience type of question as they pertain to past experiences in and reactions to developmental math.

Question #3) How do you describe your attitudes towards mathematics?
Probe: What past experiences in mathematics classes have shaped your current attitude?

Question #4) Describe how motivated you are to learn mathematics?
Probe: What past experiences in mathematics classes have shaped your current motivation level?

This pair of questions was adapted from the College Student Inventory (CSI) Form B instrument. As described by (Levine-Brown, Bonham, Saxton & Boylan, 2009), the “CSI is a self-report motivational assessment that is designed to identify the strengths, needs, and attitudes of students. It provides educational institutions with information to enable staff to assess student dropout likeliness, receptiveness to institutional help, educational stress, and potential for academic difficulty” (p. 3). According to the Noel-Levitz (n.d.), the motivational assessment component of this instrument “allows advisors to identify areas of strength and challenge for individual students at a glance. The motivational scales are reported in two ways, as a
percentile rank and with a bar graph”. The motivational question was adapted from the survey to address mathematics specifically and its structure was changed to yield open-ended qualitative data, rather than percentile rank. Questions three and four also fit within the category of feeling questions, which “tap the affective dimensions of human life” (Merriam, 2009, p. 96).

Question #5) Think about times when you have encountered a difficult problem in a mathematics class. How do you handle situations where you do not know the answer to a mathematics problem?
**Probe:** If you still are unable to solve a mathematics problem after those steps, why do you think that is?
**Probe:** When faced with challenge in math, do you tend to invest more effort to overcome it or do you tend to be discouraged and give up? Why is that?

Question #6) Have you ever experienced anxiety during a mathematics class?
**Probe:** If so: Please describe the situations that have caused anxiety for you.
**Probe:** If so: How have you dealt with this anxiety?
**Probe:** If not: What strategies do you use to keep calm or feel confident in a mathematics class?

This pair of questions was adapted from the Math Study Skills Evaluation (MSSE) instrument. As stated by Saxton, Levine-Brown, and Boylan (2008), the “MSSE is a 35-item computerized survey designed to prescribe learning strategies. It is a complementary assessment constructed to employ the research-based learning principles described in Winning at Math. The objective is to locate specific learning problems. Five subtest areas are examined: study effectiveness, memory and learning, reading and homework, classroom learning, and test-taking and anxiety” (p. 2). Nolting (2007) created this instrument based on research showing that non-cognitive variables in some cases may be better predictors of math success than cognitive skills. The problem (#5) and anxiety (#6) questions were loosely based on survey items from this instrument, although transformed from Likert scale responses to open-ended
questions. Similar to questions #3 and #4, these are both feeling questions (Merriam, 2009; Patton, 2002).

Question #7) Describe your current study habits. How do you prepare for mathematics classes?

Question #8) I’d like you to describe some abilities that you are successful with (not limited to mathematics). Describe how you were able to learn the skills necessary for your abilities.

*Probe:* What helps you to learn something new?

This pair of interview questions was based upon the Learning and Study Strategies Inventory (LASSI), which according to Saxton et al. (2008) is “a 10-scale, 80-item study skills assessment designed to diagnose relative student strengths and weaknesses. It provides standardized scores and national norms for scales falling under the descriptions of skill, will, and self-regulation of strategic learning... This instrument measures a combination of student cognitive and non-cognitive characteristics” (p. 2). The LASSI instrument assesses specific, categorized study habits and skills, while these interview questions are open-ended, allowing the participant to create his/her own options for responding (Plano Clark & Creswell, 2010).

These questions fall under the category of experience and behavior questions (Merriam, 2009; Patton, 2002), as they address the study activities (or lack thereof) and skills of the interviewee.

Question #9) In all the mathematics courses you’ve taken, which did you learn the most from?

*Probe:* What was it about these courses that led you to learn the most from them?

Question #10) In all the mathematics courses you’ve taken, which did you learn the least from?

*Probe:* What was it about these courses that led you to learn the least from them?
This pair of interview questions did not originate from validated survey instruments. Instead, they were crafted to learn, from the interviewee’s perspective, what has helped and/or hindered them from learning mathematics. These interview questions can be considered experience and behavior questions and also opinion and values questions (Merriam, 2009; Patton, 2002), as they are designed to evoke both “the things a person does or did, his or her behaviors, actions, and activities” and “a person’s beliefs or opinions, what he or she thinks about something” (Merriam, 2009, p. 96).

Question #11) Suppose I was a new mathematics instructor teaching developmental mathematics courses. What advice would you give me to become an effective teacher?

Question #12) Why did you choose to participate in this study?

The final two questions of the interview protocol served as a hypothetical question and opinion question, respectively. The hypothetical nature of prompting a question with the term “suppose” allowed the interviewee to respond what they might do, or what it might be like in a particular situation (Merriam, 2009). Data collected from this question was used to explain what contributions a teacher can make to improve the quality of a developmental mathematics course. Question 12 is an insightful, opinion question (Merriam, 2009; Patton, 2002) and yielded rich, descriptive data about why a student or faculty member is motivated enough to invest hours of their time to share their experiences with developmental mathematics.

Standards of Rigor and Trustworthiness

Numerous frameworks for ensuring rigor and trustworthiness in application of qualitative research have been in existence and practiced reliably for many years. Guba’s
constructs, in particular, were some of the first to have won considerable favor and staying power. Numerous qualitative researchers (Lincoln, Lynham, & Guba, 2011; Merriam, 2009; Creswell, 2013a) have expanded on Guba’s initial work and provided perspectives on qualitative rigor that range from viewing qualitative “validation” in terms of quantitative equivalents to identifying a set of qualitative “validation strategies” (Creswell, 2013a), which form the focus of this section. According to Creswell (2013a), there is an emphasis in qualitative research on accepted strategies to document the rigor of a study and he recommends that “qualitative researchers engage in at least two of them in any given study” (p. 253). For the remainder of this section, the four qualitative validation strategies promoted by Creswell and implemented in this qualitative research study are discussed.

**Prolonged Engagement in the Field**

This strategy employs the process of building trust with participants, learning the culture, and checking for misinformation or distortions introduced by the researcher or informants (Lincoln & Guba, 1985; Merriam, 2009; Creswell, 2013). As Creswell (2013) states, in the field, “the researcher makes decisions about what is salient to study, relevant to the purpose of the study, and of interest for focus” (p. 251). As the sole qualitative researcher, it was my responsibility to gain the trust of all participants and to have a deep understanding of the culture of the system bounded by the study. At the time of the study, the researcher had been an instructor in the subjects of information technology and mathematics for nine years at the site from which data were collected. As such, the researcher had the unique opportunity to learn and immerse himself in the culture of the community college for a prolonged period of...
time. The research was conducted with the purpose of understanding the affective characteristics of developmental mathematics students and not, by any means, to evaluate or pass judgment upon them. In addition, in the description of the research study provided to each student and faculty participant, the researcher was clear to state that the purpose of the research is to explore their affective characteristics as a means to gather meaningful information with the hope of improving the quality of developmental mathematics education for students at the college. The research was not conducted for the purposes of evaluation or comparison with other schools. The participants and the researcher entered the process together and participants’ trust was encouraged by intently listening to and understanding their perspectives, not by evaluating or passing judgment upon them.

**Triangulation**

The strategy of triangulation makes use of multiple and different sources, methods, investigators, and theories to provide corroborating evidence (Lincoln & Guba, 1985; Merriam, 2009; Creswell, 2013). Maxwell (2013) defines the triangulation strategy as “collecting information from a diverse range of individuals and settings, using a variety of methods” (p. 128) and elaborates that the triangulation of data collection methods “involves using different methods as a check on one another, seeing if methods with different strengths and limitations all support a single conclusion” (p. 102). This research employed the use of triangulation among the cases of developmental mathematics students and faculty members by purposefully sampling from a diverse range of individuals. Specifically, there were three cases in the multiple case study, which include voices from completer students (successfully passed the
prescribed sequence of developmental math coursework on the first attempt), repeater students (enrolled in the same developmental mathematics course for multiple semesters) and developmental mathematics faculty (including an instructor, counselors and an administrator). In each of the cases, data were collected from at least three individuals to further diversify the range. To triangulate the methods of data collection, the study employed the use of physical artifacts, interviews, and field notes to construct a layering of themes. By using several methods, the researcher counterbalanced flaws that may be inherent in a single method and used the data collected from each method to build a base of evidence that supported the conclusions from data analysis. As Maxwell (2013) states, “In the final analysis, validity threats are made implausible by evidence, not methods” (p. 128).

Rich, Thick Description

The validation strategy of “rich, thick description” is often associated with the qualitative research tradition. In this strategy, the researcher describes the participants, setting, bounded system and/or cases in great detail. With such detailed description, the researcher enables readers to make decisions about the transferability of the study based on shared characteristics (Lincoln & Guba, 1985; Merriam, 2009; Creswell, 2013). According to Stake (2010), “A description is rich if it provides abundant, interconnected details...” (p. 49). Creswell (2013a) further elaborates that “It can also involve describing from the general ideas to the narrow, interconnecting the details, using strong action verbs, and quotes” (p. 252). Maxwell (2013) provides specific instructions for interview data: “In interview studies, such
data generally require verbatim transcripts of the interviews, not just notes on what you felt was significant” (p. 126).

In this research, rich descriptions have been provided to give the reader details about the bounded system, including a description of the research site, each of the three cases (completer, repeater, faculty), the 10 research participants and the setting of each data collection opportunity. During the data collection process, each of the semi-structured interviews was recorded using a digital device and transcribed into a Google Doc, which was shared between the researcher and his Ph.D. adviser. Furthermore, the transcriptions were reviewed and compared to the digital recordings by the researcher to verify accuracy, and then analyzed for relevant data to the study. Field note reflections were written immediately after the interview that contained descriptive notes on the behavior, verbal and non-verbal cues of each participant as well as the insights and emotions experienced by the interviewer (Merriam, 2009). The researcher utilized the process of member checking and consulted with participants, committee members, and other colleagues to ensure that the rich, thick description created was accurate and sufficient. One of the operational goals of providing rich, thick description of the bounded system, each of the three cases, and all 10 participants is to “enable readers to transfer information to other settings and to determine whether the findings can be transferred because of shared characteristics” (Creswell, 2013a, p. 252). The detail of the descriptions can be used to assist other researchers in replicating the study under other comparable settings (Creswell, 2013a).
**Member Checking**

In this validation strategy, the researcher solicits participants’ views of the credibility of the data collection and interpretations (Lincoln & Guba, 1985; Merriam, 2009; Creswell, 2013a). Maxwell (2013) further elaborates on member checks, which he also terms “respondent validation” are “…systematically soliciting feedback about your data and conclusions from the people you are studying. This is the single most important way of ruling out the possibility of misinterpreting the meaning of what participants say and do and the perspective they have on what is going on…” (p. 126). With regards to this research study, member checks were employed on two levels. After collecting field notes from the sharing of physical artifacts and producing transcriptions of the interviews, each participant was asked for their feedback in regards to accuracy of the data collected. The first iteration of member checks was also used to clarify any ambiguous or unclear data that might have during the transcription process. In addition, due to the nature of semi-structured interviews (Merriam, 2009), some questions (or probes) that might not have been scheduled during the initial interview, but provided rich data in subsequent interviews were asked to all participants.

In the second stage of member checks, each participant was presented with the analysis of the data collected during our meetings, as well as the rich, thick description of their character and the associated Hawaiian navigational star name that was used as their pseudonym. This analysis took the form of a summary which consisted of descriptions, themes, comparisons, trends, and quotes from that participant’s data (Creswell, 2013a). Each participant to review the data analysis and reflect on the accuracy of the account and on
interpretation that is inaccurate or missing. The two phases of member checks also serve to keep the participants involved with and informed about the progress of the study and enables them to direct the course of the research. This approach is supported by Stake (1995) who claims that participants should “play a major role directing as well as acting in case study research” (p. 115).

A Bounded System

One of the defining features of a case study is that it operates under a bounded system, which specifies the boundaries of the research, usually indicated by time and place (Creswell, 2013a). For qualitative case studies, it is argued that “the single most defining characteristic of case study research lies in delimiting the bounded system, the case” and “If the phenomenon you are interested in studying is not intrinsically bounded, it is not a case” (Merriam, 2009, p. 41).

The cases in this study are bounded by the scope and influence of a developmental education center at a public, community college in the state of Hawai‘i over the period of three academic semesters: fall of 2013, spring and summer of 2014. The developmental education center itself is considered to be a centralized program (Roueche & Snow, 1977), since it is a separate site that provides developmental courses and services, rather than a spattering of courses strewn over several academic departments.

The center offers developmental courses in mathematics and English, in addition to a comprehensive set of student services, including tutoring and peer mentoring, counseling support, academic advising, activities and workshops to assist students for the duration of their
community college enrollment. The center offers year-round sections of three mathematics courses, including elementary algebra, foundations of mathematics and accelerated elementary algebra. According to an Achieving the Dream annual report (2011), the developmental center served a total of 850 academically unprepared students in mathematics in the summer, fall and spring semesters of the 2012-2013 academic year.

The Research Participants

The research took place during the timespan of June 2013 through August 2014 in a community college in the state of Hawai‘i. Diligent care was exercised to protect the confidentiality of the participants. Pseudonyms were used throughout this work for names and places that might otherwise produce a breach of their privacy. In order to uphold ethical standards and minimize issues of coercion, none of the student participants in this research study were current mathematics students of the researcher, nor was it likely for them to be potential future students of the researcher. Furthermore, although the researcher teaches information technology and business mathematics courses at the data collection site, he does not teach within the developmental education center or the developmental sequence of courses from which research participants were selected.

Interviews were conducted in safe, innocuous locations on state property where the researcher and participant had a private conversation in a public or semipublic setting. Each interview setting, typically an office, meeting room, dining area or student lounge or lab was chosen with the convenience and the comfort of the individual participant as a primary concern.
The participants in this study were comprised of past and present developmental mathematics students and current full-time faculty. Six student participants in this study were equally selected from two distinct categories: students who withdrew from, repeated a course multiple semesters, or failed to complete developmental mathematics courses (repeater) and students who completed the developmental sequence on-time and proceeded into at least college-level mathematics course (completer). To complete the study, four faculty members who are actively engaged in developmental mathematics in some capacity (an educator, two counselors, and one administrator) were recruited as participants to represent the faculty perspective.

The researcher posted a call for participants through various bulletin boards of the community college, as well as through site visits to the developmental education center and by word-of-mouth in order to find developmental mathematics students and faculty who are interested in participating. Altogether, the research involved 10 individuals who responded to the call for participants, met the criteria and consented to be interviewed. The average duration of each interview consumed approximately one to one-and-a-half hours.

Ethical Conviction and the Respect for Persons

Although the researcher designed this qualitative research to be of minimal risk to its participants, it is of critical importance that a conviction to ethical practices and respect for persons be maintained at all times during the study. Mertens and Ginsberg (2008) cover the topic of ethics and ethical issues in social research as it relates to the proper treatment of people. If the research study poses a risk, the human subjects must be given the full details of
any anticipated effects due to the participation in the study. It is believed there is little risk to participants in this study, but the researcher has urged that if at any time during the study a participant becomes uncomfortable answering any of the interview questions or discussing topics, the question can be skipped, or a recess taken, the interview can be stopped or the participant can choose to withdraw from the project altogether.

Other broad areas of concern with respect to the ethical treatment of people include consent of involvement; knowledge of the risks of involvement; and the rights of privacy, confidentiality, and anonymity (Mertens & Ginsberg, 2008). In this qualitative research study, a consent form to participate in a research project was submitted to the Human Studies Program at the University of Hawai‘i and then later distributed to potential research participants, prior to conducting the study (see Appendix A). In the consent form, participants were ensured that in the data collection, analysis and reporting of this research project, participant names, or any other personally identifying information, such as places or times, would not be used. Rather, the researcher used pseudonyms and reported findings in a way that protects privacy and confidentiality to the extent allowed by law. Furthermore, all data were kept in a secure location. Only the researcher and his University of Hawai‘i advisor had access to the data, although legally authorized agencies, including the University of Hawai‘i Human Studies Program, could review research records. Attention to these issues of consent, knowledge of risk of involvement and rights of privacy, anonymity and confidentiality helped to ensure equal and ethical treatment to all groups of people.
Institutional Review Boards

Institutional Review Boards (IRBs), such as the Human Studies Program at the University of Hawai‘i at Mānoa, have been set up by the U.S. federal government to continue the vigilance necessary to uphold ethical behavior within the research community. IRBs are required in any type of institution that receives federal funding and is involved in research, which includes the University of Hawai‘i. The IRB reviews specific components included in any research study involving people and can approve, reject, or withdraw approval at any time during the research process. Initial approval by the IRB for this study was obtained before the research began. The researcher was careful to remember that a relationship is established between the Institutional Review Board, the researcher, and participants due to the fact that research studies have the purpose of developing or contributing to the body of generalizable knowledge. It is imperative that this relationship be nurtured by a dedication to following ethical practices and by demonstrating utmost respect for research participants.

Data Collection

Creswell (2013b) defined a case study as “a qualitative design in which the researcher explores in depth a program, event, activity, process, or one or more individuals. The case(s) are bounded by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time” (p. 241). According to Yin (2009), case study research draws upon multiple sources of information, such as documents, archival records, interviews, direct observations, participant observation, and physical artifacts. For this
study, physical artifacts, interviews and narratives were used to construct a layering of themes (Creswell, 2013).

**Physical Artifacts**

At the convenience of the participants, initial meetings were scheduled, beginning with the first in June, 2013. When the researcher met with each participant at the agreed-upon time, we collaboratively reviewed the research information sheet and the consent form (Appendix A). After reviewing these, the consent forms were signed. Copies of both the information sheet and a signed consent form were given to each participant.

As part of the consent form, participants were asked to bring in three physical artifacts to represent or symbolize them personally and describes who they are as an individual. Participants were asked that one of the physical artifacts represent their relationship with or how they feel about mathematics. In our initial meeting, the researcher provided an overview of the study and the research process and then artifacts were explored. The researcher took time to review each artifact and encouraged participant to explain its significance from their perspective. Field notes of the researcher’s impressions were documented immediately after the conclusion of the meeting. With the participant’s permission, photographs of each of the participant’s artifacts were taken using a digital camera for later observation and analysis.

In addition to their utility as a medium that relaxes a formal atmosphere, physical artifacts are also regarded as cues in the social and physical environment in which people operate and are likely to initiate a sense or meaning-making process (Weick 1995). Artifacts provide people with points of reference and can be viewed as "seeds" that evoke open-ended
and ongoing interpretations (Weick, 1995). In addition, Gallman (2009) states that the appropriate usage of artifacts and other arts based research “provides uniquely deepened understanding, accessibility, and deep connection” (p. 135).

**Interviews**

The second meeting, or in some cases a continuation of the first depending on the availability of the participant, was a semi-structured interview format. The semi-structured format is a mix of structured questions used to determine specific information from each participant and yet allows the researcher to respond to the perspective unfolding and the emerging worldview of the respondent (Merriam, 2009). Students and faculty were encouraged to share their own narrative in their own style. This semi-directive approach was chosen to yield data that more accurately reflects the priorities and concerns of the students and faculty themselves (Gubrium & Holstein, 2003).

Two interview protocols, one for student participants and one for faculty members, were developed based on the five sub-questions listed in chapter one, guided by the lens of Bandura’s self-efficacy theory and the experiences of the researcher. An explanation of the interview process and a list of 12 questions for students are listed on the protocol (see Appendix B) and 13 questions on the protocol for faculty members (see Appendix C). These were emailed to the participants prior to the conversations to allow reflection time. Guided by the interview protocol questions, the researcher conducted each semi-structured interview and inconspicuously recorded them using a digital device. The semi-structured interviews, lasting approximately 60-90 minutes each, were held on school grounds in a location removed from
the mathematics classroom. Each recording was manually transcribed shortly after the interview process. The transcriptions were reviewed and compared to the digital recordings by the researcher to verify accuracy, and then analyzed for data relevant to the study. Field note reflections, written immediately after the interview, contained descriptive notes on the behavior, verbal and non-verbal cues of the informant as well as the insights and emotions experienced by the interviewer (Merriam, 2009). In all, nine interviews were conducted, recorded, transcribed, and analyzed for data relevant to the purpose of this study. The developmental education counselors asked to be interviewed together and were accommodated. The transcripts were sent to the participants to allow them to comment on or provide revisions to their text. In this way, member checks were conducted to ensure accuracy of the transcriptions.

Data Analysis

Although this section is delineated from data collection, it is important to note that the researcher conducted data analysis in conjunction with data collection (Merriam, 2009). The researcher employed the constant comparative method of data analysis, which involved comparing one segment of data with another to determine similarities and differences. Data were grouped together on a similar dimension. This dimension was tentatively given a name; it then became a category. The overall object of this analysis was to identify patterns in the data (Merriam, 2009, p. 30). As suggested by Creswell (2013), the researcher created a set of 25 to 30 categories early in the data analysis, which was later reduced or combined into a group of five themes to describe the perspectives and experiences of the participants.
Within-case Analysis

Analysis of interviews were coded during data collection as soon as transcriptions were available. Codes were inductively generated using the “grounded” approach of Glaser (1965) and emerged from participants’ experiences and perspectives of developmental mathematics from an affective stance. Matrices were constructed from the data and were used to identify patterns, comparisons, trends and even paradoxes. Further questions and possible paths of inquiry were devised to answer the questions that emerged from the matrices. Weekly review of all collected data as well as all the analytic field notes were conducted to form a narrative summary and a list of unanswered questions from the researcher’s perspective. During this analysis, the researcher met once a month with an education colleague, knowledgeable about and experienced with qualitative research and the research site itself, to summarize the status of the research and to discuss themes, concepts and explanations.

In the final phase of within-case data analysis, each interview was reread with the goal of creating individual interview summaries. These summaries allowed the researcher to observe threads that run through interviews to extract quotes to be used as examples when writing up the findings. This compilation of quotes for each code was used to notice common trends and opposing contrasts. Finally, the data were reviewed to compare student perspectives with faculty perspectives of the same affective characteristics, as well as to investigate alignment of perceptions among students and faculty.
Cross-case Analysis

Once the researcher processed all three within-case analyses, the cross-case data analysis commenced. In this process, the first step was a construction of a conceptual framework (Miles and Huberman, 1984) containing the demonstrative themes of the affective characteristics of developmental mathematics students. Each theme was broken into factors and displayed graphically or in text to illustrate the relationships between them.

Patterns and themes were sought out by construction of cross-case displays and matrices. Plausible explanations and metaphors emerged as the variables were related, split and factored (Miles and Huberman, 1984). The goal was to build a logical chain of evidence and to construct a coherent explanation and comparing against rival explanations or negative evidence.

Summary

The purpose of this qualitative study is to understand and make meaning of the affective characteristics of developmental mathematics students from their own perspective as well as the perspective of faculty who serve them. The qualitative approach suited to enhancing the researcher’s understanding of their experiences was a collective, multiple-case study. The researcher recruited participants to tell the stories of their experiences before, during, and after enrollment in a developmental mathematics program. For this study the researcher utilized digitally recorded interviews, observational field notes, coded transcripts, and physical artifacts as data sources. The nature of the research was explained to all
participants meeting the criteria for the study and consent forms were signed. The semi-structured interviews were recorded, converted into transcription and reviewed by the researcher. The transcribed manuscripts were submitted to respective participants for member-checks in order to eliminate possible errors and to verify the accuracy of the data. The transcripts were then analyzed using the constant comparative method on a within-case and cross-case basis, together with other accepted principles of qualitative research and interpretation, in order to gain a better understanding of the affective characteristics of developmental mathematics students.
CHAPTER 4. FINDINGS OF THE STUDY

Introduction

In this chapter the results of a collective case study analysis are presented within a descriptive framework of the qualitative tradition. The analysis is provided within and across all three cases of the study, including completer, repeater, and faculty cases. Ten participants from the same public, postsecondary institution comprised the three cases; six of which were student participants, four were faculty members. The six students were drawn equally from the completer case (developmental coursework completed in first attempt) and the repeater case (developmental coursework repeated or withdrawn from). The four faculty participants in this study demonstrate promising practices and reinforce what is already known to contribute to effective teaching and student support and success in developmental education.

Yin (2013) suggests that a descriptive framework helps to organize case study analysis, such that the faculty and student participants’ backgrounds, beliefs, and experiences with developmental mathematics are compared. In looking for evidence and examples within the cases of completer and repeater students, similar patterns and themes emerged and became meaningful with frequency and intensity. Using examples and evidence of the data collected from the six student and four faculty participants through artifact sharing and semi-structured interviews, key similarities and differences across the cases are highlighted and conclusions drawn.
The purpose of this study was to seek understanding of the affective characteristics of developmental mathematics students and how these characteristics influence completion of their prescribed mathematics coursework, as examined through the perspectives of both students and developmental mathematics faculty. The findings of this study are drawn from data that address the research questions guiding the study:

1) How do developmental mathematics students assess their own affective characteristics?
   a. What are student attitudes towards mathematics?
   b. To what extent do students accept responsibility for their own academic behavior?
   c. To what extent do students experience anxiety toward mathematics?
   d. How do students perceive their own self-efficacy towards mathematics?

2) How do developmental mathematics faculty perceive the affective characteristics of their students?
   a. How do faculty view the attitudes of their students towards mathematics?
   b. What do faculty believe about how students accept responsibility for their own behavior?
   c. What do faculty believe about mathematics anxiety among their students?
   d. How do faculty perceive the self-efficacy of their students?

Data for this study included interviews, a researcher journal, field notes, and artifacts. Analysis of data identified themes that reflected the perspectives of student and faculty participants. It also characterized participants’ perceptions of affective characteristics that influenced their completion of developmental mathematics coursework.

Overview of Participants

The participants for this study consisted of a diverse assemblage of 10 individuals, who represented populations of developmental mathematics students and faculty members,
including educators, counselors, and administrators. The six students selected for this study had either enrolled in, completed, or were unable to complete a range of between one and five developmental mathematics courses. Half of the student participants were born into the millennial generation, while the other half represented Generation X (Pew Research Center, 2014). There are four women and two men represented in the student participants. An equal distribution of three completer and three repeater students was present.

To represent the developmental mathematics faculty population, one educator was selected, one administrator serving in the role of department chair, and two counselors were selected for the study. The educator teaching developmental mathematics had a combined total of 38 years teaching, with 25 of those years spent teaching developmental mathematics at the college at which this study was conducted. The faculty member who represented administration had over 10 years of teaching experience in the subject of college English, writing, composition and developmental English. At the time of the research study, she was serving in the role of department chairperson of developmental education. There were two faculty members who represented the population of counselors in developmental education at the institution. Both counselors were female, one had been a counselor with the college for 17 years and within the developmental education department for a little over a year. The other faculty member brought 36 years of counseling experience, of which 28 years had been spent serving students at the institution of this research.
Participant Pseudonyms and their Meanings

In this research study, participants were given a pseudonym from a list of navigational stars (“hōkū” in Hawaiian) used in Pacific Island voyaging. The choice of pseudonym options served as a powerful metaphor. As navigational stars guided both ancient and contemporary Pacific Island sailors, the participant stars have guided this research. The choice of navigational star names is also junctional with the worldwide voyage of two Hawaiian sailing canoes, Hōkūleʻa and Hikinanalia, which are circumnavigating Earth’s oceans over the years 2013-2017 in pursuit of a global movement toward a more sustainable world through stewardship of the natural world, and the use of the canoes as a classroom to infuse indigenous knowledge, values and twenty-first century skills into STEM-based education (Hōkūleʻa, 2014).

Student Participant Profiles

Makaliʻi

Makaliʻi is a student of the generation X population and, at the time of this research study, was pursuing an associate’s degree in information technology. In her interview, Makaliʻi shared that she had recently been hired as a network engineer with a large-scale cable and Internet service provider; her sustained employment was contingent upon the completion of her degree. At the time, she had completed all the requirements for her degree with the exception of two math requirements, including Math 25, a developmental mathematics course that she was repeating for the fourth time. The fulfillment of her two requisite mathematics courses were the only obstacle in the progression of her college degree and career.
Makaliʻi is also a single mother, working 40 hours per week and raising a 13-year-old daughter. She established early in the interview that her daughter was her primary motivation for completing her degree, even with the setbacks in developmental math. According to Makaliʻi, “I have to make sure that we survive. I want to make sure that she actually turns out alright because, you know, I didn’t have both parents either and I’m worried about her because she’s an only child and she doesn’t have both parents and she may have certain issues. So far she’s ok...so far.” Makaliʻi was balancing the threefold responsibilities of being a full-time mother, full-time student, and a full-time professional in the field of information technology.

In regards to her background in mathematics, Makaliʻi had not taken a class in over 15 years before enrolling in the community college. Once enrolled at the college, she understood that she would have to take a placement exam to determine what mathematics and English courses were recommended to take during her first semester. Although Makaliʻi was aware of the preparation opportunities for the test offered by the college, she did not elect to participate because, in her words, “I think that the times that it was available before I took the test I was still working, so I wasn’t able to make any of those and it was kind of late when I found out. It didn’t work out, so I did my own little studying, which was barely anything. I went in there with whatever, you know? Whatever I could remember.” The placement test determined her math coursework would begin with a developmental sequence. Makaliʻi expressed a feeling of disappointment when she discovered the results. In her words, “Bummed, because I looked at the path that I needed and...I knew that it would take an additional semester or two to get where I needed to. I’m just older. If I was younger, I don’t mind taking my time, but I needed
to get schooling done and hurry up and look for a job so that I could support my daughter and myself.”

With regards to the subject of mathematics itself, Makaliʻi shared a favorable impression, even though she also viewed it as an obstacle towards her degree completion. In her words, “I always thought math was fun, that’s why I guess I was bummed on it [her placement] because last I remembered when I used to do math I was pretty good at it actually and I liked it...For me, it’s like a puzzle, and it’s the challenge that I like about it and I know there’s an answer to it.” Makaliʻi’s views indicate an agreeable perception on the subject of mathematics, yet she expressed a frustration with her developmental math experience. She has demonstrated persistence to continue with her degree, primarily motivated by her daughter and future career as a network engineer.

Since her graduation is pending upon completion of a developmental mathematics course, which she has repeated on four iterations, her perspectives are considered among the repeater population.

According to Makemson (1941), the name “Makaliʻi”, means “little eyes” or “little stars” and has also been interpreted to mean highborn stars. Makaliʻi was chosen as a pseudonym for the student participant because she is a single parent and takes on most of the day-to-day responsibilities of raising her 13-year-old daughter. Over the duration of several years, Makaliʻi has enrolled in five developmental mathematics courses and has repeated the Math 25 course four times. In the sharing of her artifacts and during her interview, Makaliʻi described that her daughter was her primary motivation for her to persist through the multiple iterations of
developmental mathematics courses. As discussed further in the findings, whenever Makali’i needed support, she could always rely on the “little eyes” of her daughter for motivation. Therefore, to honor the bond and close relationship between mother and daughter, the pseudonym Makali’i was given to this participant.

Me’e

Me’e is a current student at the community college in which this study was conducted, pursuing an associate’s degree in Information Technology. He has been taking an assortment of classes within the Hawai’i system of community colleges for the past 20 years. During the process of artifact sharing, Me’e revealed some strong feelings towards the subject of mathematics, which stemmed back as far as elementary school. “Math was the hardest thing for me...I could not get it. I have very bad memories of math. I had a hard time when I came to college to forget the memories and try to do it.” In addition, Me’e shared that he had particular difficulties with the subject due to his documented physical and learning disabilities. “I had to do it the way I think and I have a hard time conceptualizing certain questions of mine because of my disability, so it takes me a while to get it. For my end, I have a disability of memory. For my end, as a student I wish they [teachers] understand not all students are the same. Some students can learn given a test later than learn here and give the test right after.” In his semi-structure interview, Me’e expressed a frustration with his learning disabilities and how he felt underserved by the math teachers in his public elementary school to find alternate ways to present the content in a manner that suited his learning preferences. “I wish the teachers did better to help me in elementary school to understand it [math]. The teachers did not know
how to teach it even though they had the curriculum to follow. The way they taught it wasn’t a way I understood it because probably back then I had issues with development...I wish I could tell them, you know what I don’t understand how you are explaining this to me can you explain it in a different way?”

Upon his completion of high school, Me’e entered the community college, where he learned he was required to take several math courses in order to graduate. Me’e scheduled and took a Compass test and was placed into Math 24. He earned a “D” grade in the course, which did not fulfill the prerequisite grade of “C” or higher to enter Math 25. As a result, Me’e decided to delay his requisite coursework, while he pursued other courses and spans of full-time employment to pay for college. Five years passed before he enrolled in Math 24 again. Me’e shared his perspective of this experience as follows.

I did not mind the first time because I knew I needed it. The second time I was concerned. It’s like do I have to go through this again and they [counselors] told me, yeah. I was willing to do it. If I haven’t had math in 5 years or so between the time to the last. I said to them, I’ll do it again...I’ll just take it for the credit. Even the teacher told me, I tried to do my best, but I was still struggling to understand it.

Me’e successfully completed Math 24 in the second iteration and then proceeded on to Math 25, which was also repeated twice, and Math 81, for a total of five developmental mathematics courses. In his 20 year span of postsecondary education, Me’e experienced many financial challenges, balancing the cost of education with a limited work schedule and full-time academic course load. In his words:

I had the drive to finish it, but finance had become an issue. I could not work enough so I had to stop going to school to try to save up but every time when you get into work you get into this cycle of you have to pay the bills and stuff and you don’t have time to
save. You get stuck doing that until they let you go. Then they let you go and you try to scramble money to go back to school and that’s what happened to me. On and off, on and off. If I was given the opportunity, I would love to finish this [degree].

Me’e is a student of the millennial generation with a documented physical and learning disability, which has resulted in difficulties with long-term memory retention, coupled with physical discomfort if seated in a stationary position for an extended period of time. While Me’e has demonstrated success in the vast majority of his information technology courses, his combined disabilities have proven particularly challenging in mathematics classes. As Me’e has experienced multiple repetitions of developmental math courses, his perspectives were shared as part of the repeater population.

The Hawaiian name Me’e represents the constellation Corvus (The Crow). According to Makemson (1941), the translation of Me’e means “voice of joy.” This name is appropriate for the student participant selected, as he is known on campus as a jovial individual and his voice during the artifact sharing and interview meeting exuded happiness.

**Nanamua**

In this research study, two of the participants were identical twin sisters. Nanamua, a female participant of the millennial generation, was the first of the sisters to share her perspectives and insights with the researcher. During the process of artifact sharing, Nanamua indicated a keen interest in the field of technology and contemporary gadgetry. After entering the community college, she described an initial attempt at a degree in nursing, but her “parents wouldn’t let me do anything in the health field.” Near the completion of her degree, she “took a [computer] networking class and just loved it.” At that point, she decided to terminate the
nursing degree and pursue a career in information technology. “I went into IT and just absorbed so much of what technology can do. I’ve been buying all these gadgets because they’re cool and it’s what defines me.” In her artifact sharing, she provided the researcher with several examples of her collection of gadgetry, including her latest laptop and tablet devices. Nanamua describes herself as feeling “lost and miserable without the Internet” and spoke at length about the use of technology as a “second brain” for her mathematical computations. “If you always have a mobile device, you have no brain to think for yourself... I can always Google search the answers if I wanted to instead of thinking for myself. 2+5, if I don’t want to think for myself, I would just type it in.” Nanamua also described an apprehension to solving mathematical problems that did not involve immediate computation. “My biggest fear in math was word problems. I wasn’t good in reading comprehension and so whenever I got the problem, I would be like I don’t know. Even though I could learn it, but it didn’t hit me until I took Math 103 after five times.” She describes her experiences with math in grade school as “I hated math...part of it is my thinking skill with reading comprehension in terms of word problems.”

In high school, Nanamua took mathematics classes for all four years of her secondary education and also enrolled in summer classes “because the math was the hardest, so I would always take it during the summer.” She completed coursework in pre-algebra, algebra 1 and 2 while in high school. Upon entry into the community college and completion of her Compass placement exam, Nanamua was situated into Math 24, with the expected progression into Math 25. The sequence of these two courses was expected to take two semesters, or one academic year, however due to reasons explored further in the findings, Nanamua had to
repeat Math 25 during three separate semesters, requiring over two years to complete the developmental mathematics sequence. Nanamua’s first attempt at developmental math began in 2002 and she completed objectives for an associate in science degree in Information Technology in 2012. Due to the repetition of Math 25, Nanamua’s insights were shared under the repeater population of this collective case study.

In Hawaiian astronomy, Nanamua is one of the two brightest stars in the constellation Na Mahoe (Gemini), which is widely known to represent a pair of congenial twins, visible at night with arms outstretched around each other’s shoulders. The twins are known to have a strong bond and affection for each other. According to Makemson (1941), Nanamua means “to come first” or to “look forward”. In the Hawaiian sky, Nanamua is the first of the two twin stars to rise at night. The pseudonym Nanamua was given to the student participant because she is one of the identical twins who participated in this research and also came first in the order of interviews.

Nanahope

Within the student participants, Nanahope is the identical sister of Nanamua and came second in the sequence of student interviews. With regards to her academic preparation in high school, Nanamua enrolled in a mathematics course during each of her four years. In the interim between academic years, she also attended math class during summer school, including the summer before she enrolled in the community college at which this study was conducted. During the interview, Nanahope shared that she was reluctantly guided to take summer classes at the request of her teacher. She recollected the experience as follows.
My teacher in high school told me that during the regular school year you will not pass, and I was kind of wondering why, and I guess it’s because my memory can only know so much about math, and she told me if you take summer school you actually do better. I guess because it’s shorter, and quicker, and you can retain faster, which is kind of true, I guess to an extent because that time I took math in summer school with the long division I actually did better, because actually my grades were kind of junk if it’s during the whole long year.

Nanahope also expressed her perspectives on the subject of mathematics when she entered the community college as “I didn’t like math at all and I’ve been taking math all my life until I found my degree. I mean, I should go achieve better, but I didn’t because I knew it would get more complicated.” She explained that her unfavorable views towards mathematics were shaped as early as elementary school “I think it was when I reached third grade because we have to do a math test, and the fact that I failed it. I think it was a quiz. From then I did not like it, that’s when I didn’t like math.” Nanahope also shared how her views were shaped partially by parental influence: “In science you create stuff, and math is just logic, and problem solving, which I don’t like problem solving. And I guess it goes back with my dad saying: ‘science is alive and math is dead.’ I think I took that to heart and that’s why I don’t like math at all.”

Nanahope also perceives herself as an “outsider of math” because, in her words:

I think it’s one of those stereotypical Chinese family things because Chinese usually excel in math, but I didn’t like math because I guess I was an outsider of math because I didn’t get it. I don’t know if where I was sitting at school and trying to understand math or, to me, it should have been presented as literal images…I think I wasn’t trying to understand math because it wasn’t given like that - it was just numbers to your face.

Upon entry into the college, Nanahope took the Compass placement exam and was initially placed into a pre-college mathematics course, which is an optional, non-credit, pass/fail preparation course, usually completed before the recommended developmental mathematics
sequence of Math 24 and 25. Nanahope spoke about her disdain experience with the placement test and the results of the exam as follows:

I was frustrated. I didn’t want to do it. I just took it randomly; and that’s where I got placed. I think if I knew better I would have gotten a higher score, but the fact that it was stressing me, because I had to do back-to-back summer school - and I didn’t even have a summer - and I had to go summer school and then it’s like start up regular year.

Since her placement into pre-college mathematics was optional, Nanahope instead elected to enroll directly into Math 24 and completed it in a single semester. Rather than proceeding into Math 25, she took an alternate path into Math 81, which she also completed in a single semester, and proceeded onward to college-level mathematics. When reflecting on her experiences in developmental math, Nanahope shared a sentiment of regret. In hindsight, she wished she was informed more about the implications of the test placement and the cost of developmental mathematics classes. In her words:

When I was taking my [Compass placement] test I was like ‘I know this’. I could have placed higher... The higher you go in math, you don’t have to pay for the lower classes because the lower classes is like a repeat of high school. It is basically like two classes combined just to pay for your one class of math and it’s kind of redundant in a sense of paying for the same class you’re already taken throughout your high school because the fact that when I’ve taken my math class here I was like ‘heck I knew this -- why do I have to pay so much when I already knew this?’

Even with the regret, Nanahope was able to persist and achieve success at the community college. At the time of this research study, she had completed an associate’s degree in New Media Arts and was enrolled in coursework covering topics of information technology. Due to her completion of the prescribed sequence of developmental mathematics courses, each passed on the first iteration, Nanahope’s voice was included in the completer population of this collective case study.
The star Nanahope (or Pollux), completes the pair of the constellation Na Mahoe (Gemini, or The Twins). Nanahope means “to come second” or “to look behind”, and has been interpreted to mean that it is looking out for its twin, Nanamua (Makemson, 1941). In the Hawaiian night sky, Nanahope rises shortly after the star Nanamua. This also coincides with the age of the twins, as Nanahope was born a few minutes after her sister, Nanamua.

Puana

Puana is a female student participant of generation X completing a degree in information technology. During the interview session, she described herself as being a very structured individual and provided an analogy for herself through culinary endeavors. “Baking is my favorite. Cooking you can think outside the box and create your own unique recipes but in baking it’s very structured. I like that because I always had trouble thinking outside of the box. I’m kind of a recipe following kind of person. So that’s very exact and structured I guess.” Puana also spoke about her experiences working for a sewing machine company and drew parallels with the process of learning mathematics. At the start of her employment, she did not know how to sew, but learned the process through colleagues and family members. When describing her learning process, she shared that “I never went to sewing school, but my mom knows how to sew. Also from working at a sewing store. Our store sold sewing machines and all the girls that worked there knew how to sew. My manager was a teacher from a fashion school so she taught me a lot of tips and tricks.” Shortly after, she related this formative experience in the sewing machine store to her preferences for learning mathematics through peers in the classroom. “We can bounce questions and ideas off of each other which helps a
lot. In the math class I noticed it’s kind of good because with other students we can help each other. At least I knew other kids had issues too. I’m not the only one. I can figure it out, so that’s kind of good.”

Her views toward mathematics are mostly favorable and she described a certain fascination for the subject during the interview. She explained her relationship with math as follows.

Actually, I do enjoy math. It’s an interesting subject. I think it’s kind of cool how you can figure out all of the numbers in the equations or something I guess. At first, I learned, wow it’s just a jumble of numbers, but to be able to come up with an actual answer from it is interesting. I like the thought process. I’m not good at remembering all that stuff, but I like figuring out that stuff. I guess, I like the logic of it too. Going step by step.

Along with her self-described enthusiasm for the subject of mathematics, Puana also expressed a significant apprehension for the examination component of her coursework. She described the onset of anxiety and the resultant effects as follows. “I would take all of the math classes if I didn’t have to take the exams...too much anxiety over the exams. It killed me. In all of my classes though the anxiety of the tests gave me stress. When the test time came my heart will start pounding and I would draw a blank. Oh my God.”

When Puana entered the community college, she took the Compass placement test and the results indicated she take a sequence of two developmental mathematics courses, Math 24 and 25. At the time, she felt that the courses would be useful to her since her last mathematics course in high school was Geometry, taken in her junior year. She was not required to take a math class in senior year, seven years prior. Puana also expressed an opinion that the Math 24
and 25 sequence would cover new topics, such as algebra, that were not presented in her high school coursework. “After I took the Compass exam, I knew I would have to take it [developmental math] because I didn’t know a whole lot. I knew all of the basics but not all of the higher, algebraic expressions.” She was able to complete Math 24 and 25 in a single semester each and thus represents a voice of the completer population of this collective case study. At the time of this research study, Puana had completed all the developmental and college-level math requirements for her degree.

Makemson (1941) states that the Hawaiian name Puana represents a blossom and was selected for the student participant because after a career related to sewing, Puana is attempting a second career in information technology and is blossoming as a new software developer. She also admitted to opening up and feeling more comfortable with her personality while at the community college through exposure to colleagues who later became friends. From an astronomical standpoint, Puana (also called Procyon) is the brightest star of the constellation Canis Minor, which is also known as the little dog.

Kealiʻiokonaikalewa

Kealiʻiokonaikalewa is a student participant from Generation X and came to the community college with prior coursework completed at San Francisco State University and University of California at Davis. His prior experiences with mathematics classes in grade school were favorable and he described his perspective on math as “I like math. I sometimes feel that if I went for engineering I would use it more. Once I see the formula, I understand it very well.
No big deal. I never had a problem. My SAT was 700 or something like that in math. I always had an easy time with math. I took Calculus in high school.” Keali’iookaikalewa attributed his positive views on math back to middle school and the influence of his father, who also served as his math teacher. “My dad was my 5th grade teacher. I don’t think it was legal but we did it anyways at the public school he taught at. Even before that math just came to me naturally. It made sense. Math was just pure. There’s right and there’s wrong. There’s no in between.”

While Keali’iookaikalewa shared his stories of success, he also offered an explanation for his placement into developmental mathematics, content which he had already completed in high school. “It was 10 years since my last math class at San Francisco State.” When Keali’iookaikalewa first entered the community college, he was prompted to take the Compass placement exam because “The school needed to know what I knew so they sent me to the library [site of testing center].” After taking the exam, Keali’iookaikalewa discovered that he would have to complete a developmental sequence of Math 24 and 25 coursework, which would take at least two semesters to complete. Keali’iookaikalewa spoke about his experience with the exam. “Unfortunately all of the math I’d taken, I forgot it all and they made me retest. I tested terribly. I didn’t study for it. If I would have realized, I would have studied and probably passed at least to [Math] 103.” After a series of successes with mathematics in high school, Keali’iookaikalewa felt dejected with his results on the college placement exam:

I felt like a bonehead. I thought it was for bonehead math, what we used to call for dumb kids. So I thought oh, my God I damaged my brain in the last 10 years. What happened to me and then I was like what a minute, I did this all in high school. What is this? This is crap, but I got to do it though. There’s no way around it.
Perceptions aside, Keali‘iokonaikalewa was able to succeed in Math 24, which he completed in the spring of 2012 and then proceeded into Math 25, which he passed in the fall of 2013. He then went on to finish his college-level mathematics requirements for the bachelor’s degree he is pursuing in the field of information technology. Keali‘iokonaikalewa describes the whole process of taking math courses at the community college as follows:

So I spend 900 dollars on that for all three classes which was a pain in the butt, but I got all A’s. It was easy, once I started doing it. Oh, I can’t say it was easy, the homework was tedious and long but it’s math, that is what math is. I understand math.

Due to his successes with developmental mathematics at the community college and his completion of both Math 24 and 25 during the first iteration, his prerogatives and insights were shared in the completer population of this collective case study.

The Hawaiian star Keali‘iokonaikalewa (Canopus) is translated as “the chief of the southern skies” (Makemson, 1941). It is the second brightest star in the cosmos and, viewed from Hawai‘i, spends most of its visible time at night in the southern quadrant. The pseudonym Keali‘iokonaikalewa was chosen for this student participant because, as indicated during his sharing of artifacts, he spends the majority of his free time surfing or sailing along the south shores of Hawai‘i. Since the student participant is knowledgeable and experienced with the ocean around the south shore, which corresponds to the same area that the star Keali‘iokonaikalewa spends during its visible nighttime rotation, it is fitting that the two share the same name.
Summary of Student Participants

The following table provides a summary of all the student participants in this research and can be used as a reference while reading the presentation of this findings in this chapter. The student participants are grouped by case, either repeater or completer. The column heading “Years w/o Math Class” represents the time span between the last mathematics course the student attended prior to enrolling in the community college of this research study. For the first four student participants listed below, the time interval was between high school and community college; for Puana, it had been 23 years since her last post-secondary math course at another institution; for Kealiʻiokonaikalewa, this period spanned his previous post-secondary institution in California and the institution of this study.

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<th>Pseudonym</th>
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<th>Category</th>
<th>Academic Major</th>
<th>Degree Objective</th>
<th>Years w/o Math Class</th>
<th>Years Pursuing Degree</th>
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<td>Bachelor of Applied Science</td>
<td>10</td>
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Faculty Participant Profiles

Aʻā

At the time this collective case study was conducted, Aʻā was serving in the capacity of department chairperson of developmental education within the research site. Prior to her current position, Aʻā taught English composition at the developmental and college level for nearly 14 years. Aʻā shared that “there is a certain transferability from developmental composition, yet also unique aspects to the math situation.” Even though her expertise involves developmental writing and composition, she “gets just as interested in the math side.” During her interview, Aʻā spoke about her inspiration to become an English professor which came by way of an unfulfilling first career in the publishing industry.

I thought I always wanted to be an editor and I graduated from college when I was 20 and got a job as an editor in a San Francisco publishing company. I took a train every day. I had to be there at 8:30 and I had to be in my cubicle until 4:45 and I thought I would freak out in this cubicle. I hated it instantly. I liked the work but hated the atmosphere.

As she voiced her disdain for the confinement of her position as an editor, she also reflected that it afforded her exposure to the possibility of a teaching career. In her words, “I got into teaching through service learning. Basically, this publishing company had a work release program and we could go out into the community and volunteer...I could get out of the cubicle for two hours a week and I was like yes, sign me up! Where do I go?” Aʻā volunteered her time at a homeless shelter and “tutored people in reading and writing poetry, with totally crazy homeless people...It was an intense environment and I felt so much more at home in the north Tenderloin San Francisco homeless shelter versus the corporate cubicle.” This experience
showed Aʻā that she “was uncomfortable being where I was groomed to be, where my level of education and my aptitudes tracked me for this career.” Aʻā also shared that in her early twenties, she “didn’t have the drive to make money. It wasn’t imperative to me. I just wanted to do good...I wanted to teach poetry in a homeless shelter.” Aʻā soon realized that she could congruently teach and “have a reasonable and professional living in a community college” and began as an adjunct faculty member at the research site before being hired full-time. Aʻā related her motivation for teaching English composition within the developmental education department to formative experiences in community based education. In her words:

The professionalization of education allows you to stay in it, but I miss sometimes that gritty quality of really community based education. But that’s the reason I’m here in the developmental ed. department and that’s what I love about it, is that it’s the gritty edge. You get to meet the most interesting people...It remains what I love about teaching. I love the incongruousness and the chance of it, like you all signed up for this class and look we have 32 sessions together. Me and all of you, and otherwise we would never have met.

In addition to over a decade of teaching English composition, Aʻā recently completed a Doctor of Philosophy degree in Educational Administration, which she is currently utilizing in her position as department chairperson. In many of her interview responses, she drew upon her wealth of educational research. When describing her teaching philosophy, she discussed employing the principles of Lev Vygotsky’s (1978) work on the zone of proximal development within developmental education.

The zone of proximal development, that’s basically my teaching philosophy. That’s the whole game. That’s the skill of it is to understand the zone of proximal development for 20 to 35 people who are each individuals who are all starting from the side of a different place. How much do they know? What can they do by themselves? What can they do with just a little bit of help?
In addition, Aʻā’s teaching philosophy is shaped by other educational researchers. As she explains:

My second aspect of my philosophy is concept of unconditional regard. This comes from the work of Nel Noddings, who talks about love. It’s unconditional love, but we use the phrase unconditional regard. It sounds safer. I would like to say, it’s about love to my students, but then I sound like a hippie, right? But unconditional regard is nice, professional and it’s true.

One measure of the effectiveness of Aʻā’s teaching philosophies, as well as pedagogy within the classroom, is evidenced by her recent award earned for excellence in teaching at the University of Hawaiʻi system-wide level. At the time of this research study, she was serving as department chairperson of developmental education, thus her perspectives are shared in the role of administration within the population of the four faculty participants.

As a Hawaiian navigational star, Aʻā (Sirius), is known to astronomers as the brightest star in the night sky. Aʻā has been translated from the Hawaiian language to mean “burning brightly” (Makemson, 1941). In addition, Aʻā also serves as the zenith star of Tahiti, which means that at the latitude of Tahiti, Aʻā is directly overhead an observer when it reaches its nightly culmination. As is discussed in the findings, Aʻā’s dedication to her students burns brightly, hence the pseudonym assigned to her.

Kamailemua

Kamailemua is a counselor within the developmental education department, with a collective total of 36 years of counseling experience, 28 of which had been spent at the institution in which this research was conducted. During the process of artifact sharing,
Kamailemua shared her background on how she decided on a career in counseling. In her words, the journey began in college.

I was really lost in college. I’ve experienced all the things students go through. Identity crisis, major, what are you going to do, who are you, where the heck are you going and how are you going to get there? I was always curious about how do people become who they are? That’s always something I’ve been interested in. How do you grow in becoming the best? In college I was basically lost, so I looked into a psychology major but I knew I wouldn’t get anywhere in that, so I decided to go into education. I thought at least I could work with the little kids. Maybe I could plant seeds. Maybe I could make a difference. Maybe I could have control. Somewhere along the line, I stumbled into counseling and I just fell in love with it. I just knew in my heart this is what I could do without pain and still have passion for it. I stumbled into it and I loved it.

Prior to her full-time counseling position at the community college, Kamailemua served as a counselor for 10-year-old elementary school boys in Waimanalo, Hawai‘i. In this formative experience, she described challenges with the students and an overall dissatisfaction with “things in the system” that she could not fix. In her words, “I loved them but they were a handful. It wasn’t for me. I couldn’t handle them...I wasn’t really happy.” Following this experience, she dedicated eight years to counseling on the mainland and then returned back to the state of Hawai‘i to serve as a counselor within its community college system. During the interview, Kamailemua described a passion for her current counseling position and elaborated on her philosophy of counseling.

I really believe in the human potential to grow, to create, to change and to evolve into whatever they want. That basically human nature is good. Everyone can learn. Everyone should be evolving if not. We should learn how to make every experience we go through and grow from it. Whatever that is. There is a jewel in every student, so basically I just believe that good things happen when students realize and recognize who they are. Our job is basically to help them figure out where they’re going and how they’re going to get there. So that’s counseling in a nutshell.
Her perspectives on counseling and supporting developmental education students are further elaborated in the findings of this research. Kaimaelemua represents one of the two counselor voices in this study and her experience is shared as part of the faculty participants.

The star Kamailemua (Beta Centauri) is part of a constellation that is known in Hawaiian navigation as Na Kuhikuhi (The Pointers). Together with its partner star, Kamailehope, these two stars connect to point directly at the Southern Cross, which is used in navigation as a primary indicator of the location of the south celestial pole. Kamailemua is translated from Hawaiian as “the first maile” (Makemson, 1941). Maile is a sweet smelling, flowering plant endemic to Hawai‘i that is often used in the composition of a lei (wreath of flowers). Often times, maile lei are presented to an individual as a welcome, in adornment, or in recognition of an accomplishment. The pseudonyms, Kamailemua and Kamailehope, were reserved for the developmental education counselors who participated in this study, as counselors serve to “point” students in a successful direction and also provide a warm welcome and recognize student accomplishments, similar to the maile lei. The pseudonym, Kamailemua, was given to one of the two faculty participants who represented the counseling population of developmental education. Since Kamailemua means the first maile, the pseudonym was given to the counselor who first began serving in the developmental education department.

Kamailemua

Kamailemua was a relatively new member of the counseling faculty within the developmental education department. At the time of the interview, she had been working with the department for a little over two years, but in her career, she had a cumulative total of 17
years of counseling experience at the institution of this research study. Prior to joining the college faculty, Kamailehope spoke about the periphrastic path she followed on her journey to becoming a counselor.

I came into counseling a little by an accident. Part of it was when I was growing up, I always wanted to know why. Why are things the way they are? When I got older I realized there aren’t any answers. I chose psychology as a major to discover why things are the way they are. Why do people think the way they do?

After completing her Bachelor’s degree in psychology, Kamailehope entered a graduate program to study rehabilitation and school counseling because “it was a little bit more hands on and more application based.” During her years of graduate study, she volunteered at a rehabilitation hospital working with adults who had “traumatic brain injuries and spinal cord injuries.” During this impressive time, Kamailehope expressed that she began to “look at peoples’ abilities as opposed to disabilities” and continued this belief into her school and rehabilitation counseling practice.

I worked at an elementary school, middle school and then rehabilitation counseling, working with adults with disabilities, helping them. I think the whole goal of that was how to support people with disabilities to live healthful, productive meaningful lives. When I graduated there was a hiring freeze going on with the state. My college professor put an ad on my desk and it was a community college counseling position. I said, I can’t do that. I’ve never worked at a college and I really wanted to work with adults with disabilities. She said [Kamailehope] transferable skills. So, I applied for the job and...that’s how I ended up in college counseling. The core of counseling is human development, human potential and how do you help people to problem solve and navigate through. I think that’s the part that I could apply to different fields. I did love that about counseling, especially with rehab, looking at the potentials and looking at the abilities and how to help build on that.

During the process of artifact sharing, Kamailehope explained her capacity as a counselor by drawing parallels to aspects of Pacific Island voyaging and navigation. She viewed
students as the navigators of their lives with visions of their destinations and considered herself as a guide along their journey. In her words:

I see my role as helping them way find. That’s what we constantly talk about in our unit. Helping them way find and looking at their strengths and special gifts and just recognizing that for them and helping to encourage students. Helping their way into college and beyond when they leave us. So I see that as my role as a counselor.

Kamailehope explained that her views of counseling also align with the developmental education department’s vision to guide students along their college journey. She spoke about the importance of establishing rapport early and elaborated on some of the strategies she employs as a counselor. In her initial meetings with students, she asks them questions about their motivations to complete a college degree and support strategies that may help them to succeed. In line with the voyaging analogy, Kamailehope asks students to visualize their future destinations, in regards to career choices and goals. She explained the process as follows:

I think sometimes students don’t realize their life experiences and certain attitudes they have can really help them in college. So getting them to kind of recognize that just by asking them questions about their previous life experiences or what they think is going to help them to really survive college and keep going. It’s kind of the questions I ask them. Sometimes they express it any way they want to. Looking at where is their destination, where do you want to go? What are your hopes and dreams? Let’s look at ways to help you get there. Again, they’re the navigators, but we just kind of find a way for them to way find. Building that from that foundation of what do they envision for themselves and what do they have within themselves that is going to help them get there. I think they come to us with so much already.

With regards to the selection of her pseudonym, the star Kamailehope (Alpha Centauri) is part of the constellation known to Hawaiian navigation as Na Kuhikuhi (The Pointers).

According to Makemson (1941), Kamailehope is translated as the second maile (Makemson, 1941). Kaimailehope is also recognized by astronomers as the third brightest star in the night
Kamailehope was given to the second faculty participant to represent the counseling population of developmental education.

Kapuahi

Kapuahi was the first faculty member to be interviewed for this qualitative research study. On the day of the interview, he was retiring from a distinguished career in mathematics education with over 38 years of experience. Kapuahi taught developmental mathematics at the community college of this study for 25 years and earned an excellence in teaching award for his service and accomplishments. This year was also momentous for him, as Kapuahi was celebrating his 70th birthday and retiring to spend more time with his wife, children and grandchildren. For Kapuahi, this interview served as a culminating account of his career in mathematics education. Early in the interview process, Kapuahi explained his affinity for the subject of mathematics and the certainty of its solutions.

When I was in college, I liked math. I always liked math because there was a right answer and a wrong answer and it wasn’t a discussion thing...I got my degree in business because when I got out of high school and went to college, I didn’t know what I wanted to do. I had no idea, like a lot of folks. Anyhow, I took business and I found that I liked the math. The more mathematical the courses were, like the math and statistics and stuff, the more I liked that and the less I liked the talk about stuff.

As an educator, Kapuahi dedicated nearly 40 years of his life to teaching in a variety of schools, including a private high school on the Caribbean island of St. Croix, a private high school in the state of Hawai‘i, and a quarter-century within the community college of this research. His path to a career of teaching developmental mathematics was circuitous and varied. During college and into his years of graduate business school, Kapuahi “started putting
up musicians in my house and one of the bands I was putting up in my apartment said: ‘We need people who understand business and numbers, why don’t you be our road manager? So, I dropped out of graduate school and went on the road with a black blues band. Then I did music business, but then I got tired of being on the road.” After several months of reflection, Kapuahi made a clear decision on his path toward teaching. He described the internal debate he was having as follows:

I really wanted to do something to help people and teaching seemed like if I can teach, I can help people. It will be easy because I like math, I thought. This is what I was thinking. It’ll be easy, I just like math, I’ll go back and try to teach math. So, I went back to school because I was getting married and I wanted to get off the road, because music, living on the road is crazy. I got married and went back to school and took a year and got certified as a teacher and went into teaching.

Kapuahi was convinced he made the right career change and expressed repeatedly throughout the interview session how much he “loves helping other people. I really love these people and I want to help them. I get as much back from them as I give to them. You know, a hundred times over, every single day.” Kapuahi mentioned a personal connection with students who were experiencing particularly difficult life situations, as he could relate through his own background. Kapuahi was raised by his mother in upstate New York in a single parent family and was the first member to attend college. His family endured financial hardships, trying to make ends meet in order to pay for college, much like many of the students he taught in developmental math.

I started to realize that a lot of us are single parents, which was my mom, whole bunch of people who are having a hard time getting by in life, which was my mom and me and my brother. We were like the only unit in the world that we had. So, I really realized that these were my people. I don’t know if it got deeper because of that or what, but
somehow it turned out it’s all I wanted to do. I realized then...I mean teaching math, I love it.

Kapuahi also described how, over the years, his connection with his students deepened both in and out of the classroom. He spoke about building rapport with his students by engaging in activities that interested them. His mantra for developing relationships in the classroom was to “find out what the student loves and help them become that. Help them become what they want to become.” Outside classroom hours he participated with students in mutual interests. Kapuahi shared an example of the relationship building during the interview.

I started a band with the kids, and maybe this is why I relate to students and maybe it’s partly how it all worked, because they ended up being like my kids and my friends at the same time. We had a band and then we ended up playing at concerts, opening act at different concerts. My experience from the music business helped us, helped me, know how. In the end, one of those guys now, he’s touring the world.

As Kapuahi was both answering interview questions and providing an emotional account of his nearly 40 year profession, he reflected deeply about the importance of teaching in his life. Repeatedly, he mentioned

I’m really lucky. I got to do what I love. There’s nothing that I love more than helping other people. I mean how much higher can anything in the world make you than that? I’d sign up and they would ask me ‘What math course do you want?’ and I’d say the lowest level possible, please. Let’s go to work!

Kapuahi expressed a passion for teaching mathematics and helping others throughout the interview. For the purposes of this research study, Kapuahi’s insights represent the perspective of a faculty member engaged in the teaching of developmental mathematics.

The pseudonym is derived from the Hawaiian navigational star, Kapuahi (or Aldebaran), which is translated from Hawaiian into the expression “sacred fire” (Makemson, 1941). It is
part of the constellation Taurus (the bull) and in mythology is often depicted as the red eye of the bull. The faculty participant given the pseudonym Kapuahi was selected for his fiery personality and passionate views about developmental mathematics, which surfaced in both the artifact sharing and interview process.

Summary of Faculty Participants

The following table provides a summary of all the faculty participants in this research and can be used as a reference while reading the presentation of this findings in this chapter. The student participants are grouped by position and are listed below congruent with their interview order. The column heading “Years in Profession” represents the cumulative time each participant has served within the position listed below. For example, Kapuahi had 38 total years of experience teaching mathematics in all of the schools he worked in. The “Years at Institution” column represents the time span a participant had spent serving in their position at the institution of this research study.

<table>
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<tr>
<th>Pseudonym</th>
<th>Gender</th>
<th>Position</th>
<th>Department</th>
<th>Years in Profession</th>
<th>Years at Institution</th>
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<tr>
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<tr>
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<td>Mathematics Educator</td>
<td>Developmental Education</td>
<td>38</td>
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Data Analysis

Creswell’s (2013a) data analysis spiral was used for this study. Four loops, outlined by Creswell (2013a), were used including: (a) organizing the data; (b) reading and memoing; (c) describing, classifying, and interpreting the data into codes and themes; and (d) representing and visualizing the data. This spiral consisted of, “moving in analytic circles rather than using a fixed linear approach” (Creswell, 2013a, p. 182).

The first stage of analysis, organizing the data, involved the verbatim transcription of each digitally recorded interview into a Google Doc. Sensitive information such as the names of students and faculty members were identified with the use of pseudonyms. Data were organized into online file folders according to the four affective characteristics under study: attitude, locus of control, anxiety and self-efficacy (Creswell, 2013). Google Drive was used to securely host these folders and facilitate data sharing with the graduate adviser of this research.

The second step of analysis was reading and memoing the data, which involved “…trying to get a sense of the interview as a whole before breaking it into parts” (Creswell, 2013a, p. 183). The researcher listened to the digital recordings, read the transcripts, and reflected on each interview several times. This allowed the researcher to become immersed in the data and, as a result, developed a sense of familiarity with the content. Memos consisting of initial impressions, key ideas, and recurring themes were written in the margins of the transcripts by utilizing the comment feature of Google Docs. This began the preliminary interpretation or exploration process of the database (Creswell, 2013a).
In the third step, the researcher described, classified, and interpreted the data. The researcher, working more carefully through the transcriptions, recorded initial thoughts, interesting participant statements, and possible codes in the transcription’s right margin. In addition, the margin of the transcription was used to capture emerging themes found in the data. Codes and emergent themes were differentiated by use of a label, either “Code” or “Theme” in the comments of each Google Document. After the initial descriptive phrase, the list of codes was scrutinized and clustered together (Creswell, 2013a).

In the fourth step, multiple experiences and perceptions of the participants were described. Verbatim comments were used to emphasize the participants’ experiences. Individual and cross-case data were used, and the study’s findings were guided by the main themes that emerged from the data. Analyzing the data in this manner allowed the researcher to develop naturalistic generalizations from the three cases of the study.

Presentation of the Findings: Five Major Themes of the Research Study

Theme 1: Attitude – Role of Prior Experiences

When conducting the synthesis of qualitative data from the participant interviews, artifact sharing, and researcher’s journal it became apparent that students reported entering developmental mathematics with preconceived notions and rooted attitudes about the subject stemming from prior experiences. The spectrum of attitude ranged from highly unfavorable to favorable and was present in both completer and repeater cases. Some students in each case reported an affinity for mathematics, some expressed a contempt for the subject.
Unfavorable Attitude towards Mathematics

In this research study, both within-case and cross-case analysis revealed that half of student participants formed a predisposed, unfavorable attitude towards developmental mathematics before entering the course, typically stemming from experiences in mathematics classes during primary and secondary school. Meʻe (Student, Rep.) described the formation of his attitude in the following way:

Math was the hardest thing for me. The way the teacher taught me, I could not get it. I have very bad memories of math. I was having a hard time when I was coming to college to forget the memories from elementary school. For some reason it keeps bothering me. So, it is a psychological thing that what happened to you in the past does affect what happens to you in college. If you were to ask my history of math, I would say a very bad history. I wish it was better and wish the teachers did better to help me in elementary school to understand it.

Nanamua (Student, Rep.) had a similar aversion to mathematics, expressed by her disdain of taking mathematics classes throughout high school, during both the academic year and summer school. In her words, she took these math classes:

Just to get rid of it, but I couldn’t. My mom was like, well since you aren’t doing anything during the summer, you better take math during summer school. I’m like why? It’s not like it would benefit me…I just took it. I never liked math. Only reason I took math every year was just to get rid of it so I can take something else.

In addition to experiences in grade school mathematics shaping negative views, research data revealed that other individuals influence attitude towards mathematics. Student participants recounted memories of what relatives and friends have said about mathematics that has, in turn, shaped their own attitude. Nanahope (Student, Comp.) described an influence her father left upon her:
I don’t like math. Too much thinking. It is too much thinking and I guess because it will take me a really long time to find out a solution if I don’t know what it is. But if it’s between math and science, I’d pick science. Because in science you create stuff, and math is just logic and problem solving, and I don’t like problem solving. And I guess it goes back to my dad saying: ‘science is alive and math is dead’. I think I took that to heart and that’s why I don’t like math at all. And I know why because my science grades are better than my math grades.

Nanahope offered a perspective that was prevalent throughout the cross-case analysis. At some point during their lives, participants shared that either a friend, relative, teacher or even television show had shaped their attitudes towards mathematics. Parents and engaging teachers often influenced student participants to have favorable views, while friends and discouraging teachers imparted adverse attitudes towards mathematics. During the interviews, student participants recollected painful memories, typically involving authority figures in their grade school mathematics classes.

The faculty population of this research agree about unfavorable attitudes being formed throughout students’ K-12 mathematics classroom experiences. Kapuahi (Faculty, Educator) spoke at great lengths about many of his students feeling as if they had been branded as failures by authority figures in mathematics classes. He believes many students adopt unfavorable attitudes about the subject itself due to the pain they have endured by this categorization. Many students feel the agony they experienced in grade school will continue throughout their post-secondary education, including their developmental mathematics courses. Kapuahi describes the torment as follows:

You’ve been told for the better part of your life, that there is no way you can do it [math]. You just walked into a place that the chances are it would be a miracle if you didn’t fail. You are a failure and they’re putting you into a place when you’ve been proven a failure repeatedly because you wouldn’t be at this level of math at this age if
you hadn’t failed a lot of math, so this is not a hypothetical. Now, how do you feel? Hopeless. There’s no way I can do this. I’ve never been able to do this. There’s no chance I can succeed. I’m going to be belittled, feel even worse than I did when I walked into this room, but somebody said I had to do it.

Administration within the developmental education department is well aware of the negative attitudes previously instilled in many developmental students. From the perspective of Aʻā (Faculty, Admin), the department chairperson, students generally perceive both mathematics and English composition to be harrowing experiences. She was quick to identify that these students enter class with a preconceived deference towards mathematics; that these learned attitudes are systemic and pervade elementary through high school years. She emphasized that part of the responsibility of a developmental educator is to undo the attitude damage accumulated in secondary schools. Aʻā further elaborates:

Most of our [developmental] students are recent high school graduates. They went to our public high schools and I’m not blaming our public high schools, but they’re not learning math in high school. They didn’t take high school seriously, or they didn’t take math as a senior. Many of them hate math and they hate writing. They have a predisposition. They have learned negativity before the first day of class, so developmental education starts from unlearning whatever the negativity comes from.

During the within-case analysis of the faculty population, the counselors, Kamailemua and Kamailehope shared a frame of reference for how some students might develop an unfavorable attitude towards mathematics subliminally through the attitudes of figures of authority, as early as elementary school. The premise supported by both counselors is that elementary school teachers are required by their profession to teach a multitude of subjects, in which they have a varying degrees of ability. For some elementary teachers, mathematics is the subject in which they are the least proficient and consequently least confident about. This
lack of confidence may be transmitted to their own students and shape their attitudes towards mathematics, whether the teachers realize it or not. Kaimailehope (Faculty, Counselor) explains:

For elementary teachers, a lot of them select elementary education as a major and a career because they like the breadth and maybe not necessarily having to know the depth of each subject they’re teaching, like math. I know that they’re doing research on elementary teachers’ attitudes towards math and so I know that there are some, and I know it’s not the teachers’ faults, but if you have educators that chose the specific profession because they themselves don’t feel confident in math, that attitude, subliminally and unconsciously, could get relayed to the elementary students and growing up through middle school and high school...that math is a scary thing, math is an unknown thing. Totally not intended, but educators may have planted some fears or apprehension towards math.

Kamailemua (Faculty, Counselor) further elaborated on her colleague’s remarks by explaining that the transfer of attitude and lack of confidence from teacher to student is likely to impact their future performance in mathematics. She offers poignant commentary that an unfavorable attitude towards mathematics may contribute more to their performance (or lack thereof) on the mathematics placement exam when they enter college than any of the other affective characteristics under inquiry in this research. In her words, “That whole not liking math or having negative experiences, that’s more overriding. That may affect where they place on the placement and hence their enrollment in below Math 100 level classes. I see that more often than any other characteristics.” Me’e (Student, Rep.) shared his experience in elementary school, which further supports the position advocated for by the counselors in his remark:

The teachers did not know how to teach it [mathematics] even though they had the curriculum to follow. The way they taught it wasn’t a way I understood it. I wish I could tell them, you know what I don’t understand how you are explaining this to me. Can you explain it in a different way? We did not have special teachers like that.
From what participants in the repeater case and all participants in the faculty case shared, painful experiences and unfavorable attitudes towards mathematics contribute to a utilitarian condition in which students delay or attempt to avoid mathematics at the postsecondary level. This may be due to attitudes of teachers or others in positions of authority throughout grade school, in which unfavorable views were imparted to and internalized by the students themselves.

**Favorable Attitudes towards Mathematics**

The interview data supports this position for the completer case, as several examples emerged where a student’s positive attitude towards mathematics coincided with a successful completion of his or her sequence of prescribed developmental coursework on the first iteration. The data show this association, as emphasized by Keali‘iokonaikalewa (Student, Comp.):

I like math. I sometimes feel that if I went for engineering I would use it more. Once I see the formula, I understand it very well. No big deal. I never had a problem. My SAT was 700 or something like that in math. I always had an easy time with math. I took Calculus in high school.

Puana (Student, Comp.) shared a similar viewpoint and explained during her interview that teachers in her grade schools made mathematics engaging. Her favorable attitude towards mathematics indicates that she would pursue higher levels of coursework, past developmental and even math courses required for her degree. She offers the following perspective.

“Actually, I do enjoy math. I don’t dislike it. I would take all of the math classes if I didn’t have to take the exams. I like it because it’s interesting.” Student participants expressed a penchant for tackling problems that were clear cut. The participants enjoyed the certainty of an answer
and promptly knowing whether a solution was correct or not. This may further support Oblinger’s (2003) research about the millennial generation’s desire for immediate feedback. Kapuahi (Faculty, Educator) shares a perspective of how he prefers the definitive solutions to mathematical problems and sought out a career in teaching mathematics.

Anyhow, I took business and I found that I liked the math. The more mathematical the courses were, like the math and statistics and stuff, the more I liked that and the less I liked the talk about stuff. I love helping people. I love math, I’m really lucky. I got to do what I love. I really wanted to do something to help people and teaching seemed like if I can teach, I can help people. It will be easy because I like math, I thought.

There is also a trend across cases indicating that students will have more favorable attitudes and a greater inclination to learn mathematics if they are aware of the utility, or usefulness, of the coursework in their daily lives. Me’e (Student, Rep.) speaks about the utility of mathematics as applied to his future career:

If my job depended on it I would definitely learn it immediately. You’re going to need math wherever you go. I mean in business, talking about finance. I need to know math because the world runs on math, so it’s part of our life. But, if I was getting a job that does not deal with math I would not use it at all. Then I would forget and I would have to go back to school and relearn this whole process again.

Both faculty and students see eye-to-eye on this issue. Across student and faculty cases, the notion of not seeing the utility in mathematics classes is associated with unfavorable attitudes toward the subject. Students often voice their concern in the comment “When are we ever going to use this?” which indicates a disconnectedness between the course content and the expectations of their daily lives. Faculty are aware of this detachment, particularly in developmental education. A’ā (Faculty, Admin) poignantly expressed the conundrum in her remarks:
Math is so weird because we don’t really use it in our daily lives. We really don’t, so students are so hung up on like who uses this? It’s not visible. We don’t see math in action. It’s kind of hidden and computers do all our math.

**Utilitarian Function of Attitude**

The findings from the qualitative data, including interviews and artifact sharing with student and faculty participants, indicated a utilitarian function of attitude. According to the widely cited psychology research of Daniel Katz (1960), the utilitarian function of attitude is founded on the notion that an individual will make decisions based upon producing the greatest amount of happiness and will deliberately avoid situations that are painful or of little use. A student’s attitude on developmental mathematics is clearly based on a utilitarian function when the decision revolves around the amount of pain or pleasure it brings. On the other side of the utilitarian function of attitude, Katz (1960) explains that individuals pursue experiences that bring pleasure, thus under this lens, students who had positive or even happy memories of mathematics are likely to have favorable attitudes toward it.

When the qualitative data were synthesized, patterns emerged showing students with unfavorable attitudes toward mathematics associated with painful experiences in their previous K-12 classes. In cross-case analysis, the majority of students from the repeater case reported a dislike of mathematics, while the consensus of completer students enjoyed or were interested in the subject. All three cases agreed that friends, family, or teachers had shaped student attitudes towards mathematics, whether they be favorable or unfavorable. This particular finding dovetails into the next theme, “Locus of Control – Amotivation by Way of Irrelevance, Intrinsic Curiosity through Engagement.”
Theme 2: Locus of Control – The Influence of Motivation

Locus of control is conceptually defined as the extent to which individuals tend to accept responsibility for their own behavior, the results of their behavior, or both (Messick, 1979). Messick further elaborated that locus of control contrasts internals, or individuals who think of themselves as responsible for their own behavior with externals, or individuals who attribute responsibility to the force of circumstances, or other individuals, or luck (1979). When explaining locus of control among developmental mathematics students, it is imperative to include a discussion of another closely related trait of students, their motivation. As Andersen and Bourke (2000) elaborate “Among the affective characteristics empirically linked with motivation are locus of control and interest” (p. 3).

Irrelevance and Lack of Motivation

Student participants across cases were clear to explain that often times they did not see relevant connections between developmental mathematics and their own lives. Many expressed a desire to learn mathematics if it was applicable to the “real world” or future careers. Without a relevant connection to the issues of their daily lives, students felt unmotivated or even averse towards learning developmental mathematics. The relationship between irrelevance and lack of motivation is strongly supported by student testimony emerging from within and cross-case qualitative data analysis. Me’e (Student, Comp.) shared the following perspective:

It [developmental mathematics] just gets harder and harder as you move along. I’m going through it just to make it through the degree, but what relevance? Why can’t I learn the basics of mathematics to make it in the real world? If they could bring the
relevancy within the math class and say, okay this concept we are learning is really important for this purpose, then it would make sense to me, but a lot of times it’s not. A lot of times teachers don’t teach you the relevance of what you’re learning. Like, if you’re going to be a phlebotomist you need to know these things or if you’re going to be a doctor or something you need to know those things. Then it would make more sense.

In addition to a feeling of irrelevance, student participants in both cases described the current state of curriculum in developmental mathematics as being wasteful of their time. Many students feel tension between the pressures of their everyday lives and the completion of developmental mathematics in fulfillment of their degree. In many cases, students express a complete lack of motivation for learning mathematics, but in a few instances they demonstrate external motivation to complete the coursework for their college degree or career requirements. Keali‘iokonaikalewa (Student, Comp.) summarizes his sentiments as follows:

I think it’s wasteful. It’s nice to have a basic knowledge of mathematics, but we don’t really use any of the other stuff in the real-world. Outside of that my motivation was get what was required for the degree. I wouldn’t do it for fun. I don’t go home and go solve this. The old regurgitation sucks. We’ve been in education for how long? Seems like math is a lot of regurgitation and little application. So much in my brain I don’t want to know anymore.

From Keali‘iokonaikalewa’s position, he verbalizes no interest or enjoyment in the subject of mathematics itself. His degree requirements provided enough external incentive for him to complete the sequence of developmental coursework and he emphasizes that irrelevance and “regurgitation” in math class are primary sources of his lack of motivation.

Puana (Student, Comp) also stressed the importance of relevant coursework and expressed that students would “get it” if word problems were related to their lives. In her words:
Bring it down to more relatable or understandable level. Don’t talk so technical and you can use things that are relevant to life. If it’s too general, like those distance problems, students are like what? What?!? One instructor broke it down to if you were coming from Mililani and I’m coming from Honolulu and we’re going to meet somewhere in Pearl City and x amount in distance, I’m going 55 mph and you’re going 75 mph, something like that. It seems like students get it then. When you put it in those kind of terms instead of saying, car x and car y. That seems to help. That’s what I liked about teacher. He made the word problems a little more relevant.

The developmental education counselors, Kamailemua and Kamailehope, are in agreement with the students’ analysis. Both counselors expressed an external motivation for students to complete mathematics courses for degree requirements. If a student needs the mathematical skills for their future career, they will be inclined to learn the content. However, under the current structure of developmental math curricula, counselors are keen to explain that students do not take these courses because they find them inherently interesting or enjoyable. Thus, for most developmental students, mathematics is a matter of compliance to fulfill a college degree, but not intrinsically motivating. Kamailemua (Faculty, Counselor) explains the situation as follows:

I going to start by saying that they’ll probably be motivated if it’s something that’s required by their degree or career goal that they want. If they really want to become a nurse, they want that nursing degree, and let’s just say Math 100 is part of that, and they’re placed into developmental, let’s say Math 24, they’re going to want to feel motivated to do it because that’s going to lead them to their nursing degree. I have seen the motivation, even if they feel like they’re not good at it. It’s like “I got to”, “I need to”, and “got to pass this.” So, they’ll take it as many times because they want the nursing career. I think that naturally motivates students in my experience. Motivation by itself: coming in and saying “I’m really excited about developmental math”? I don’t think so, not on its own.
Another student participant, Nanamua (Student, Rep.), explored this mathematical amotivation from a locus of control perspective. She felt that when mathematics content is not relevant or engaging, why should she bother to learn it? Whenever she brought up this viewpoint with her teachers, she would be “at fault” for challenging the status quo. In her mind, she is “right” to expect relevant coursework, but she felt “at fault” for taking action to change the course. In her views, she adopted a strong persona of external locus of control, in which she assigns responsibility for the irrelevance of course content to other individuals, namely her teachers. In a nutshell, her struggle for a relevant mathematics curriculum and the letdown of losing her battle left her in a state of dejection. She summarized her argument as follows:

It’s not me that’s the issue. It’s always them and if it’s ever my fault then I won’t do anything like in terms of it’s always not my fault in any given situation because I’m always thinking I’m right and at times, I mean most times the battles I’ve taken it’s always never my fault and I just left it like that because if I argue more and more, then I would need more therapeutics.

Some students express an external locus of control, but place the responsibility for the amotivation towards mathematics on the system, rather than the instructor. Kamailehua (Faculty, Counselor) shared an anecdote about a student who spoke with her at lengths about the failure of the developmental education system for not having alternate means of teaching the mathematics content. The student emphasized that he had failed developmental math a multitude of times and placed an external locus of control for the repeated failures on the department. Kaimaimua explains the situation as follows:
I had a student come yell at me about not passing his math class. He didn’t blame the instructor at all -- he blamed the whole system, the department not having another way of teaching math. And he having failed so many times, asked why are we still teaching him the same way, kind of thing?

The implications for a student who does not complete their developmental coursework are dire. As Kamailemua continued to elaborate:

There are some students who have taken Math 25 maybe three or four times -- very frustrated over it -- and they leave school or change careers. That’s the detriment we see...With math, if you don’t show up when you’re supposed to show up, you lose the sequence and you lose background and you’re behind already and then coming back trying to understand how you got to Z when you were on B and you’ve gone in-between here and there, it’s one of the hardest things. It’s not like history where you pick up your book and you can kind of continue to read. Students don’t realize it that when they get back on board they can’t learn the math any more. From then it’s just a lost cause and the teacher will say withdraw.

Part of the challenge of motivation and locus of control in developmental mathematics involves the content of the course and the way it’s delivered in the classroom setting. Faculty participants spoke at length about the complex and varied “life issues” that many students face on a daily basis. Often times, the immediacy of struggles and issues outside of the classroom take precedence over the learning of mathematics in fulfillment of a degree, particularly if students view the content as irrelevant. A‘ā shared insight about the complex life issues that the students in the developmental education department face, often times overwhelming their motivation to learn mathematics. A‘ā (Faculty, Admin) describes a “dissonance” between utility, relevance and the abstractness of developmental math:

There are other motivational issues, like the thing I see with students having mind boggling life problems. Mind boggling. Cancer, relatives with cancer, prison, homelessness, and cars that breakdown, shitty retail jobs with bosses that don’t have any interest in these kids going to college, surf...It’s very hard to see the importance of Math 24. I don’t teach Math 24, but my impression is it’s too highly abstract when
students are dealing with so many real and so many immediate issues. Looking at equations? Just seems crazy. Just seems ridiculous...I would say it [lack of motivation] comes from the mismatch of math seeming useful versus all the things available for my time right now. I have so many things to do, why on Earth would I study that equation? It’s a dissonance between immediate utility and gratification versus abstract computational practice.

Engagement and Motivation

On the other end of the spectrum, cross-case data analysis among students and faculty revealed higher reported motivation when an instructor engaged students in the subject of mathematics, often times by using diverse and non-traditional pedagogical approaches. Some students, in particular, shared fond memories of their experiences in mathematics based upon contributions of their instructor. Students from both completer and repeater cases shared stories about things their teacher did, both in and out of the classroom, to make mathematics more accessible, relevant and engaging. Data emerged to support the notion that intrinsic motivation could be fostered through this type of engagement.

Nanamua (Student, Rep.) shared a perspective of how a developmental mathematics instructor intrinsically motivated both herself and her twin sister, Nanahope (Student, Comp.), with his pedagogical approach. She describes the fascination the faculty member instilled within her as follows:

His personality. I guess it was his little things that he taught in class to focus math. I know it’s the aftermath of it but he had this book to discover pi or something. There was a book: The Ways of Learning Math. He taught it different. He had games and relations to how would you apply math in the real world aspect. It just so happened he gave my sister these puzzle pieces that he created patented and designed and I don’t know how my sister got involved with it, but she got into going with study with a buddy and in the conversation he had with her, brought the puzzle piece. My sister had to put it back together in one big block. I don’t know what my sister did with it, but the way he explained it, the rules and regulations of how math could be fun...I was just fascinated.
The developmental mathematics faculty member interviewed for this research study was well aware of the influence that an engaging, relevant approach could have on motivating students. Kapuahi (Faculty, Educator), shared a perspective that the more useful and relevant a math course, the more successful students would be in terms of completion. In his 25 years of teaching at the institution, Kapuahi taught the entire line of developmental mathematics courses, including Math 24, 25, and 81. While Math 24 and 25 have a focus on algebraic concepts, he explained that Math 81 has an applied focus and is more closely related to “real-world” problems. He described students obtaining passing rates of 80% on occasion in Math 81 and attributed it to the fact that the course “is real.” He argues that when a mathematics course is useful, students are more motivated to learn. Kapuahi neatly summarizes his perspective:

They could learn just as challenging material in areas that would be more useful in their lives, like get them more used to statistics early. Teach them problems by using applied situations versus purely theoretical math sequence. Math 81 is all applied math again. It’s all how’s this going to be useful in some way. Everything is trying to relate to a student’s actual life. Now, granted, some of the things they don’t see and I’m a little bit idealistic and everybody is, but part of the success and completion rates is the fact that it’s real, I think, it’s real. You can do quadratic formula, which we teach at the end of Math 81, but what the hell is a student who’s having trouble with math in life supposed to understand what the quadratic formula means in terms of their life?

Kapuahi further elaborates that in order to develop an internal locus of control, students need to be engaged with the process of learning. He strongly believes in learning to love the process and argues that in order for a student to achieve this, the teacher must provide a scaffolding of support. Specifically, he realizes that some students enter their developmental courses with preconceived negativity and unfavorable attitudes towards mathematics. Some students even feel like failures because they have struggled through math
coursework in grade school, have had to repeat classes and now entered developmental mathematics through a placement exam, in which students feel like they “fail” in order to take developmental coursework. Kaimailehope (Faculty, Counselor) recognized this perception as well “What I’m used to hearing from students is that I failed the Compass.”

Part of Kapuahi’s strategy is to support students, encourage them and mentor them to understand they are not failures. Once that has been established, he believes a renewed, inherent motivation for learning mathematics can be accomplished by teaching them to “fall in love with the process” of learning. Kapuahi explains his position as follows:

If a student is ok, you get him curious in how to figure out an answer to a problem. You have to build their curiosity. They have to know, this is not a failure. You didn’t fail. You’re not helpless. Ah, I read a great one: “the way to succeed in the world is to fall in love with the process of learning,” whether it’s golf, whether it’s guitar, or whether it’s math. You have to fall in love with the process. They haven’t been taught, they haven’t learned how to love the process.

**Linking Locus of Control and Motivation**

As the locus of control characteristic is categorized into *internals* and *externals*, motivation is often classified as being either *intrinsic* or *extrinsic*. According to Ryan and Deci (2000), intrinsic motivation refers to motivation that is driven by an interest or enjoyment of the task itself. Students who are intrinsically motivated are more likely to engage in a task willingly, as well as work to improve their abilities without external incentives. Students are likely to be intrinsically motivated if they attribute their educational results to factors under their own locus of control (Ryan & Deci, 2000). On the other end of the motivation spectrum, extrinsic motivation comes from outside the individual and refers to the performance of a task or activity in order to attain an outcome (Ryan & Deci, 2000). Common extrinsic motivators are
rewards, incentives, competition, and the threat of punishment (Ryan & Deci, 2000). Thus, the affective characteristic locus of control and motivation operate in lock-step.

According to Ryan and Deci (2000), amotivation is a state in which an individual lacks intention to participate in a given task. Amotivation results from not valuing an activity, not feeling competent to do it, or not believing that it will yield a desirable outcome (Ryan & Deci, 2000). In the continuum of motivation levels, amotivation is placed on the far left, or least level of motivation, while extrinsic motivation spans the middle and intrinsic motivation encompasses the far right, or highest motivation levels (Deci & Ryan, 2002).

From the process of qualitative data analysis, across completer, repeater and faculty cases, the data support the notion that irrelevant mathematics coursework is associated with amotivation and an external locus of control for the subject itself. However, even with the current system-wide constraints of developmental mathematics curricula, there are rays of hope that intrinsic motivation for the subject can be fostered by faculty members via the means of engaging and eclectic pedagogy.

**Theme 3: Anxiety – The Etch a Sketch Effect**

The affective characteristic of anxiety is frequently associated with a target of mathematics. Mathematical anxiety has been researched under numerous empirical studies (Hembree, 1990; Ashcraft, 2002; Cates & Rhymer, 2003) and a scale to measure this anxiety, the Mathematics Anxiety Rating Scale, has been in use since the early 1970s (Richardson & Suinn, 1972). In this qualitative research study, interview data revealed that mathematics exams are a major source of anxiety, particularly for developmental students. Several
participants described the stress they experienced during a math exam being so overwhelming, it would cause them to “blank out” and temporarily forget their mathematical knowledge, regardless of how much advance preparation and study time involved. This phenomena can be related to the familiar Etch a Sketch toy, such that the anxiety of a math exam and the stress involved rattles a student to the point of temporary amnesia or being hindered from accessing what they know. Metaphorically, exam anxiety functions like the shaking of an Etch a Sketch: it causes a clearing of the slate, no matter how detailed the original contents.

*Heightened Anxiety*

Cross-case analysis of the completer and repeater cases revealed almost a complete overlap in the affective characteristic of anxiety. Both cases reported paralyzing anxiety when faced with the prospect of a mathematics exam. Representing the completer case, when asked about any feelings of anxiety in a developmental mathematics course, Puana (Student, Comp.) was quick to respond about her experiences of panicking and forgetting previous knowledge of math during exams. During her interview, the anxiety she described and stress she experienced, both physically and emotionally felt almost palpable to the researcher. She described the situation with vivid emotion:

When the test time came my heart will start pounding and I would draw a blank. Oh my God. I would second guess myself. I change my answers a lot, go back and forth. I would do the equation and I would second guess myself, it doesn’t look right and then I’ll change it again and re-plug in the numbers. Mostly, I would draw a blank and my heart would be pounding so hard. It’s just a major stress.

Both Puana and Keali’iokonaikalewa (Student, Comp.) added that math exams are a major source of anxiety due to their timed nature. Keali’iokonaikalewa also expressed concerns
about using exams to measure a student’s knowledge of mathematics, as there exists a disconnect between how evaluations are conducted in college courses and how they are done in the workplace. He offers the following perspective:

Well, they [math exams] put pressure on the students. That’s always the way it’s been done. I personally have test anxiety...The whole time constraint thing. They want to make sure you soak up what you learned and that makes sense, but in the real world these days we all have access to computers. For me I can’t stand testing.

During Puana’s interview, she spoke in lengthy detail about the timed nature of math exams and the effect that it has on her anxiety level and cognitive performance. She describes certain triggers that heighten anxiety, such as the practice of an instructor announcing when there is a limited time left on the exam. The onsets of panic that occur afterward prohibit Puana from completing even the simple tasks that she would otherwise feel competent with. She describes what the anxiety feels like during a math exam as follows:

It gets worse when the teacher says, you have 10 minutes. Come on you have 5 minutes. I’m like, oh God. I hate when they start counting down like that. I really panic and I can’t finish. If I get stressed, I forget. I can’t answer. Nervous, erratic. Mostly my heart starts pounding and my mind goes blank right there. Even if it’s a simple thing, oh no! I try to take a big breath, just get a grip on my stress and say get focused, but I tend to blank out more.

This sentiment was echoed in the repeater case as well. The student participant Meʻe (Student, Rep), describes a common scenario that he experienced while taking exams in Math 24 and 25 in which anxiety would take control over his mathematical aptitude. He describes the onset of anxiety during test time when he reached a problem that he did not know how to solve and began thinking of how his grade would suffer as a result.
At that point, I would panic and want to move on, so I would move on to the next problem, but as I’m moving on, in the back of my mind, I’m still thinking about that problem. So the next problem doesn’t make any sense. Then I move on to the next problem and doesn’t make any sense because I’m still frustrated about the first one. There is a psychological effect to this that kind of snowballs where you kind of start to feel like why am I at school if I don’t understand this and you want to give up. You try to work on the other problems and you’re all flustered and angry and you get frustrated and say okay forget this I’ll just go home and play games or watch videos or something.

In addition to the mental stress of developmental mathematics, students in the repeater case spoke about the physical effects of anxiety. Makali‘i (Student, Rep.) explained a situation in which she was enrolled in Math 25 with an instructor that she did not coalesce with. In this course, Makali‘i viewed the teacher’s pedagogical practices as demeaning and had difficulty with her instructional style. Makali‘i shared the resultant effects of the severed relationship between student and teacher:

I broke out into a rash. I got a lot of stress in that and I found out while I was taking that class that my stepmom is a nurse and she said that I was getting stress rash and then I dropped out of that class and immediately it was gone. Honestly, it was because of the teacher. No patience, expecting you to know what they’re about to teach you and what the lesson is and language barrier a little bit. I couldn’t understand the instructor very well. I think it was the instructor’s approach, scolding you instead of encouraging you to try do it on your own first. So, it was very discouraging. You end up building a resistance and not wanting to go. It’s not motivating at all.

For both counselors, mathematics anxiety is an issue in which they had awareness of and experience handling throughout their careers. They shared a unique perspective of the outcomes of students with high math anxiety and the grim consequences of leaving it unaddressed. They cautioned that many students with anxiety tend to suppress or hide it from their peers and teachers. In some cases, the stress caused by anxiety was overwhelming and lead to some students withdrawing from their developmental coursework, and even their
college aspirations, altogether. It tended to be an internal battle and the counselors described the ones who quietly dis-enroll from classes or school as “the disappear-ers.” Kamailemua (Faculty, Counselor) describes the struggle with anxiety as follows:

I think there’s an awareness and education about how to deal with anxiety. I think a lot of it is covered up by student when they have it. They just stop coming and I think last semester was the worst semesters ever. I hear faculty say, it was the worst semester ever because students just stopped doing work and stopped coming. These are the ones that are not going to share with you the anxiety. As a consequence of that, they disappear and we lose them, so that’s hard.

Aʻā’s (Faculty, Admin) perspective on mathematics anxiety provides another angle on the complexity of the issue. She recognizes the high level of math anxiety in developmental courses, especially since they are exam based. However, she brings to light a paradox. Given the frequent testing students experience during their K-12 education, especially with Hawaiʻi State Assessment (HAS) exams, Aʻā makes the case that one would expect the saturation of tests to insulate or even immunize students from test anxiety. Contrary to her beliefs, in practice, it turns out that the anxiety is still high. Aʻā explains the phenomenon as follows:

Fear. Learned failure. Dread. They’ll put it off. It’s actually a problem. Students putting the course off. What I’ve seen is high test anxiety...Even with the self-paced class, practice, quiz, practice, and quiz, it’s an unavoidable situation of taking exams. I think that’s a very good question especially given so much standardized testing we’re doing now in high schools. I would think that it would be no big deal because they do testing for weeks every year. I would think would actually learn not to care very much about these tests...if I give an in-class exam or an in-class final, I totally would see students anxiety level escalate and their skills de-escalate. Not just because of the time component, but because they contract their thinking to play it safe for the test. Maybe that’s what causes anxiety is that they feel the box of the task and they’re going to get a score that’s either right or wrong. Who wants to do it wrong?
Alleviated Anxiety

In addition to sharing the significant effects of high stress and high anxiety developmental mathematics courses, students and faculty also shared promising practices they experienced in their educational voyage to alleviate anxiety. The two counselors spoke about many of the support services available on campus, as well as the levels of advising support for a developmental student across several departments. Kamailehope (Faculty, Counselor) explains the multi-faceted support structure for a student as follows:

With counseling, if they have any kind of anxiety or fear or don’t like their teacher or have life issues with math, we’re always there to ask what’s the next step, how to solve their situation. I also wanted to mention that in addition to our counseling, we’re [developmental education] counselors, so our target is students enrolled in below Math 100 level classes. In addition to that, the students enrolled in dev. ed. Courses also have access to the other counselors on our campus too in their academic programs...We have special pops [populations] counselors too, like the disabilities counselors, Native Hawaiian program, single parent program, some of them may be veterans. Our counseling structure on campus doesn’t prevent them from seeing only one counselor...We have that type of support structure in place. Just because they’re enrolled in a below 100 level course does not mean that they can only see certain counselors. They can seek support from other points of the campus as well.

In addition to multi-layered points of support on campus, another means by which anxiety can be addressed and even diminished emanates from the course instructor. Students and faculty reported that the enthusiasm of an instructor for a topic is often contagious. The excitement in a faculty member could often times translate into engagement in the subject among the students. When considering the unique position an instructor has to work with a student who faces math anxiety, Aʻā (Faculty, Admin) believes that the teacher is proximally positioned to undo or pacify some of that anxiety. Aʻā shared the following memory of what the contagious enthusiasm looks like through her experiences:
I think one thing math teachers can do is model their own excitement for the topic. An instructor had this lesson plan on symmetry and art and he shared it one time during our department meeting. I had no idea what he was talking about from the math point of view, but he was so excited. He was like, this is so beautiful, this is math and this is the universe. When you kind of see that maybe it undoes some of it [math anxiety]. When they can show a practical use. Something they can get better at.

Nanahope (Faculty, Counselor) added another dimension of the capability of a teacher to reduce, or even reverse some of a student’s mathematical anxiety. She ties her argument in with her position on self-efficacy (see Theme 4: Self-Efficacy – Relationship with Confidence) in that the longer a student persists in developmental mathematics, the more competence and self-efficacy that student will develop and, in-turn, the less anxiety the student will experience. Over time, the practice of persistence in the initial developmental course (e.g., Math 24) by students will result in greater success in the subsequent courses. Nanahope shares her observations in the following passage:

If they seem puzzled they don’t wait for the student to raise their hand, they’re supposed to approach the student immediately before the student gets into an anxious state. I think there’s more careful observation and attention to those details. And I think once you pass 24 and place in 25 there’s a lessening of anxiety the higher in math you go, I think. I think there’s a little more confidence and competence with math, because it’s a continuation of the algebra. In the past, I had students coming in crying, but many times it wasn’t because of the math, it was because of the teacher -- it was because of how the teacher made them feel.

In this section, student and faculty participants have shared their views on mathematics anxiety, including some of the major triggers that instantiate it. These include math exams, time restrictions on exams, abrupt notification about a test approaching its time limit, and a strained relationship between teacher and students. Participants also shared promising practices to alleviate anxiety, such as an instructor’s enthusiasm about a subject, providing
multiple options and levels of support for the student, and a dedication of persistence through Math 24 to lower the level of anxiety in subsequent math courses.

**Theme 4: Self Efficacy – Relationship with Confidence**

The affective characteristic of self-efficacy is conceptually defined as “the belief in one’s capabilities to organize and execute the courses of action required to manage prospective situations. Efficacy beliefs influence how people think, feel, motivate themselves, and act” (Bandura, 1995, p. 2). Bandura (1995) elaborated that “self-efficacy refers to belief in one’s power to produce given levels of attainment” (p. 382). While conducting within-case and cross-case data analysis, both student and faculty participants spoke in volumes about assessing their self-efficacy in mathematics terms of being either confident or diffident (lacking confidence) in the subject. Most of the completer and repeater students reported a feeling of diffidence in mathematics that had been established and reinforced over years of classes throughout K-12 education. Both faculty and student participants elaborated on the origins and persistent sources of their lack of confidence, which are explored further in this section.

Although the majority of students and faculty participants spoke about the overwhelming diffidence of developmental mathematics students, several described experiences in their postsecondary education that fostered a sense of confidence, albeit fragile, and a slight sense of self-efficacy towards mathematics. The following sections shall present evidence emergent from qualitative data analysis to explore both perspectives.
**Entrenched Diffidence**

Of all the targets that can be attached to self-efficacy, mathematics is one that students generally perceive as having low self-efficacy toward and feel inadequate to complete the tasks required of them. The low self-efficacy in mathematics extends to the point in which students aren’t willing to even attempt to learn because they have ‘learned’ that it is too difficult. This diffidence toward mathematics has been deeply entrenched throughout the years of grade school. Nanamua (Student, Rep.) shares her own perception of self-efficacy toward math in the following description:

I guess I never gave it a try to learn. The generalization of how math is being taught, math is frustrating and stressful. I never gave it a chance to beat the odds of what everybody says. I just kind of let that sink in.

The data emergent in this study also show that a feeling of low self-efficacy in mathematics is associated with low self-esteem and ego perception as well. Students who are placed into developmental mathematics as a result of taking the COMPASS exam often feel they have ‘failed’ or are ‘failures’ themselves, regardless of how long it’s been since their last mathematics course or review of the material. Keali‘iokonaikalewa (Student, Comp.) shared that he took a calculus course in high school and scored over 700 on the quantitative component of his SAT exam, but a lapse of 10 years had occurred between his last math class and his COMPASS placement exam. Even under his circumstances, he reported a perspective of low self-esteem and diffidence towards mathematics after receiving his placement exam results. In his words:

I felt like a bonehead. I thought it was for bonehead math, what we used to call for dumb kids. So I thought oh, my god I damaged my brain in the last 10 years. What
happened to me and then I was like what a minute, I did this all in high school. What is this? This is crap, but I got to do it though. There’s no way around it.

Students tend to internalize a low self-efficacy in mathematics as a reflection of their own abilities in general. In particular, student participants report certain triggers or events that have contributed to their overall low sense of self-efficacy in mathematics. One of the main factors, explained by both completer and repeater cases, is the pedagogical practice of isolating a single student to respond to a mathematics problem. This seems to be a source of both anxiety and subsequently low self-efficacy when a student is put on the spot to answer a mathematics problem, especially if they are not able to complete the task, or if their anxiety in the moment hinders them from answering correctly. Puana (Student, Comp.) shares a perspective of what it feels like to be a student who is prompted with a mathematical challenge to complete in front of the class:

I already thought it was my problem because I get stressed out and I never know if other students get stressed out like that. That I’m going to look stupid. Like what the hell are you doing here? Being wrong, I like to be right, but I’m wrong a lot and I’ve always been kind of the shy side and I don’t like to be in front of people and talk. That’s pretty much it. I don’t like being in the front. I like to be in the crowd blended with everybody. I’m not ever trying to stand out at any time.

In cross-case analysis, the same sentiment arose from the data from the repeater case. Specifically, Makali‘i (Student, Rep.) described in detail the pressure and potential embarrassment of being “put on the spot” to answer a mathematics problem, especially if the student feels unable to answer correctly. Developmental math students find this process nerve wracking and they often attribute an intimidating persona to the teachers who employ this approach in the classroom. Left unchecked, this process and the subsequent view of an
intimidating teacher leads to a degradation in rapport among students and faculty. Rather than face the embarrassment, students opt out of asking questions in class to the teacher and resort to asking their peers either privately or outside of class time. Makaliʻi explains what goes on with students behind the scenes once rapport has degraded between students and the faculty member:

For the most part, they [the teachers] expected you to know what they were already going to teach you and they did the same thing, put you on the spot. Once you’re put on the spot, it’s embarrassing because you really don’t know the answer or you can’t really get there and explain it correctly, so you don’t want to ask questions, you just give up. You try on your own later and then you give up because you don’t want to ask the teacher...I think if the students were not intimidated, the teacher would know because they would be asking a lot of questions and letting him know I don’t get it. When they’re intimidated in the class, people weren’t saying it, so of course he wouldn’t know. He wouldn’t see the frustration. They were probably too afraid to even express that, even in their facial expressions. Of course only the students will see that because they will do that to each other and ask each other “are you getting it?”

The counselors add a perspective that developmental students perceive low self-efficacy in mathematics from experiences that occurred earlier in their education, before they enter college. In their combined interview, Kamailemua and Kamailehope augmented a perspective shared in Theme 1: Attitude – Role of Prior Experiences, in which some elementary school teachers who are not confident in their own mathematical abilities, may be subconsciously or indirectly transmitting an unfavorable attitude in math as a whole. The counselors added a viewpoint that throughout their educational voyage, students are receiving conflicting messages about the utility of mathematics. Students are consistently told that math is unlikely to be necessary in their future careers, so they should enroll in as few courses as necessary for completion of their degree. The counselors take a stance that the less students are immersed
in mathematics, the less they improve their ability and, consequently, develop a low sense of self-efficacy in the subject. Kamailehope (Faculty, Counselor) explains her view as follows:

I think it stems from before a student even gets to college. Based on their prior experiences or what they've been told by people they've perceived in an authority position about their own ability, their own exposure to experiences and their ability to try and succeed at something and keep building that competence. If those prior experiences weren't there it would shape how they perceive their ability to complete tasks. If they are getting messages like: “Are you going to need math?” “What major are you going to go into?” “Oh, you don’t need math, don’t do it.” This is something they heard a lot, so students do the least amount. The less they get exposed to something or a concept, the less they challenge themselves. The less they challenge themselves, the less they develop the efficacy. It’s just a vicious cycle.

Aʻā, developmental education department chairperson, spoke at length about what happens when a student does not cultivate the level of self-efficacy necessary to be successful in their mathematics coursework. She describes the inability of some students to escape from the clutches of developmental mathematics coursework in a manner that is congruent with Earl Shorris’ (1997) notion of ‘surround of force,’ in which individuals living in poverty are unable to improve their socioeconomic status due to the dominant and overwhelming circumstances in their lives. In this purview, the developmental coursework that is intended to prepare and promote students to college level mathematics is instead serving as an obstacle and sometimes fortifying the ‘surround of force.’ As a result of this mathematical barrier, a student’s sense of self-efficacy is diminished and they are less likely to persist. Aʻā explains the complexity of the issue as follows:

If they fail they go back to their family and their next life choices with the feeling I tried, I strived and I got sent back or I got smacked down, it reinforces that surround of force. Getting a “D” in developmental math is the surround of force. It says, sorry not for you and that’s where with developmental education is that border zone. One phrase that’s used with dev. ed. is that it’s a border zone and that’s how I see it. I’m saying, hey I
have a Ph.D, I show you guys how to do it, I’ll teach you how to play this game, but some people see it as a gatekeeping and they put developmental ed. out here. Sure, we’re an open door institution but to get in you really have to get past this and you have to do this, you have to do this and you have to do this. You have to show up, you need to know how to do this, take this test and it’s really not an open door institution. You have that one chance….The ‘A’ students were ‘A’ students when they came. They find their skills and we praise them and send them on. With the ‘D’ students, the transformation is much less than it needs to be. Often they come in as a ‘D’ student. They turn right back around as a ‘D’ student and they’re less likely to try again.

According to Kapuahi (Faculty, Educator), the sustained effects of low self-efficacy are even more grim. As a developmental mathematics educator for 25 years, he shared observations of what happens to students if they are unable to cross the border zone of their prescribed developmental coursework.

If a student fails once and repeats and fails again, sooner or later they are not only going to stop taking math, they’re going to realize that they’re not going to get the degree they’re going for, which makes them realize that there’s no reason for them to be in college and they drop out.

Fragile Confidence

Although the state of entrenched diffidence and low self-efficacy in mathematics is daunting due to its well-established history from elementary through secondary education, student and faculty participants share means by which the detriment can be diminished and self-efficacy fostered once again. Student participants spoke about this in terms of reestablishing confidence in mathematics and expressed that the process could be initiated in small steps of reinforcement towards completing a task. Students perceive a need for encouragement in the skills in which they are competent and a non-judgmental identification of the skills which they need to develop. Kealiʻiokonaikalewa (Student, Comp.) shared his view on restoring confidence and renewing self-efficacy towards mathematics:
What makes me confident is the reinforcement of getting a good grade. Having a professor look at your work and on the screen and saying, good job you’re right. The positive reinforcement of hearing, hey that’s good, you know. It may seem silly but it really does help. We try our best but things can be done on MyMathLab for accuracy purposes right before the test so you know, hey my skills are good at this, and I’m not good at this and maybe I need a little more work on that and then I can focus on it.

It is interesting to note that the assessment of skills that warrant improvement is made neutrally by the online educational package, MyMathLab. In Theme 1, participants shared their experiences of teachers who instilled unfavorable attitudes towards mathematics within their students through feedback that is perceived as belittling, rather than constructive. Kapuahi (Faculty, Educator) argues that MyMathLab might be appropriately used for this purpose within developmental math courses. When speaking about the software and its ability to provide neutral feedback, he states “There are plusses and minuses to it and the plusses come from two things: one is that it’s not a person putting them down. Now, that can also be corrected by having a teacher who’s a person who’s not putting them down.”

In within-case analysis of the faculty population, participants mentioned awareness of residual damage to self-efficacy that occurred in mathematics classes prior to students entering college. While the damage may be deeply seated and lasting, all faculty participants had hope that it could be undone or reversed. In order to accomplish an increase in self-efficacy among developmental students in particular, they believed it is necessary for the students to experience a series of successful attempts in completing a mathematical task. Kapuahi begins to describe the process of restoring self-efficacy as follows:

For these guys who have been knocked down, there hasn’t been enough times when they did the process and succeeded. You have to do it and succeed a couple of times. You always get knocked back, but eventually you succeed. You have to do it in little
steps, learning the process. You can’t just throw the big textbook at the little kid and say “learn”. My belief is that when they pound “I got it, I got it, I got it!” they know, in themselves, they think it, they believe it. It’s not words. When that happens, it’s coming from the depths of their soul. They actually believe they have figured something out, with whatever help. It doesn’t matter...My hope, my belief, is that the next time they will work a little harder, a little bit longer.

The counselors are in agreement with Kapuahi’s analysis of rebuilding confidence and self-efficacy. In their view, the process may require a bit of “undoing” damage before student perceptions of self-efficacy can be changed. In Kamailehope’s (Faculty, Counselor) words,

Kamailehope is a strong practitioner of self-efficacy, which is along those lines that, if you believe you can do it, you can do it. I think those perceptions can be taught and we have to undo some stuff which might take a little bit of effort, but I think they all can be taught. I think faculty members can help students perceive their ability to complete tasks by teaching them how to complete tasks because once they achieve it, once they experience completing it, then their perception starts to change. I did it, and I can do it, and I am! I don’t think we look at that. We look at the numbers and not their ability to complete tasks. But self-efficacy can play a very positive part.

When the fragile confidence and generally low self-efficacy towards mathematics is considered, participants have shared how the influence of their teachers can either boost or diminish self-efficacy. Puana (Student, Comp.) also described an experience with an educational resource outside of the classroom in which her already fragile confidence was impacted even further. She spoke about visiting math tutors on campus for assistance with her Math 24 homework and feeling derided because the tutors were enrolled in a significantly higher level of mathematics and treated developmental coursework as rudimentary. The perceptions of the tutors diminished Puana’s sense of self-efficacy in math, as she explained in the following recollection:

This is just my opinion, but they [the tutors] were really smart. When I went to see them during my Math 24 it seemed so basic to the tutors. The girls told me, “oh my gosh, I’m
in calculus that’s so basic.” So she had to think about it and then she was like okay, okay then told me. Those kids are really smart but maybe for something so basic like that it takes them a while to remember how to do it. Their mind is more focused on the advanced stuff, it seemed like.

Surprisingly, Aʻā (Faculty, Admin) expressed another related perspective on this issue, even though neither participant had ever met, nor were they aware of each other’s interview responses. During her interview, Aʻā spoke about the stigma associated with going to see a tutor for assistance with developmental mathematics:

For the most part, I don’t find our tutors overwhelmed with demand...Do you ever get tutored in something you are good at? Actually, no. You get tutored in something you’re bad at...So a lot of how we frame our support services, we don’t think from the students perspective.

The perspectives and insight shared by all participants in this qualitative case study have shaped what is known about the entrenched diffidence and fragile confidence of developmental math students. Student participants across cases have shared experiences from their educational history, such as the belittling of teachers and tutors that have further weakened their sense of self-efficacy and deepened the ‘surround of force’ from being successful in mathematics. However, both students and faculty have spoken in detail about how self-efficacy can be restored through a series of successes in mathematics, the positive reinforcement of faculty, the support of peers who relate to them, and receiving timely, constructive feedback. Kamailemua (Faculty, Counselor) succinctly brought these elements together and described the growth of self-efficacy through the following powerful metaphor:

We’re all like mangoes on the mango tree ripening at all different times... so she didn’t get it when maybe her friend got it, so therefore she then labeled herself and saw herself in a certain, you know, perception, that she was not competent in math, and therefore she’s afraid and therefore she’s not going do it because she’s not going to get
it anymore. But if she had understood from the beginning that some people will take two minutes, some will take five, some will take half an hour, some will take two hours. It’s how much you want to invest time in this to learn. I think when students have the awareness and they’re educated about the processes...no one educates students about processes; it’s all about products.

**Linking Self-Efficacy and Confidence**

In a college setting, students tend to invest more time on tasks they believe they are capable of learning or being successful with. Students in this domain tend to develop an “I can do that” sense of self-efficacy. On the contrary, when a student perceives a task as too difficult or unattainable, it is a typical response to develop the “I can’t do that” prerogative (Anderson & Bourke, 2000). As these classifications suggest, self-efficacy is a learned characteristic. Anderson and Bourke (2000) state, “A predominance of successes likely leads to self-efficacy, whereas a predominance of failures likely leads to its negative counterpart, learned helplessness” (p. 35).

As this research study is organized under the theoretical framework of self-efficacy, originally published by Albert Bandura, one of the most widely cited researchers in the field of psychology, it is important to be specific about the link between self-efficacy and self-confidence under his proposed framework. According to Bandura (1997):

It should be noted that the construct of self-efficacy differs from the colloquial term 'confidence.' Confidence is a nonspecific term that refers to strength of belief but does not necessarily specify what the certainty is about. I can be supremely confident that I will fail at an endeavor. Perceived self-efficacy refers to belief in one's agentive capabilities that one can produce given levels of attainment. A self-efficacy belief, therefore, includes both an affirmation of a capability level and the strength of that belief (p. 382).
Under this perspective, confidence may serve as a proxy for self-efficacy when it is not attached to a target, or even influence an individual’s self-efficacy toward a target, but it is important to note that under the lens of this research study, the two should not be used interchangeably. As Bandura (1997) claimed, confidence is a nonspecific term for an individual’s strength of belief without a particular target, while self-efficacy is rooted in a theoretical system that specifies its determinants, mediating processes, and multiple effects.

**Theme 5: Developmental Educator as Cornerstone**

Each of the preceding four themes emerged from the poignant reflections of the 10 participants and serve as the pillars for the findings of this study. During the synthesis of qualitative data, one additional theme actualized to interweave all four pillars. The fifth theme can be described as the developmental educator serving as a cornerstone for student learning. All 10 participants shared perspectives on how developmental mathematics faculty members had far-reaching impact on shaping students affective characteristics of attitude, locus of control, anxiety, and self-efficacy. The effect of an instructor to influence these characteristics in a dichotomous manner: attitudes towards math could shift between unfavorable to favorable, locus of control from external to internal, anxiety from tense to relaxed, and self-efficacy from diffidence to confidence. The single factor that all participants mentioned had influence across all characteristics was the role of the developmental educator teaching the course.

At the time of this research study, Aʻā (Faculty, Admin) had experience serving as both a developmental educator and administrator within the department. Her position as the
department chairperson allowed her to immerse herself in student feedback from all educators within developmental education and every semester she is able to listen and respond to all students who participate in course evaluation. She spoke about the considerable influence of developmental educators being prevalent across student evaluations.

I mean I see everybody’s evaluations as department chair, so you know the students always talk about the instructors and we still need instructors. It’s still a personal interaction. You still can’t learn Math 24 just from a computer. I’m basing this on reading instructor evaluations. They really feel real when students say, Mr. So and So was there for me every day. He answered my email at 11 o’clock at night. If I didn’t understand it he would explain it to me in a different way. They really like that caring relationship. It really seems to make a difference. I mean that’s teaching in general, but developmental education in particular is a connection with a caring instructor because this is so scary to developmental students and then you add all the math fear in. That’s pretty scary, so what helps them is the caring teacher...That’s really important. Almost never have I seen, oh tutoring helped me so much. Oh my counselor helped me so much. It really is still the magic of the instructor, and the student, and the classroom relationship that really matters. That’s what helps them succeed and that’s what helps them persist and want to go on.

Community of Learning

In earlier themes of this chapter, both student and faculty participants described a favorable attitude towards the subject of math associated to its definitiveness and the preciseness of mathematical solutions. However, although these participants liked the straightforward, clear cut answer to a mathematics problem, they also strongly voiced a desire for a personal relationship and interconnectedness with their instructor and classmates. Across all cases in this research, participants wanted to feel connected, cared for, and noticed. In many cases, participants expressed that their persistence or success in the course hinged upon the relationships that were established among colleagues and their instructor. In a holistic sense, students are searching for a developmental mathematics course that functions as a
community of learners. Kamailemua (Faculty, Counselor) described one instance of what a community of learners looks like at the institution of this research study.

My students talk a lot about instructors they really sense care for them and know them. It creates an environment where students can best learn because they feel understood and supported and it takes some of that fear away. Instructor qualities and instructor approaches and the instructor’s pedagogy is important to a lot of students and their ability to succeed in math. One of our instructors was in the beginning very much a lecturer and he’d deliver lectures that were really “sage on stage” kind of style. He was a math instructor here, but over time I see him high-fiving students all the time, fist-bumping, laughing in the classroom and they bring Jamba Juice for each other. Somehow a relationship was established and we have students coming back because of that relationship...It’s about how to work with people. How do you make people feel?

Kamailehope (Faculty, Counselor) also spoke about the importance of establishing a community of learning within the classroom and shared a perspective of the impacts of what occurs when the community goes unfounded. In her words:

I met this one instructor and I felt so sad because he realized this and half the semester had gone by and the students sit next to each other in the computer lab and they were self-paced and they didn’t know who they were sitting next to. So, I think he kind of realized that may be affecting the students’ experience in the classroom and was very open to trying to change that and improve it so students would succeed the next semester. I think he eventually incorporated icebreaker type activities in the first week of the class so the students will know each other on a different level and there’s a better chance that they can help to encourage each other. There’s that whole mattering theory -- when you matter to someone how much it increases your chances of persisting.

As the counselors have indicated, the importance of establishing a learning community is essential for students to feel that they “matter”. In Theme 2: Locus of Control – The Influence of Motivation, A‘ā shared that the students she sees in developmental education are often experiencing “mind-boggling life problems.” In her view, these students often have to weigh the value of attending math class against the issues of their everyday lives. Often times,
the gravity of life issues overwhelms their participation in math courses, especially if a student feels disconnected from the class. The net effect is that students will either withdraw or “disappear” from the class by not attending for the remainder of the semester. In response, both counselors agreed that establishing a community impacts students’ feelings of significance and “mattering” in the class, which may lead to higher persistence in their developmental courses.

Student participants were keen to remark about aspects of their developmental mathematics courses that either fostered a community of learning or resulted in students feeling isolated. Makali’i (Student, Rep) shared an experience of one instructor’s approach to building relationships and connections among his students.

He hands out a sheet in the beginning of the course so that he can find out things about his students, what they struggle in, and if they like it fast paced, if they don’t, just so he can get to know his students at that level. He will know if they have any problems speaking out, and can probably talk to them on the side that way. Help them to be more comfortable, so they can be successful in the class. I think finding out about your students will help you a lot, without assuming that every student is the same as the next, no. Everyone learns at their own pace.

Another student participant, Keali’iokonaikalewa (Student, Comp), shared a perspective of how a feeling of safety in the classroom community contributes to his learning.

Make the connection. Make the eye contact. Make them know and feel safe. I’m with you, not to worry...Try to have fun with it. Get to know the students, so if any of them are having problems, you can talk to them personally.

During Keali’iokonaikalewa’s interview, he mentioned that the combination of an instructor establishing a relationship with students, coupled with a safe environment created a
classroom community that fostered his learning and eventually led to his success in developmental mathematics.

**Approach to Teaching**

All 10 participants in this study believed that an instructor’s approach to teaching had significant impact to the learning environment and fostering of community within a developmental mathematics course. In their views, an instructor’s approach to teaching is inextricably woven with students’ desire to learn in the course. Student participants were verbose with advice for successful teaching approaches and also shared approaches that estranged them from feeling a sense of community in their college courses. During the interview process, Keali‘iokonaikalewa began the discussion by explaining the use of personality, rapport and trust to build the classroom community. In his words:

> When we joke around in class, it makes it fun. You have to work with what you got and if you’re teaching a subject that’s not fun, you have to use your personality and draw upon the strengths and weaknesses of the class. Gaining the trust of people is very important. When you talk about things off subject and relate your lives and humanities to each other...that’s a good way to start.

In this narrative, humor and trust building are important for a constructive learning environment, particularly in developmental mathematics. One of the counselors, Kamailehope, voiced an analogous perspective about instructor approaches that foster success. In her opinion, developmental mathematics students have a desire to feel cared for by their teachers.

> My students talk a lot about instructors that they really sense care for them and know them. That seems like it creates an environment where students can best learn because they feel understood and supported and it takes some of that fear away. Instructor qualities and instructors approaches and pedagogy is important to a lot of students and their ability to succeed in math.
Kapuahi (Faculty, Educator) provided an example of his approach to teaching through relationship building with “his kids.” He spoke about a dual relationship, in which his students also became his friends at the same time. In order to grow this relationship, Kapuahi related his experience as the manager of a touring rock band with students who expressed an interest in a similar pursuit. Kapuahi recounted the story as follows.

Find out what the student loves and help them become that. Help them become what they want to become. I started a band with the kids and the guys, and maybe this is why I relate to students and maybe it’s partly how it all worked, because they ended up being like my kids and my friends at the same time. We had a band and then we ended up playing at concerts, opening act at different colleges for concerts. My experience from the music business helped us, helped me, know how.

Student and faculty participants also offered guidance for a developmental educator’s approach to delivering mathematical content. Two student participants advised new faculty members to understand the student’s point of view and “where they’re coming from” prior to class time. Me’e (Student, Rep) pontificated about the approach to teaching he believes would support his learning, even before the semester begins.

Ask your students how they want to learn in school. That would be the first. The second would be to communicate with them on what they’re having difficulties understanding. This is before we start school and then once you get that information, take a look at what you’re teaching. What would be the appropriate style and how you want to teach them to understand math? Understand how they, asking each student individually or even asking them in a group setting, then you’ll understand where they’re coming from and take that understanding home to help you prepare your lessons so that everyone can learn on the same page.

Makali‘i (Student, Rep) shared a similar perspective in which educators should be operating “at the same level” as their students. She expressed that students often feel “intimidated” by faculty members who “talk down” to students or move at a pace that students
cannot maintain. Makali‘i suggested that educators should instead determine the abilities of the students from their perspectives and then proceed after understanding what they already know. She offered the following advice to new developmental mathematics faculty.

When you’re at the same level, I think people feel a little less intimidated, even if you’re a stranger. Absolutely, I think that could work. Just once in a while, have a seat, talk story. Find out any questions, any problems. Just being able to talk to them because math is one of those classes where you do get intimidated because you don’t want to look like the stupid one that doesn’t know how to do it. I think when the teacher asks a question it should be “explain to me what you do know,” not “Why don’t you know? It’s right there?” That’s scolding and I think having the student explain to you what they do know, you can figure out what they don’t know and then say “well, if you did this, do you think it would work?” I think that would be a better approach instead.

The teaching approach of “understanding from a student’s perspective” was voiced among the faculty population as well. A‘ā (Faculty, Admin) spoke about the use of fine-tuned diagnostics to understand the mathematical abilities of each student in the class. In her view, once an educator is aware of what students can accomplish on their own and what they can achieve with the support of an instructor, they will be able to reach the “zone of proximal development” pinnacle of learning. In her interview, she stressed the importance of a teaching approach from each student’s perspective and understanding.

One aspect of it is working with students where they are at, understanding what they know and don’t know. Fine tuning our diagnostics is an important part of reforming developmental education. We have to get better than just that Compass score. What exactly is the issue? How much do they know? What can they do by themselves? What can they do with just a little bit of help? That’s the zone of proximal development. That’s basically my teaching philosophy. That’s the whole game. That’s the skill of it is to understand the zone of proximal development for 20 or 35 people who are each individuals who are all starting from a different place.

In addition to describing effective approaches, student participants were also keen to describe approaches to teaching that hindered both learning and the establishment of a
community of learning. Specifically, Puana (Student, Comp) recounted an educator who made snarky comments whenever he felt that students were asking “obvious” questions in their developmental mathematics course. To Puana, this approach was both intimidating and demeaning to the students in the class. She explained,

> Some teachers are a little intimidating...Maybe that’s just their personality. They have that more intimidating personality. I remember some people in a math class made remarks like: “I don’t like asking questions in that class because the teacher makes me feel like an ass.” His comments make you feel stupid. You shouldn’t do that. Just, answer it nicely, so they don’t feel like they shouldn’t have asked.

In her perspective, when students feel belittled, they will refrain from voicing questions or engaging in the class, mainly due to the intimidation factor of the teacher. Puana also shared an example of an approach that degraded the learning community within her developmental math classes. Specifically, she commented upon the habit of certain teachers to habitually rush out of the room when class ended. Students had questions remaining, but their teacher left no time at the end of class. Puana felt this sent a clear message that the educator did not want to be part of the community any longer than required. She recounted the following experience.

> Be available for students that need help during office hours. At least stay after class. Don’t be like class pau and then just walk out. I had a couple of instructors like that. As soon as class ended they left. I noticed that other students would have questions and they would want to ask the teacher before they left class.

The relationship between a teacher’s approach to the establishment of a community of learning was discussed further by Kamailehope (Faculty, Counselor) and Kapuahi (Faculty, Educator). Kamailehope spoke about the results of a survey distributed by counselors to understand the needs of students. Feedback indicated that students desired greater
encouragement from their professors. In her interview, Kamailehope enlightened the researcher about an encouraging approach to teaching with the following anecdote.

We did a survey on the needs of students. The number one need I remember at that time was that students would love to have more encouragement. What does that mean, to encourage a student? I think if we really looked at that very deeply and come up with strategies on how we encourage students on our campus and on our classrooms...and the word “courage” is in there, too, so it means to break through certain things. So we have to be “in” “I-N” courage. Something moves inside of them once they have the courage to see. We think we’re being all the doers but it’s really not, we’re just igniting or facilitating; it’s really for them to do.

Kapuahhi expressed the need for developmental educators to continually change their approach to teaching to serve the interests of their students. In his interview, he shared his mantra to “fall in love with the process of learning,” which he felt pertained to both students and faculty members. In his prerogative, the students of the millennial generation learn differently than his own. Kapuahhi felt strongly that the approach to teaching should adapt to the needs of the student population, and not automatically mimic “the way we did it.” Kapuahhi explained the flexibility and responsiveness in his approach to teaching as follows.

We gotta do this, these are my people. We got to keep changing. I mean we got to keep trying new things because there is no answer to this. There is no one answer. The only answer is to keep trying. Fall in love with the process of learning. Just like we want students to be better. Not “We’re going to do it this way, this is the way we did it. It’s the only way to do it.” These aren’t the same people we were. They’re different.

In addition to having an adaptive approach to teaching, two of the student participants shared experiences of their learning being facilitated by an instructor’s diversity of teaching methods.
Diversity of Methods

All three students from the repeater case elaborated on the effectiveness of certain developmental educators to present the same content in alternate formats to accommodate their needs. In some cases, the instructor was impactful when the explanation was simply presented in a different fashion than that of the course textbook. In other accounts, students spoke about innovative approaches that instructors took, utilizing a diversity of methods.

Makali‘i (Student, Rep) shared the impact of an instructor explaining a mathematical concept in a manner that varied from the computerized MyMathLab approach.

He just had a way of explaining it differently. Something that I was stumped on before and it was just easier to understand. He broke it down in a different way. It was nice to see someone do it in a different way, and I don’t know if he came across the same to other students who couldn’t understand the other way it was explained to them before, so he had to find another way.

Me‘e (Student, Rep) discussed how one of his developmental math instructors was able to blend the traditional textbook algorithm to a reach a solution, with his own customized approach. During the interview, Me‘e elaborated about how the combination of methods provided him with multiple tools to attempt the coursework, sometimes preferring one over the other, and other times utilizing strategies from each approach.

He [the instructor] understood the point of view from a student and then he prepared his teaching style that way. He knows that people have a hard time learning math. He told us, I know what the book says, but I created my own way that will help you understand it better and faster. So we tried it. He also told us you can learn it the book way so you have two choices to choose from. If you prefer the book way, then you can do the book way to get the answer. If not try this quick way, if that works use this. If there were things like that set in school, I think I would get A’s in all of my classes.
Nanamua (Student, Rep) added another perspective to the diversity of methods, in which both her sister and herself were both motivated and enthralled by an instructor’s innovative approach to presenting mathematical content. This particular instructor utilized aspects of gaming to teach the rules of operator precedence, which both engaged the sisters and helped them to learn a topic which was the source of prior difficulty. In Nanamua’s words,

He taught it different. He had games and relations to how would you apply math in the real world aspect. It just so happened he gave my sister these puzzle pieces that he created patented and designed and I don’t know how my sister got involved with it, but she got into going with study with a buddy and in the conversation he had with her, brought the puzzle piece. My sister had to put it back together in one big block. I don’t know what my sister did with it, but the way he explained it, the rules and regulations of how math could be fun…I was just fascinated.

In these findings, participants voiced the importance of the role the developmental educator plays in the mathematics courses. In a holistic sense, students viewed impactful teachers as cornerstones in the class. A cornerstone is defined as “an important quality or feature on which a particular thing depends on” or “the starting place in the construction of a monumental building”, a developmental educator can serve as the basis for monumental learning among the students. From the findings in this qualitative research, educators attain this status by creating communities of learning in their classrooms, adopt approaches to teaching that support, encourage and adapt to student needs, and are able to employ a diversity of methods to clarify mathematical content.
Summary

In this chapter, findings from the qualitative case study of six student and four faculty participants directly addressed the affective characteristics under inquiry as stated in the questions posed by this research. The perspectives and insights of student and faculty participants led to four themes about how attitudes are formed by prior experiences in mathematics, often times adopting a utilitarian function from pleasurable or painful experiences; how locus of control is often influenced by motivation, such that irrelevant coursework spawns amotivation, while engagement fosters intrinsic curiosity; how math anxiety can be incapacitating; and how low mathematical self-efficacy perceptions are deeply entrenched, but can be delicately rebuilt with the encouragement of faculty. The fifth theme, in which the developmental educator is considered a cornerstone for student learning, interwove among all four of the previous themes. Student and faculty participants expressed that cornerstone educators create communities of learning, have adaptive and supportive approaches to teaching and implement a diversity of methods to deliver content.

CHAPTER 5. SUMMARY, RECOMMENDATIONS, AND CONCLUSION

Study Overview

The design of this qualitative research study was framed under the lens of Albert Bandura’s (1977) self-efficacy theory, based on the notion that achievement is dependent on interactions between a person’s behaviors, personal factors, and the environment. The study
utilized a collective, multiple case study design, which was implemented in conjunction with a developmental education program at an urban community college in Honolulu, Hawaiʻi.

Three cases were defined and comprised of students who completed the prescribed sequence of developmental sequence of courses on the first attempt (completer case) and a grouping for students who have withdrawn from, failed, or otherwise did not complete the developmental mathematics course(s) on the first attempt (repeater case). The third case consisted of fulltime developmental mathematics faculty members, including educators, counselors, and administrators (developmental faculty case).

In eight independent, face-to-face interviews with students and faculty, and one interview with two members of college’s developmental education counseling faculty, participants answered a series of questions in order to explore the affective characteristics of developmental mathematics students, including attitudes, locus of control, anxiety and self-efficacy. Through the use of open-ended interview questions, utilizing a semi-structured interview protocol, quality responses that reflect the lived experiences of the participants were obtained. The participants’ perspectives were categorized according to common terms and expressions used to explain the affective characteristics of developmental mathematics students. Emergent themes were identified to reflect the participants’ deep thoughts and important viewpoints shared in their responses to the interview questions.

The qualitative data collection methods of interviews, physical artifacts, and field notes were employed in this research to reveal insight about the affective characteristics of developmental mathematics students from the perspectives of the students themselves and
the faculty members who support them. Qualitative analysis was performed at two levels: within each case and across the cases. Credibility of the findings was established through prolonged engagement in the field, rich description, triangulation, member checking, peer review, and clarification of researcher bias.

The co-constructed reality shared from all 10 participants can be used to assist developmental students, educators, counselors, and administration to develop more effective learning communities for developmental students.

Summary of the Findings Related to the Literature

Research Questions

1) How do developmental mathematics students assess their own affective characteristics?
   a. What are student attitudes towards mathematics?
   b. To what extent do students accept responsibility for their own academic behavior?
   c. To what extent do students experience anxiety toward mathematics?
   d. How do students perceive their own self-efficacy towards mathematics?

2) How do developmental mathematics faculty perceive the affective characteristics of their students?
   a. How do faculty view the attitudes of their students towards mathematics?
   b. What do faculty believe about how students accept responsibility for their own behavior?
   c. What do faculty believe about mathematics anxiety among their students?
   d. How do faculty perceive the self-efficacy of their students?

In response to the questions posed by this qualitative, collective case research study, student and faculty participants shared a wealth of information about their own affective characteristics or the students who they support, including attitudes, locus of control, anxiety,
and self-efficacy. With regard to student attitudes towards mathematics, the study revealed a complexity of preconceived notions and rooted attitudes which stemmed from prior experiences in secondary and grade school. These attitudes were not predictable. Some students representing the repeater case had a favorable view of math. Makali’i (Student, Rep) shared “I always thought math was fun...I remembered when I used to do math I was pretty good at it actually and I liked it. For me, it’s like a puzzle, and it’s the challenge that I like about it and I know there’s an answer to it.” When this research was conducted, Makali’i was repeating a developmental math course for the fourth time, yet she still had a favorable attitude towards the subject. The complexity of attitude speaks to its far-reaching sources. Participants’ views were shaped by friends, parents, relatives, and especially teachers. Parents and engaging teachers often influenced student participants to have favorable views, while friends and discouraging teachers imparted adverse attitudes towards mathematics. Patterns emerged from the data indicating students’ attitudes towards developmental mathematics was clearly based on a utilitarian function when the decision revolves around the amount of pain or pleasure it brings. Under Katz’s (1960) utilitarian function of attitude, individuals pursue experiences that bring pleasure, thus under this lens, students who had positive or even happy memories of mathematics are likely to have favorable attitudes, while those with prior painful experiences will have a disdain for math.

The findings about the locus of control characteristic revealed a close relationship with motivation. Both student and faculty participants spoke about how motivation influenced their responsibility, or even desire, to complete tasks in mathematics. Many students offered testimony that their motivation to learn mathematics would be heightened if the content was
applicable to their daily lives or future careers. Without a relevant connection to the real world, students felt unmotivated or even averse towards learning mathematics. Students described irrelevant mathematics curriculum as being wasteful of their time. Faculty members agreed that the primary motivation for completing a prescribed sequence of developmental coursework was solely motivated by the attainment of a certificate or degree, not for intrinsic motivation for the subject itself. Some students expressed an external locus of control and placed the responsibility for their actions (or sometimes inactions) in developmental math on the system of how it was being taught. Faculty participants spoke about complex “life issues” that many students face on a daily basis and when weighted against the responsibilities of developmental mathematics, the life issues would take precedence, especially if students felt the coursework was irrelevant. Through cross-case analysis, data revealed that the locus of control and motivation characteristics could be positively influenced when an educator engaged students in the subject of mathematics, often by diversifying instructional approach and relating content to the students’ lives.

Qualitative data analysis affirmed that anxiety in mathematics was widespread and experienced in a debilitating manner among students. All student participants in this research study reported high anxiety in mathematics. Particularly telling, the aspect of developmental mathematics most likely to heighten anxiety levels were examinations. Several students reported an almost paralysis during test time, particularly when “time left” announcements were made in a jarring manner. The practice of some instructors to isolate or call out certain students to answer mathematics problems also induced a heightened sense of anxiety. On the flip side, both students and faculty shared tactics that were either promising or effective at
alleviating anxiety. Counselors spoke at the multi-faceted levels of support that a student could utilize, including developmental education, academic major, special populations, and mental health counseling. Developmental educators were mentioned as resources for relieving anxiety by sharing a contagious enthusiasm for the subject being taught. Students were keen to pick up on an instructor’s excitement and were positively affected by it, specifically in a reduction of anxiety.

The self-efficacy affective characteristic was found to be closely related to confidence. Low self-efficacy was associated with diffidence, or lack of confidence, that had been entrenched over years of negative experiences with mathematics. By the time some of the students entered college, they weren’t willing to even attempt to learn because they have ‘learned’ that math is too difficult. This diffidence toward mathematics had been deeply entrenched throughout the years of grade and secondary schooling. The emergent data from this research study showed that a feeling of low self-efficacy is further established when students enter college and complete a mathematics placement exam, only to find out that they must complete a requisite set of developmental courses before starting coursework towards the attainment of their degree. Students often feel like they have ‘failed’ the placement exam or are ‘failures’ themselves, regardless of how long it’s been since their last mathematics coursework.

Even though the process of reversing a feeling of low self-efficacy is daunting given its well-established history from prior experiences, student and faculty participants shared means by which a sense of self-efficacy can be restored. Faculty mentioned that self-efficacy could be
established by dividing tasks into smaller components, with students building competence at shorter and more frequent intervals. As supported by Anderson and Bourke’s (2000) research involving the self-efficacy characteristic, a predominance of successes in completing tasks in mathematics is likely to lead to self-efficacy.

Interpretations and Recommendations for Practice

Most educators would agree that a certain amount of mathematical knowledge is necessary for all college graduates. At the minimum, students should exhibit a comfortable level of mathematical ability that does not limit significant choices, such as the choice of a major or career. A primary role of educators should be to foster and support students in building the self-efficacy in mathematics to pursue these life goals, rather than be shunned away from them.

By fusing the concepts of developmental education and engaging the affective characteristics of their students, teachers of developmental mathematics courses could hold the key for college success. For this reason, it is recommended that developmental educators train in a diversity of methods, practice authentic assessment, give prominence to relevant content, foster a community of learning, and promote mathematics refreshment to augment the set of pedagogical strategies they employ as educators.

Train in a Diversity of Methods

During the semi-structured interviews, student participants often associated mathematics with “one correct way” of solving problems or the manner in which instructional
content is presented in class. Students were often frustrated when the delivery of content precisely replicated the manner in which it was presented in the textbook. If the textbook content was inaccessible, students felt that educators were responsible for presenting the material in another manner. This sentiment was echoed in the counseling population, who shared an experience with a student who “blamed the whole system, the department for not having another way of teaching math. And having failed so many times, asked why are we still teaching him the same way, kind of thing?”

As Nanamua (Student, Rep) shared in her interview, “I asked my dad for help and he said it’s a lot easier this way, but when I took it to school they didn’t accept it because it wasn’t the same way even though I got the same answer... They just said we weren’t taught that way. You have to do it by the book and how we teach it. Nope you can’t do it because you didn’t do it the correct way.” Kamailehope (Faculty, Counselor) added to this viewpoint by stating “Some teachers expect you to explain the procedure the way they taught you. If not, you’ll be discounted type of thing.”

In the researcher’s opinion, mathematics educators should embrace and champion multiple methods to solutions and practice differentiated instruction in our pedagogy. Especially in developmental mathematics, educators should structure learning environments that address the variety of learning styles, interests, and abilities found within a classroom. In order to differentiate instruction, educators should embrace the fact that diverse abilities, experiences, and interests have a tremendous impact on student learning. In this regard, an
educator should identify the level at which individual students are operating in mathematics, using both cognitive and affective assessments, such as a learning style inventory.

It is also critically important that educators learn about student interests. On a regular basis, educators should ask students to identify topics that interest them and activities that occupy their non-school time. Using the input from students, educators should brainstorm ideas for activities, tasks, and authentic assessments that address a specific concept or skill based on the interests of the class. These ideas should emerge from the range of learning preferences, abilities, and interests among the students. The methods used to implement the ideas should be diverse and target auditory, visual, and kinesthetic learners.

To foster a diversity of teaching methods, developmental educators should be supported by their colleges to participate in professional development which highlights differentiated instruction. Faculty members should also be encouraged to share their pedagogical approaches among their colleagues and with neighboring institutions in open forums, involving deep discussion, and critical reflections. Faculty should be encouraged to share promising practices, freely adopt new strategies and constructively critique methods that did not produce favorable results. It is the researcher’s opinion that the diversity of methods will be strengthened by the diversity of participants in these forums.

**Practice Authentic Assessment**

From the findings of this research study, students experienced unnecessarily high mathematics anxiety, particularly during examination time. All six students described a situation of mathematics test anxiety. This affective characteristic was demonstrated to be so
overpowering in some situations, students would report that during a math exam “my heart starts pounding and my mind goes blank right there” (Puana). The pressure of a single examination, heavily weighted in the overall course average, should not be the focus of assessing course competencies, especially in developmental mathematics.

Wistfully, some research indicates that the assessment methods of community college may not differ much from those used in K-12 schools (Grubb, 1999). "Skill and drill" pedagogy is still thought to dominate most instruction and exams are used as the primarily instrument to assess student attainment of course competencies (Goldrick-Rab, 2007). Under this repetitive paradigm, students who failed to learn mathematical concepts in their K-12 education and developed high test anxiety are basically presented the same material and assessed in the same way yet again in college. It should be no surprise that the methods that failed to work the first [or second, or third] time are also ineffective at the community college level.

To break this vicious cycle of repetition, as community college faculty, we should strive to assess the mathematical competencies of students in a broader, more inclusive, and authentic manner. In this regard, developmental math educators should practice authentic assessment, an evaluation process that involves multiple forms of performance measurement reflecting the student’s learning, achievement, motivation, and attitudes on instructionally-relevant activities. Examples of authentic assessment techniques include performance assessment, portfolios, and student self-reflection.

Instead of high stakes testing, which places the emphasis of a student’s grade on approximately an hour’s worth of high anxiety, developmental educators should identify
alternative methods of assessing student performance and understanding, using a variety of strategies, including performance-based and open-ended assessment. These activities should blend teacher-assigned and student-selected projects and offer students a choice of projects that reflect a variety of learning preferences and interests. This cycle of assessment should be interactive, ongoing and of lesser weight, rather than infrequent with high stakes. Assessment cycle data should increase teacher understanding of students' abilities, interests, and needs, and be incorporated into future planning for the course.

**Give Prominence to Relevant Content**

In the findings of this qualitative research study, students reported an indifference or even animosity towards mathematics because of the irrelevant manner in which the content was presented. In Kealiʻiokonaikalewa’s words, “I think it’s wasteful. It’s nice to have a basic knowledge of mathematics, but we don’t really use any of the other stuff in the real-world...The old regurgitations sucks.”

The researcher is in agreement with this viewpoint. It is a failure of the developmental education system if students attempt, or even complete, the coursework without gaining an appreciation for mathematics and the ability to apply it in their lives. Instead, our mission as educators is to demonstrate and model mathematics as well-connected, highly linked and penetrating in our society through relevant science, economics, engineering, and even sports applications.
Developmental educators should focus the relevance of mathematics in a number dimensions of society. These include the practical mathematics for routine tasks of daily life, civic mathematics to understand societal issues, and a professional dimension in which mathematics skills are required for high paying careers. Educators should also exemplify mathematics in a leisure dimension, as used for gaming, puzzles and wagers, and perhaps most important, the cultural dimension which demonstrates mathematics as one of the greatest accomplishments of humankind.

If mathematics is taught as skills and procedures to be mastered as either right or wrong, then we teach a form of mathematics that has little relevance in society. Instead, developmental educators should teach mathematics through relevant content, engagement, and investigation to become active participants in the class. Students should also be encouraged to pose their own problems, not just solve them and share themselves what they find relevant. This is one of the hallmarks of learning.

**Foster a Community of Learning**

In the qualitative data analysis, participants mentioned the lack of interaction and personal relationships in some developmental mathematics created by the self-paced, computer-aided learning approach. Kamailehope (Faculty, Counselor) recounted the experience of an instructor utilizing the MyMathLab online educational system for individualized instruction, with the absence of peer interaction or classroom community. She shared that “half the semester had gone by and the students sat next to each other in the computer lab and they were self-paced and they didn’t know who they’re sitting next to.”
While she believed the computer-aided instruction was helpful in accommodating some of the specific learning needs of the students, she added that educators should foster a community of learning “so they know each other on a different level and there’s a better chance that they can help to encourage each other. There’s that whole mattering theory: when you matter to someone, it increases your chances of persisting.”

In the researcher’s opinion, creating a community of learning is the foundation of effective teaching. An educator could be passionate about the subject being taught, plan relevant and engaging activities, and assess students authentically, but this is of little value if students are afraid to speak up in class, are not provided opportunities to contribute, and don’t get the support and encouragement they need to learn.

In this research study, three of the six student participants indicated a strong unfavorable attitude towards mathematics. The developmental educator has the potential to connect with, engage and inspire students to influence and raise their beliefs about math. Particularly in developmental mathematics, educators should foster a sense of welcome in the classroom by making the effort to learn about the backgrounds, interests, and work experiences of their students. Another way to foster a community of learning is to ask students to talk about themselves and their educational goals and their hopes or concerns for the class. An educator should inquire with students about how they learn best.

In the community of learning, an educator should encourage students to take the time to learn about each other. College may offer some students their first opportunity to engage with and relate to a wide diversity of people, and this can help them make the transition to
their eventual careers. A developmental educator should encourage students in the class to share their backgrounds, experiences, and culture with each other. In the 21st century workplace, access to a network of peers with diverse talents, skills, knowledge, or unique attributes is needed on the pathway to success in addressing the challenges of the future.

Promote Mathematics Refreshment

Incoming post-secondary students are typically placed in college math courses based on scores on a placement, such as Compass or Accuplacer. Students often take these placement exams with minimal preparation or after a long break since their last math class. In this research study, the average time span between the last math course the student attended prior to enrolling in this community college was 8.3 years. For one student participant, Puana, it had been 23 years since her last mathematics class.

According to research from the National Center on Education Statistics (NCES, 2008), students pursuing an academic certificate or degree who took developmental courses were significantly less likely to complete their credential or degree than students who did not need remedial courses. Students who were enrolled in one or two developmental math courses were about 25% less likely to complete their degree or certificate as students who did not have to take any developmental courses (42 percent compared to 69 percent). The NCES (2008) has shown that the more remediation a student needs, the less likely they are to complete college. In addition, the high cost of developmental coursework is also a barrier for community college students. At the institution of this study, each three-credit, developmental mathematics course costs between $318 and $912 in tuition alone, depending on residency status of the student.
It is the researcher’s opinion that all students entering community college should be extended a free offer to participate in a mathematics refresher experience prior to their first semester of coursework. This one to two week experience should provide math refresher materials covering a wide range of mathematical concepts together with information about success in college. Beyond math content, the course should also provide college success information, such as test-taking strategies, new student orientation, study techniques and an emphasis on building mathematical self-efficacy. In addition, participating students should be informed about the gravity of placement exams, the real cost of developmental coursework, and presented data explaining the impact of placement. Students who complete the mathematics refresher should be able to take (or retake) the math Compass placement test at the end of the session at no cost.

In the researcher’s beliefs, the study materials in the course will help students prepare for (or perform higher on) placement exams. Higher placement on the exam means fewer required math courses in college, thus a higher rate of degree and certificate completion and lower tuition costs to the students. College students who have started, but not finished their math courses, should also be eligible for the refresher and be able to retake a placement exam and possibly place out of a math class. The mathematics refresher course should utilize individualized instruction, perhaps through computer-aided instruction, based on a student’s current mathematical knowledge.

Currently, this opportunity is afforded at the community college of this research study in the form of a mathematics “boot camp,” which has exhibited Hence, this recommendation is
for a broader set of colleges who are still implementing a mathematics placement exam without supplemental instruction or support.

Limitations of the Study

This qualitative, collective case study is subject to the following limitations:

1. Qualitative research, by nature, is subjective because researchers must rely on subjective judgments of participants to interpret the phenomenon under investigation (Merriam, 2009). The participants in this study were asked to talk about their own affective characteristics or those of their students. This included participants sharing their perspectives and experiences with developmental mathematics. The researcher served as the instrument of data collection and analysis, which, by human nature, has the potential for bias in the interpretation of the results.

2. As a part of qualitative inquiry, the interview process involves finding out what another person is thinking (Creswell, 2013a). Knowing the inner workings of another’s consciousness involves asking a series of thoughtful and response provoking questions. It is possible that some questions pertinent to this study might have been overlooked by the researcher and resulted in not covering the entire range of participants’ experiences.

3. Because of the researcher’s position as an instructor at the community college site, some students and/or faculty members might have been reluctant to openly share their feelings and experiences concerning their own affective characteristics, or those of their students.
4. The study is limited to a bounded system of one research site; a developmental education program at a public community college in the state of Hawai’i over a period of 14 months. The findings relied on a small sample of 10 volunteer participants.

5. Because of the nature of qualitative research, the results of this study may not be generalized; however, its findings might be found transferable to similar settings and contexts, such as other developmental mathematics programs at community colleges within the state of Hawai’i and nationwide (Merriam, 2009).

Recommendations for Further Study

Continued research is needed in the area of studying affective characteristics of developmental mathematics students. With the results of this research assessing the affective characteristics of developmental mathematics students and their impact on completion of a prescribed set of developmental coursework, prospects for future research concerning the mathematics self-efficacy of students enrolled in developmental mathematics courses are promising. First, a longitudinal quantitative study involving a representative sample of the developmental mathematics population needs to be conducted to assess the affective characteristics of these students across colleges and aggregate the data. Second, diverse instructional strategies need to be developed, piloted, and evaluated to determine their influence on enhancing affective characteristics, especially self-efficacy. Third, additional research should qualitatively approach the population of non-completers of developmental education, namely the ones who were not successful with their prescribed sequence of coursework and did not persist in a later semester. There are no easy solutions to the complex
problems that face students with low levels of mathematics self-efficacy, but continuing attempts should be made at enhancing the affective learning experience for them.

Conclusion

Currently, there is a national movement in transforming developmental mathematics education within America’s community colleges. There is much momentum, extensive research, and a wealth of promising practices. Many schools have instituted courses that teach students how to study, organize their time, and have a more productive stance towards academic pursuits (Zachry, 2008). Faculty have implemented forms of supplemental instruction (Rambish, 2011), learning assistance centers (Perin, 2004) and emporium models (Bishop, 2010) in which lecture meetings are completely replaced with instructional software. Counselors have tried to break down barriers in a student’s academic journey that make it difficult for them to navigate the complex pathways of coursework that must be followed to succeed in developmental math and pass college-level coursework. Faculty and administrators have redesigned the curriculum in order to accelerate it, slow it down, or remove unnecessary topics.

One of my beliefs as a mathematics educator and researcher is that in order to make substantive improvements in mathematics learning, we need to transform the way mathematics is taught. In particular, I believe that students who have failed to learn mathematics in a deep and lasting way will be able to do so if mathematics educations can convince them, first, that mathematics is relevant and enriching to their lives and that mathematics is prevalent and valued within their local culture, history, and environment.
I believe that if we teach mathematics as a coherent and related system of ideas and procedures that are logically linked and steeped in local culture and values, student learning will be deepened, their affective and emotional stance will be engaged, and the desire to reason and question fundamental concepts, rather than blindly memorize, will be planted. I believe this approach may reach developmental students who have not benefited from the way they have been taught up to this point and dissolve the age old question:

“When are we ever going to use this?”

**Ethnomathematics**

To answer that age old question, I believe in pursuing the ideals of *ethnomathematics*. According to Ubiratan D’Ambrosio, who is credited for introducing the term, mathematics knowledge steeped in a culturally relevant perspective is viewed as a version of ethnomathematics – ethno defined as all culturally identifiable groups with their jargons, codes, symbols, myths, and even specific ways of reasoning and inferring; mathema defined as categories of analysis; and tics defined as methods or techniques (D’Ambrosio, 1985; D’Ambrosio, 1997). In the culturally relevant ethnomathematics classroom, the teacher builds from the students’ ethno or informal mathematics and orients the lesson toward their culture and experiences, while developing the students’ critical thinking skills (Gutstein, Lipman, Hernandez, & de los Reyes, 1997).

Educators working within the ethnomathematics perspective demonstrate a belief that students can be competent in mathematics regardless of race or social class; provide students with scaffolding between what they know and what they do not know; extend students’
thinking beyond what they already know, and exhibit in-depth knowledge of students as well as subject matter (Ladson-Billings, 1995). Ladson-Billings argued that “all children can be successful in mathematics when their understanding of it is linked to meaningful cultural referents, and when the instruction assumes that all students are capable of mastering the subject matter” (p. 141).

As a local example of ethnomathematics potential, in May 2014, the Polynesian Voyaging Society (PVS) embarked upon the first international leg of a three year worldwide voyage to share the message of Mālama Honua, “to care for our Island Earth – our natural environment, children and all humankind” (PVS, 2013). Through the worldwide voyage, PVS hopes to become a catalyst for educational change in Hawai‘i and has partnered with many formal and informal educators and organizations to develop more culturally relevant and sustainable curricula within Hawai‘i’s schools. PVS warns that the world’s “compass” currently points toward an unsustainable future and believes that our ability to survive is directly dependent on our ability to help each other. In their words, “by bringing together and working with scientists, educators, policy makers, business leaders and concerned citizens, we believe Hawai‘i can one day become a model of social and environmental responsibility to the world” (PVS, 2013).

In response to the critical and urgent call sounded by PVS, I propose the creation of a developmental mathematics curriculum based on the values and learning inherent in the design, construction and sailing of Pacific Island outrigger canoes (wa‘a kaulua). I wholeheartedly believe that aspects of developmental mathematics and Pacific Island canoe
construction can be woven together to facilitate the acquisition and deep understanding of developmental and college-level mathematics, in addition to fostering engagement in the subject among students. I embody the tenets of ethnomathematics, project-based and service learning as the pillars for this curriculum. Through ethnomathematics, students use a variety of examples to solve problems from a variety of cultures, and recognize that learning mathematics is a unique process for every individual (Arismendi-Pardi, 1999). In project-based learning, students are exposed to an extended process of inquiry to learn significant content in response to a complex problem or challenge, such as building a canoe (Boss & Krauss, 2007). Service learning is a teaching and learning strategy that integrates meaningful community service with instruction, giving students the opportunity to strengthen local communities (Furco & Billig, 2002). All canoes would be donated to nonprofit organizations that promote canoe culture and provide opportunities for the public to experience Pacific Island outrigger canoes.

Although, to the extent of my searching, I have not uncovered the existence of a similar curriculum, in concept or in practice, for this exercise I attempted creating my vision through a skeletal course syllabus, which is presented as Appendix D in this paper. The actual implementation of this curriculum is one of my life goals and I am optimistic and passionate about connecting the findings of this research about the affective characteristics of developmental mathematics students to inform the curricular and pedagogical decisions of such a course. I believe that this future research endeavor may be a catalyst for reform in the teaching methods and routines that define developmental mathematics in community colleges. I also hope this future direct may assist institutions of higher learning to determine if a similar ethnomathematics, project-based, service learning application of developmental mathematics
curriculum is appropriate for adaptation to fit the needs of their student population within their college.

I am convinced that the challenges students and educators face in the realm of developmental mathematics are complex and, as a collective assembly, are tackling them from diverse methods and perspectives. I am optimistic that reform is currently underway and positive impact is being made in pockets of colleges across the nation. I hope to contribute to this movement and am grateful to engage in this research with a group of students and faculty members who are equally committed to improving the state of developmental education. In my mind, teaching is the world’s greatest craft. I believe Aʻā summarized this perspective and shared similar passion in the closing remarks of her interview.

Hold the classroom space as a gift and an opportunity for something really precious. A really precious and special opportunity. Recognize what a great job this is. This position is a great honor, so go with that and don’t teach your class like it’s such a slog and a burden. Teach it like it’s awesome.
Appendix A: Participant Consent Form

Consent to Participate in Research Project:

A Qualitative Inquiry Exploring Affective Characteristics of Developmental Mathematics Students and Faculty

Aloha kākou. My name is Michael Paulding. I am both a faculty member at [name removed], teaching business mathematics and information technology and a graduate student at the University of Hawai‘i at Mānoa within the College of Education. As part of the requirements for earning my doctoral degree and to serve the community of Hawai‘i, I am conducting research project to study the perceptions of developmental mathematics students and faculty to explore affective characteristics of students, such as attitude, locus of control, anxiety and self-efficacy. I am asking you to participate in this research because you are either a former or current student of a developmental mathematics course, or a faculty member teaching developmental mathematics.

Activities and Time Commitment: If you participate in this project, I will meet with you for two sessions at a location and time convenient for you. The first session will be an introduction and ice breaker for us to get to know each other. I will ask you to bring in 3-5 physical artifacts (objects) that represent who you are as an individual. One of the artifacts you bring should represent your relationship with or feelings about mathematics. In our second meeting, we will get together for a semi-structured interview. The interview will consist of 10-15 open ended questions, and will take 45 minutes to an hour. Interview questions will include questions like, “What is your current attitude towards mathematics?” and “Have you ever experienced anxiety during a mathematics class?” Only you and I will be present during the interview. I will audio-record the interview so that I can later transcribe the interview and
analyze the responses. You will be one of about 12 people whom I will interview for this study.

**Benefits and Risks:** There will be no financial compensation to you for participating in this interview. It is my hope, however, that this research will give voice to several involved stakeholders (students and faculty) in the developmental mathematics community. From the collective voices, it is believed that the results of this project will help the University inform and improve its developmental mathematics curriculum, to benefit future students. I believe there is little risk to you in participating in this research project. If however, you become uncomfortable answering any of the interview questions or discussing topics with me during the interview, we can skip the question, or take a break, or stop the interview, or you can choose to withdraw from the project altogether.

**Privacy and Confidentiality:** During this research project, I will keep all data in a secure location. Only my University of Hawaiʻi advisor and I will have access to the data, although legally authorized agencies, including the UH Committee on Human Studies, can review research records. After I transcribe the interviews, I will provide you with digital copies to review for accuracy. When I type and report the results of my research project, I will not use your name or any other personally identifying information. Rather I will use pseudonyms (fake names) and report my findings in a way that protects your privacy and confidentiality to the extent allowed by law.

**Voluntary Participation:** Your participation in this project is completely voluntary. You may stop participating at any time without any penalty or loss.

If you have any questions about this research project, please call me at (808) 734-9308 or email me at mpauldin@hawaii.edu. If you have any questions regarding your rights as a research participant, please contact the UH Committee on Human Studies at (808) 956-5007, or uhirb@hawaii.edu

If you agree to participate in this project, please sign and date this signature page and return it to: Michael Paulding, Principal Investigator at the University of Hawaiʻi at Mānoa

I have read and understand the information provided to me about participating in the research project: A Qualitative Inquiry Exploring Affective Characteristics of Developmental Mathematics Students
My signature below indicates that I agree to participate in this research project.

Printed name: ______________________________

Signature: _________________________________

Date: _________________________________

You will be given a copy of this consent form for your records.
Appendix B: Interview Guide for Student Participants

A Qualitative Inquiry Exploring Affective Characteristics of Developmental Mathematics Students

Research Question

1) How do developmental mathematics students assess their own affective characteristics?
   a. What are student attitudes towards mathematics?
   b. To what extent do students accept responsibility for their own academic behavior?
   c. To what extent do students experience anxiety toward mathematics?
   d. How do students perceive their own self-efficacy towards mathematics?

Interview Questions for Student Participants

1) When the last time you took a developmental mathematics (Math 24, 25 or 81) course?

2) Describe your initial reaction and thoughts when you found out “You have to take Math 24, 25, or 81 (developmental math course).”
   a. Probe: Did you personally think you needed to take a developmental mathematics course? Why or why not?

3) How do you describe your attitudes towards mathematics?
   a. Probe: What past experiences in mathematics classes have shaped your current attitude?

4) Describe how motivated you are to learn mathematics.
   a. Probe: What past experiences in mathematics classes have shaped your current motivation level?

5) Think about times when you have encountered a difficult problem in a mathematics class. How do you handle situations where you do not know the answer to a mathematics problem?
   a. Probe: If you still are unable to solve a mathematics problem after those steps, why do you think that is?
   b. Probe: When faced with challenge in math, do you tend to invest more effort to overcome it or do you tend to be discouraged and give up? Why is that?
6) Have you ever experienced anxiety during a mathematics class?
   a. *Probe: If so: Please describe the situations that have caused anxiety for you.*
   b. *Probe: If so: How have you dealt with this anxiety?*
   c. *Probe: If not: What strategies do you use to keep calm or feel confident in a mathematics class?*

7) Describe your current study habits. How do you prepare for mathematics classes?

8) I’d like you to describe some abilities that you are successful with (not limited to mathematics). Describe how you were able to learn the skills necessary for your abilities.
   a. *Probe: How do you learn new skills or concepts best?*

9) In all the mathematics courses you’ve taken, which did you learn the most from?
   a. *Probe: What was it about these courses that led you to learn the most from them?*

10) In all the mathematics courses you’ve taken, which did you learn the least from?
    a. *Probe: What was it about these courses that led you to learn the least from them?*

11) Describe your current study habits. How do you prepare for classes?

12) Suppose I was a new mathematics instructor teaching developmental mathematics courses. What advice would you give me to become an effective teacher?
Appendix C: Interview Guide for Faculty Participants

A Qualitative Inquiry Exploring Affective Characteristics of Developmental Mathematics Students

Research Question

2) How do developmental mathematics faculty perceive the affective characteristics of their students?

   a. How do faculty view the attitudes of their students towards mathematics?
   b. What do faculty believe about how students accept responsibility for their own behavior?
   c. What do faculty believe about mathematics anxiety among their students?
   d. How do faculty perceive the self-efficacy of their students?

Sample Interview Questions for Faculty Participants

1) What inspired you to become a(n) [educator/counselor/administrator]? Why did you choose this career path?

2) What is your philosophy or framework for [teaching/counseling/supporting] students?

3) What outlets of [supplemental instruction, counseling, mentoring and/or other support] are available to developmental mathematics students?

4) From your perspective, what characteristics do you see displayed by the developmental students?
   a. Probe: Did you think most students placed into Math 24, 25, or 81 need to take a developmental mathematics course? Why or why not?

5) How do you describe student attitudes towards development mathematics?
   a. Probe: What are some past experiences or things students have told you that have shaped their attitudes? Why do you think they feel that way?

6) Describe how motivated students are to learn developmental mathematics.
a. *What are some past experiences or things students have told you that have shaped their attitudes? Why do you think they feel that way?*

7) **What are some of the challenges that students face in developmental mathematics? How do students handle difficult situations?**
   
   a. *Probe:* What do students do when they are stuck with the content?
   
   b. *Probe:* When faced with challenge in math, do you believe developmental math students tend to invest more effort to overcome it or do they tend to get discouraged and give up? Why is that?

8) **Do students report experiencing anxiety during a mathematics class?**
   
   a. *Probe:* If so: *Please describe the situations that cause anxiety for students.*
   
   b. *Probe:* If so: *How do students dealt with this anxiety?*
   
   c. *Probe:* If not: *What strategies do students use to keep calm or feel confident in a mathematics class?*

9) **Generally speaking, how to developmental mathematics students perceive their ability to complete tasks?**
   
   a. *Probe:* *What do you think shapes their perspective or worldview about achieving goals?*

10) **Please describe the study habits of developmental students. How does the department foster study habits or class preparation among its students?**

11) **What aspects of developmental mathematics courses do students report as helping them to learn?**

12) **What aspects of developmental mathematics courses do students report as hindering them from learning?**

13) **Suppose I was a brand new instructor teaching developmental mathematics courses. What advice would you give me to become an effective teacher, from the perspective of a faculty member?**
Appendix D: Preliminary Syllabus for Developmental Ethnomathematics

MATH 25A Course Syllabus:
The Algebra of Pacific Island Outrigger Canoes
Community College of the University of Hawai’i System

Course Description:

Math 25A is an elementary algebra course steeped in the vast traditions, values and culture of Pacific Island outrigger canoe construction. In this course, students will be immersed in basic algebra topics, using a blend of traditional and contemporary canoe building approaches. Mathematics instruction includes units on canoe design, materials estimation and construction, exponents, polynomials, factoring, rational expressions and equations, radical expressions and equations and quadratic equations. The capstone project for this course is the creation of a fully functional Pacific Island outrigger canoe, built according to student design. To culminate the learning, canoes will be paddled and sailed by students from Waialae Beach Park to the Ala Wai Boat Harbor in Waikiki, a distance of 5 nautical miles.

Course Philosophy:

The pedagogical focus of this course is approached through the lenses of Ethnomathematics, project-based and service learning.

- Through Ethnomathematics, students use a variety of examples to solve problems from a variety of cultures, and recognize that learning mathematics is a unique process for every individual (Arismendi-Pardi, 1999)
- In project-based learning, students are exposed to an extended process of inquiry to learn significant content in response to a complex problem or challenge (e.g., building a canoe)
- Service learning is a teaching and learning strategy that integrates meaningful community service with instruction, giving students the opportunity to strengthen local communities. All canoes will be donated to non-profit organizations that promote canoe culture and provide opportunities for the public to experience Pacific Island outrigger canoes.

Instructor: Michael Paulding
Email: mpauldin@hawaii.edu
Students should expect a response to their email within 24 hours, excluding weekends and holidays.
Class “rooms”: Outdoor Canoe Hale – the shaded, covered area where we will build canoes

Meeting Days/Times:
  Mon and Tues: 4:45pm - 6:00pm
  Wed and Thurs: 4:45pm - 6:00pm

Course Homepage on Laulima: [https://laulima.hawaii.edu](https://laulima.hawaii.edu)
CRN: 12345

“Office” Hours:

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<tr>
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<th>Location</th>
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<tbody>
<tr>
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<td>3:30 - 4:30pm</td>
<td>Canoe Hale</td>
</tr>
<tr>
<td>Tuesdays</td>
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<td>Canoe Hale</td>
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<tr>
<td>Wednesdays</td>
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<tr>
<td>Thursdays</td>
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<tr>
<td>Sundays</td>
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<td>Online</td>
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<td>Blackboard Collaborate</td>
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</table>

Other times by appointment.

**Please note that office hours will be held in the canoe hale rather than a traditional office for several reasons:
1. The canoe hale is a lively and open environment where students can collaborate on projects and ask questions together
2. Our canoes live there!
3. The tools and technology to support our canoe construction are available.
4. We don’t have to squeeze into my closet-sized office 😊

### Required Reading for Math 24A

<table>
<thead>
<tr>
<th>Title</th>
<th>Author</th>
<th>ISBN-13</th>
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<tbody>
<tr>
<td><strong>Building Outrigger Sailing Canoes</strong></td>
<td>Gary Dierking</td>
<td>978-0071487917</td>
</tr>
<tr>
<td><strong>The Elements of Boat Strength</strong></td>
<td>Dave Gerr</td>
<td>978-0070231597</td>
</tr>
</tbody>
</table>
An Ocean in Mind
Author: Will Kyselka

Prerequisite(s): A grade of "C" or higher in MATH 24, or a grade of "C" or higher MATH 81, or a Compass placement test recommendation of MATH 25.

Course Competencies: Upon successful completion of MATH 25, the student should be able to:

- Identify and use laws of exponents to simplify expressions with integral exponents.
- Use scientific notation in calculations.
- Add, subtract, multiply, and divide polynomials in one or two variables.
- Factor the greatest common factor from a polynomial expression.
- Factor a polynomial of four terms by grouping.
- Factor general trinomials $ax^2 + bx + c$, where $a$, $b$, and $c$ are integers.
- Recognize and factor the difference of two squares.
- Recognize and factor a perfect square trinomial.
- Write rational expressions in lowest terms.
- Add, subtract, multiply, and divide algebraic fractions.
- Solve equations containing rational expressions.
- Solve word problems that lead to equations containing rational expressions.
- Identify a given radical as rational, irrational, or not real.
- Evaluate a radical expression.
- Simplify a radical expression.
- Add, subtract, multiply, or divide radical expressions.
- Solve equations containing radicals.
- Solve word problems that lead to equations containing radical expressions.
- Solve a quadratic equation with integral coefficients by factoring.
- Solve equations of the form $(ax + b)^2$, using the square root property of equations.
- Complete the perfect trinomial square given a partial trinomial.
- Use the quadratic formula to solve quadratic equations.

Grading:

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<th>Component</th>
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<td>Projects (8)</td>
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<tr>
<td>Problem Sets</td>
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<tr>
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<tr>
<td>In-class Assignments</td>
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Appendix E: Conceptual Map of the Research Study

**Goals**

**Conceptual Framework**

**A Qualitative Inquiry Exploring Affective Characteristics of Developmental Mathematics Students**

1. How do developmental mathematics students assess their own affective characteristics?
   - a. What are student attitudes towards mathematics?
   - b. To what extent do students accept responsibility for their own behavior?
   - c. To what extent do students experience anxiety toward mathematics?
   - d. How do students perceive their own self-efficacy towards mathematics?

2. How do developmental mathematics faculty perceive the affective characteristics of their students?
   - a. How do faculty view their student attitudes towards mathematics?
   - b. What do faculty believe about how students accept responsibility for their own behavior?
   - c. What do faculty believe about mathematics anxiety among their students?
   - d. How do faculty perceive the self-efficacy of their students?

**Methods**

**Internal Validity (Credibility, Trustworthiness, Rigor)**

**Practical Goal** To facilitate a greater insight of affective characteristics among developmental mathematics students themselves and the faculty members who teach and support them.

**Intellectual Goals** To understand the affective characteristics of developmental mathematics students and faculty; to add to the body of literature (student and faculty perceptions of affective characteristics of developmental mathematics students at the postsecondary level).

**Personal Goals** To connect findings of this research with future initiative to construct a developmental mathematics curriculum centered around Polynesian canoe building and to attain a Ph.D. degree in Education in Curriculum Studies.

**Existing Research** Literature on American community colleges, developmental mathematics education, affective characteristics, self-efficacy theory, qualitative research, case study, and interviews.

**Theoretical Framework** Self-Efficacy Theory (Bandura, 1997) – the beliefs a person holds to affect situations strongly influences the power a person has to overcome challenges.

**Research Design** Qualitative inquiry; Exploratory case study

**Setting** Community college campus

**Participants** 6 dev. mathematics students, 4 dev. mathematics faculty members

**Data collected from** Interviews, narratives, artifacts and field notes

**Purposeful Sample Selection** Maximum variation sampling used to identify and select student and faculty participants who "represent the widest possible range of the characteristics of interest for the study" (Merriam, 2009, p.79); Criterion for sampling include completers and repeater students. Developmental mathematics faculty, including educator, counselors, and administrator selected to ensure triangulation.

**Researcher Role** Teacher as Researcher; researcher as key instrument (Creswell, 2013), where the researcher gathers information from students and fellow faculty; researcher and participants co-construct reality

**Data Collection** Interviews with purposefully selected students and faculty; narratives and use of artifacts to provide background and context

**Data Analysis** "Data analysis is done in conjunction with data collection" (Merriam, 2009, p. 178)

Coding for themes—to make comparisons within the same organizational and substantive categories (Maxwell, 2012)

Full transcripts and detailed narratives

**Triangulation**

- Multiple participants (purposefully selected students and faculty)
- Multiple data sources (interviews, narratives and artifacts)
- Rich, thick description

**Member Checks**

- Soliciting feedback and confirmation from participants on interview transcripts and analysis

**Prolonged Time in the Field**

- Identifying researcher’s relationship to the participants
- Identifying researcher’s positionality
Appendix F: Human Studies Program – Approval of Exempt Study

June 7, 2013

TO: Michael Paulding
   Principal Investigator
   College of Education

FROM: Denise A. Lin-DeShetler, MPH, MA
       Director

SUBJECT: CHS #21348- "A Qualitative Inquiry Exploring Affective Characteristics of Developmental Mathematics Students"

This letter is your record of the Human Studies Program approval of this study as exempt.

On June 7, 2013, the University of Hawai‘i (UH) Human Studies Program approved this study as exempt from federal regulations pertaining to the protection of human research participants. The authority for the exemption applicable to your study is documented in the Code of Federal Regulations at 45CFR 46.101(b) (Exempt Category 2).

Exempt studies are subject to the ethical principles articulated in The Belmont Report, found at http://www.hawaii.edu/irb/html/manual/appendices/A/belmont.html.

Exempt studies do not require regular continuing review by the Human Studies Program. However, if you propose to modify your study, you must receive approval from the Human Studies Program prior to implementing any changes. You can submit your proposed changes via email at uhirb@hawaii.edu. (The subject line should read: Exempt Study Modification.) The Human Studies Program may review the exempt status at that time and request an application for approval as non-exempt research.

In order to protect the confidentiality of research participants, we encourage you to destroy private information which can be linked to the identities of individuals as soon as it is reasonable to do so. Signed consent forms, as applicable to your study, should be maintained for at least the duration of your project.

This approval does not expire. However, please notify the Human Studies Program when your study is complete. Upon notification, we will close our files pertaining to your study.

If you have any questions relating to the protection of human research participants, please contact the Human Studies Program at 956-5007 or uhirb@hawaii.edu. We wish you success in carrying out your research project.
References


Gardner, J. (1998, November). The changing role of developmental educators in creating and maintaining student success. Keynote address delivered at the College Reading and Learning Association Conference, Salt Lake City, UT.


