CULTIVATING MATHEMATICAL AFFECTIONS:

DEVELOPING A HABITUAL INCLINATION TO SEE MATHEMATICS AS WORTHWHILE THROUGH ENGAGEMENT IN SERVICE-LEARNING

DISSERTATION PROPOSAL

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Chapter 1: Introduction

Introduction

"When am I ever going to use this?" is a statement that is often on the ears of every mathematics teacher. Please notice that I referred to this as a *statement* and not as a *question*. It has been my experience as an educator that the true nature of "When am I ever going to use this?" is typically not as a legitimate inquiry as to the appropriate timeframe in which the student will eventually apply the material at hand in a "real-life" scenario, rather, the phrase more often arises as a statement. It is a statement of frustration. It is the culmination of confusion and stress and typically serves as an exclamation by the student of their withdrawal from the mental activity at hand.[1] The real issue being raised by students is not one of application, but rather one of *values*. I have found that the best response to such a statement/question is to first translate it into what I believe the student truly meant to express, turning "When am I ever going to use this?" into "Why should I *value* this?" It is my belief that modern society (and the current educational system) has conditioned students (and people in general) to value things (including knowledge) for their practicality. So as the students begin to formulate the true question of "Why should I value this?" they phrase it in a way that expects a response in terms of how math will get them ahead in life, earn them more money, and in general fix all their problems. While the utility of mathematical concepts is certainly important, we as mathematics educators need to utilize the mathematics classroom to address the more fundamental issue of fostering a proper

[1] Certainly the question "When am I ever going to use this?" can be a legitimate question of curiosity on the part of student. It has simply been my experience (and I have found the experience of my colleagues as well) that the students asking the question legitimately would fall in the minority. Generally students asking this question seem very unsatisfied with a time-frame response of future applications, hinting that there is something deeper motivating their question/statement.

sense of values. Learning has little meaning unless it produces a sustained and substantial influence not only on the way people think, but also on how they feel and act. I believe that we as math educators need to do a better job of what I have termed "cultivating mathematical affections," that is developing a consistent appreciation for the discipline of mathematics apart from cognitive achievement on formal assessments.

Statement of Problem

Affective language permeates national published standards on the teaching of mathematics as an ideal we should strive to inculcate into students but there is little discussion on *how* to go about doing this. The NCTM Standards for Teaching Mathematics (1991) states that "Being mathematically literate includes having an appreciation of the value and beauty of mathematics as well as being able and inclined to appraise and use quantitative information." Mathematical literacy involves a proper valuation of the discipline of mathematics. *Adding it Up: Helping Children Learn Mathematics*, a report published by the National Research Council (2001) argues that mathematical proficiency has five strands, one of which is termed "productive disposition." Productive disposition is defined as "the habitual inclination to see mathematics as sensible, useful, and worthwhile" (p. 116). To be mathematically proficient (not just literate, but proficient) the valuation of mathematics must lead to a habit of seeing mathematics as worthwhile.

In both these documents there are two clear examples of affective objectives for students of mathematics with no supporting information on how to reach those objectives. Why might this be the case? In a special issue of *Educational Studies in Mathematics* devoted entirely to affect in mathematics education, Rosetta Zan notes that "affect has generally been seen as 'other' than mathematical thinking, as just not part of it" (Zan 2006, p. 113). However, one could argue that

education is inherently affective; it is inherently value-laden. It is not a question of "*Are* you teaching values?" but rather "*Which* values are you teaching?" Even the statement "We should not be focusing on values in the classroom" is itself a value-based statement. Perhaps the stance taken by the math education research community by in large is that if educators focus on cognitions, on raising standards and developing innovative teaching practices designed to increase content knowledge, then the affections of students will follow. In other words, national policy documents on the aims of math education seem to indicate that if students *know* math first then they will value and appreciate it.

However, as it stands the current methods of teaching are producing untold numbers of students who see mathematics more about natural ability rather than effort, who are willing to accept poor performance in mathematics, who often openly proclaim their ignorance of math without embarrassment, and who treat their lack of accomplishment in mathematics as permanent state over which they have little control (McLeod, 1992). In a foundational article on affective learning in mathematics in the *Handbook of Research on Mathematics Teaching and Learning*, Douglas McLeod notes how teachers will often talk about their mathematics classes in terms of their students' enthusiasm or hostility toward mathematics more than simply reporting on their cognitive achievements. Similarly, students are just as likely to discuss affective as cognitive responses, comments about liking (or hating) mathematics are as common as reports of instructional activities (McLeod, 1992, p. 575). These informal observations support the view that affect plays a significant role in mathematics learning and instruction. McLeod might as well have been writing today. He goes on to cite efforts to reform mathematics curriculum and those reform efforts' emphasis on the role of affect. The specific documents he cites are the National Council of the Teachers of Mathematics (NCTM) Standards for School Mathematics (1989) and

the National Research Council's report on math education titled *Everybody Counts* (1989). As noted above, the problem addressed in this study is very much along the lines of McLeod though it will be structured in a different way, and it begins by focusing on statements made in the NCTM's Standards for Teaching Mathematics (1991 & 2000) and the National Research Council's report *Adding it Up: Helping Children Learn Mathematics* (2001). McLeod's work will be discussed in more detail below. However, due to the strikingly similar starting point the arguments, the unchanging language of national published standards, and the similar situations of finding research on affect on the periphery, it can be argued that McLeod's work has yielded little results and is in need of an adjustment.

McLeod's basic argument is to re-conceptualize affective learning into three main areas: beliefs, attitudes, and emotions. Each of these categories can be broken down according to the direction of focus (outward, inward, toward the teaching of mathematics, toward the learning of mathematics, etc.) and the strength of feeling. The flaw of McLeod's approach is that only the category of attitude fits properly within the affective domain of learning as developed by Krathwohl (1964). The affective domain of learning is really about demonstrated behavior, attitude, and characteristics of the learner (Krathwohl, 1964). Beliefs are more cognitive (and McLeod admits as much) and emotions are typically intense and quite fleeting making the difficult to gauge in any research sense. McLeod also admits this point, offering the example of the joy a student may feel over having an 'aha' moment of discovery and insight. To be fair, the point of McLeod's approach was to find a way to tie in affective components more closely to cognitive components of research. However, what is really needed in mathematics education is an actual framework for developing an understanding of affective learning in and of itself, primary to cognitive development, which can then be tied back to cognitive approaches, rather

than essentially redefining affective learning to make it mesh better with our understanding of cognition. To use McLeod's second category, it is the attitudes that need adjusting.

As mentioned above, the affective domain of learning is really about demonstrated behavior, attitude, and characteristics of the learner (Krathwohl, 1964) rather than subjective emotions the learner experiences. If mathematics educators and researchers can come to understand this definition of affective learning then it will be easier to see how a more systematic approach to affective teaching might be developed and affective assessments may be considered legitimate evaluators of student growth. What this study is ultimately meant to address is the habits of our students, how they are instilled, how they are encouraged (or discouraged), and how they are evaluated.

Purpose of Study

The purpose of this case study will be to analyze the role of service-learning in the cultivation of mathematical affections for students in a suburban high school mathematics classroom as they participate in a service-learning project. At this stage in the research, the cultivation of mathematical affections will be generally defined as developing a consistent appreciation for the discipline of mathematics apart from cognitive achievement on formal assessments. Service-learning will be examined as a potential pedagogical tool that can be utilized to develop a habitual inclination to see mathematics as worthwhile.

Let me take a moment to define more clearly what is meant by "mathematical affections." This phrase is in homage to Jonathan Edwards' *Treatise Concerning Religious Affections*. Edwards' goal was to discern the true nature of religion and in so doing dissuade his congregation from merely participating in a religious culture, a mimicked outward expression, and motivate them to long for true conversion, an inward reality of authentic character. The

purpose of this study is to engage educators in discerning the true nature of mathematical pedagogy, and how educators approach the teaching and learning of mathematics: does it simply mimic the modern culture of utility by requiring outward demonstrations of knowledge retention and application, or does it aim deeper at analyzing true inward character formation? For Edwards, affections were not synonymous with emotions as they tend to be in today's mathematics education research as noted by Zan (2006). Edwards understood affections as aesthetics – a way of orienting your life via a mechanism that determines what is beautiful and worthwhile. Affections are character producing and habit forming. It can be argued that Edwards' definition of affections (orientation of life, determining worth) is what actually appears in the policy documents that have been cited above. Consider once more that being mathematically literate involves having an appreciation of the value and beauty of mathematics (cf Veatch, 2001), and being mathematically proficient involves a habitual inclination to see mathematics as worthwhile. Foundational documents in the area of mathematics education plainly portray mathematics as beautiful, of value, and affecting the habits of the learner to see mathematics as worthwhile. However, none of these documents develops *how* teachers are to go about accomplishing this task.

Service-learning potentially offers one tangible practice than can be instituted in the mathematics classroom as a means of inculcating the mathematical values into students which national policy documents aim for. The question at hand is does service-learning offer a vehicle for the discussion of *how* to go about instilling the values that the math education desires to see in its students? Service-learning in its most effective and well-developed sense involves a multilayered reflection process that can substantially increase its educational value in a broad sense: service-learning reflection asks the learner to become more aware of what he/she brings to

the learning process: values, assumptions, biases – many of which are unexamined and potentially problematic (Zlotowski 2005, p. ix).

As noted by Zlotowski, the process of reflection in service-learning allows the students to examine what values they bring to the learning process (many of which have been never before been examined). It would seem that the pedagogical practice of placing students in these service-based contexts that are rich with opportunities for discussion and reflection, all within the overarching goals of a mathematics course, move closer to achieving the goal of instilling an appreciation for mathematics within the hearts of students.

The proposed study will seek to answer the following research questions:

1. To what extent does service-learning impact the cultivation of mathematical affections among students?
2. What is the alignment between the affective objectives of national policy documents on the aims of mathematics education and the affective outcomes on students participating in a service-learning project?
3. To what extent does service-learning offer a viable means of achieving the affective objectives of national policy documents on the aims of mathematics education?

The research reviewed below will show that if human beings are primarily affective learners then much more research needs to be done and reexamined in regards to the emphasis on the affective domain of learning in the math classroom. There is work being done in philosophy and cognitive science that indeed argues for the primacy of the affections above the cognitions. This paper will propose three stages of analyzing affective learning in the mathematics classroom, each of which is born out of statements on national standards on teaching and assessing mathematics: instilling values, practicing virtues, and assessing affections. This model

helps provide some cohesion to research that has been done on the affections and situate it in a context that helps explain both the positive aspects and the shortcomings of the study. The model that is being proposed is potentially effective at addressing *how* to go about the cultivation of mathematical affections. Research indicates that affections are formed through the day-to-day routines and subconscious habits of the individual (Smith, 2009). Also, introducing guided reflective activities has been demonstrated to increase student appreciation of a given subject (Hulleman, 2010). Therefore the benefits of integrating more reflective activities into the daily habits of the math classroom will be argued. In particular, service-learning will be examined as a vehicle for introducing such periods of reflection.

Significance of Study

When students ask "When am I ever going to use this?" most mathematics teachers will answer this surface question rather than the underlying values-based question. Answers will range from "You'll need this to be able to handle money properly as an adult" to "You'll need this to understand what you'll learn next year" and the basic "You'll need this to pass the test next week." If a teacher is really clever then they'll revamp their curriculum to include multiple application-based problems in various scenarios in order to address the question before it is even asked. All of these approaches ignore the underlying values. In fact, these answers actually reinforce the students' perception that value only stems from application and utility. I believe that part of the reason the question is answered in these application-focused ways is because application is something educators are much more familiar with in the context of teaching as compared with values. Application is the third level of Bloom's Taxonomy, in the cognitive domain (Bloom, 1956; Anderson, 2000). Valuing is the third level of Krathwohl's Taxonomy, in the affective domain (Krathwohl, 1964). It is my argument that mathematics teachers in general

are under-trained in the affective domain and therefore do not realize that the underlying value-based question of students is just as reasonable to address as the surface level application-based question. Now, application is certainly useful in the teaching process and it should not be ignored. This study is not advocating the promotion of the affective domain over and above the cognitive. The goal is to simply bring the affective up to the same level as the cognitive; to utilize both domains in conjunction with each other. As a result of this study perhaps teachers of mathematics will come to realize that affective learning is not simply based on subjective emotions (though emotion may play a small part in affective learning), rather it's about demonstrated behavior, attitude, and characteristics of the learner (Krathwohl, 1964) – all of which are deeply linked to success in the mathematics classroom.

Definitions

1. Mathematical Affections – at this stage in the research, the cultivation of mathematical affections will be generally defined as developing a consistent appreciation[2] for the discipline of mathematics apart from cognitive achievement on formal assessments. This definition is in keeping with the "productive disposition" strand of mathematical proficiency defined in *Adding it Up: Helping Children Learn Mathematics* (2001): the habitual inclination to see mathematics as worthwhile (p. 116).
2. Service-Learning – at a basic level, service-learning can be defined as a set of activities that have two characteristics: 1) they enhance either the delivery or the impact of the curricular material, usually, but not always, within the context of a specific course, and 2)

[2] As measured by the Fennema-Sherman Math Attitudes Scale (FSMAS) (Fennema & Sherman, 1976; Mulhern & Rae, 1998) as described in the methodology section below.

they take place within a service framework where additional experience with civic engagement or social contribution will be obtained (Hadlock, 2005a, p. 2).

Chapter 2: Literature Review

This literature review will give a brief overview of research being done on affect in mathematics education and how affect has largely played a secondary role to cognition. A new way of viewing affect as primary to cognition will be put forward based on work in contemporary philosophy and psychology. Then the question "how do we instill values in students in the classroom?" in light of this new view on affect will be addressed. Finally literature on service-learning will be examined and service-learning will be seen as a practical pedagogical practice that is line with an understanding of the primacy of affect, in keeping with the literature on how to instill values in students, and results in the stated affective aims of national policy documents on mathematics education.

An Overview of Research on Affect in Mathematics Education

The purpose of this portion of this paper is to orient the reader to the current state of research on affect in mathematics teaching and learning since the time of McLeod's article in 1992. It can be argued that perhaps the affective domain of learning has often been misunderstood or misrepresented in the mathematics classroom. Research seems to approach affective learning as subjective and emotional and therefore it does not fit well with the objective mindset that is often associated with mathematics teaching and learning. In a special issue of *Educational Studies in Mathematics* devoted entirely to affect in mathematics education, Rosetta Zan states:

> Affect has been a focus of increasing interest in mathematics education research. However, affect has generally been seen as 'other' than mathematical thinking, as just not

> part of it. Indeed, throughout modern history, reasoning has normally seems to require the suppression, or the control of, emotion (Zan, 2006, p. 113).

The research that exists on affect can be organized into two different categories: research that examines instilling values in students and research that examines virtue practiced by the students. The research that is reviewed below will be organized according to these two points of emphasis.

The reference of "instilling values in students" is a broad label that can be applied to research that focuses on Krathwohl's categories of receiving (refers to the student's willingness to attend to particular phenomena of stimuli), responding (refers to active participation on the part of the student), and valuing (concerned with the worth or value a student attaches to a particular object, phenomenon, or behavior). 'Values' is essentially referring to developing an attitude toward a particular subject, in this case mathematics. The NCTM Standards for Teaching Mathematics (1991) states that "Being mathematically literate includes having an appreciation of the value and beauty of mathematics as well as being able and inclined to appraise and use quantitative information." Mathematical literacy involves a proper valuation of the discipline of mathematics. Much of the work being done under this sub-discipline of affect tends to be motivated primarily by cognitive issues. This can be attributed to another statement from McLeod that the emphasis on affective issues in the U.S. reform movement in mathematics education is related to the importance that the reform movement attaches to higher-order thinking (1992, p.575). If students are going to be active learners of mathematics who willingly attack non-routine problems, their affective responses to mathematics are going to be much more intense than if they are merely expected to achieve satisfactory levels of performance in low-level computations' skills. Building on the work of McLeod (and even using the same quote provided in the previous section of this paper), Maaz (2009) explains the historical perspective of research on affective issues in mathematics. The first case of such detailed research stemmed

from research on gender aspects which led to an interest in attitudes toward mathematics (Fennema and Sherman, 1976). However Maaz notes that a more interesting direction in affect research has involved studies of mathematical problem solving (McLeod, 1989). Observations of students carrying out various problem solving tasks demonstrated that their reaction during the solution process could not be understood as a purely cognitive process. Problem-based learning leads to demonstrating a greater knowledge in solving more difficult math problems (cf Carpenter, et al's 1989 Cognitively Guided Instruction study) and this knowledge ties it to shaping opinions – problems are challenging but students have a feeling of success (Cotic, 2009). Lebens (2011) notes the importance of affective factors in mathematical achievement and how it differs by achievement bands – children of average ability are less influenced by affective factors than children with mathematical difficulties. Botella (2012) intended to analyze and describe the importance of the emotional factors (emotions, beliefs and attitudes) in mathematics education. The study showed that the emotional factors and the academic performance of students were correlated, accentuating the need to grant a more important role to the affective components in order to improve the quality of the mathematics. Ma (2006) noted that although changes in cognitive factors had more comprehensive effects on participation in a mathematics classroom than those in affective factors, changes in attitude toward mathematics had the most important effect on participation. Gomez-Chacon (2000) discussed the importance of taking into account affective factors in academically failing students and the article's main focus is on developing interaction between affect and cognition so as to explain emotion in more detail. Prawat (1994) examined the affective experiences of fourth and fifth graders engaged in mathematics seatwork. Students' affect was found to be primarily negative and achievement related. Anger was the most prevalent affective response.

These above examples seem to indicate a trend that much of the research on developing values (values as it has been defined above broadly, which may include some researchers work on beliefs or attitudes) in the mathematics classroom is largely driven by increased attention to higher-order cognitive thinking and its impact on the affections of students, rather than vice-versa. This ordering of the cognitive as primary and the affective as subservient to the cognitive tends to lead to some discrepancies in actually defining some of the affective terminology (i.e., beliefs actually being cognitive as opposed to affective). Despite the above body of work Sfard writes:

> Finally, the self-sustained "essences" implied in reifying terms such as knowledge, beliefs, and attitudes constitute rather shaky ground for either empirical research or pedagogical practices – a factor of which neither research nor teachers seem fully aware (2008, p.56).

However, there does appear to be some work being done which studies the affections for the sake of the affections (as opposed to having cognitive concerns). Taylor (2006) focused on mathematics anxiety as an attitude towards mathematics that affects students' perception of mathematics to the extent that mathematics is often seen as a barrier to success by many. This paper reported on the design, development and evaluation of an interactive multimedia resource designed to explicitly address students' beliefs and attitudes towards mathematics by following five characters as they progress through the highs and low of studying a preparatory mathematics course. Further, it uses a number of multimedia alternatives (video, audio, animations, diary writing, interactive examples and self-assessment) to encourage students to feel part of a group, to reflect on their feelings and beliefs about mathematics, to expose students to authentic problem solving and generally build confidence through practice and self-assessment. Evaluation of the resource indicated that it encouraged students to value their own mathematical ability and helped to build confidence, while developing mathematical problem solving skills. Notice that

cognitive problem-solving is still involved it just isn't given the primacy that the previous research had given it. The implementation of guided reflection is a key component of this study that we will return to when addressing service-learning.

There is some work being done on the basis of the discipline of psychology moving away from a strong tradition concerning the analysis of cognition and affectivity as dichotomous processes explaining human behaviors (Arujo, 2003). Such work aims to produce a new unit of analysis for the study of mathematical activity, integrating affectivity and cognition. While this is certainly a step in the right direction, integrating the affective and cognitive, it doesn't go the extra step to suggest the primacy of the affective. This work is cited primarily as a reference to show that current trends in psychological analysis do indeed have implications for the teaching and learning of mathematics. A stronger statement in regards to the primacy of affective learning is made by Hannula (2006). In examining motivation in the math classroom, Hannula notes that in order to understand student behavior in classrooms we need to increase our understanding of what motivation is and how it is regulated. The first relevant issue that he discusses is the importance of the unconscious (or pre-conscious) in motivation. He also goes on to note that as a potential, motivation cannot be directly observed, but rather it is only observable as it manifests itself in affect and cognition, for example as beliefs, values, and emotional reactions. Goldin (2002) extended the categories of affect by defining the category of values, ethics, and morals. Building on that work Goldin (2006) discusses a research-based theoretical framework based on affect as an internal representational system. Key ideas include the concepts of meta-affect and affective structures, and the constructs of mathematical intimacy and mathematical integrity. Goldin understands these as fundamental to powerful mathematical problem solving, and deserving of closer attention by educators. Hannula indicates a recognition if the pre-conscious

(and hence pre-cognitive) place of motivation which then influences students' affective actions. Goldin indicates an approach that sees affect as an internalized organization structure which is necessary for students to succeed in the cognitive task of mathematical problem solving. However the drawback of each approach is the continued focused on improving student cognitions.

The reference of "virtues practiced by students" is a broad label that can be applied to research that focuses the last two stages of Krathwohl's taxonomy of the affective domain of learning: organizing (concerned with bringing together different values, resolving conflicts between them, and beginning the building of an internally consistent value system), and characterization by value or value set (individual has a value system that has controlled his or her behavior for a sufficiently long time for him or her to develop a characteristic "life-style" – thus the behavior is pervasive, consistent, and predictable). 'Virtues' simply refers to allowing values to inform practices. *Adding it Up: Helping Children Learn Mathematics*, a report published by the National Research Council (2001) argues that mathematical proficiency has five strands, one of which is termed "productive disposition." Productive disposition is defined as "the habitual inclination to see mathematics as sensible, useful, and worthwhile." To be mathematically proficient (not just literate, but proficient) the valuation of mathematics must lead to a habit of seeing mathematics as worthwhile. One fruitful point of research is offered by Malmivouri (2001 & 2006). Malmivouri is building off the work of McLeod, and McLeod even points to her work on his own personal website (https://newscenter.sdsu.edu/education/crmse/douglas_mcleod.aspx accessed May 8, 2015). So while there may be some underlying issues in McLeod's approach as discussed above, here is an example of continuing work on the level of organization and characterization of student affections in mathematics classes. Malmivouri (2006) presents affect

as an essential aspect of student's self-reflection and self-regulation (which fits well with Krathwohl's organization category in the affective domain). Students are viewed as agents who constantly interpret and evaluate their experiences and regulate their behavior, in interaction with their mathematics learning environment. Not only are students organizing a value system in mathematics but they are evaluating it and allowing it to inform their behavior and habits. Research has also proposed moving beyond the individual student as the unit of analysis, but the classroom or social context as a whole. In Malmivouri (2001), a study was done that concentrated on the dynamic interplay of affect and cognition in school mathematics learning. The aim of the study was to produce a systematic analysis and rich theoretical description of the functioning of affect and cognition in socio-culturally and contextually conditioned mathematics learning situations. Further theoretical deepening of these personal and unique situational dynamics resulted in a detailed analysis of meta-level processes, personal agency, self-regulatory reflections and actions as the core of students' personal mathematics learning or self-system processes and their affective self-experiences with mathematics. Moreover, these personal aspects or self-system processes were considered as the core of the dynamics of affect and cognition in mathematics learning processes in a social environment (the emphasis in the study being on the social environment as a means to analyze affections). Also, Haladyna (1983) argues that the unit of analysis is typically the individual student in examining attitudes towards mathematics but this ignores the social context of the classroom. He argues that analysis must be performed at the class level. This approach actually fits quite well with Krathwohl's development of typical verbs for the characterization phase of the affective domain, suggesting that a student "being rated highly by their peers" would be an optimal way to assess a student's characterization by a value or value set.

In summary, there is very little research available in regards to developing the organization and characterization levels of the affective domain in the mathematics classroom. Despite several potential reasons for the lack of work in this area there have been some promising approaches in incorporating the social aspects of the learning environment for discussing the value-based habits of learners. There is work being done on social/psychological interventions in education as a way to shape student values. Yeager et al (2013) states a position similar to that argued in this paper of suggesting that teachers should look beyond how they communicate academic content and try to understand and, where appropriate, change how students experience school (p. 62). In this same vein of research Hulleman (2010) shows that introducing a time of guided reflection significantly impacted students' valuation of the discipline. This guided reflection has been cited above and it plays a key role in the understanding the benefits of service-learning as will be discussed below.

A New Way of Understanding Affect in Education

Having outlined the tendency of research on affect in math education to focus on cognitive outcomes, this section will begin with an analysis of work being done that suggests that human beings are primarily affective learners and then secondarily cognitive learners. All of the research cited above treats the affective domain of learning as needing to be interconnected with the cognitive domain but none of the research argues for the primacy of the affective domain. I would like to proceed with the following analysis: if human beings are primarily affective learners, how then do educators develop the affections?

From a philosophical perspective, much work has been done in the last century to suggest shifting the center of gravity of the human person from the cognitive to the non-cognitive – from the cerebral head to the affective region of the body (Heidegger, 1966; Brann, 2007). Now the

reference of the "affective region of the body" is a significant one. Often the affective dimension of the human person is associated with the heart and emotion (as discussed above). However, current philosophical work seems to support the notion that it is the actions/habits of the body that work to form and portray affections (Smith, 2009). This philosophical notion seems to be confirmed by contemporary work in cognitive science as well (Wilson, 2004; Bargh, 1999). It is bodily practices that train the body (including the brain) to develop habits or dispositions to respond automatically in certain situations and environments. Smith (2003) noted that the dominant paradigms of social sciences reflect human beings as rational machines and he calls for a more holistic understanding of humans as believing (affective) or what he terms "narratological" animals (creatures driven by story at an affective level rather than logic and rationality at a cognitive level). Taylor (2004) notes that what humans think about is just the tip of the iceberg and cognition cannot fully or adequately account for how or why humans make their way in the world. For Taylor, there is something beneath the cognitive, what he terms "the imaginary" – defined as the way ordinary people imagine their social surroundings which is not expressed in theoretical terms but is carried in images, stories, and legends. Here Taylor uses "imaginary" not in the romantic sense of invention, but rather in reference to a pre-cognitive framework or lens through which we view and interact with the world. While much of the above work in philosophy and cognitive science needs to be developed in more detail as it pertains to mathematics education, it nonetheless establish the groundwork that such academic work on the primacy of affections is out there and is in fact growing.

In summary, the research discussed above shows a need for more work to be done on developing values in students apart from a primarily cognitive approach. Though cognition and

affection are certainly interrelated, more research needs to be done on the assumption of the affections as primary to the students' learning process.

The Aims and Outcomes of Service-Learning

One the major contributors to the discussion of service-learning in mathematics is Charles Hadlock, having edited the book *Mathematics in Service to the Community: concepts and models for service-learning in the mathematical sciences* (2005), the most significant resource available to date on the topic. Hadlock has also penned various other articles and given presentations on service-learning in mathematics as well. Any discussion of the literature on service-learning in mathematics needs to begin with a synopsis of his reports. In his introduction to *Mathematics in Service to the Community*, Hadlock defines service-learning in a way that takes it beyond simply having math students tutor at an underprivileged school (not to say this act of service is not beneficial – it can in fact be extremely useful in courses for future math educators). At a basic level, service-learning can be defined as a set of activities that have two characteristics: 1) they enhance either the delivery or the impact of the curricular material, usually, but not always, within the context of a specific course, and 2) they take place within a service framework where additional experience with civic engagement or social contribution will be obtained (Hadlock, 2005a, p. 2). Hadlock goes on to note that the enhancement of curricular impact can derive from different sources, such as exposure to new techniques and ideas, motivation from seeing curricular material in action, higher student energy level due to bonding with a client organization and helping meet its needs, or more extensive discussion of course material due to the interactive nature of most service-learning projects. What is key for Hadlock is that a carefully managed reflection process is used to ensure that students derive the full educational potential from their experiences, and he references some resources developed by

Campus Compact. He states: "Some people may think that this reflection process refers to a kind of 'touchy-feely' exercise that might be quite foreign to the mathematics classroom…." Here the quote from Zan above seems very apt. But Hadlock continues: "…I prefer to think of it as the processing of a rather complex set of experiences to assure that students share and solidify their insights and thus obtain maximum lasting benefits. This has actually been one of the most important contributions of the service-learning initiative" (Hadlock, 2005a, p.2). Hadlock goes on to argue that the effectiveness in mathematics learning that service-learning contributes to stems largely from increases in student motivation – an area of research that falls into the category of affect, not cognition. So from Hadlock's introductory piece in the foundational work on service-learning in mathematics a couple of key points can be gleaned: 1) Hadlock offers a robust definition of service-learning that allows educators to identify a given project example as being a service-learning activity or not, 2) in the need for a reflection process it can be seen as to why service-learning is not widely instituted in mathematics courses since affective processing is seen as something other than mathematical thinking, and 3) Hadlock presents an underlying argument that service-learning ties heavily into student motivation and thus relates more with the affective side of learning rather than the cognitive (though cognition is obviously still involved). Ultimately the motivation for service-learning in Hadlock's view is not only developing higher-order critical thinking in real-world contexts but also increasing the feeling of engagement on the part of the student (Hadlock, 2013), or what might be termed as student motivation. Hadlock then clearly emphasizes the ability of service-learning to impact the affective domain of learning while still also regarding highly the cognitive learning objectives of a given course.

In the past decade, two unpublished dissertations are noteworthy to mention in regards to service-learning in the context of mathematics. Roemer (2009) sought to determine if the

teaching and learning of mathematics would be enhanced by service-learning, in the context of a community college course. Where this study differs from Roemer is the focus on the affective impact of service-learning. Roemer notes that practicable connections do exist between service-learning and mathematics, however results regarding enhanced teaching and learning (cognitive gains) through service-learning are mixed. Roemer argues that the reason for mixed results is that motivation in mathematics and community service is impacted by general student motivation and the quality of the service experience. In other words Roemer's work seems to suggest that there is more to be gleaned by examining service-learning through an affective lens. Another important result from Roemer is the conclusion that reflection is critical to learning.

The second dissertation of note is the work of Leong (2006). Leong noted that participants in a study that investigated the relationship between mathematics and statistics related attitudes and beliefs of 11 high school students in an introductory statistics course designed around a 13-week long service-learning project, reported greater confidence doing statistics and contribute this confidence, in part, to service-learning. Participants also experienced a heightened sense of social awareness and social responsibility through the service-learning project. What is most notable about Leong's work is that it is one of the few pieces of research on service-learning in high school mathematics and also the fact that Leong notes these results provide evidence that service-learning can be utilized to solidify positive attitudes and beliefs regarding statistics among high school students. Leong offers service-learning as a clear vehicle to impacting student affect in mathematics. Where this study will differ from Leong is that Leong analyzed service-learning through McLeod's (1992) framework of the affective domain, whereas this study will reconceptualize affect based on the work of Smith (2009) as discussed below.

Service-learning is a pedagogical tool that research would seem to indicate can be utilized to address the issues raised above (Hadlock, 2005b). Service-learning offers one tangible practice than can be instituted in the mathematics classroom as a means of inculcating the mathematical values into students which national policy documents aim for. Service-learning offers a vehicle for the discussion of *how* to go about instilling the values that the math education community desires to see in its students. As noted by Zlotowski (2005) in the earlier quotation, the process of reflection in service-learning allows the students to examine what values they bring to the learning process (many of which have been never before been examined). This study will seek to show that by placing students in these service-based contexts that are rich with opportunities for discussion and reflection, all within the overarching goals of a mathematics course, is taking a step in the right direction to actually achieve the goal of instilling an appreciation for mathematics within the hearts of students.

Theoretical Framework

The theoretical framework of this study builds primarily off of the work of Smith (2009). As Smith notes: "Behind every pedagogy is a philosophical anthropology" (p. 27). Before you can teach a human being you must first have a notion of what a human being is. Smith notes that a pedagogy that focuses on cognition, that sees education as primarily disseminating information, tends to assume human beings are primarily "thinking things" and cognitive machines. Smith's thesis is that human beings are primarily affective beings before they are cognitive beings, and this anthropology bears itself out in the current educational system regardless of whether it is recognized. Smith describes education as not primarily a heady project concerned with providing information; rather, education is most fundamentally a matter of formation, a task of shaping and creating a certain kind of people (Smith 2009, pp. 26-27). Smith explains further that an

education is a constellation of practices, rituals, and routines that inculcates a particular vision of what is good by inscribing or infusing that vision into the heart by means of material, embodied practices. For Smith, there is no neutral, non-formative education.

For Smith human beings are first and foremost creatures of desire before they are creatures of thought or even creatures of belief. Affections pull humanity through life toward our vision of "the good life" rather than cognitions rationally pacing out humanity's steps. Humans are creatures of love, and love requires practice. In other words, affections are shaped by the practices/habits/rituals that people are immersed in. Smith refers to these as liturgies – rituals of ultimate concern: rituals that are formative for identity, that inculcate particular visions of the good life, and do so in a way that means to trump other ritual formations. While Smith offers much to unpack for educators, for the purposes of examining affect in mathematics education the following points are significant to note: 1) the argument that human beings are primarily affective rather than cognitive, and 2) affections are shaped by practices (liturgies).

Combining Smith's view on liturgies with the emphasis on the ability of reflective processes to impact student value systems in the classroom as proposed by Hulleman (2010), it becomes clear how service-learning might serve to best impact the affective learning of students in the mathematics classroom. Hadlock (2005) stresses the importance of regular (habitual) practices of reflection throughout service-learning activities. Service-learning will be studied as a viable means to cultivate mathematical affections of students by providing a habitual practice of reflection in an educational context where the aim of the project is not primarily the increase of student cognition.

Conceptual Framework

The conceptual framework of this study will center on research question 2: What is the alignment between the affective objectives of national policy documents on the aims of mathematics education and the affective outcomes on students participating in a service-learning project? Specifically this study will focus on the description of "productive disposition" offered by the National Research Council in *Adding it Up: Helping Children Learn Mathematics* (2001). Productive disposition is defined as "the habitual inclination to see mathematics as sensible, useful, and worthwhile" (p. 116). The collected data will be analyzed as to how it gives evidence of students seeing mathematics as sensible, recognizing the usefulness of mathematics, and understanding mathematics as a worthwhile task to be performed.

Chapter 3: Methodology

Introduction

The overall goal of this study will be to describe the development of affect in students within the context of a mathematics classroom as students engage in a service-learning project. This affective development will be analyzed through the above theoretical framework with a particular emphasis on examining the impact of regular guided reflective practices on student valuation of mathematics. The proposed study will seek to answer the following research questions:

1. To what extent does service-learning impact the cultivation of mathematical affections among students?
2. What is the alignment between the affective objectives of national policy documents on the aims of mathematics education and the affective outcomes on students participating in a service-learning project?

3. To what extent does service-learning offer a viable means of achieving the affective objectives of national policy documents on the aims of mathematics education?

The nature of the affective domain of learning lends itself naturally to being examined through qualitative methods. This particular study is not intended to quantify affect in students but rather to offer a description as to how affect forms in students as they engage in service-learning. The descriptive nature of this study makes a qualitative approach more appropriate. In particular this study will be conducted as a case study, focusing on a select group of students in a high school mathematics class as they engage in a service-learning project. The students will be high school seniors and juniors in an AP Statistics class. As a course project, all students will participate in a group which will provide the following four service components: meeting with a non-profit agency and developing a survey instrument, conducting survey, compiling data and performing statistical inference procedures, and presenting results. All students will take a shortened version of the Fennema-Sherman Math Attitudes Scale (FSMAS) (Fennema & Sherman, 1976; Mulhern & Rae, 1998) early in the fall semester, prior to the assignment of the service-learning project. From the student responses to the FSMAS and initial interviews, small group of students will be selected for the case study. This group of students will be selected in a way that that makes the case study group representative of the classes as a whole: both males and females will be represented as well as high and low performing academic students. The experience of these students will be documented through observations (primarily of students as they interact with one another in their group and the ways in which they interact with the partner service organization), student interviews, and collected artifacts (such as weekly reflection journals that are employed throughout the project). All students in the course will participate in

the reflection journal component of the project but only the responses of the students in the case study will be analyzed thoroughly. The observation framework will be based on the work of Schorr and Goldin (2008) in researching student affect in a math classroom – it will focus on the visible student cues that could lead one to infer the affective engagement of the student. The interview protocol will be shaped based upon prior student interviews over a service-learning project from the pilot study. Finally the artifacts that are collected will be designed around successful examples of reflection guides as presented by Hadlock (2005) and other appropriate research on service-learning in a mathematics context.

Again continuing in the same vein as Schorr and Goldin (2008), while the data collection process will follow the guidelines of a case study, the data analysis will follow more of a grounded theory approach. The goal of the study will be to document fully the experience of select students as they engage in a service-learning project (with particular emphasis on the development of affect) and then from this data offer a proposed general description as to how mathematical affect forms in students involved in service-learning. The initial gap in the existing literature on affect in mathematics education is the absence of a description as to how to go about forming the desired affections of students. The ultimate purpose of this study will be to address this question particularly within the context of service-learning. The hope is that future research may then be able to explore how affect is developed (or not developed) by comparison within the context of the "typical" classroom approach. It is also suggested that a broader theory on affect should be developed that recognizes the primacy of affect to cognition. This study is meant to offer some supporting evidence upon which that theory can be developed.

Design

This study will be conducted as a case study, focusing on a select group of students in a high school mathematics class as they engage in a service-learning project. A case study is an

exploration of a "bounded system" or case (Creswell, 1998). According to Creswell (1998), the case being studied is bonded by time and place and can consist of a program, event, activity, or individuals. In this study the case is bounded by the 2015-2016 academic school year, the location of the school and the descriptions of the students: the students will all be high school seniors and juniors in an AP Statistics class. The particular case in question will focus on the affective response of the individual students involved in the service-learning activity. Because the true focus is on the broader issues of cultivating mathematical affections and service-learning, this study will serve as an instrumental case study (Stake, 1995), using the experiences of these students to illustrate broader issues.

As a course project, all students will participate in a group which will provide the following four service components: meeting with a non-profit agency and developing a survey instrument, conducting survey, compiling data and performing statistical inference procedures, and presenting results. All students will take a shortened version of the FSMAS (included in Appendix A) early in the fall semester, prior to the assignment of the service-learning project. Though the FSMAS asks students to respond on a Likert scale in response to a series of statements regarding attitude in mathematics (as will be explained further in the "Instruments" section below), for the purposes of this project the modified FSMAS data will be analyzed qualitatively rather than quantitatively. The FSMAS has significant influence in current research on affect (Wilson, 2011, p. 68) and hence its inclusion in this study. However there has been significant disagreement on the use of quantitative measures in assessing affect. McLeod (1994, p.640) notes that "complicated statistical analyses of questionable questionnaire data have not necessarily been reflecting accurately what students have been thinking and feeling." In relation to research on problem solving, narrative and interpretive methods are being more widely used for assessing attitude (Larsen, 2013, p. 4). The student responses to the FSMAS survey will simply

provide a starting point for assessing which students may provide the richest descriptions of their affective experience in mathematics and it will also allow students with a variety of initial attitudes to be selected in a sample for further study. Once this group of students is selected they will be interviewed as a follow up to their survey responses. The interview protocol will be emerging from their responses and will be primarily aimed at having students provide a narrative for their reasoning in their survey responses.

As the students engage in the service-learning project throughout the course of the school year, the experience of these students will be documented through observations (primarily of students as they interact with one another in their group and the ways in which they interact with the partner service organization), student interviews, and collected artifacts (such as weekly reflection journals that are employed throughout the project). As stated, the students will work in small groups of three to five in order to complete the project. At regular intervals throughout the year, students will be allowed a project workday in class. These workdays will form the basis of the collected observations. All students in the course will be interviewed prior to the assignment of the project and in response to their responses on the FSMAS survey. As mentioned, this initial interview will aid in determining which small group of students to focus on for this case study. This group of students will be selected in a way that that makes the case study group representative of the classes as a whole: both males and females will be represented as well as high and low performing academic students. All students will also be interviewed near the close of the fall semester. While the project will proceed throughout the course of the year (see appendix C for details on the project calendar), the bulk of the statistical work will be done in the spring after students have learned some basic techniques of statistical inference. Therefore the initial student responses to the introduction of the project throughout the fall semester will be

monitored for every student through observation, interviews, and collected reflection journals. This will give a full perspective on every student starting point in terms of mathematical affections and how their affections are being impacted by the project. From here, at the start to the spring semester, a small group will be selected as the focus of the case study that can provide the most rich and varying descriptions of their experience in the project. All students in the course will participate in the reflection journal component of the project throughout the course of the entire year as it has been noted that the reflective process is vital for students to gain the most from a service-learning experience (Webster 7 Vinsonhaler, 2005, p. 257). However, from the spring semester onward, only the responses of the students in the case study will be analyzed thoroughly. Again continuing in the same vein as Schorr and Goldin (2008), while the data collection process will follow the guidelines of a case study, the data analysis will follow more of a grounded theory approach. The goal of the study will be to document fully the experience of select students as they engage in a service-learning project (with particular emphasis on the development of affect) and then from this data offer a proposed general description as to how mathematical affect forms in students involved in service-learning.

Setting

The setting for this study is a suburban private high school in central Texas. The students involved in the study will be a mix of juniors and seniors in an AP Statistics course. As a pre-requisite for the course, every student must have completed at least through Algebra II successfully. While all students meet the minimum pre-requisite mathematical knowledge, the mathematical experience of students enrolled in the course is varied; from those who have recently just barely passed Algebra II up to those who are concurrently enrolled in AP Calculus.

The content of the course follows the prescribed curriculum for AP Statistics given by the College Board and includes the following topics:

- Exploratory Data Analysis: Planning a study, including deciding what to measure and measurement methods that minimize bias.
- Data Collection: Exploring and describing data by searching for quantifiable patterns and departures from patterns.
- Probability: Anticipating patterns, which include producing models using probability theory and exploration of distributions.
- Statistical inference: Includes developing confidence intervals and performing tests of significance.

Each of the major four topics above will be addressed in the course service-learning project. A description of the project (including a grading rubric and calendar) as it will be presented to students is included in Appendix C.

It should be noted that while the mathematical background of students in the course will be varied, the socio-economic background of the students is rather homogeneous by the nature of attending this particular private school. This is one notable drawback of this study is that it does not address students from varying socio-economic situations. Another important factor to consider by conducting this study with students at a private school is that this particular private school has an expectation of service on the part of the students. Community service is not foreign to these students and many have years of experience with it. However, as noted in the literature review above, there is a difference between community service and service-learning. In service-learning the content of an academic course is integrated into the service requirement placed on students. In that respect, these students do not have extensive experience with service-learning, though it must be noted that it is possible some students may have experienced true service-learning before coming to this class. Student backgrounds and experiences with service-learning will be fleshed out more in the interview process.

The organization that students will be working with on their service-learning project (henceforth referenced as "the partner organization") is a homeless outreach program in a central Texas city. The partner organization operates under a philosophy that homelessness is more than house-less-ness, it is rather a severe break in community from others. The partner organization has purchased land just outside of the city on which they are currently developing a community of affordable housing for the chronically homeless. This property also has amenities such as a gardening center, animals such as chickens and goats, a clinic, a workshop, and a meeting space for classes. Everything about the property is designed to foster a sense of complete community.

The founder and president of the partner organization is interested in joining with the students in the AP Statistic course to complete a study based largely on Bruce K. Alexander's "Rat Park" experiment (as referenced in Hari, 2015, p. 170ff).[3] Basically, seminal studies that had proven the addictiveness of drugs such as heroin (and others) had done so through administering the drug to rats in cages in isolation. Alexander set up a study in which the rats were allowed to operate in community and found that the amount of drugs consumed went down drastically, indicating that environment and community (or lack thereof) can play a significant role in drug use. The partner organization is interested in seeing if the residents of their community will have the same response as the rats of "Rat Park." The partner organization is interested in having students survey the residents of their new community development on issues related to their life on the streets (physical, psychological, and spiritual) prior to moving to the new community and how those issues have changed since moving to the community. So for instance, has the drug use among the occupants of the property significantly decreased in

[3] Though not referenced here, see also: "The effect of housing and gender on Morphine self-administration in rats." *Psychopharmacology*. 58, pp. 175-179. and "Effect of early and later colony housing on oral ingestion of morphine by rats." *Pharmacology, Biochemistry, and Behaviour*, Vol. 15, pp. 571-576.

comparison to their life on the streets in isolation? With this basic premise, the students will be tasked with developing the complete survey, methodology, and appropriate analysis as part of the service-learning project.

Sample

As indicated above, the sample for the case study will come from the students enrolled in AP Statistics at a suburban high school in central Texas. The course typically has two sections of around 20 students each. As information is collected from the students from the FSMAS survey and initial fall interviews, a small group of five students will be determined in order to gather the richest and most complete description of the student experience of the service-learning project. This group of students will be selected in a way that that makes the case study group representative of the classes as a whole: both males and females will be represented as well as high and low performing academic students.

Instruments

Surveys

Prior to assigning the project, every student will be asked to complete a modified version of the FSMAS. A sample is included in Appendix A. As noted, the FSMAS has significant influence in current research on affect and hence its inclusion in this study. The FSMAS was developed with a focus on exploring research into gender differences in mathematical engagement and consists of nine sub-scales: Attitudes towards success in mathematics, Mathematics as a male domain, Confidence in learning mathematics, Effectance motivation in mathematics (the motivational aspects of competence), Usefulness of mathematics, Father (concerning the father's perceived opinions/beliefs/attitudes), Mother (concerning the mother's

perceived opinions/beliefs/ attitudes), Teacher (concerning the teacher's perceived opinions/beliefs/attitudes), and Mathematics anxiety (Wilson, 2011, p. 68).

There are many examples of studies on affect being completed using a modified version of the FSMAS (Mulhern & Rae, 1998) or new instruments developed based on the FSMAS (Larsen, 2013, p.4). This study will also use a modified version of the FSMAS in order to shorten the length of the questionnaire from its original 108 questions and also to deal specifically with the domains most associated with general affect and not on gender specific issues. The scales of "math as a male domain," "father," "mother," and "teacher" were discarded since their focus was on gender differences and the perception of mathematics the students had based on the people in the environment around them. For this study, the only focus is the affective dimensions of learning experienced by the students and how they change from the beginning of the project through the end (and not concerned with where these affections were initially instilled in students). The "attitudes toward success in mathematics" scale was also discarded as it had to do with how students felt they were perceived by their peers and not on the mathematical content at hand.

The scales that were retained were "confidence in learning mathematics," "effectance motivation in mathematics," "usefulness of mathematics," and "math anxiety." Within in these scales statements were retained that most similarly reflected the intent of commonly used questions in service-learning reflection (see Appendix B). At least one positively worded statement and one negatively worded statement was retained for each scale and the same amount of each was retained within each scale. The positive statements are graded on a Likert scale of 1 to 5 with 1 indicating strongly disagree and 5 indicating strongly agree. The negative statements are also graded on a Likert scale but the 1 and 5 distinctions are reversed, with 1 being strongly agree and 5 being strongly disagree. This allows high scores to always indicate a positive response and low scores to always indicate a negative response.

As mentioned, the modified FSMAS will not be analyzed through quantitative methods due the general untrustworthiness of quantitative methods to capture affective responses in students (McLeod, 1994). However, the responses will provide a general baseline for the initial level of mathematical affections held by each student. The modified FSMAS will also form the basis of the initial interviews conducted with students to gather a narrative description that can be analyzed qualitatively. The survey will be given again upon the completion of the project. Any significant quantitative changes will be noted, but primarily the survey will again act as a jumping off point for student interviews that will offer a qualitative description.

Observation protocol

Observing affect is inherently difficult. The observation framework will be based on the work of Schorr and Goldin (2008) in researching student affect in a math classroom – it will focus on the visible student cues that could lead one to infer the affective engagement of the student. Schorr and Goldin sought to study episodes where key affective events occurred in the context of conceptually challenging mathematics with the purpose of characterizing instances where there is evidence for powerful affect—patterns of emotions, attitudes, beliefs, and values that foster engagement, persistence, and success (p. 135). By conceptually challenging mathematics, Schorr and Goldin meant mathematical activity involving the need for a new conceptual understanding and/or for conceptual change; where students are likely to experience the need to "figure something out," or to have a sense of impasse (Ibid.). They also define a key affective event to be an occasion, in the context of doing or discussing mathematics, where significant affect or a significant change in affect (of a student or the teacher or across the class) is expressed or can be inferred (Ibid.). Examples include moments of frustration, anger, or withdrawal, as well as moments of engagement, elation, delight, or satisfaction.

Following Schorr and Goldin, key affective events will be the focus of observation. As students are given in-class workdays in which to work on their project with their groups, as the instructor, I will be able to move about the classroom and monitor student interactions with other students and with the project material. By Schorr and Goldin's definition above, the entire project presents students with conceptually challenging mathematics and so the project workdays are ideal times to observe key affective events. After the key affective event is observed field notes will be taken on the students words and actions as they process through that affective moment until it has been resolved in some fashion. This process will be repeated through the class workdays during the course of the project.

Reflection Journal

Reflection is essential for any well designed service-learning project (Hadlock, 2005). Every student in the class will be expected to maintain a reflection journal through the course of the project and regularly updating said journal will be considered part of the overall project grade. The school assigns every student a student email account through Google. A Google Drive document will be created for every student and serve as their reflection journal throughout the project. This electronic journaling will serve as an easy way for the instructor to ensure that the students are updating their reflections in a timely manner. The project will require students to update the journals at minimum every two weeks. The reflection questions designed by Webster & Vinsonhaler (2005) that are included in Appendix B will serve as ongoing prompts for the reflection journals. Students will generally have the option of responding to questions of their choosing or to simply reflect on their own. Occasionally, at certain key points of the project, the instructor may ask every student to respond to one question in particular. For instance, at the close of the project being sure that every student has responded to question 7 in Appendix B and

communicated their understanding of the broader role the service organization plays in society. Also, at the beginning of the project, before any real work has been done, every student will be asked to respond to a prompt the pre-service prompts offered in Appendix B.

Interviews

Interviews will be conducted toward the end of the fall semester and then again at the close of the project. Every student will be interviewed both times. The interviews in the fall will aide in determining which students will be the focus of the case study in the spring. Only the final interviews form that group of students will be included for qualitative analysis.

The fall interviews will be based first on student responses to the modified FSMAS survey, asking them to add narrative to their quantitative responses to the survey. By the end of the fall semester the students will have completed the design phase of their service-learning project. In keeping with the prompts from the pilot study, students will be asked to describe their experience in the project thus far. The spring interviews will again be based on the responses to the second FSMAS survey students will complete at the close of the project, asking them to explain the reasoning of their response or to get them to clarify why certain responses might have changed as compared to the fall. Finally the spring interview will ask them to describe their experience on the project as a whole now that it has been completed.

Data Collection

The initial modified FSMAS survey will be administered early in the fall semester, several weeks into the school year yet prior to the formal assigning of the service-learning project. This will give the students time to settle into the rhythms and routines of the classroom and to have an initial sense of the material that is going to be covered in AP Statistics. The project will be formally assigned after the completion of the first unit in the course. The first unit

covers how to design a study. By waiting until after the completion of the first unit to assign the project the students will then be equipped to handle the first steps of the project: designing a survey instrument for the study. The remainder of the fall semester will be spent refining and piloting the survey instrument with the intention of gathering the data early in the spring semester, analyzing data by the middle of the spring, and having a conclusion and presentation at the end of the spring semester.

Toward the end of the fall semester every student will be interviewed. The interview will stem from their responses to the FSMAS survey and it will also ask them to describe their experience with the beginnings of the project through the fall semester. From the surveys and fall interviews a group of five students will be selected by the close of the fall semester for further analysis in the case study during the spring semester. This group of students will be selected in order to provide a rich and varied description of the project through the spring semester.

From the beginning of the project assignment in the fall semester until the end of the year, students will be expected to keep updated reflection journals with entries every two weeks. The school issues every student a student email address through a Google account. A Google Document will be created for every student and serve as their reflection journal throughout the year. This electronic journaling will be easy to check that every student has been updating it appropriately. The entries during the fall semester will aid in determining the group of students to be the focus of the case study. Only the journal entries for those students in the case study will be significantly analyzed for the final results.

At the close of the project at the end of the spring semester every student will again be given the same modified FSMAS survey they were given in the fall and any significant differences will be noted, but not analyzed quantitatively. Rather, the responses to the spring

survey will serve as the basis for the final interviews that will be conducted on every student, but only qualitatively analyzed for the students who were the focus of the case study.

Data Analysis

From the initial FSMAS survey responses, fall interviews, and fall reflection journal entries, a group of five students will be chosen as the focus of the case study. These students will be selected so as to provide for varying initial positions in regards to their attitude toward mathematics or service-learning. The students will also be selected who provide evidence of providing rich descriptions of their thought process and affective changes.

The student interviews, field observations, and collected reflection journals will be coded in a similar manner to the pilot study, following the three major themes of a productive dispositions: seeing math as sensible, useful, and worthwhile. The fourth theme that emerged from the pilot study of relationship building will also be included in the coding of the data from this project. While these four codes will be used, open coding will also be used to see if any further themes emerge from the collected data.

In addition the Likert responses to the FSMAS surveys given at the beginning of the year to every student will be compared to the responses of every student at the end of the year. The proportion of students who improve their responses (increase in positive attitude) will be recorded.

Limitations

One of the major limitations of this study is that I as the researcher am also the instructor of the course in which the students will be performing the service-learning project. I will be functioning as a participant observer, immersed in the daily school lives of the students in this study (Creswell, 1998). Participant observation is a method of qualitative data collection

typically ascribed to an ethnography (Creswell, 1998), in which the focus is on examining a group's patterns of behavior. This study is not interested in discovering the meanings of behavior or culture-sharing interactions amongst students, but rather in examining the students' experience in a bounded service-learning activity. This makes a case study approach more appropriate. In general, the participant observer is concerned with employing multiple overlapping data collection strategies: being fully engaged in experiencing the setting while at the same time observing and talking with other participants about whatever is happening (Patton, 2002). While I will be participating with the students throughout the service-learning project, I will not be participating in exactly the same fashion as I will not be taking on the role of student myself. As the instructor I will have some level of separation from the participating students during the research process.

One potential area for concern is that the students may feel beholden unto me to provide positive responses either to the FSMAS survey or to qualitative measures during the study such as the student responses in reflective journals or in interviews. It will be made clear to students from the very beginning (and students will be reminded throughout the project) that their responses to the FSMAS survey, journal prompts, or interview questions will have no bearing on their final grade on the project or in the course. One key component of the service-learning project will be to organize it in such a way as to have the partner organization have a significant say in the evaluation of the final project. In this way I hope to be seen as a facilitator in the partnership between the partner organization and the students and not the ultimate authority on the project. This will hopefully provide students an opening to share both positive and negative responses with me, viewing me as someone who is on their side to help develop the best product possible for their client, the partnering organization. In addition to the structuring of the service-

learning project so as students don't feel beholden unto me as their instructor, I also have the benefit of an established history with this course at this school. This will be my fourth year teaching AP Statistics at this school and a service-learning project, including aspects of reflection and student experience surveys, has been utilized every year. The part and parcel of the course is not being changed in order to gather data for this study. Though more reflections will be asked of students this year than in previous years, reflection is not a new component being added to the course. In other words, the amount of work of type of responses required of the students is not being affected by their involvement in the study, thus opening the door for them to respond freely as students have for the past several years.

Another concern in this study is the effect I have as an inquirer and the extent to which the predispositions or biases of the evaluator may affect data analysis and interpretations (Patton, 2002). As the researcher, I will need to be sure to clearly state my own previous experience and disposition toward service-learning in the final data analysis. Rigorous data collection and analytical procedures like triangulation are aimed at substantiating the validity of the data and minimizing the inquirer biases (Patton, 2002).

Finally, one additional limitation is that this study will be performed on AP Statistics students. While AP Statistics is offered as a math course there are some clear distinctions between the disciplines of mathematics and statistics. So, one may wonder if this study is about cultivating statistical affections rather than mathematical ones. While there admittedly is a distinction between statistics and mathematics at higher levels of education (post-secondary and beyond), what is important in this study is the perception of the students involved. AP Statistics is offered as a math credit, taught in a math classroom in the mathematics wing of the school building, and has a math pre-requisite of Algebra II. While students' views on statistics as

separable from the discipline of mathematics may evolve over time, it is safe to assume that as juniors and seniors in high school that distinction has not yet been made – making the results of studying service-learning in a statistics course applicable to other secondary mathematics courses.

Pilot Study

Several years ago I instituted a service-learning project while teaching AP Statistics at a rural Texas high school. The summer prior to that school year Texas was struck by an unusually large amount of wild fire activity – some of which occurred in the community where I taught. Many students in my AP Statistics class had friends and family that were displaced by the fires and lost everything. When I proposed a spring project for statistics that was going to be service-based and tied in to the local community, the students overwhelmingly determined to focus their attention to helping the victims of the fire. Ultimately the students settled on comparing the effectiveness of the city in responding to the needs of wild fire victims with the effectiveness of local charity outreaches. The project garnered a lot of attention from the community and the students ultimately presented their results in front of the city council. The school district where I taught decided to make a promotional video highlighting this project for the district website and other media outlets. The media director for the district took a sample of students from the class and interviewed them about their experience with the project, using a few sound bites in the final version of the video. A copy of the unedited interviews was provided to me by the district upon the completion of the video. These are the interviews that have been transcribed and included in this pilot study data analysis. The long-term goal of analyzing these interviews is to form a framework for developing an interview protocol for a full study (that also includes observations of students and an analysis of student artifacts). The themes that arise in the following interviews

will inform the focus of the future case study and the types of questions to ask of the students involved in the process.

Data Collection

As indicated above, these interviews were conducted by media director for the district. The stated goals of the district were to highlight the increased engagement of students, the greater control given to students over their learning outcomes, and the facilitation of deeper conceptual understanding of the material (Navasota Independent School District: Learning, Leading, Succeeding Blog (http://www.learningleadingsucceeding.com/2012/06/evaluating-patronage-and-deliverance.html Accessed March 24, 2015). These goals were the driving force behind the questions that were asked of the students. As seen in the transcripts, the interviewer does not stay consistent with wording for each student, but generally focuses on the same issues for each student. Working back through the interviews, it would seem that the students were asked some version of the following questions:

1. What is your impression of service-learning in general as a way to engage in a class in comparison with more traditional classroom methods such as lectures?
    a. If another teacher was considering doing something similar to this project with their students, based on your experience, would you recommend that they do so? Why or why not?
    b. How was working on something that was relevant to the community beneficial to you as a student?
2. Describe your experience as you have moved from the beginning of the project until now.
    a. Did the project unfold the way that you expected it to?
    b. What difficulties or hurdles did you face in this project?

I have grouped the sub-questions (a and b) beneath questions 1 and 2 as it seems that those questions were other ways of phrasing the main question the interviewer was interested in gathering information/sound bites on. The first question is clearly meant to elicit a response from the student that will speak to their engagement in the project. The second is a general question aimed at having students describe their experience in their own words.

Data Analysis

The major themes that emerge from examining the interviews are very much aligned with the description of productive disposition: students indicate that they are seeing math as sensible, useful, and worthwhile. These three concepts are very much interrelated and many of the cited quotes below reveal how one of these areas very easily bleeds into another. However, for the purposes of attempting to organize this data analysis each of these components of productive disposition will be treated separately.

Key indicators that showed students saw mathematics as sensible were phrases that indicated that the students viewed service-learning as a viable means for learning the material. In other words, through the service-learning process the mathematics made sense or could be seen as sensible. This type of response can best be typified by Student 11 who indicated: "You know, personally I believe that we learn a lot more through this process because of the fact that you don't just ask the teacher questions, you ask your fellow students questions a lot. For me, I can honestly say that I was little bit more curious." It was common for students to respond that their overall impression of service-learning was that it aided them in their understanding of the material. Student 1 noted: "when you have to do something, you're going to remember it. You're going to remember this like actually having to do that project in high school. 'Oh I know how to do that. I did that.'" The indication here is that the results of a service-learning project will have

a lasting impact on their understanding of the subject. Student 3 noted the benefits of the participatory aspect of service-learning as a key factor in developing a deeper understanding of statistics: "I think it was probably one of the best things I've learned since I've been in high school because usually you just sit in a classroom with textbooks and lectures, but this way, you've got everybody in the classroom involved because you… had to participate." Other general comments on students' ability to have a deeper understanding of the sense of the material ran along the lines of "I learned a lot more that way than I did over his lectures" and "I think it's a great way for students to get a better understanding of the material." All of these comments also reiterate the position of much of the previously discussed research that affect cannot be completely divorced from cognition. In moving forward from the pilot to a complete study it will be important to keep this in mind. Affect is separate from cognition but not independent of it. The student comments also seem to indicate that affective aspects of the project (the physical engagement in routine that differs from a traditional lecture) are in fact the triggers for the cognitive gains that students experience and not vice versa. It is not because the student learned more that they then developed this stage of their productive disposition, but rather they engaged first at an affective level and this led to solidifying their cognitive understanding. This point will need to be brought out with greater detail and data support in the full study.

Key indicators that showed students saw mathematics as useful were phrases that indicated that the students viewed service-learning as a viable application of mathematics. In other words, through the service-learning process the students were more engaged in hands on application and came to see mathematics as being applicable and useful to everyday life. This general theme of usefulness or student engagement in application can certainly be attributed to the phrasing of the questions and the stated aims of the interviewer as mentioned above. Since

the end goal of the interviewer was to make and market a video, questions were asked in a leading way that were aimed to have students respond about an increase in their engagement level. However it is significant that every student when asked to compare service-learning with traditional classroom methods made some comment to the effect that they were more mentally involved in the process of learning during the project. The modifier "actually" was used extensively throughout the interview, as in students saying they "actually had to go do something." This type of phrasing portrays an implicit understanding of the traditional classroom as a passive learning experience. Students indicated that through this project more of the onus for learning was placed on their shoulders and they spoke of that in a positive light. Another recurring phrase was students indicating their preference for doing something "hands on." This indicates a benefit not simply in shifting the onus of learning to the student but also in having a component of that learning that involves physical application. Another common reference to "real-world application" helps support this notion of students learning more from doing, statistics in this case, in a life-application setting as opposed to simply hearing about statistics in a classroom environment. Apt quotes on this theme come from students 9 and 10. Student 9 noted: "By doing this we are taking it out of the classroom and applying it in real-life situations and we'll be able to utilize it later on down the road because we've used it before in a situation other than just a test or a quiz or a worksheet." Student 10 noted: "We got hands-on learning. We got to learn how to communicate with other people, go out and actually tackle a project. It wasn't something in the class, it was something we had to do on our own time, and it was a lot of responsibility." As in the first theme of seeing mathematics as sensible, a key observation is that students appear to be engaged at an affective level primarily. The changing of routines, or habits

of the math classroom (what Smith would call "liturgies," 2009) seem to engage students at a visceral, pre-cognitive level and work to develop this affective productive disposition.

Key indicators that showed students saw mathematics as worthwhile were phrases that indicated that the students viewed service-learning as a valuable or enjoyable experience. In other words, through the service-learning process the value of the end result of the mathematics was clear and could be articulated by the student. The worthwhileness of service-learning is evident in student interviews in several ways. Many students discuss the increased sense of community, of building better relationships. Student 6 states "It kind of brings everybody together no matter what you're doing. If you're part of the class you're part of a group. And you know, it's a lot of fun." To which the interviewer responds (unexpectedly) with "That's great insight." This idea of relationship building will be discussed in greater detail as its own separate theme below, but it lends itself to instill a sense in students of the value of what they achieved through the service-learning project – they believe they are better for having done it. Other comments that indicate the valuableness of this service-learning activity were comments of overcoming obstacles and the satisfaction that came with those achievements. For instances Student 2 notes: "It was pretty stressful at times, but it really teaches you responsibility and just having to take on things and having to get people to work, in your groups you know just being a leader." Student 2 clearly indicated a sense of personal growth through the project which is inherently a worthwhile endeavor. Of every student, Student 2 also most clearly noted a sense of self-accomplishment and self-efficacy to the extent of recommending service-learning as a regular classroom practice: "I recommend it because it really pushes people to step out of their comfort zone and it helps you to realize what you can do as just a teenager in your high school." As with the other two themes, the comments related to seeing mathematics as worthwhile

indicate an affective response of students beyond simply what they gained cognitively from the course.

In addition to the three major themes related to developing a productive disposition, another theme emerged from the data: relationship building. This major theme of relationship building is a bit more interesting in that the questions didn't necessarily prompt this type of response as they had on the concept of engagement. Student 1 discussed the importance of bringing emotion into the project (empathy for the victims) as well as the significance of face-to-face contact and "actually" talking to people. This was verified by Student 2 who spoke of the importance of learning how to relate emotionally with the people that they surveyed. The relationships that developed were more than just between the students and the subjects of their study, but also between the students themselves in building an atmosphere of teamwork and also between the student and the teacher. The importance of teamwork and the involvement of all students were emphasized throughout the interviews. The organization of the service-learning project into a group or team based project seemed to be vitally important for the students' positive experience of the project. Teacher vulnerability and humility throughout the project was also a contributing factor the students' positive experience. Often hurdles or unforeseen problems in the project were discussed (though prompted by the interviewer) but the students seemed to indicate that they were able to handle those hurdles through the help of other students or conversing with the teacher in a more relaxed manner than in the formal setting of a classroom. The teacher was almost seen as co-involved student since the outcome of the project was uncertain. On relationship building the interviews with Student 5 and Student 6 were particularly revealing. Student 5 mentioned six different times the importance of building relationships with different kinds of people in order to make the project a success. Student 6

spoke about the project being fun and enjoying the time spent with Student 5 (with whom Student 6 was good friends) and a Student cameraman who aided in the project that Student 6 wouldn't normally hang out with. Student 6 also talks at length about the story of a particular wild fire victim and how hearing that story affected them. Student 7 also noted how the project gave some insight as to how the victims were actually affected, more so than could be gleaned off the news coverage of the fire. This theme of relationship building speaks to the formative nature of education in general and service-learning specifically. Many of the issues raised by students tie into affective components of math education mentioned in the theoretical framework. This particular theme was surprising and more will need to be done in the full study to determine how this fits with the conceptual framework of developing a productive disposition.

Implications

It is clear from the transcripts that the students often wanted to discuss the specifics of the project (statistics, wild fires, survey process, etc.) and the interviewer was looking for a more general statement on service-learning (several times clarifying "can you speak to your experience, not of this project specifically, but in a general sense…) – hence the rewording and re-asking of questions to obtain that desired response. In developing future interview questions it is noteworthy that students tended to not be able to separate the specifics of their project with service-learning as a general teaching strategy (perhaps since this was their lone experience of it). Future questions will need to take this into account and be phrased in such a way as to glean general insights on service learning while still addressing the specific student experience of their project. The unexpected theme of relationship building seems to indicate that in designing a successful service-learning project in the future (and thereby having a richer experience from which to gain insight through student interviews and observations) the relational component that

will be expected of students needs to be taken into serious account. It was clearly a valuable experience for students to learn how to operate as a team and also learn how to relate to the subjects of their study. Also, a more complete future study should take into account student perspectives both before and after the project experience to note any changes in perspective. Finally, the full study will need to gather data over a longer period of time (for instance from the beginning of the year to the end). While the student interviews included in the pilot study were revealing, those interviews alone don't speak to one of the key components of this study: examining how a change of habit contributes to forming/cultivating mathematical affections. By definition a longer amount of time needs to be examined before any comment can reasonably be made in regards to the students' habits.

Appendix A

Modified Fennema-Sherman Math Attitudes Scale[4]

The confidence in learning mathematics scale (C)

C3+ I am sure that I can learn mathematics

C7- I'm no good at math

The mathematics anxiety scale (A)

A1+ Math doesn't scare me at all

A2+ It wouldn't bother me at all to take more math courses

A8- Mathematics makes me feel uncomfortable, restless, irritable, and impatient

A12- Mathematics makes me feel uneasy and confused

The effectance motivation scale in mathematics (E)

E2+ Mathematics is enjoyable and stimulating to me

E3+ When a math problem arises that I can't immediately solve, I stick with it until I have the solution

E11- I would rather have someone give me the solution to a difficult math problem than have to work it out for myself

E12- I do as little work in math as possible

The mathematics usefulness scale (U)

U2+ I study mathematics because I know how useful it is

U4+ Mathematics is a worthwhile and necessary subject

U6+ I will use mathematics in many ways as an adult

U7- Mathematics is of no relevance to my life

U10- Taking mathematics is a waste of time

U12- I expect to have little use for mathematics when I get out of school

[4] The labeling and phrasing of each statement comes from Mulhern & Rae (1998) based on Fennema & Sherman (1976). The '+' symbol indicates a positive wording of a statement while the '-' symbol indicates a negative wording of a statement. The negative statements will be scored on a reversed Likert scale so that an overall high average score will indicate positive responses and an overall low average score will indicate negative responses.

Appendix B

Potential Questions for Journal Reflection[5]

For Pre-Service Reflection:

1. What mathematical skills will you need to use in order to complete your project?
2. What other skills will you need to use in order to successfully complete your project? (technology skills, communication skills, problem-solving skills, writing skills, etc.)
3. What aspects of this project do you expect to be exciting, challenging, frustrating, rewarding for you?
4. What are your expectations about the site where you will do your project – what will it look like? What will the people be like at the site?
5. How does your project relate to your mathematics class as a whole?
6. What kind of help will you need from your instructor and from the school to make your project successful?
7. What assumptions might the staff at the community partner organization have about high school students engaged in service-learning? How can you make the best possible impression at the community partner organization?

For Mid-Semester or End-of-Semester Reflection Sessions:

Questions about student skills:

1. What mathematical skills did you use in order to successfully complete your service project?
2. What people skills and communication skills did you use to successfully complete this project?

Questions about success of the project:

3. What was the best part of your service-learning experience?
4. What would you change about the design of the service-learning project?
5. What specific comments and recommendations do you have regarding communicating with the community partner, working in groups, logistics, and the time commitment required for the project?

Questions about the community partner:

6. What limitations or obstacle does your community partner face? (lack of money, space, staff, etc.) How do service-learning students help the organization? Based on your observations, what further technical assistance does your agency need? Where could your organization turn to in order to get that assistance?
7. What societal problems is your agency addressing? How do they address them?

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[5] From Webster Vinsonhaler (2005), modified for a high school context as opposed to a college setting. Though this list splits the reflection questions into pre-service and mid-service/end-of-service, modified versions of these questions can be used as prompts during the regular journaling process throughout the project.

Questions about service after graduation:

8. Do you envision yourself lending your mathematical skills or time to community organizations or individuals in the future? If yes, what kind of work would you find satisfying? Direct service work? Serving on a non-profit agency Board of Directors?
9. How would you define "corporate responsibility to the community"? Do you believe that large corporations have a responsibility to help out the community that they operate in? Do you believe that schools have a responsibility to assist in the community that they reside in?

Appendix C

Student Handout: Project overview

AP Statistics Project
Serving the Community through Statistics

Project Overview:

Mobile Loaves and Fishes (MLF) is a homeless ministry here in Austin. They have recently purchased a tract of land on which they plan to construct an affordable living community with trailers, RVs, and some permanent buildings. You can find more info on MLF and this project at their website: mlf.org/community-first/. The hope of MLF's Community First ministry is to overcome the homeless mindset and demonstrate that home is more than a physical structure, it is relationships. According to the MLF website:

> "Taking someone off the streets, putting a roof over his head and a cup of soup in his stomach will not change the status of a homeless person. To no longer be homeless, a person must think of home as a matter of community, that home is about belonging, connectedness, and shared memory and that home involves relationships of trust."

MLF has graciously allowed our class to participate with them in this project. Your assignment is to utilize your understanding of statistics to conduct, analyze, and present survey research the evaluation of the Community First program. Students will participate in a group which will provide the following four services: meeting with agency and developing a survey instrument, conducting survey, compiling and coding data, and analyzing data.

All students will compose a written report on the findings of the project to submit to the instructor. The instructor will select one report to return to the group to be used as the basis of the presentation that will be given to the partnering agency.

How You Will Be Graded:

Since the components of your project will vary from group to group depending on your assignment with the agency, there is not much of a set rubric to follow as there was for your previous projects. Sorry, but this is how math, and projects in general, work in the real world. Ultimately your grade will come from the satisfaction of your client.

I can say that every group will complete at least the following components:

1. Project Proposal – this is where you show me your plan of attack moving forward. The proposal is a typed document, one per group, that must be approved by _____.

Notice this is the deadline for *approval* not simply submission. You may submit your proposal at any time prior to this date and receive feedback for modifications without penalty. The proposal should essentially contain the following:

a. Who? – The organization you are partnering with and the names of the members in your team
b. What? – What are the major questions your group is going to focus on answering
c. Why? – Why are the questions you listed above *worth* answering? What value can be gained by reading the results of your final project?
d. How? – This is the bulk of your proposal where you explain the different stages your group will have to work through to meet your objectives. An excellent sample "How? Statement" from last year will be provided for you as reference.
e. When? – Provide a timeline for the completion of various stages of your project. Your final reports are due to me on _____. Everything in between is determined by your group.

2. Final Written Report – while the groups will collaborate throughout the project, the final report will be written individually and will count as 50% of your final grade for the project. Groups will collect and analyze data together and then it will be the individual's responsibility to synthesize this information and present it in a clear way. The audience of your report is not the instructor. The audience of your report is your client organization. How long should the written report be? As long as it needs to be.

3. Presentation of Findings to Partnering Organization – this will be an oral presentation, accompanied by any necessary visuals and the best written report from your group that will be given directly to the partnering agency. Your task will be to schedule this meeting sometime during the week of _____. It can take place either on school campus or off (depending on what works for your client). The instructor must be present at the presentation, so you need to inform me as soon as you have a date and time scheduled. The feedback provided by the organization on the effectiveness of your report will determine 25% of your final project grade. The remaining 25% of your grade will come from an evaluation form that you will fill out on yourself and the other members of your team.

Statistics Service Project Rubric

Written Report	**50**	
Demonstrates how and why the particular topic was chosen	10	
Shows how the research was conducted	10	
Includes the collected data and its analysis	10	
Delineates what conclusions were obtained	10	
Discusses the strengths and weaknesses of the selected statistical methods	10	

Client Feedback	**25**	
Communication was maintained throughout the project and was conducted in a professional manner	5	
Presentation is thorough, well organized, easy to understand and questions are handled appropriately	5	
Project addresses the problem at hand, providing useful information and new insights	15	
Additional Comments:		

Personal Reflection and Group Evaluation	**25**	
Student completes an honest self-assessment and reflection assignment	5	
Personal evaluation of quantity of work (time commitment to project components)	5	
Personal evaluation of quality of work (practical contributions to the team)	5	
Project manager evaluation	10	
Project Manager Comments:		

Total	**100**	

Project Calendar	
Date	**Event**
September	Project Introduced
October	Experience in Surveying Initial meeting with Partnering Organization
December	Initial Proposal Submitted
January	Final Phase of Project Assigned - Component Detailed Descriptions - Project Calendar - Grading Rubric - 12 Step Guide - Teamwork Rubric Workday – Group Meetings with Mr. Wilkerson to revise proposals
February	Have a data collection time/date/place scheduled with organization
March	Deadline to have new proposal (and survey if giving one) approved
March/April	Workdays - Bring laptop if wanting help on spreadsheet files
End of April	Written Reports Due
End of April	Reports Returned with Feedback Final Workday
End of April	Presentations to Partnering Organizations
Beginning of May	**ALL PROJECTS DONE** **REVIEW WEEK FOR AP EXAM 5/9**
Mid May	Self Reflection Assignment Due - Details on this to follow

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