AN ABSTRACT OF THE DISSERTATION OF

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Title: Validation of an Instrument for Mathematics Enhancement Teaching Efficacy of Pacific Northwest Agricultural Educators

Abstract approved:

Larry G. Enochs

Teacher efficacy continues to be an important area of study in educational research. This study tested an instrument designed to assess the perceived efficacy of agricultural education teachers when engaged in lessons involving mathematics instruction. The study population of Oregon and Washington agricultural educators utilized in the validation of the instrument revealed important demographic findings and specific results related to teacher efficacy for the study population.

An instrument was developed from the assimilation of three scales previously used and validated in efficacy research. Participants' mathematics teaching efficacy was assessed using a portion of the *Mathematics Teaching Efficacy Beliefs Instrument* (MTEBI), and personal mathematics efficacy was evaluated by the mathematics self-belief instrument which was derived from the Betz and Hackett's Mathematics Self-Efficacy Scale. The final scale, the *Teachers' Sense of Efficacy Scale* (TSES) created by Tschannen-Moran and Woolfolk Hoy, examined perceived personal teaching efficacy. Structural equation modeling was used as the statistical analyses tool to validate the instrument and examine correlations between efficacy constructs used to determine potential professional development needs of the survey population. As part of the data required for validation of the Mathematics Enhancement Teaching Efficacy instrument, demographic information defining the population of Oregon and Washington agricultural educators was obtained and reported.

A hypothetical model derived from teacher efficacy literature was found to be an acceptable model to verify construct validity and determine strength of correlations between the scales that defined the instrument. The instrument produced an alpha coefficient of .905 for reliability. Both exploratory and confirmatory factor analyses were used to verify construct and discriminate validity.

Specifics results related to the survey population of agricultural educators concluded that personal mathematics efficacy has a stronger correlation with mathematics teaching efficacy than personal teaching efficacy of teachers for this population. The implications of such findings suggest that professional development and pre-service preparation should be more focused on mathematics content knowledge rather than pedagogical knowledge when the objective is to enhance mathematics in interdisciplinary lessons.

Validation of an Instrument for Mathematics Enhancement Teaching Efficacy of Pacific Northwest Agricultural Educators

by
Daniel J. Jansen

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APPROVED:

Major Professor, representing Science Education

Chair of the Department of Science and Mathematics Education

Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Daniel J. Jansen, Author

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Who would have thought of this… a small town farm kid putting together ideas well enough to achieve a doctorate degree!

This accomplishment was part of a collective effort over three decades in the making. I can trace the impact that many different individuals, majority of which were my teachers, who contributed to this benchmark in my professional life. These individuals span all levels of my education from the late Sandy Fort, a third grade teacher, to agricultural education teacher mentors and FFA Advisors Rolland Aschim and Michael Swan. There are so many names and faces in between to mention.

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Success in education depends on great teachers to provide the proper guidance and motivation in the learning process. I have mentioned those who have made a direct impact on my professional life as I traveled down the road toward this milestone. One prominent attribute emerged among all of those individuals mentioned – character. This story would not be complete without acknowledging one more important person. Dr. Greg Thompson has been a research colleague, teaching mentor, boss, editor, and coach over the past four years. But it is Dr. Thompson's dedication to others and belief in their individual abilities that has made the largest impact on my approach to teaching. I wish to thank you for your critical eye and your ability to challenge good to become better.

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CHAPTER 1

INTRODUCTION

As early as 1945, a report published from the Harvard Committee indicated how valuable Career and Technical Education (CTE) is to aid understanding for mathematics and other core academic studies required for technological training. The report advocated for courses in art and shop being the gateway for experimentation. Opportunities to manipulate objects and use tools allowed students to develop spatial relationships and foster engagement that connects knowledge with the production of skill. “The lack of shop training is at present a most serious deterrent to entry into all types of technological work and to college and postgraduate training in science, medicine, and engineering” (Harvard Committee, pg.160).

The true value of CTE programs today inspires ongoing debate among education leaders in our country. Since the adoption of the Smith-Hughes Act in 1917, the trajectory of vocational instruction has changed course in the winds of public opinion and policy. Vocational instruction, now identified as Career and Technical Education, face many struggles for resources and identity in a standards-based environment stressing higher student achievement in core academics such as mathematics and science. The struggles have prompted changes in pedagogical methods and curriculum content for CTE instruction in secondary public institutions. The tradition in which CTE was founded, and perpetuates still today, is a monumental reason why many academic disciplines look to CTE curriculum for assistance with adding relevance to their subject matter (Hochlander, 1999).

The following study examines CTE teachers' efficacy when enhancing mathematics in the contextual subject area of agricultural education. Relevant literature regarding teacher efficacy, mathematics instruction, and the value of context in student learning provided the foundation for the related research objectives. Most notable was a study conducted by the National Research Center for Career and Technical Education (NRCCTE) involving the use of mathematics enhanced lessons within CTE curriculum to determine if increases in student mathematics performance were achieved (Stone, Alfeld, Pearson, Lewis, & Jensen, 2006).

The NRCCTE study found that student mathematics achievement on standardized tests was improved through contextual applications without detrimental effects on specific subject matter content outcomes. What was not addressed in the NRCCTE study, and becomes the motivation for this project, was the level of efficacy CTE teachers felt as they prepared and delivered mathematically enhanced lessons. Wu and Greenan (2003) highlight the issue of teacher perceptions toward their ability to provide instruction of mathematics in their lessons from research related to this topic:

> An important factor impeding student mathematics achievement in CTE programs is that some CTE teachers did not feel confident and/or responsible to systematically teach mathematic skills in their programs. CTE teachers were not required to take mathematics courses to become a certified CTE teacher; therefore, they were likely not comfortable teaching mathematics in

> their CTE programs. This suggests the need for staff development for CTE teachers in the integration [or enhancement] of mathematics skills and CTE curricula. (pg 46)

The implications presented by Wu and Greenan (2003) challenge researchers to investigate and determine potential factors that lead to the lack of mathematics confidence CTE teachers experience when enhancing mathematics in lessons. By identifying potential contributing factors which lowers teacher confidence, staff development as prescribed by Wu and Greenan will be more focused toward the root of the problem.

The speculated causes for CTE teachers to struggle with mathematics enhancement of their curriculum stem from several different factors. A conceptual reason involves teacher beliefs toward the value or relevance of enhancing mathematics in their curriculum (Martin-Kniep, Feige, & Soodak, 1995). For example, some teachers believe they are responsible for subject matter content only; therefore knowledge related to CTE is foremost on their agenda, and instruction of mathematics is to be left in the mathematics classroom (Grossman & Stodolsky, 1995). CTE teachers who place a high value on purposely teaching mathematics embedded in CTE lessons may vary greatly in their perceived abilities to effectively teach mathematics. Although these teachers may view the relevance of enhancing mathematics in their curriculum, they encounter pitfalls related to mathematics background knowledge, which in turn fuels deficiencies related to pedagogical content knowledge required to effectively teach mathematics (Ball, Lubienski, & Mewborn, 2001).

Additional speculations for consideration regarding CTE teachers' proficiency in mathematics enhancement involve more epistemological factors for this phenomenon. These factors may include years of teaching experience, mathematics courses completed as a student, and a teacher's level of coursework in mathematics successfully completed (Enochs, Scharmann, & Riggs, 1995). In any case, much of the underlying concern stems from a lack of perceived teaching efficacy related to the teaching of concepts in which CTE teachers may not have been formally prepared to teach.

Rationale and Statement of the Problem

As educational and political leaders push for more emphasis on student mathematics and science performance, the needs for improved mathematical experiences are apparent. Teaching mathematics in contextual formats has been found to contribute to student engagement in the learning process of core academic subject matter through realistic and pragmatic connections (Hill, Rowan, & Ball, 2005; Wu & Greenan, 2003).

Agricultural education, like other CTE programs, is a valuable discipline to promote contextualized instruction for mathematical enhancement in secondary education (Stone, 2003). Within the curricula framework of agricultural education, content areas offer a wide-range of opportunities to enhance mathematics concepts. However, meaningful instruction in mathematics is highly dependent upon a teacher's pedagogical ability (Ball, et al., 2001). Being mindful of the relationship between teachers' practice and student learning, implications arise for mathematics enhancement strategies embedded in contextual subject matter.

The problem that surfaces is the lack of research related to CTE teachers' efficacy toward mathematics teaching. Specifically, how CTE teachers perceive their ability to enhance mathematics in their lessons and what factors contribute to mathematics teaching efficacy. Thus, even though agricultural education curricula supports practical situations for mathematics to be enhanced within a certain context, agricultural educators may lack the ability to purposely teach mathematical concepts for student understanding.

Purpose and Importance of Study

Hill, Rowan, and Ball (2005) examined the relationship between teacher mathematics knowledge and student mathematics performance. One of the recommendations from this study stressed the need for further research investigating whether or not differences in teachers exist regarding their levels of pedagogical content knowledge in mathematics, and specifically what these differences have on student performance in mathematics. Following the Hill, et al. recommendation, this study investigated perceived differences in teaching ability of mathematics in a specific population of teachers.

The research conducted for this study had two overarching objectives: 1) Validate an instrument to assess teacher efficacy associated with enhancing mathematics and 2) Determine the level of preparedness Oregon and Washington agricultural educators have with enhancing mathematics within their respective curricula.

As school reforms pressure educators to meet rigorous standards for student achievement in mathematics performance, alternative modes of instruction can become valuable tools for student learning. Effectively teaching embedded mathematics in contextual lessons reinforces the understanding of mathematical concepts outside of the general mathematics classroom (Hochlander, 1999). However, if teachers are not efficacious in their ability to effectively teach mathematics for conceptual understanding, then attempts to enhance mathematics will be only be trivial at best (Brophy, & Alleman, 1991). The development of a valid model used for predicting the correlation of factors that contribute to mathematics teaching efficacy will have future implications for professional development activities and provide evidence required for change in pre-service preparation of CTE teachers.

Assumptions of the Study

Assumptions for consideration involving this study were:

1. Because this was a multi-state project, agricultural educators' secondary and post-secondary mathematics education background and pre-service programs were assumed to be relatively consistent.
2. Because the entire population of agricultural educators had an email address provided on the contact lists, it was assumed that all teachers had equal access to, and thus equal potential for completion of the questionnaire.
3. The validation of an instrument to measure teacher efficacy is the focus of the study under investigation. Although the impact on student learning is

important in determining the effectiveness of contextual curriculum, student achievement is beyond the scope of this study.

Research Questions

The following are the research questions used to guide this study:

1. Are personal mathematics efficacy and personal teaching efficacy valid constructs for determining correlations with teachers' confidence in their ability to enhance mathematics?
2. What are the demographic characteristics for agricultural educators in Oregon and Washington?
3. Which factor, personal mathematics efficacy or personal teaching efficacy, establishes the strongest correlation with a teacher's confidence in their ability to enhance mathematics in agricultural education?

Theoretical Framework

It has been established through research that teacher efficacy directly impacts student academic achievement (Ross, 1992). Recent studies involving teacher efficacy have theoretical underpinnings derived from self-efficacy theory postulated by Albert Bandura (1977). Bandura's work on self-efficacy concentrated on how belief in one's own ability to perform a task can affect his or her willingness to participate and influence the level of proficiency at which the individual will complete the task (Bandura, 1997). By understanding the various conditions that contribute to self-efficacy in teachers toward their abilities to instruct students, professional development programs and other assistance can be targeted more specifically to improve teacher practice (Guskey, 1981).

The factors that contribute to teacher efficacy vary widely and have dynamic characteristics (Tschannen-Moran & Woolfolk Hoy, 2001). Survey instruments have been commonly used to solicit perceptions of teachers regarding beliefs about their own teaching abilities (Guskey, 1987; Tschannen-Moran & Woolfolk Hoy). From a questionnaire, researchers were able to identify constructs influencing efficacious teaching and use the constructs to predict efficacious teaching in teacher populations (Tschannen-Moran & Woolfolk Hoy).

The specific problem presented in this study examines the perceptions CTE teachers have when enhancing mathematics in their subject matter. Research has shown that many barriers exist preventing a teacher's willingness to engage in or their effectiveness at performing a curriculum intervention (Battista, 1994; Martin-Kniep, et al., 1995; Wilson, et al., 2002; Wineburg & Grossman, 2000).

Baseline knowledge regarding mathematics efficacy for Oregon and Washington agricultural educators was not available from previous studies. By surveying the population of teachers, valuable evidence was collected supporting conclusions for the readiness of teachers to enhance mathematics concepts in their lessons. Data from this instrument was used to validate a conceptual model constructed to determine the most probable influences on teacher efficacy for this population.

Conceptual Framework

It was believed that correlations could result among different constructs of a teacher's efficacy related to mathematics and teaching ability. To examine potential correlations, a search of the literature revealed instruments used to measure efficacy constructs. The research goal was to understand career and technical education teachers' level of mathematics teaching efficacy and to determine correlations with constructs that may impact efficacy. To accomplish this, an instrument would need to be developed and validated measuring several constructs of efficacy that may provide insight into possible factors contributing to mathematics teaching efficacy.

The statistical tool of path analysis has been used for many studies involving self-efficacy or teacher efficacy (Berry, 1987; Enochs, Smith, & Huinker 2000; Midgley, Feldlaufer, & Eccles, 1989; Schunk, 1984; Sheldon, 2005; Wood & Bandura, 1989; Zimmerman & Bandura, 1994). Structural equation modeling, an extension of path analysis, allows a researcher to conduct confirmatory factor analysis and construct path coefficients for determining relationships between factors. Using structural equation modeling therefore is a solid statistical tool used to determine construct validity and develop evidence for potential predictions among constructs.

A prerequisite for the utilization of structural equation modeling is the defining of a hypothetical model derived from theory defining constructs to be measured (Grimm & Yarnold, 1995; Kline, 2005). For the purposes of this study, a hypothetical model was created from the literature related to teaching efficacy. Figure 1 represents the hypothetical model that was determined as the basis for measurement.

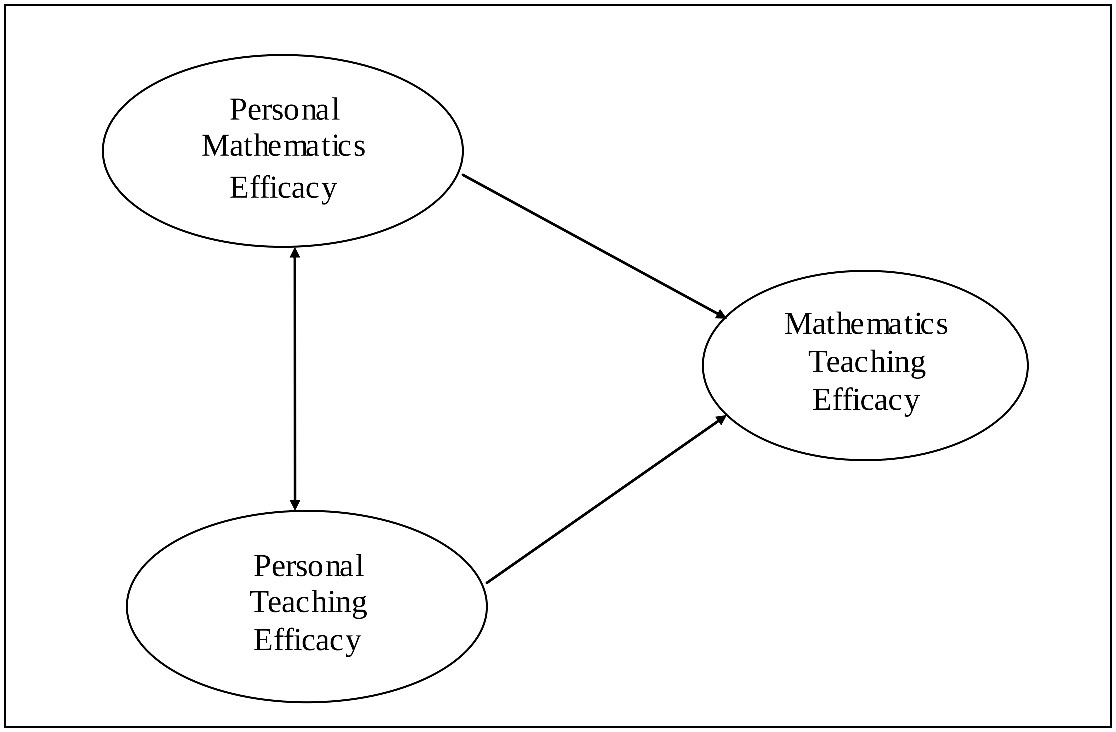

Figure 1. The conceptual model illustrating the potential relationships among two constructs of personal efficacy with mathematics teaching efficacy.

The three ovals in figure 1 represent constructs measured using various questionnaire items asking for teacher perceptions regarding their confidence in teaching ability related to the respective construct. It was believed that statistical results from testing this model would provide insight into the level of mathematics teaching efficacy a teacher population has, and determine the contributing efficacy constructs that produce the strongest correlation to mathematics teaching efficacy.

Limitations of the Study

This research study was conducted under the following limitations:

1. Because this study was conducted on a target population of Pacific Northwest agricultural educators, it presents limitations for generalizing to other teacher populations.

2. The use of a questionnaire limits the type of data collected and prohibits a richer understanding of the respondents' opinion and feelings. Questionnaires are generally inflexible and may not ask questions in a format understandable to all participants (Gall, Gall, & Borg, 2003).
3. The instrument measures three identified constructs of teacher efficacy. Kline (2005) warns of two important misconceptions regarding the interpretations of structural equation modeling results (p. 176):
    a. One misconception is that the factor name was assigned based on the hypothetical model and may not be accurate in describing the true nature of the intended construct. Therefore, the names of the factors should be viewed as labels rather than descriptions of factors.
    b. Reification is the belief that a hypothetical construct must correspond to the real phenomena.
4. Many factors may contribute to an individual teacher's efficacy. This study only examined subject matter content and pedagogical aspects of the study population. Other efficacy influences have been documented in research including additional external environmental forces, such as collaboration (Ross, 1992; Wheatley, 2002) and student outcome expectations (Ashton, & Webb, 1986; Enochs, Scharmann, & Riggs, 1995).

Definition of Terminology

The following terminology and operational definitions apply to this study:

Agricultural Education - Secondary public education related to technical knowledge and skill preparation in agriculturally related subject matter. This subject matter may include (but is not limited to) instruction in animal science, crop science, and horticulture. However, many of these teachers will have a portion of their assignment in agricultural mechanics related subjects including metals and welding, construction, and structural systems maintenance. Nationally, programs have specialized to include agribusiness, leadership development, and research with other specialty courses in food science, aquaculture, and various natural resource-based contexts (i.e. forestry or wildlife management). In some cases, the reference of Natural Resources Education is used synonymously with Agricultural Education (The National FFA Organization, 2006).

Agricultural Educators - Teachers of agriculture subject matter as described above. Agricultural educators are referred to as agricultural science and technology teachers in Oregon and agricultural science teachers in Washington State.

Career and Technical Education (CTE) - Secondary and postsecondary education to prepare students for careers in Agriculture, Business, Family and Consumer Sciences, Health Occupations, Technology and Trade/Industrial disciplines (Association for Career and Technical Education, 2006).

Contextual Education or Contextualized Instruction - Applied instruction in subject matter that have practical connections to real world experiences (Stone, 2003).

Self-Efficacy – An individual's belief in their own ability to perform a task (Bandura, 1997).

Teaching Efficacy – A teacher's belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998, as cited in Knobloch & Whittington, 2002).

CHAPTER 2

LITERATURE REVIEW

Introduction

The purpose of this chapter was to present a summary of the related literature and research findings which define key ideas associated with teacher efficacy as it relates to enhancing mathematics in agricultural education. The topics that were determined germane for this examination include the following: (1) The Mathematics Education Challenge, (2) Value of Context, (3) Math-in CTE Project, (4) Mathematics in Context, (5) Teacher Efficacy, (6) Pertinent Studies in Agricultural Education, and (7) Summary.

Literature Selection and Review Process

Evidence to support pertinent concepts and themes for this study underwent narrative analysis to determine content appropriateness. The most prominent source for literature was the Oregon State University Library including general catalog and ERIC research databases. Specifically, within ERIC databases, Professional Development, Psychology and Behavior, and Vocational and Career Collections were scanned as well as Academic Search Premier. Professional research journals such as the *Journal of Agricultural Education* and the *Journal of Vocational Education Research* were hand searched via hardcopy and online formats. Other additional resources came from graduate coursework, professional conferences and publications, internet searches, and organizational websites.

The literature contained in this chapter originated in various contexts, including research related to psychological and behavioral sciences, mathematics, science education, and agricultural education. Because contextual learning and teacher efficacy have been important areas in educational research, the quality of material provided an adequate foundation for this study.

The Mathematics Education Challenge

A shortfall of research-based methods for teaching of mathematics exists, and more should be done to find improved ways of teaching and measuring student progress in mathematics (United States Department of Education, 2004). Battista (1999) argued that evidence-based reforms for improving mathematics instruction are ignored, and “traditional” approaches are standard practice in our schools. Battista implied that evidence in support of reform efforts for mathematical pedagogy is not voluminous. Additionally, Battista concluded there is overwhelming evidence proving that traditional methods of instruction are ineffective at promoting student achievement.

Why then are mathematics predominately taught using proven methods which appear to be failing? The National Assessment of Educational Progress (NAEP) estimated 13% to 16% of twelfth grade American students are proficient in mathematics (cited in Battista, 1999). The Business-Higher Education Forum (2005) reported in the year 2000 the NAEP estimate for mathematics proficiency was slightly higher (20%), but still far below expectations. The National Research Council (1989) reported that college enrollments in secondary-level mathematics courses exceeds 60%, and the cost to business and industry for mathematics training of employees exceeds the combined expenditures for mathematics education in both secondary and post-secondary institutions.

Current mathematics teaching methods are not translating into student understanding. Change necessarily does not lay in innovative new reforms, but in old approaches revisited. The Center for Occupational Research and Development (CORD) produced curriculum packages with the objective of improving student performance in mathematics. These packages are mathematics lessons within contextual formats aimed to establish better connections with the student learner. In two separate evaluative reports on CORD mathematics curriculum, it was determined that employing applied lessons had a similar to significantly positive effect on student achievement than traditional curricula (Graves, 1998; Keif, & Stewart, 1996). In fact, Graves (1998) reports a 70% increase in conceptual understanding of mathematics utilizing CORD lessons.

Value of Context

"Teaching specific topics or skills without making clear their context in the broader fundamental structure of a field of knowledge is uneconomical." (Bruner, 1960, p. 31) In a report published by the American Psychological Association (1997, pg. 3), the quote, "Learning does not occur in a vacuum," was used to emphasize the point of teaching academic concepts within a setting where concepts are routinely used. This suggestion, arguing for context in learning, is one of the fourteen psychological principles identified as important characteristics of learner-centered prescriptions for school reform and redesign (American Psychological Association).

To examine the effects which context has toward enriched learning experiences of students, the following section provides an overview of literature addressing the value of context in teaching.

The case for contextual or applied learning experiences has long standing traditions. The value of context was highlighted in American educational philosophy through the writings of John Dewey. Dewey argued that student learning experiences should be conducted in the natural settings for which they will be later encountered (Dewey, 1916). He also stressed that instruction should be facilitated in a practical way to be meaningful for the learner. Others have followed Dewey's work by studying the effects that context has on learning. Russian philosopher Lev Vygotsky (1962) discovered how tools, in the form of speech (language), helped to situate meaning for people within the context associated with speech iterations. This particular context Vygotsky discovered is the basis for personal thought as it is shaped from the societal or cultural significance in which it was experienced. Without context, words could not transfer meaning to the listener.

Depending upon previous experiences, or context in which a person uses to shape their perspective for interpreting words, a very different meaning from the message could be derived. To illustrate Vygotsky's key idea, consider an email message sent from a lesser known colleague across the country. If the colleague does not clearly articulate the context for which the message was crafted, the meaning is left to only abstract words on the screen. As Wiggins and McTighe (2005) suggested; "All interpretations are bound by the personal, social, cultural, and historical contexts which they arise" (p. 91). Therefore, without being aware of nonverbal cues, voice inflection, or other attributes to aide the transfer of meaning, the email may be misinterpreted if vaguely written.

Context assists students in taking abstract concepts, generalizing the understanding, and transferring those concepts to specific situations which are relevant in students' daily life (Wu, & Greenan, 2003). Bransford, Brown, and Cocking (2000) associate enhancing the transferability of knowledge across subject areas as the prerequisite for, what Bruner coined, "economical" teaching.

"Transfer is affected by the degree to which people learn with understanding rather than merely memorize sets of facts or follow a fixed set of procedures" (Bransford, et al., 2000, p. 55). Bransford, et al. describes how understanding promotes the transfer of knowledge via student thinking. However, a clear definition of what it means to understand is necessary. Wiggins and McTighe (2005) provide foundation for the concept of understanding that draws clear distinctions between knowing and understanding. A lesson can teach a student to know facts and procedures which the student may successfully be able to remember, and assessment methods such as multiple-choice or matching can accurately measure. According to Wiggins and McTighe, true understanding requires the student to mentally process why the facts and procedure are important to the broader ideas involved with the concept, and more importantly, what science or theory is the cause for their results on an activity. These authors suggest six facets of understanding provide the evidence needed to prove learning has taken place at a level of understanding rather than a simple accumulation of disconnected knowledge which is difficult for students to transfer.

Teaching for understanding rather than teaching for the sake of providing knowledge, is dependent upon context to provide connection between abstract concepts and application within specific tasks (Bransford, et al., 2000). If students understand the meaning behind concepts and big ideas, it will allow them to use and adapt this knowledge in different settings for different purposes (Wiggins, & McTighe, 2005).

In much of the literature, the pedagogical methods related to contextual instruction are referred to as “applied” or “hands-on” instruction (Bond, 2004). In more recent research on effective teaching, “situated” practice has become extremely valuable in defining the importance of context. Two variations of situated practice theory surface in this school of thought: situated cognition and situated learning. Brown, Collins, and Duguid (1989), describe situated cognition “as the process of individuals deriving meaning from their experiences or interactions with environmental factors.” This parallels much of Vygotsky’s claim that meaning is derived within individuals as they interpret the environment for which they are participating.

Lave and Wenger (1991), in situated learning theory, depart from learning solely as a personal endeavor to much more deeper connections in social communities of practice. Situated learning theory enhances the aspect of social participation, or the context of culture, within a person's environment. This places the learner in dual roles as a student and as a contributor towards meaning.

In either case, such theories rely on underpinnings framing learning as being dependent upon the context from which it resides. Much of Dewey's thoughts regarding the importance of effective learning being embedded in the setting for which it will later be used is echoed in situated cognition and situated learning theories.

Possibly the true value attained in the argument for contextual learning rests in the studies conducted to prove its significance. Data provided by the Educational Testing Service, reported that students who were taught mathematics using hands-on approaches out-performed peers by approximately 70% of a grade level (Wenglinsky, 2000). This same survey found less than one in four mathematics teachers use hands-on teaching strategies in their curriculum.

Contextual Learning Institute and Consortium (CLIC), conducted an investigation involving four Oregon schools yielding quantitative data from student standardized testing as well as qualitative data from students and teachers in science and English courses (Parnell, 1999). The results concluded that instruction using contextual-based curriculum yielded average tests scores as good if not significantly better than the national average. Parnell concluded from the qualitative feedback, contextual learning has five advantages (p. 4):

- Engages and motivates students
- Improves student productivity
- Does not require traditional texts

- Improves attendance
- Increases teacher and student energy levels

Disadvantages of the CLIC study revealed the concern that contextual lessons may require more planning time, pose problems for assessment, and adds difficultly in efforts to meet required content expectations (Parnell, 1999). Despite these claims, very favorable results were determined regarding the use of contextual curriculum.

Another related study conducted by Center on Organization and Restructuring of Schools, involved 1500 elementary, middle, and high school students across 16 states (Newmann, 1996). Interventions were employed aimed at restructuring schools in an effort to improve the intellectual and social competence of students. The results indicated four key areas of focus for restructuring of schools; most notable was the recommendation of authentic pedagogy. This prescription was described as pedagogical methods which bring the vision to life in teachers' classrooms. Authentic pedagogy creates learning experiences that "challenge students to think, develop in-depth understanding, and apply academic learning to important, real-world problems" (Newman, pg. 7).

Bond (2004) separates contextual teaching from traditional approaches by suggesting seven characteristics of contextual teaching. These characteristics reflect the importance of connecting learning experiences with pragmatic and real-life experiences. The characteristics also show the need for learner-centered concerns in establishing relevance between the learner and the content. It is Bond's suggestion to eliminate the knowledge intimidation factor that provides the most original value for contextual teaching.

Math-in-CTE Project

In a recent study conducted by the National Research Center for Career and Technical Education (NRCCTE), Stone, Alfeld, Pearson, Lewis, & Jensen (2006) determined that improvement in student comprehension of mathematical concepts embedded within career and technical education (CTE) contexts is possible. The study employed a pedagogical strategy to facilitate the enhancement of mathematical concepts found in CTE lessons across specific content areas. The pedagogical model, *The Seven Elements of a Math Enhanced Lesson*, served as a guide for the process of providing explicit instruction of mathematics concepts by having CTE teachers "pull out" the mathematics from the contextual material to purposely reinforce mathematics principles. Teachers in CTE subjects were paired with mathematics teachers to develop enhanced lessons, learn how to provide instruction using the seven elements model, and encourage collaboration between the CTE and mathematics teachers.

By using the prescribed pedagogical approach, students were able to learn mathematics in a more meaningful way which led to improved test scores in mathematics on standardized examinations (Stone et al., 2006). In addition to improved mathematics performance, data indicated negative impact on student learning associated with the contextual subject matter was non-significant (Stone, et al.). This is valuable because of a documented concern some teachers have of sacrificing subject matter content of their discipline to accommodate interdisciplinary concepts (Conroy, 1999; Hochlander, 1999; Wineburg, & Grossman, 2000).

The pilot study for the Math-in-CTE project was conducted in six different sites across the country and included 274 CTE teachers (Stone, Alfeld, Pearson, Lewis, & Jensen, 2005). Oregon and Washington agriculture teachers who taught horticultural science courses were among the participants of the pilot (Jansen, Enochs, & Thompson, 2006).

Agriculture teachers were paired with mathematics teachers to develop lessons and participate in collaborative professional development sessions learning the pedagogical model of instruction. The results of the pilot study yielded similar results for the Oregon and Washington student population; improved student performance on mathematics examinations and evidence of no ill effects on horticultural knowledge were found (Stone, et al., 2005).

Mathematics in Context

Ball, Lubienski, and Mewborn (2001) build on previous research claims that teacher mathematics knowledge plays an important role on student outcomes. Teacher content knowledge and teacher pedagogical content knowledge are two areas of interest identified as being associated with good instruction of mathematics.

Mathematical Content Knowledge

In a recent report published by the Business-Higher Education Forum (2005), *A Commitment to America's Future: Responding to the Crisis in Mathematics and Science Education*, the call for "more highly qualified teachers of mathematics and science" (p. 8) is not being answered. Despite the reasons for this challenge being unanswered, what stands out in their claim is the statement of "highly qualified."

What constitutes a highly qualified teacher? This will be an important definition as No Child Left Behind reforms are implemented. A somewhat pessimistic perspective to address efforts in defining a highly qualified teacher can be found in the literature on teacher education in mathematics. It appears to some researchers that exactly what a teacher should know about mathematics in order to be effective seems elusive at best (Ball, et al., 2001; Grouws, & Schultz, 1996).

An even more inspired debate is whether student achievement can be contributed to teacher content knowledge. Grouws and Schultz (1996) report little evidence is present to support the notion that student performance and teacher preparation in mathematics are correlated. Hill, Rowan, & Ball (2005) counter this claim by providing evidence toward the significance of teacher mathematical knowledge and improvement of student performance on standardized testing. Other researchers have conducted correlation studies examining the effects of variables related to teacher preparation in mathematics (i.e. number of mathematics courses completed, level of mathematics completed, and the degrees held associated with mathematical subjects, etc.) aimed at understanding which factors impact student performance the greatest (Miller, & Gliem, 1994, 1996; Ball, et al, 2001). These sources helped to develop demographic questions for the survey instrument to provide potential correlations and insight into the respondents' background knowledge and the impacts this knowledge can have on mathematics enhancement.

Pedagogical Content Knowledge for Mathematics

"Effectiveness in teaching resides not simply in the knowledge a teacher has accrued, but how this knowledge is used in the classroom" (Hill, et al., 2005, p. 375). Hill et al. differentiates how teachers use mathematical content knowledge for meaningful instruction. In mathematics instruction, procedural knowledge and conceptual knowledge have very different consequences for understanding mathematics (Eisenhart, Borko, Underhill, Brown, Jones, & Agard, 1993). According to Eisenhart, et al., procedural knowledge defines the mastery of routine sets of mathematical rules, definitions, and algorithms needed for basic computational skills. Conceptual knowledge is described by these authors as pertaining to the relationships and interconnections of ideas which allow learners to construct meaning for the mathematical procedure encountered. Teaching for conceptual understanding is the goal of mathematics education, but procedural pedagogy remains the dominate approach in education (Battista, 1999; Hill et al.).

Teacher Efficacy

The theoretical basis for this study is supported by self-efficacy theory proposed by Albert Bandura (1977, 1986, 1993, 1997). Self-efficacy theory, which encompasses a person's belief in their ability to perform a task, asserts that peoples' behavior is directly influenced by personal factors (cognitive, affective, and biological) and the external environment they function in (Bandura, 1997). Bandura (1986) termed this as "triadic reciprocal causation" (illustrated in Figure 2), and further explained that the level of a person's performance at a task (behavior) can be determined by their belief in being able to control environmental factors.

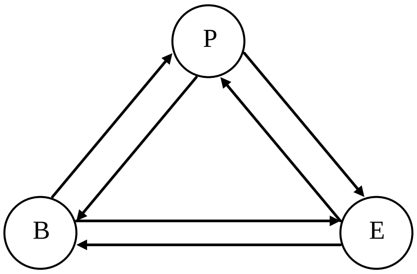

Figure 2. Triadic Reciprocal Causation Model reproduced from Bandura (1997, p.6). P represents personal factors, B symbolizes behavior, and E represents external environment.

If a person believes they cannot change the outcome of a task because the external factors have more influence, they will be less likely to engage in this activity at a level necessary for the desired outcome. To apply this to a teacher efficacy scenario, if a teacher does not feel they can improve student understanding of a mathematical concept embedded in their lesson because of the teacher's deficient skill level in mathematics, then they will likely not even try. On the other hand, if a person has a greater sense of internal control over external factors, they will be more positive and extend greater effort toward achieving a desired goal. By changing our environmental conditions to more favorable situations, this can in turn promote positive changes in behavior and increase positive personal experiences (Of course, the inverse is also true).

For teachers, this concept was originally approached in the work of Rotter (1966) as the theory of locus of control. Where Bandura's theory of self-efficacy departs from Rotter’s locus of control theory, is described by Guskey (1998). Guskey contends that self-efficacy (teacher efficacy) treats internal and external factors as independent of each other and that both may equally influence efficacious outcomes. Locus of control, on the other hand, places internal and external factors on opposite ends of the same scale. Such a distinction results in a more dichotomous relationship rather than a complementary relationship between factors. This is important because Bandura recognized that both factors, internal and external influences, need to operate as a relationship rather than a person having either one influence or the other.

From Bandura’s influence on efficacy, other researchers sought out improvement to early Rand research instruments designed to measure constructs of teacher efficacy (Ashton, & Webb, 1982; Gibson, & Dembo, 1984; Guskey, 1981; Soodak, & Podell, 1996). One of the greatest challenges to overcome in developing constructs for teacher efficacy has been reliability and validity. This issue was properly addressed by Pajares (1992) through his examination of using teacher beliefs as the mode of data collection for teacher perceptions, and most recently through investigations of Tschannen-Moran and Woolfolk Hoy (2001). Tschannen-Moran and Woolfolk Hoy measured constructs of teacher efficacy with a belief reporting instrument proven to be very consistent and valid. For their efforts, the Ohio State Teacher Efficacy Scales (now referred to as the *Teachers’ Sense of Teacher Efficacy Scale*) yielded reliability levels consistently at the .90 range. The researchers also reported that construct validity remained reasonably good throughout their analyses in these studies. This instrument and other recent instruments measuring teacher efficacy are analyzed in the Tschannen-Moran and Woolfolk Hoy (2001) article entitled *Teacher Efficacy: Capturing an Elusive Construct*.

In the search of the literature on teacher efficacy, specifically in mathematics efficacy, two additional instruments surfaced that fit the goals of this study. The first was a subscale included as part of a mathematics self-beliefs instrument employed by Schulz (2005) and tested internationally as part of the Program for International Student Assessment. This subscale was designed to capture the perceptions of mathematics self-efficacy in respondents. Included in this subscale were eight items soliciting the level of confidence a person has in relation to calculations of mathematical problems with varying degrees of difficultly. The subscale had a reliable coefficient of .83 and the instrument as a whole reported a confirmatory factor analysis fit index of .91 (Schulz).

Mathematics Teaching Efficacy Belief Instrument (MTEBI) developed by Enochs, Smith, and Huinker (2000) to assess preservice elementary teachers efficacy in teaching mathematics emerged from the literature as another very reliable and valid instrument for assessing teacher efficacy. The alpha coefficient statistic for the MTEBI was .88 and confirmatory factor analyses provided evidence of construct validity for the scale with an index fit value of .919.

Pertinent Studies in Agricultural Education

To examine pertinent studies specific to agricultural education, this topic is divided into three subsections: (a) Connections with Contextual Learning in Early Agricultural Education, (b) Agricultural Educators' Content Knowledge in

Mathematics, and (c) Agriculture Teacher Efficacy.

Connection with Contextual Learning in Early Agricultural Education

Two prominent names emerge from literature research for Career and Technical Education (CTE), more specifically agricultural education. John Dewey contributed many theoretical underpinnings of pragmatic instruction which lends well to the instructional design of CTE (formerly known as vocational education). Although Dewey was supportive of the basis of the practical applications vocational education could provide for learning, he had a profound ideological objection to learning for the sake of employment (Dewey, 1916). As found in the teachings of Aristotle, Dewey shared Aristotle's opinion that learning should be sought for intrinsic purposes not extrinsic or instrumental reasons such as training for work (Palmer, 2001). However, even if Dewey was not overly supportive of "vocational education" in this sense, he did champion social learning based on investigation and project oriented curricula which dominates agricultural education today (Talbert, Vaughn, & Croom, 2005).

Charles Prosser, on the other hand, was determined to incorporate work-related objectives into his sixteen theorems related to vocational education (Prosser, & Allen, 1925). Prosser et al. insisted that the environment in which the learner is trained should be a replica of the environment in which that learner must ultimately work, and if training is required for these tasks it should be provided in the same form in which it will be needed. Contained in his subsequent theorems, Prosser implied the idea of adaptive learning and addresses expert practice, teachers as practitioners, and asserts the claim that vocational curriculum should be elastic and fluid rather than rigid and standardized (Prosser, & Quigley, 1949). It should be noted that Charles Prosser was a promoter for the value of contextual learning in agricultural education.

Agricultural Educators' Content Knowledge in Mathematics

To explore content knowledge related to mathematic skill, Miller and Gliem (1994, 1996) investigated agricultural educators' abilities to solve mathematical problems. Two independent studies were conducted exploring the relationship of agriculture teacher educational preparation in mathematics and their ability to successfully complete mathematical story problems embedded in agriculture subject matter. One study included all practicing Ohio agricultural education teachers in 1994, and the other study in 1996 was comprised of pre-service agriculture teachers in Ohio. In both studies, scores on a standardized college entrance exam (American College Testing program) produced the strongest correlation to a teacher's ability to be successful at mathematical problem solving questions. The findings in these studies also suggested that the level of mathematics has more to do with the success of problem solving ability than the number of mathematics courses taken. Further, their research concluded that algebra was the highest level of mathematics needed to successfully answer mathematical problems most likely encountered in agricultural education courses. For pre-service teachers, Miller and Gliem (1996) concluded that a "lack of competence" in mathematical ability existed in the population studied.

Because of the scope of these two studies, neither addressed how well the ability of solving problems (or lack of) transferred to teacher's competence to instruct students for meaningful understanding of mathematics. However, the implications of their research added more support to the issue in question:

> Can the agricultural education profession make progress towards infusing science and mathematics into curriculum, when the people who will likely determine the success or failure of curricula integration are not capable of applying basic skills to agriculture-related problems? (Miller, & Gliem, 1996, p.19)

Agriculture Teacher Efficacy

Knobloch and Whittington (2002) stress the need for further understanding of perspectives toward agriculture teachers' confidence in personal teaching ability in order to better prepare these teachers for practice. This suggestion aligns with the teacher efficacy literature found across subject matter disciplines.

In a subsequent study, Knobloch and Whittington (2003) highlighted that over the history of agricultural education, only a few teacher efficacy studies have been conducted to investigate the level of efficacy agriculture teachers have. This confirms the sparse results that literature searches yield pertaining to agriculture teacher efficacy. Also noted by these researchers was the fact that the few studies addressing teacher efficacy in agricultural education were over a decade old (Knobloch & Whittington, 2003). Armed with this knowledge of a deficiency of teacher efficacy literature in agricultural education, an apparent need to discover teacher characteristics related to this topic becomes apparent.

Summary

The literature review presented core ideas related to the goals of this study for mathematics enhancement teaching efficacy including such topical areas as effective mathematics instruction and teacher confidence in abilities to enhance student learning. Although the literature that has been reported is not an exhaustive account of all studies compiled within identified core areas, this literature review offers a summary of seminal writings that establish evidence of the importance for this study.

The section entitled “The Mathematics Education Challenge” established a need for evaluating mathematics instruction for effectiveness in promoting student achievement. Traditional methods of instruction for mathematics seem to be underperforming in relationship to current expectations. The literature provided examples of new innovations in curriculum design showing promise for improvement in student proficiency of mathematics. Clearly, albeit some indication of progress, more work is needed in regards to instructional approaches for mathematics.

One caveat for success has been identified in studies conducted to purposely enhance mathematics performance situated in context (Parr, Edwards, & Leising, 2006; Stone, et al., 2006; Young, Edwards, & Leising, 2007). Context was identified in many empirical studies as a mode to improve student understanding and ultimately increase a student’s ability to generalize information for transfer of conceptual ideas across learning domains. However promising teaching mathematics through contextual application is; a question still remains about CTE teachers’ readiness to champion mathematics enrichment in their curriculum.

Ball, et al. (2001) established that a teacher's mathematical knowledge influences student performance. To address the issue of teacher readiness and confidence, studies in teacher efficacy provide insight on theory, and presented tools for measuring teacher confidence in their abilities to affect student performance. The *Teachers' Sense of Teacher Efficacy Scale* (Tschannen-Moran & Woolfolk Hoy, 2001), a subscale of Schultz's (2005) mathematics self-beliefs instrument, and the *Mathematics Teaching Efficacy Beliefs Instrument* (Enochs, Smith, & Huinker, 2000) emerged as stable and valid questionnaires for soliciting a teacher's perception of their level of efficacy.

The literature also provided a glimpse into the need for more research in agricultural education in the areas of mathematics enhancement and teacher efficacy. Not much is known, and minimal evidence exists about agricultural educators regarding their perceptions towards mathematics enhancement of their curricula. The research conducted for this study will contribute to the agricultural education literature base by providing a measurement tool aimed to identify an aspect of the professional development needs of teachers in a time of educational reform.

CHAPTER 3

RESEARCH METHODS

Introduction

The purpose of this study was to develop, test, and validate an instrument for measuring teacher efficacy related to enhancing mathematics instruction in agricultural education lessons. The instrument consisted of four parts, including: 1) Demographic information, 2) Personal teaching efficacy, 3) Personal mathematics efficacy, and 4) Mathematics teaching efficacy (Appendix A). Data collection was facilitated by an internet based survey instrument and analyses conducted using SPSS® and EQS® software packages. Validation of the instrument was sought using several strategies including a panel of experts, principal component analysis, and confirmatory factor analysis. A pilot study, surveying Utah agricultural educators established reliability, content validity, and face validity prior to surveying the target population of Oregon and Washington secondary agricultural education instructors.

In this chapter, research procedures employed to conduct the instrument validation are explained. Included in this examination of procedures are: (1) Design of Study, (2) Description of the Study Population, (3) Description of the Survey Instrument, (4) Efficacy Measures of the Instrument, (5) Face and Content Validity of Instrument, (6) Data Collection Procedures, (7) Pilot Test of the Instrument, (8) Data Analysis of Target Study, (9) Data Screening, and (10) Summary.

Design of Study

An electronic-based questionnaire was used to obtain demographic characteristics of the study population and perceptions of efficacy related to three constructs under examination. Gall, Gall, and Borg (2003), suggest that a survey research method such as a questionnaire is an appropriate tool for descriptive and causal-comparative studies because such tools can collect data which is not directly observable. An online questionnaire of this type was chosen because of the convenience and relatively inexpensive costs associated with facilitating data collection (Dillman, 2007).

Demographic statistics concerning the composition of the study's target population was used for analyses comparing significant characteristic differences (i.e. gender) found within the population related to efficacy measures. Demographic statistics also supported the construction of inferences necessary to generalize population characteristics from the responses provided by the teachers (Creswell, 2003).

Specifically for the purposes of validating the instrument, data collected from the efficacy scales were essential for regression analyses associated with validating the hypothetical structural model defined *a priori* in this study. The instrument was comprised of interval scales which are a perquisite for structural equation modeling protocols (Grimm & Yarnold, 1995).

Description of the Study Population

The study population included secondary agriculture teachers from Oregon and Washington. Access to the population was provided by teacher educators for agricultural education from Oregon State University and Washington State University (Appendix B). After obtaining permission to use databases from each teacher educator institution, the databases were updated and screened to verify that all individuals listed were in fact actively teaching secondary agriculture at the time of the study.

The verification process yielded a participant pool of 375 potential responders; 121 Oregon teachers and 254 Washington teachers. Having adequate contact information for the population of potential participants and the ease of data collection via electronic survey method used, the questionnaire was distributed to the entire population of agriculture teachers in the two states. Because the study targeted an entire population, threats of inadvertent misrepresentation of population demographics due to sampling error was minimized (Dillman, 2007).

Description of the Survey Instrument

The survey instrument begins with nine questions exploring teaching experience, gender, preservice preparation in agricultural education, and education in mathematics. A subset of four additional demographic questions are grouped under the heading of “Career Commitment,” were identified by Knobloch and Whittington (2003) as correlating factors of teaching efficacy in agricultural educators. The four career commitment questions used a six level agreement scale including items ranging from strongly disagree to strongly agree. For the purposes of this study, career commitment questions were treated as demographic variables included to measure potential correlations between career commitment of agriculture teachers and the efficacy constructs.

A review of the literature on teaching efficacy and self-efficacy related to mathematics produced the majority of the questions included in the instrument. Three existing valid and reliable instruments related to constructs under examination in this study were modified and combined to comprise the body of the survey instrument. Measurement of agricultural educators' personal mathematics teaching (enhancement) efficacy was conducted utilizing a portion of the *Mathematics Teaching Efficacy Beliefs Instruments* (Enochs, Smith, & Huinker, 2000). Personal mathematics efficacy was derived from Schulz's (2005) international study of student mathematics self-efficacy. The personal teaching efficacy scale consisted of the short-form version of the widely used *Teachers' Sense of Efficacy Scale* developed by Tschannen-Moran and Woolfolk Hoy (2001). These scales are examined in more detail in the following section.

Efficacy Measures of the Instrument

Mathematics Teaching Efficacy Beliefs Instrument

The *Mathematics Teaching Efficacy Beliefs Instrument* (MTEBI) developed by Enochs, et al. (2000) measures teachers' beliefs toward their abilities to teach mathematics for student understanding. This instrument was derived from the Science Teaching Efficacy Beliefs Instrument developed by Riggs and Enochs (1990), a widely used scale in science teacher efficacy literature.

The MTEBI consists of two subscales, one measuring personal mathematics teaching efficacy, and the second measuring mathematics teaching outcome expectancy. For the purposes of this study, only the personal mathematics teaching efficacy subscale was used and re-titled as Mathematics Teaching Efficacy (MTE). Because the mathematics teaching outcome expectancy scale was largely associated with beliefs about student performance, it did not fit into the scope of the identified research objectives. In addition to omitting the outcome expectancy subscale, modifications were made to the personal mathematics teaching efficacy subscale to reflect mathematics enhancement rather than mathematics teaching. Item numbers 2, 8, 11, 16, and 17 of the original MTEBI had wording alterations or additions to provide clarity for the target population in this study.

Reliability for the personal mathematics teaching efficacy subscale of the MTEBI yielded an alpha coefficient of .88. Confirmatory factor analysis was performed using EQS® software leading to conclusions of construct validity for the MTEBI. One note of importance regarding the MTEBI is the issue of negatively worded questions. These questions identified by Enochs, et al. (2000) must be recoded during the analysis process to reflect consistency of scale. The items specifically used in this study which needed to be recoded for analysis included items 2, 4, 5, 7, 9, 10, 11, and 13 (these item numbers correspond with the MTE scale provided in the instrument found in Appendix A).

Mathematics Self-Belief Instrument

A study conducted as part of the *Programme for International Student Assessment* (PISA) survey examined factors associated with student self-beliefs' in mathematics. In a report published by Schulz (2005), 4500 students from 40 countries were surveyed using a mathematics self-belief instrument comprised of three subscales: Mathematics Self-Efficacy, Mathematics Self-Concept, and Mathematics Anxiety. The mathematics self-belief instrument provided by Schulz was largely based on the Betz and Hackett's Mathematics Self-Efficacy Scale published in several efficacy studies involving mathematics (Betz & Hackett, as cited in Kranzler & Pajares, 1997).

The scope of this study was only concerned with efficacy related to mathematics. Therefore, only the Mathematics Self-Efficacy subscale of Schulz's instrument was used. This subscale consists of eight items measured by a four level confidence scale. Because this scale was used for teachers rather than the original student audience (which Schultz studied), some of the questions were modified to reflect the needs of the population. Note wording changes for items 1, 2, and 8 from the original instrument. Schulz (2005) reported that statistical analyses were conducted for validity and reliability. Confirmatory factor analysis showed a model fit index of .91 for the instrument and reliability for the mathematics self-efficacy scale was determined at .83.

Teachers' Sense of Efficacy Scale

From their extensive research on the history of teacher efficacy measurement, Tschannen-Moran and Woolfolk Hoy (2001) published an agreement scale offering nine levels of influence a teacher believes they have over student behaviors in their classrooms. The *Teachers' Sense of Efficacy Scale* (TSES), originally named the *Ohio State Teacher Efficacy Scale*, was tested in three separate studies to refine the items and validate the instrument (Tschannen-Moran & Woolfolk Hoy).

The TSES offers a long-form version consisting of 24 questions or a short-form version consisting of 12 questions. The instrument was reported yielding alpha coefficients for reliability measurements of .94 and .90 respectively for the two versions. Three subscales were defined by the authors (Efficacy in Student Engagement, Efficacy in Instructional Strategies, and Efficacy in Classroom Management) and are reflected in both the long-version and the short-version of the instrument. Using previously validated instruments found in teacher efficacy literature, Tschannen-Moran and Woolfolk Hoy (2001) correlated their newly constructed instrument with existing teacher efficacy measures and determined the TSES was "reasonably valid and reliable" (p. 801) for measuring the construct of teacher efficacy.

For the purposes of this study, it was determined that the short form version would adequately measure the construct of personal teaching efficacy. Considering the stability of the short-form and the number of questions included on the survey from other scales, this recommendation would allow for proper measurement of the construct without adding unnecessary length to the questionnaire.

Face and Content Validity of Instrument

Prior to pilot testing of the instrument, a panel of experts reviewed the questionnaire for content and face validity. The panel of experts included dissertation committee members and teacher educators representing Oregon, Utah, and Washington.

According to Gall, Gall, & Borg (2003), content validity, the representation of sample of items intended to cover the phenomena being studied, can be evaluated by a panel of experts to determine how well the test reflects the range of content being measured. In this study, terminology used in the instrument was critical because the survey was being conducted in teacher populations across states. Educational jargon can vary among different states, thus it was important to have representatives from all participating states review the questionnaire for proper terminology.

In addition to content validity, face validity is a casual subjective examination of the questionnaire to ensure it has relevant components for the topic being studied and that the instrument has good readability (Gall et al., 2003). After the review of the instrument, both content and face validity were confirmed by the panel of experts with only minor recommendations to formatting for clarity.

Data Collection Procedures

Institutional Review Board

Ethical research conducted with human participants involves institutional review of the protocol for data collection procedures to protect subjects from potential harm endured during their participation in a study (Oregon State University, 2006). An application for human subject research was approved without board review for this study. The protocol for investigation; including procedures, confidentiality protections, data storage, and reporting was outlined for the Institutional Review Board (IRB). All communications to the participants were critically examined by IRB and required changes were made to those documents prior to the approval of the application.

Evidence of signature for participants' consent was waived by the IRB because of the design of the electronic format, and the fact that each participant had a unique password required to access the survey online. It was determined that a unique password would protect the confidentiality of the respondents and provide evidence of their willingness to complete the survey free of coercion.

Questionnaire Dissemination

The questionnaire was provided to participants in electronic format facilitated by Oregon State University's Business Solution Group online survey system (Oregon State University College of Business, 2006). Each potential participant was sent a pre-notification letter via U.S. Mail 10 days prior to the online survey being sent to their email address (Appendix C). It is noted by many experts in survey research that a pre-contact letter is necessary and increases the potential response rate (Dillman, 2007; Gall, et al., 2003; Miller, Torres, & Lindner, 2005).

The email message, sent to all teachers included on the verified database, served as the cover letter informing the participants of the purpose for the survey and how the information would be utilized (Appendix D). The cover letter contained a hyperlink that opened to the informed consent document (Appendix E) outlining participants' rights as approved by the Oregon State University Institutional Review Board. Informed consent was negotiated by the participants' willingness to continue with the survey. To continue, each respondent was provided a unique password that was required to log into the questionnaire. Besides providing informed consent, the login password was recorded to prevent follow up requests being solicited from initial respondents.

For non-response to the initial questionnaire, a second attempt was made ten days after the initial survey instrument was sent. Following advice provided by Dillman (2007), the follow up contact was delivered to all potential participants listed on the database who did not submit a response to the initial survey request. Responses from the initial contact were kept separate from the late-responders' data for comparative analyses related to non-response error (Miller, Torres, & Lindner, 2005).

The final step in the data collection procedures was to issue a thank you response to the respondents. This email communication was done to thank the participants and signify that their responses were received.

Pilot Test of Instrument

Procedures for Pilot

Field testing of the instrument was conducted by administering the survey to Utah agricultural educators. After suggested revisions were made from the expert panel review, the questionnaire was administered online to the population of Utah secondary agriculture teachers. Utah teachers were selected because the proposed target study included the entire population of agricultural educators for Oregon and Washington. Permission and assistance related to conducting this pilot study in Utah was granted by Dr. Brian Warnick a teacher educator at Utah State University. Utah teachers received a pre-notification letter and electronic communication as anticipated for the target population in the study. The questionnaire reflected minor changes to headings such as the substitution of Utah for Oregon and Washington references. Otherwise, the questions and the content of the communications were identical.

Reliability of the Pilot Instrument

Because items on the survey instrument were not be dichotomously scored, internal consistency testing was conducted using Cronbach's coefficient alpha; a statistical method of rational equivalence (Gall, et al., 2003). Gall, et al. suggests tests should yield a reliability coefficient of .80 or higher for most research studies.

Instrument reliability was analyzed at the conclusion of the pilot test to ensure the robustness of the questionnaire prior to initiating the target study. The questionnaire is divided into four main sections including demographic information, mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy. Cronbach's *alpha* coefficients were constructed using SPSS® software for mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy measurement scales both separately and collectively. The results of these analyses are reported in Table 1.

Table 1.

Reliability Analyses of Pilot Study Survey Instrument (N = 23)

Section Title	*alpha* Coefficient
Mathematics Teaching Efficacy	.916
Personal Mathematics Efficacy	.888
Personal Teaching Efficacy	.908
Overall Combined Efficacy Instrument	.927

From the results of the statistical measurement for reliability in the pilot, the instrument was determined to be stable in terms of internal consistency as it exceeded the .80 benchmark.

Data Analysis of Target Study

The online survey system collected and stored the data in spreadsheet format under a protected password. Once downloaded, data were transferred into the appropriate software program required for a particular statistical analysis. The following describes the statistical methods employed to answer the research questions outlined in chapter one.

1. Research question number one: *Are personal mathematics efficacy and personal teaching efficacy valid constructs for determining correlations with teachers' confidence in their ability to enhance mathematics?*

Teacher efficacy instruments have been found to lack sufficient reliability in past attempts, however teacher efficacy instruments such as the *Teachers' Sense of Efficacy Scale* have reported reliability coefficients exceeding .90 (Tschannen-Moran & Woolfolk Hoy, 2001). Kline (2005) stresses the importance of reliability since an assumption of structural equation modeling is that independent variables are measured without error.

In addition to previously mentioned testing regarding face and content validity of the instrument in pilot testing, construct validity is of major concern to researchers of teacher efficacy (Guskey, 2001; Tschannen-Moran & Woolfolk Hoy, 2001). With constructs being a product hypothesized from the literature, the data must be used to determine the goodness of fit of model components rather than defining the constructs (Gall, et al., 2003). For this examination, exploratory factor analysis and confirmatory factor analysis were used. Because the factors are already defined by the individual instruments used to comprise the questionnaire, exploratory factor analysis will provide verification that items are not measuring multiple factors. Cross loading of items provides an initial point of consideration to remove questions that measure multiple factors (Pallant, 2005). It should be noted that exploratory factor analysis was not being used in this study as a way to define factors for confirmatory factor analysis (CFA) – the *a priori* model established CFA loadings. The exploratory factor analysis procedure was to verify that the items used from various efficacy instruments are discriminate when implemented together on the same test.

Confirmatory factor analysis (CFA) provided the true measurement model for construct validity; however factor loadings using CFA also indicated convergent and discriminate validity among the measures (Kline, 2005). Confirmatory factor analysis is designed to determine the goodness of fit for a model *a priori* (Grimm & Yarnold, 1995; Kline, 2005). Therefore, this measurement procedure can confirm whether or not the constructs hypothesized in the *a priori* model actually exist (Gall et al., 2003). For the test of confirmatory factor analysis in this study EQS® software was used.

2. Research question number two: *What are the demographic characteristics of agricultural educators in Oregon and Washington?*

Data collected from the survey were analyzed using descriptive statistics. Nine questions were included on the questionnaire soliciting demographic information and an additional four questions were asked concerning career commitment of the participants. For the purpose of this study, this information was represented in tables in the form of frequencies and percentages.

3. Research question number three: *Which factor, personal mathematics efficacy or personal teaching efficacy, provides the strongest correlation with a teacher's confidence in their ability to enhance mathematics in agricultural education?*

The data collected from the survey instrument were used to construct path coefficients for structural equation modeling. Literature recommends *Pearson r* correlation coefficients for path analysis and structural modeling because it will produce a small standard error (Gall, et al., 2003; Kline, 2005). Path coefficients were constructed utilizing multiple regression methods. The primary software used to conduct regression analyses was EQS®, as SPSS® does not support the complexity of structural model analyses (Pallant, 2005).

Four general assumptions of the data were confirmed prior to conducting the analyses. These assumptions include: 1) Normality and multicollinearity, 2) Linear, additive, and causal relationships among variables, 3) One-way flow of the model, and 4) Variables measured without error on an interval scale (Courtney, 2006). Once path coefficients were constructed, and goodness of fit for the model verified, conclusions were made based on statistical evidence indicating strength of relationships between variables measured.

It is important to recognize that the output results from the structural equation modeling analyses were reported using robust estimates. The robust estimates provide a more conservative estimate of measurements needed when data distributions are determined to be skewed or show kurtosis related concerns (Kline, 2005). Table 2 reports the summative means for each test of the target population study.

Table 2.

Means for Scales for Mathematics Enhancement Teaching Efficacy Instrument

Measurement	Mean	Scale
Mathematics Teaching Efficacy (MTE)	3.71	1-5 Agreement Scale
Personal Mathematics Efficacy (PME)	3.72	1-4 Confidence Scale
Personal Teaching Efficacy (PTE)	7.30	1-9 Influence Scale

Table 2 suggests the results are negatively skewed toward the upper end of the distribution for each scale. Kurtosis is also a concern because the results tend to peak at extremes values in the distribution. For example, the accumulative mean score for Personal Teaching Efficacy is 7.30 on a scale of 1-9 with 9 being labeled as “A Great Deal of Influence.” This finding suggests that the population studied clustered toward the upper end of the scale for this test. By using the robust EQS® output results for interpretation of data analyses, skewness and kurtosis in distributions such as those determined in the data concluded can be reasonably accounted for. Additionally, having a sample size exceeding 200 cases provided a reasonably large sample that reduces the risk of problems associated with skewness and kurtosis in data sets (Tabachnick & Fidell as cited by Pallant, 2005).

Data Screening

Kline (2005) reports that missing data poses a serious problem to the integrity of structural equation modeling outcomes, and claims that there is "no magical statistical fix" for lost data (p 53). The author outlines four options for dealing with missing data ranging from available case methods to imputation. However, Kline suggests with only a few missing data points in a large sample, it is justifiable to delete the incomplete cases from the data set.

This study yielded 230 responses, of which 213 participants had responded to all efficacy related items provided. Grimm and Yarnold (1995) set the minimum threshold of responses for measurement using path analysis at 200-300. However, Kline (2005) suggests a sample size that exceeds 200 is a large sample most adequate for robust results using structural equation modeling. Therefore, it was determined the best course of action for the 17 cases missing data was to remove them from data set prior to statistical analyses.

Summary

The primary method used to determine the goodness of fit for the *a priori* model was structural equation modeling. Kline (2005) outlines the steps needed to complete structural equation modeling analyses: 1) Specify the model, 2) Determine whether the model is identified, 3) Select measures, 4) Use computer software to estimate the model, 5) Re-specify the model if necessary, and 6) Accurately and completely describe the analysis (pg. 64-65). Chapter three has addressed the first four recommendations prescribed by Kline.

Theory related to teacher efficacy and mathematics efficacy provided the concepts required to specify and identify the hypothetical model mentioned in steps one and two. From the literature, measures were assimilated representing three constructs; mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy. The instrument items were tailored to fit the objectives of this study and pilot tested for reliability and validity measures. After reliability content and face validity were completed, the online questionnaire was distributed via email to 375 agriculture teachers from Oregon and Washington. A total of 213 responses were found to be free of missing data and useable for structural equation modeling (SEM) analysis.

Once data were collected and the initial tests for reliability were concluded, EQS® software facilitated the statistical estimation for data assumptions and model fit. The product from the SEM process addressed two of the research questions guiding this study. Confirmatory factor analysis, part of the SEM process, provided the basis for construct validation of the instrument. Combined with initial measurements of reliability, the first research question concerned with the validation of a teacher efficacy instrument measuring confidence of mathematics enhancement could be verified. The second procedure of SEM produced a structural model measuring the strength of the correlations between the factors which provided clarity for the third research question of this study.

In addition to data related to efficacy beliefs, population demographic characteristics for the respondents were solicited for future correlations with the efficacy scales. The data from these questions were analyzed using descriptive statistics derived from SPSS® software. Conclusions determined from the methods provided the foundation for discussions included in subsequent chapters reporting on study results and implications.

CHAPTER 4

RESULTS AND FINDINGS

Introduction

In chapter four, evidence supporting the findings for the research questions will be presented as a result of the methods used to collect data outlined in chapter three. The research questions guiding this study were:

1. Are personal mathematics efficacy and personal teaching efficacy valid constructs for determining correlations with teachers' confidence in their ability to enhance mathematics?
2. What are the demographic characteristics for agricultural educators in Oregon and Washington?
3. Which factor, personal mathematics efficacy or personal teaching efficacy, establishes the strongest correlation with a teacher's confidence in their ability to enhance mathematics in agricultural education?

The purpose of this study was to validate an instrument to be used as a tool for assessment of the level of mathematics enhancement teaching efficacy among career and technical education teachers, specifically agricultural educators, and to determine the level of teacher efficacy Oregon and Washington agricultural educators have toward enhancing mathematics in their lessons. The sections included in this chapter report the reliability, principal component exploratory factor analysis findings, and confirmatory factor analysis measurement model. These tests were needed to address research question number one regarding the validation of the survey instrument.

Research question number two concerning the demographic characteristics of the study population are summarized through the use of various descriptive statistics providing a comprehensive result of the demographics from which this instrument validation was based. Evidence to support findings for the third and final research question was contributed by the structural equation model representing the correlations between efficacy scales for the study population of Oregon and Washington agricultural educators.

Response Rate and Non-Response Error

The target population included all Oregon and Washington teachers of secondary agricultural education. Verification of the database by teacher educators from the respective states produced a contact list of 375 teachers. The initial collection period for responses was a period of ten days. From this first attempt to solicit questionnaire data, 180 participants responded (48.0%). A second attempt to collect data was conducted for another 10-day period a week later. The second collection period yielded 50 additional responses. Therefore, the total number of responses received was 230 representing 61.33% of the total population surveyed.

In the absence of a perfect response rate, controlling for non-response error was necessary to generalize the results to the population included in the study. The method chosen was to compare early and late respondents of the survey using SPSS® to conduct MANOVA tests to determine if a significant difference existed between early respondents and late-responders of the study (Miller, Torres, & Linder, 2005). Theory behind this method to control for non-response error asserts that late-responders and non-responders are similar; therefore if no significant differences are found between early and late responders the results can be generalized to the entire population (Miller, et al.).

MANOVA tests were conducted for MTE, PME, and PTE. Each MANOVA test was checked for assumption violations related to homogeneity of variance using SPSS® output statistics found in the Box's Test of Equality of Covariance Matrices. All three tests were found acceptable for homogeneity of variance. Inspection of the Levene's test for the assumption of equality of variance revealed all three tests violated this assumption. To remedy this problem, Pallant (2005) recommended using the more robust Pillai's Trace statistic to determine significance between groups. After analyzing the Pillai's Trace statistic it was determined that a significant difference (<.05) between early and late responders was found only in the MTE component of the instrument with a significance level of .027. Both PME and PTE reported a significance level of .30 and .76 respectively exceeding the significance threshold and therefore rejecting the null hypothesis.

The significance difference indicated for MTE was further analyzed. The first assessment was to determine if Type 1 error was reflected in the results for MTE. To examine this, Bonferroni adjustment was applied to the Tests Between-Subjects Effects. This procedure involves dividing the .05 significance level by the number of dependent variables (divided by 13 for MTE). This calculation provided a new alpha level of .003 to be used as a more robust significance level for interpreting between-subjects effect. By using the Bonferroni adjusted significance level, Type 1 error is controlled and no significant difference between early and late responders was concluded for MTE. Table 3 provides the summary of the data for this test.

Table 3.

Tests Between-Subjects Effect for MTE (N = 213)

Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
MTE 1	.125	1	.125	.258	.612	.001
MTE 2	.622	1	.622	.449	.504	.002
MTE 3	1.135	1	1.135	1.705	.193	.008
MTE 4	.001	1	.001	.001	.977	.000
MTE 5	.065	1	.065	.107	.744	.000
MTE 6	.000	1	.000	.001	.980	.000
MTE 7	3.472	1	3.472	3.633	.058	.016
MTE 8	.226	1	.226	.433	.511	.002
MTE 9	7.335	1	7.335	6.286	.013	.028
MTE 10	.601	1	.601	.398	.529	.002
MTE 11	1.205	1	1.205	1.826	.178	.008
MTE 12	.966	1	.966	1.320	.252	.006
MTE 13	3.035	1	3.035	3.198	.075	.014

Validation of the Instrument

Target Study Reliability of Instrument

At the conclusion of the data screening period, 213 cases were used in the analysis of data for the target study. Included in the analysis of the target study data was the determination of reliability for the instrument. An alpha coefficient of .905 was determined by SPSS® for the target study. Table 4 provides a breakdown of the reliability analysis for the target study by scale.

Table 4.

Reliability Analyses of Target Study Survey Instrument (N = 213)

Section Title	*alpha* Coefficient
Mathematics Teaching Efficacy	.884
Personal Mathematics Efficacy	.836
Personal Teaching Efficacy	.908
Overall Combined Efficacy Scale	.905

Additional data summaries are provided from the initial data analyses. Table 5 summarizes the individual item means and standard deviations determined from the analyses of the data.

Table 5.

Item Statistics (N = 213)

Item	Mean	Standard Deviation
MTE 1	3.9671	.69625
MTE 2	3.4225	1.18156
MTE 3	3.5164	.81029
MTE 4	3.7840	.83572
MTE 5	3.9296	.77686
MTE 6	4.3099	.75094
MTE 7	3.7324	.98514
MTE 8	3.8920	.70883
MTE 9	3.3333	1.08448
MTE 10	3.3897	1.22601
MTE 11	3.9014	.81533
MTE 12	4.0563	.85043
MTE 13	3.0563	.97450
PME 1	3.6291	.54815
PME 2	3.8779	.34221
PME 3	3.8404	.40383
PME 4	3.8310	.38800
PME 5	3.8310	.47541

Table 5 (Continued).

Item Statistics (N = 213)

Item	Mean	Standard Deviation
PME 6	3.6432	.59432
PME 7	3.3146	.77680
PME 8	3.8216	.41901
PTE 1	8.0469	1.08055
PTE 2	6.5869	1.30609
PTE 3	7.0610	1.14143
PTE 4	6.9014	1.20324
PTE 5	7.3615	1.11838
PTE 6	7.6901	1.11919
PTE 7	7.5211	1.10136
PTE 8	7.5305	1.18372
PTE 9	7.4648	1.14716
PTE 10	7.6808	1.01473
PTE 11	6.4507	1.38852
PTE 12	7.2864	1.14828

In addition to the individual item means and standard deviation, it is relevant to report Inter-Item Correlations among questionnaire items. Table 6 summarizes Inter-Item Correlations.

Table 6.

Inter-Item Correlation Matrix (N = 213)

	MTE 1	MTE 2	MTE 3	MTE 4	MTE 5	MTE 6	MTE 7
MTE 1	1.000	.143	.214	.296	.301	.155	.187
MTE 2		1.000	.431	.499	.444	.336	.373
MTE 3			1.000	.521	.545	.364	.434
MTE 4				1.000	.587	.408	.422
MTE 5					1.000	.426	.456
MTE 6						1.000	.259
MTE 7							1.000
MTE 8							
MTE 9							
MTE 10							
MTE 11							
MTE 12							
MTE 13							
PME 1							
PME 2							
PME 3							
PME 4							
PME 5							
PME 6							
PME 7							
PME 8							
PTE 1							
PTE 2							
PTE 3							
PTE 4							
PTE 5							
PTE 6							
PTE 7							
PTE 8							
PTE 9							
PTE 10							
PTE 11							
PTE 12							

Table 6 (Continued).

Inter-Item Correlation Matrix (N = 213)

	MTE 8	MTE 9	MTE 10	MTE 11	MTE 12	MTE 13	PME 1
MTE 1	.213	.252	.247	.177	.210	.183	.104
MTE 2	.348	.423	.407	.445	.347	.336	.280
MTE 3	.434	.501	.475	.499	.396	.453	.285
MTE 4	.375	.408	.423	.446	.369	.322	.308
MTE 5	.329	.543	.390	.533	.384	.354	.237
MTE 6	.364	.284	.278	.358	.320	.182	.166
MTE 7	.337	.406	.407	.484	.300	.350	.208
MTE 8	1.000	.458	.304	.381	.464	.248	.200
MTE 9		1.000	.430	.469	.537	.464	.241
MTE 10			1.000	.544	.418	.341	.272
MTE 11				1.000	.450	.345	.308
MTE 12					1.000	.343	.328
MTE 13						1.000	.181
PME 1							1.000
PME 2							
PME 3							
PME 4							
PME 5							
PME 6							
PME 7							
PME 8							
PTE 1							
PTE 2							
PTE 3							
PTE 4							
PTE 5							
PTE 6							
PTE 7							
PTE 8							
PTE 9							
PTE 10							
PTE 11							
PTE 12							

Table 6 (Continued).

Inter-Item Correlation Matrix (N = 213)

	PME 2	PME 3	PME 4	PME 5	PME 6	PME 7	PME 8
MTE 1	.003	.183	.119	-.003	.131	.133	.174
MTE 2	.163	.320	.198	.220	.276	.245	.210
MTE 3	.245	.383	.279	.240	.335	.333	.259
MTE 4	.303	.317	.309	.240	.385	.316	.267
MTE 5	.358	.325	.258	.210	.272	.279	.237
MTE 6	.221	.288	.229	.187	.217	.220	.132
MTE 7	.224	.331	.276	.245	.303	.295	.204
MTE 8	.159	.269	.191	.142	.266	.250	.205
MTE 9	.314	.370	.325	.201	.281	.351	.256
MTE 10	.283	.345	.258	.122	.392	.341	.329
MTE 11	.261	.296	.171	.285	.404	.377	.211
MTE 12	.170	.287	.286	.164	.376	.273	.267
MTE 13	.134	.239	.138	.122	.238	.163	.152
PME 1	.436	.477	.414	.319	.417	.331	.429
PME 2	1.000	.609	.519	.336	.388	.358	.407
PME 3		1.000	.550	.399	.449	.326	.528
PME 4			1.000	.407	.433	.412	.510
PME 5				1.000	.420	.553	.322
PME 6					1.000	.387	.463
PME 7						1.000	.333
PME 8							1.000
PTE 1							
PTE 2							
PTE 3							
PTE 4							
PTE 5							
PTE 6							
PTE 7							
PTE 8							
PTE 9							
PTE 10							
PTE 11							
PTE 12							

Table 6 (Continued).

Inter-Item Correlation Matrix (N = 213)

	PTE 1	PTE 2	PTE 3	PTE 4	PTE 5	PTE 6	PTE 7
MTE 1	-.010	.099	.216	.210	.106	.053	.078
MTE 2	-.016	.135	.149	.222	.148	.128	.062
MTE 3	.166	.216	.262	.227	.209	.167	.215
MTE 4	.037	.121	.103	.176	.200	.115	.097
MTE 5	.071	.129	.186	.179	.209	.105	.153
MTE 6	.034	-.052	-.006	-.018	.079	.087	.140
MTE 7	.047	.163	.086	.121	.165	.126	.177
MTE 8	.044	.069	.096	.026	.145	.118	.048
MTE 9	.119	.061	.144	.159	.297	.202	.146
MTE 10	.064	.139	.138	.103	.100	.147	.125
MTE 11	.123	.148	.159	.149	.148	.147	.173
MTE 12	.033	.097	.055	.052	.117	.142	.160
MTE 13	.114	.237	.167	.278	.202	.185	.183
PME 1	.117	.002	.097	.087	.112	.173	.126
PME 2	.067	-.008	.043	-.029	.091	.122	.057
PME 3	-.004	.026	.011	.035	.055	.109	.039
PME 4	.210	.029	.066	.015	.228	.248	.229
PME 5	-.021	-.037	-.085	-.095	.080	.087	-.020
PME 6	.100	.058	.053	.036	.145	.159	.098
PME 7	.067	-.085	.037	.003	.113	.069	.056
PME 8	.144	.028	.112	.030	.118	.153	.080
PTE 1	1.000	.371	.453	.392	.443	.652	.641
PTE 2		1.000	.685	.634	.329	.409	.426
PTE 3			1.000	.647	.385	.484	.444
PTE 4				1.000	.465	.405	.406
PTE 5					1.000	.455	.436
PTE 6						1.000	.683
PTE 7							1.000
PTE 8							
PTE 9							
PTE 10							
PTE 11							
PTE 12							

Table 6 (Continued).

Inter-Item Correlation Matrix (N = 213)

	PTE 8	PTE 9	PTE 10	PTE 11	PTE 12
MTE 1	.096	.131	.112	.167	.153
MTE 2	.122	.105	.109	.154	.074
MTE 3	.175	.187	.316	.178	.205
MTE 4	.097	.179	.152	.198	.124
MTE 5	.154	.164	.277	.183	.160
MTE 6	.069	.035	.112	.046	.039
MTE 7	.151	.219	.216	.130	.181
MTE 8	.052	.137	.162	.165	.148
MTE 9	.214	.281	.333	.116	.184
MTE 10	.071	.075	.093	.132	.068
MTE 11	.142	.211	.201	.114	.171
MTE 12	.120	.133	.196	.102	.051
MTE 13	.183	.192	.180	.190	.179
PME 1	.108	.230	.176	.115	.095
PME 2	.033	.145	.159	-.023	.065
PME 3	.040	.110	.128	-.048	.058
PME 4	.217	.188	.222	.063	.194
PME 5	-.033	.067	.083	-.013	.003
PME 6	.056	.134	.107	.053	.137
PME 7	.007	.057	.116	.073	.073
PME 8	.068	.095	.065	.017	.136
PTE 1	.681	.370	.349	.206	.415
PTE 2	.399	.286	.288	.345	.340
PTE 3	.430	.378	.383	.316	.472
PTE 4	.421	.406	.345	.380	.369
PTE 5	.517	.563	.460	.323	.474
PTE 6	.737	.451	.374	.339	.525
PTE 7	.731	.390	.411	.330	.516
PTE 8	1.000	.544	.472	.316	.533
PTE 9		1.000	.643	.348	.593
PTE 10			1.000	.330	.597
PTE 11				1.000	.433
PTE 12					1.000

Target Study Validity of Instrument

Exploratory Factor Analysis

Exploratory factor analysis assumes no predetermined factors prior to data analyses (Kline, 2005). It was believed that using exploratory factor analysis for a complied instrument of this nature would provide insight into potential measurement concerns, such as discriminate validity. The result of the exploratory factor analysis that was conducted is provided in Table 7. The extraction method was principle component analysis using an Oblimin with the Kaiser Normalization rotation method.

Table 7.

Pattern Matrix for Exploratory Factor Analysis of Mathematics Enhancement Teaching Efficacy Instrument (N = 213)

	Component					
	1	2	3	4	5	6
MTE 11	.757					
MTE 3	.700					
MTE 2	.685					
MTE 5	.684					
MTE 4	.642					
MTE 7	.635					
MTE 10	.609					
MTE 9	.607					
MTE 6	.606			-.317		
MTE 12	.578					
MTE 8	.573					
MTE 13	.536					
PTE 1		.818				
PTE 7		.785				
PTE 6		.766				
PTE 8		.746				
PME 8			.837			
PME 3			.809			
PME 4			.779			
PME 2			.767			
PME 1			.685			
PME 6			.564			
PTE 2				.731		
PTE 4				.663		
PTE 3				.641		
PTE 9					.806	
PTE 10					.798	
PTE 12					.676	
PTE 5					.570	
PTE 11					.509	
PME 5			.404			-.613
MTE 1						.575
PME 7	.333		.320			-.411

The pattern matrix provided in Table 7 shows grouping of items measuring individual factors. The first factor abbreviated as MTE consisted of questions contributed from the modified *Mathematics Teaching Efficacy Beliefs Instrument*. Twelve of the thirteen items of the MTE section were determined to measure the same factor. Likewise, six of the original eight items measuring Personal Mathematics Efficacy (PME) were consistent in measuring the same factor (factor 3 in Table 7). Personal Teaching Efficacy represented by the abbreviation PTE, consisted of items from the Tschannen-Moran and Woolfolk Hoy (2001) instrument. Consistent with the authors claim, the personal teaching efficacy instrument measures three separate constructs within the PTE instrument. Therefore, factor 2 identified in Table 7 that groups items PTE 1, 7, 6, and 8, aligns with the construct of Classroom Management identified by Tschannen-Moran and Woolfolk Hoy. Items PTE 2, 4, and 3 (factor 4 in Table 7) would be consistent with the construct Student Engagement, and items PTE 9, 10, 12, and 5 (factor 5 in Table 7) align with the construct of Instructional Strategies.

Four inconsistencies were identified from this analysis. The first is PTE 11, which is an item measuring the construct of Student Engagement according to Tschannen-Moran and Woolfolk Hoy (2001). From this analysis it has loaded with the Instructional Strategies grouping. A sixth factor was identified comprised of three items PME 5, MTE 1, and PME 7. Of the three items, the two PME questions were found to cross load in multiple factors. Such cross loading would suggest that these items may not be measuring their intended construct (Pallant, 2005).

Confirmatory Factor Analysis

Structural equation modeling requires two steps in order to complete the analysis (Kline, 2005; Needham, 2007). The first of the two steps is confirmatory factor analysis (CFA), or also referred to as the measurement model. Confirmatory factor analysis is the preferred method of determining model correctness for assessing the structural model fit. The reason for this is because a hypothetical model must be derived from theory *a prioi* and then the model can be tested to determine if it is sound. Confirmatory factor analysis therefore relies on factors that are pre-identified and analyses constrained to the set parameters determined in the measurement model. If the items measure the intended factor derived by theory, then a goodness of fit index will be strong enough to support the claims made (Kline, 2005). Table 8 reports the covariance matrix related to the CFA results reported in this section.

Table 8.

Covariance Matrix (N = 213)

	MTE 1	MTE 2	MTE 3	MTE 4	MTE 5	MTE 6	MTE 7
MTE 1	.485	.118	.121	.172	.163	.081	.128
MTE 2		1.396	.413	.493	.407	.298	.434
MTE 3			.657	.353	.343	.221	.346
MTE 4				.698	.381	.256	.348
MTE 5					.604	.248	.349
MTE 6						.564	.192
MTE 7							.971
MTE 8							
MTE 9							
MTE 10							
MTE 11							
MTE 12							
MTE 13							
PME 1							
PME 2							
PME 3							
PME 4							
PME 5							
PME 6							
PME 7							
PME 8							
PTE 1							
PTE 2							
PTE 3							
PTE 4							
PTE 5							
PTE 6							
PTE 7							
PTE 8							
PTE 9							
PTE 10							
PTE 11							
PTE 12							

Table 8 (Continued).

Covariance Matrix (N = 213)

	MTE 8	MTE 9	MTE 10	MTE 11	MTE 12	MTE 13	PME 1
MTE 1	.105	.190	.211	.101	.125	.125	.040
MTE 2	.291	.542	.589	.429	.349	.386	.181
MTE 3	.249	.440	.472	.329	.273	.358	.126
MTE 4	.222	.369	.434	.304	.262	.262	.141
MTE 5	.181	.458	.372	.337	.254	.268	.101
MTE 6	.194	.231	.256	.219	.204	.133	.068
MTE 7	.235	.434	.492	.389	.251	.336	.113
MTE 8	.502	.352	.264	.220	.280	.171	.078
MTE 9		1.176	.572	.415	.495	.491	.143
MTE 10			1.503	.543	.435	.407	.183
MTE 11				.665	.312	.274	.138
MTE 12					.723	.285	.153
MTE 13						.950	.096
PME 1							.300
PME 2							
PME 3							
PME 4							
PME 5							
PME 6							
PME 7							
PME 8							
PTE 1							
PTE 2							
PTE 3							
PTE 4							
PTE 5							
PTE 6							
PTE 7							
PTE 8							
PTE 9							
PTE 10							
PTE 11							
PTE 12							

Table 8 (Continued).

Covariance Matrix (N = 213)

	PME 2	PME 3	PME 4	PME 5	PME 6	PME 7	PME 8
MTE 1	.001	.051	.032	-.001	.054	.072	.051
MTE 2	.066	.153	.091	.124	.194	.225	.104
MTE 3	.068	.125	.088	.092	.162	.209	.088
MTE 4	.087	.107	.100	.095	.191	.205	.093
MTE 5	.095	.102	.078	.078	.126	.168	.077
MTE 6	.057	.087	.067	.067	.097	.128	.041
MTE 7	.076	.132	.106	.115	.178	.226	.084
MTE 8	.039	.077	.052	.048	.112	.138	.061
MTE 9	.116	.162	.137	.104	.181	.296	.116
MTE 10	.119	.171	.123	.071	.286	.325	.169
MTE 11	.073	.097	.054	.111	.196	.239	.072
MTE 12	.049	.099	.094	.066	.190	.180	.095
MTE 13	.045	.094	.052	.057	.138	.124	.062
PME 1	.082	.106	.088	.083	.136	.141	.099
PME 2	.117	.084	.069	.055	.079	.095	.058
PME 3		.163	.086	.077	.108	.102	.089
PME 4			.151	.075	.100	.124	.083
PME 5				.226	.119	.204	.064
PME 6					.353	.179	.115
PME 7						.603	.108
PME 8							.176
PTE 1							
PTE 2							
PTE 3							
PTE 4							
PTE 5							
PTE 6							
PTE 7							
PTE 8							
PTE 9							
PTE 10							
PTE 11							
PTE 12							

Table 8 (Continued).

Covariance Matrix (N = 213)

	PTE 1	PTE 2	PTE 3	PTE 4	PTE 5	PTE 6	PTE 7
MTE 1	-.008	.090	.172	.176	.083	.042	.060
MTE 2	-.020	.208	.201	.315	.196	.169	.081
MTE 3	.145	.229	.242	.221	.190	.151	.192
MTE 4	.034	.132	.098	.177	.187	.107	.089
MTE 5	.060	.131	.165	.168	.181	.091	.131
MTE 6	.028	-.051	-.005	-.016	.067	.073	.116
MTE 7	.050	.210	.097	.143	.182	.138	.192
MTE 8	.033	.064	.077	.022	.115	.094	.038
MTE 9	.140	.086	.178	.208	.360	.245	.175
MTE 10	.085	.223	.193	.152	.137	.202	.169
MTE 11	.108	.157	.148	.146	.135	.134	.155
MTE 12	.030	.108	.053	.053	.112	.135	.150
MTE 13	.120	.302	.185	.326	.220	.202	.197
PME 1	.069	.002	.060	.058	.069	.106	.076
PME 2	.025	-.003	.017	-.012	.035	.047	.021
PME 3	-.002	.014	.005	.017	.025	.049	.018
PME 4	.088	.015	.029	.007	.099	.108	.098
PME 5	-.011	-.023	-.046	-.054	.043	.046	-.011
PME 6	.064	.045	.036	.026	.097	.106	.064
PME 7	.056	-.086	.033	.003	.098	.060	.048
PME 8	.065	.016	.053	.015	.055	.072	.037
PTE 1	1.168	.524	.558	.509	.535	.788	.763
PTE 2		1.706	1.021	.997	.480	.598	.613
PTE 3			1.303	.888	.492	.618	.558
PTE 4				1.448	.625	.545	.537
PTE 5					1.251	.570	.537
PTE 6						1.253	.841
PTE 7							1.213
PTE 8							
PTE 9							
PTE 10							
PTE 11							
PTE 12							

Table 8 (Continued).

Covariance Matrix (N = 213)

	PTE 8	PTE 9	PTE 10	PTE 11	PTE 12
MTE 1	.079	.105	.079	.161	.123
MTE 2	.171	.142	.131	.252	.100
MTE 3	.168	.174	.260	.200	.191
MTE 4	.096	.172	.129	.230	.119
MTE 5	.141	.146	.218	.197	.143
MTE 6	.061	.030	.085	.048	.033
MTE 7	.176	.248	.216	.178	.204
MTE 8	.043	.112	.116	.162	.121
MTE 9	.275	.349	.366	.175	.230
MTE 10	.104	.106	.116	.224	.095
MTE 11	.137	.197	.166	.130	.160
MTE 12	.121	.129	.169	.121	.050
MTE 13	.211	.214	.178	.258	.201
PME 1	.070	.145	.098	.088	.060
PME 2	.013	.057	.055	-.011	.026
PME 3	.019	.051	.053	-.027	.027
PME 4	.100	.084	.087	.034	.086
PME 5	-.018	.036	.040	-.008	.001
PME 6	.039	.091	.065	.044	.093
PME 7	.007	.051	.091	.079	.065
PME 8	.034	.046	.028	.010	.065
PTE 1	.871	.459	.383	.309	.515
PTE 2	.616	.429	.382	.626	.510
PTE 3	.581	.495	.444	.501	.619
PTE 4	.600	.560	.421	.634	.510
PTE 5	.685	.723	.522	.501	.608
PTE 6	.976	.579	.424	.527	.674
PTE 7	.953	.492	.460	.505	.652
PTE 8	1.401	.738	.566	.519	.725
PTE 9		1.316	.748	.554	.781
PTE 10			1.030	.465	.696
PTE 11				1.928	.691
PTE 12					1.319

As a guide for the interpretation of the confirmatory factor analysis, Kline (2005) suggests chi-square, Comparative Fit Index (CFI), and Root Mean-Square

Error of Approximation (RMSEA), are the three major considerations to determine a model's goodness of fit using the robust method. Table 9 presents the results from the instruments using EQS® software.

Table 9.

Confirmatory Factor Analysis Results (N = 213)

Fit index	Statistic
Chi-square	627.9316
CFI	.945
RMSEA	.037

Chi-square fit index, also referred to as the likelihood ratio, tests for the over-identification of a model. A p-value is calculated based on the degrees of freedom for the test. The p-value significance level is typically set at .05 or .01 according to Bentler (1980). The analysis for this study concluded the p-value was .00002 based on the scaled chi-square statistic and 489 degrees of freedom. Therefore, the null hypothesis is rejected and the model is found to be a good fit based on this specific fit index.

Bentler (1990) sets the minimum level of Comparative Fit Index at .90. Comparative Fit Index assesses the relative improvement in fit of a hypothetical model and a baseline model. For this study the CFI was determined at .945 meeting the minimum threshold of acceptance. The RMSEA measures the error of approximation, or how well the model fits in relationship to the population covariance matrix (Kline, 2005). The higher the determined RMSEA value indicates evidence of a poor fitting model. Browne and Cudeck as cited by Kline suggest that the thumb rule for interpreting RMSEA is a RMSEA value of $\leq .05$ is an indication of a good fit. Therefore, it can be concluded that all three tests for model fit fall into appropriate ranges of acceptability for CFA.

Another important aspect involved with CFA analyses is to determine the robustness of individual items used to measure factors. Coefficient values for measurement paths between the item and the factor were evaluated to the standard of ± .4 as described by Bentler (1980) as the minimum acceptable threshold for acceptance. The following figures represent the measurement model for each section of the Mathematics Enhancement Teaching Efficacy instrument. Included in each model are the coefficients for each factor-item and item-error relationship. Due to the size of the model and the number of items included, the model has been broken into individual sections of the instrument. The figures shown include; Mathematics Teaching Efficacy Measurement Model (Figure 3), Personal Mathematics Efficacy Measurement Model (Figure 4), Personal Teaching Efficacy Measurement Model (Figure 5), and the Covariance Measurement Model of Primary Factors (Figure 6).

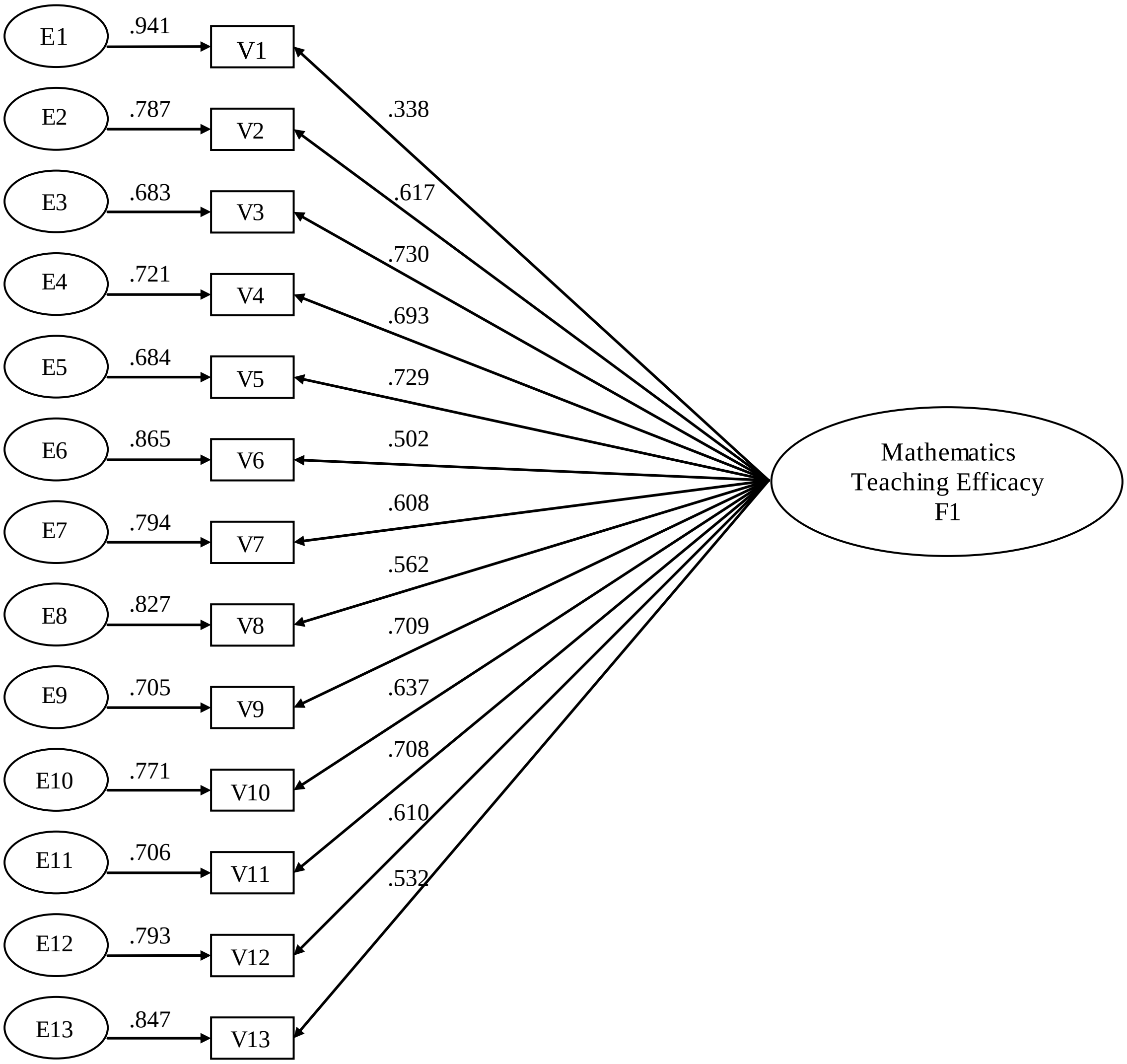

Figure 3. Mathematics Teaching Efficacy Measurement Model. The Letter "E" indicates error estimation, the letter "V" represents the variable that corresponds to the questionnaire item measuring the identified construct labeled as "F1" (factor 1).

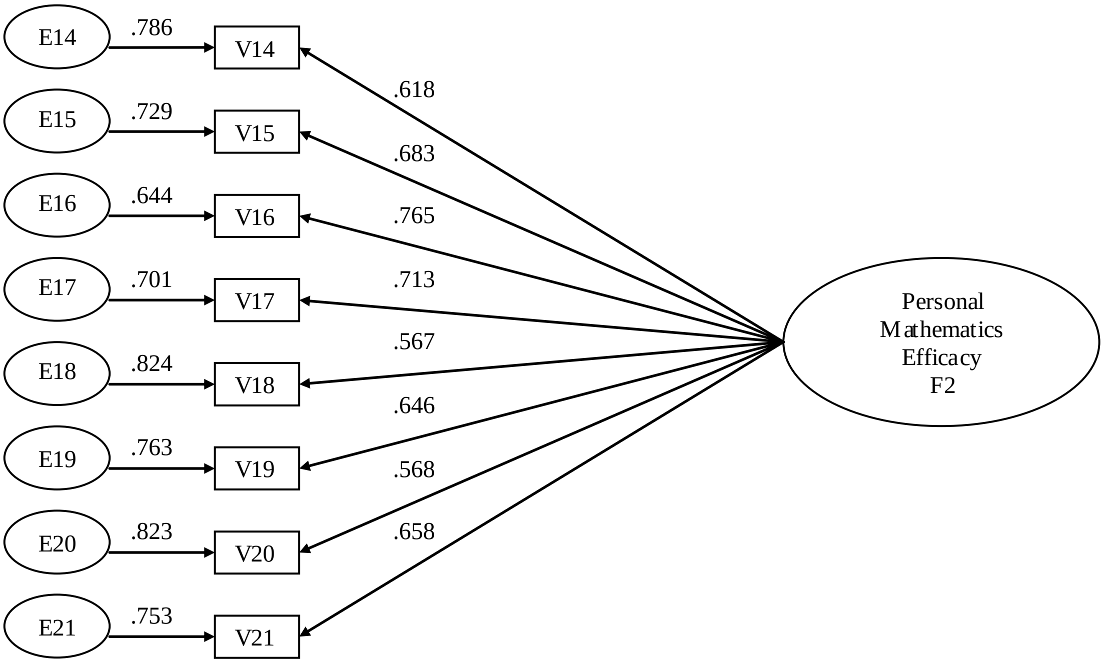

Figure 4. Personal Mathematics Efficacy Measurement Model. Variables 14-21 represent questionnaire items measuring construct “F2” identified as Personal Mathematics Efficacy.

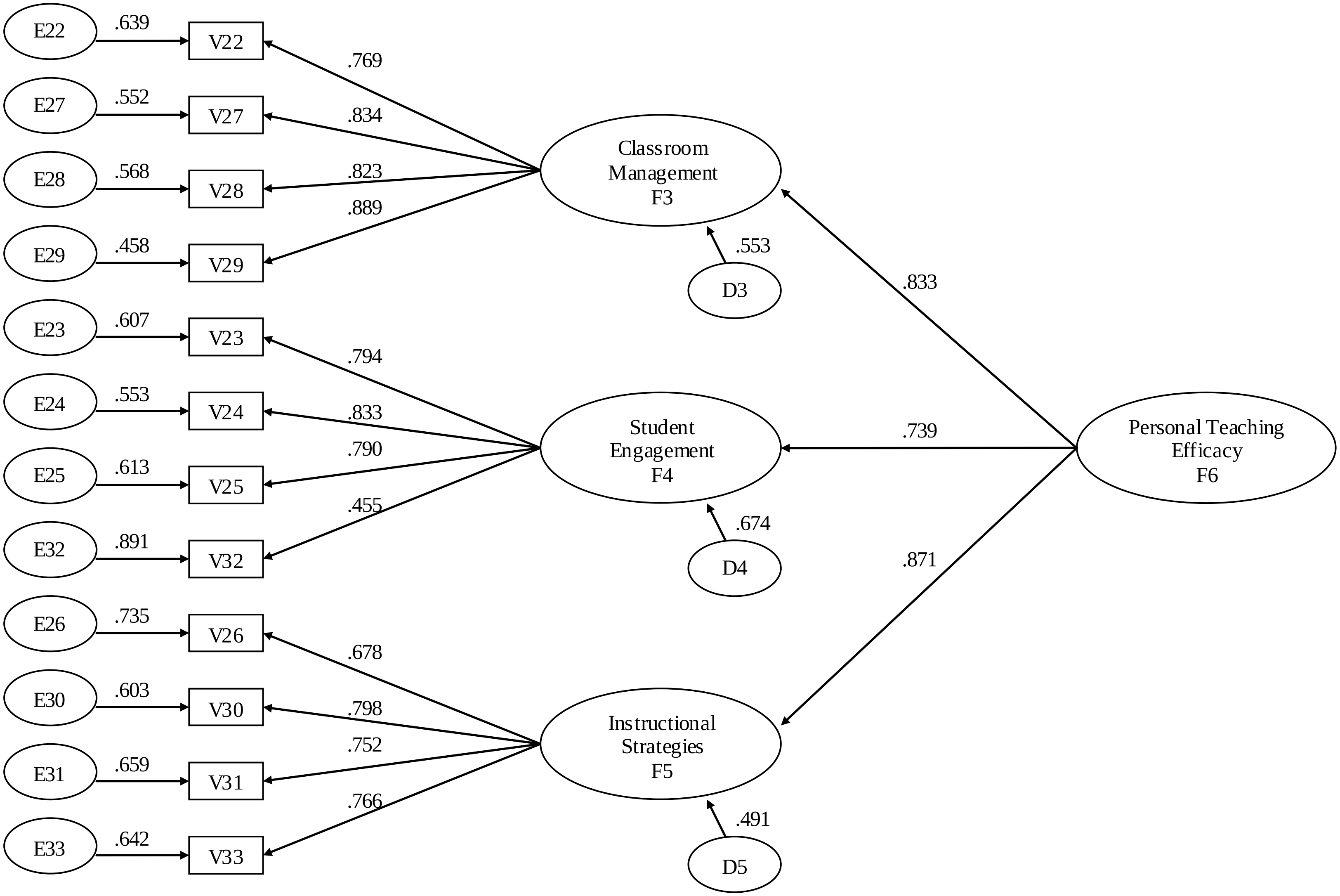

Figure 5. Personal Teaching Efficacy Measurement Model. For this study, a second order confirmatory factor analysis was included involving three identified constructs of Personal Teaching Efficacy.

In the measurement model, Personal Mathematics Efficacy and Personal Teaching Efficacy sections were found to be adequate. For the Mathematics Teaching Efficacy section it was determined that only MTE 1 failed to yield a coefficient value at or above the minimum required threshold of .4. This is the same item found to be problematic from previous exploratory factor analysis.

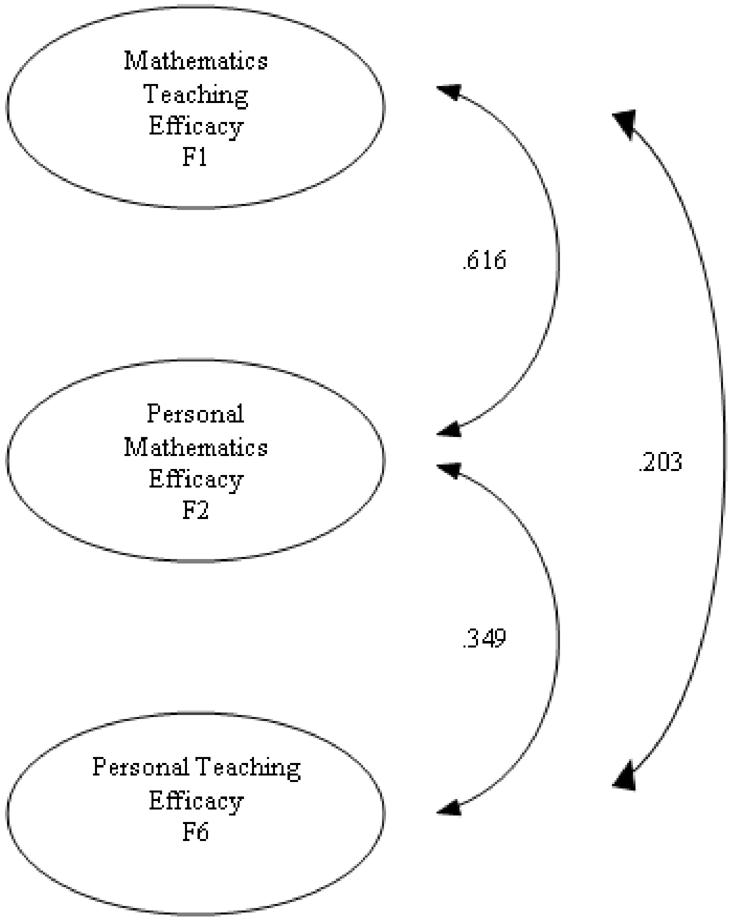

Figure 6. Covariance Measurement Model of Primary Factors. This measurement model illustrates the covariance coefficients determined among the factors.

The final examination of the confirmatory factor analysis process includes the analysis of covariance between the identified factors (Figure 6). An indication of a large covariance coefficient would lend suspect to the discriminate nature of the factors (Kline, 2005). Mathematics Teaching Efficacy and Personal Mathematics Efficacy produce the largest covariance value but not significant enough to consider the two factors as measuring a similar construct. From this analysis discriminate validity was determined sufficient for this test of the instrument.

Specific Findings Related to Oregon and Washington Agricultural Educators

Data necessary to validate the instrument also provided significant findings for the specific population from which the data was collected. The following section reports the findings related to the demographic characteristics of Oregon and Washington agricultural educators. In addition to the confirmatory factor analysis conducted to validate the model as presented in previous sections of this chapter, a structural model was developed to provide a better understanding of the population in terms of their efficacy among the three constructs measured in this study. The structural model determined the strength of correlations between factors that in turn was used to conclude potential professional development needs of Oregon and Washington agriculture educators.

Demographic Characteristics of Population

The following tables represent the summary of the results from the set of questionnaire items that comprised the demographic section. The information obtained provided valuable insight into the population composition involved in the validation of the instrument and correlation results for the structural equation model.

The years of teaching experience can impact a teacher's perceptions of their practice. Thirteen first year teachers (6.1%) responded to the survey and 31 teachers (14.6%) had only 1-3 years of experience. The largest population category was 72 teachers (33.8%) who have taught 4-10 years. Teachers with the most experience included 49 teachers (23.0%) in the 11-20 years of experience category, and 48 teachers (22.5%) reported from the 21 years or more category. Table 10 provides a summary of the results for this question.

Table 10.

Distribution of Teaching Experiences for Respondents (N = 213)

Years of Teaching Agriculture Education	Frequency	Percentage
First Year	13	6.10%
1-3 Years	31	14.55%
4-10 Years	72	33.80%
11-20 Years	49	23.01%
21+ Years	48	22.54%
Total	213	100%

Years of high school mathematics was sought to develop the picture of previous mathematics exposure the agricultural educators had in their formal schooling. All teachers indicated that they had at least one year of high school mathematics. Only 3 teachers (1.4%) indicated they completed one year of mathematics. Thirty-five teachers (16.4%) who responded had completed two years of mathematics, 79 teachers (37.1%)

completed 3 years, and 89 teachers (41.8%) completed 4 years of high school mathematics. For this population of teachers, only 7 of the 213 respondents (3.3%) completed 5 or more years of high school mathematics. Table 11 summarizes the frequency and the percentage for questionnaire item number two.

Table 11.

Distribution of High School Mathematics Completion (N = 213)

Years of High School Mathematics Completed	Frequency	Percentage
0	0	0.00%
1Year	3	1.41%
2 Years	35	16.43%
3 Years	79	37.09%
4 Years	89	41.78%
5 + Years	7	3.29%
Total	213	100%

Post-secondary mathematics completion furthered the exploration into mathematics exposure or concentration of Oregon and Washington agricultural educators. For item number three of the questionnaire, 8 teachers (3.8%) reported that they did not complete a term of college mathematics. Forty-nine teachers (23.0%) completed only 1 term, 118 teachers (55.4%) completed 2-3 terms, and 38 teachers (17.8%) pushed beyond the average by completing more than 4 terms of college mathematics. Refer to Table 12 for a summary of these results.

Table 12.

Distribution of Post-Secondary Mathematics Completion (N = 213)

Semesters/Terms of College Mathematics Completed	Frequency	Percentage
0	8	3.76%
1 Semester/Term	49	23.00%
2 -3 Semesters/Terms	118	55.40%
4 + Semesters/Terms	38	17.84%
Total	213	100%

Although exposure to mathematics in formal schooling can provide insight to teachers' choices for educational experiences, the level of achievement may be as relevant for understanding confidence in a subject area such as mathematics. Table 13 summarizes the results from the questionnaire item that solicited a response related to the highest level of mathematics successfully completed by the teacher. The results indicated 3 teachers (1.4%) reported their level of successful mathematics completion was below college algebra. Forty-six teachers (21.6%) responded that college-level algebra was their highest level, 49 teachers (23.0%) indicated geometry, 72 teachers (33.8%) reported calculus, and 43 teachers (20.2%) said that trigonometry was their highest level of successfully completed mathematics coursework.

Table 13.

Distribution of the Highest Level of Mathematics Successfully Completed (N = 213)

Highest Level of Mathematics Completes	Frequency	Percentage
Basic Math Functions	1	0.47%
High School Algebra	2	0.94%
College Level Algebra	46	21.60%
Geometry	49	23.00%
Calculus	72	33.80%
Trigonometry	43	20.19%
Total	213	100%

In some cases an agricultural educator may be misassigned to teach a mathematics course for a class period or two during the school year. In a study designed to examine a teacher's confidence in enhancing mathematics in their lessons, a misassignment in mathematics could potentially impact their perceptions toward mathematics teaching. For Oregon and Washington agricultural educators surveyed in this study, 61 teachers (28.6%) indicated that they had a mathematics teaching assignment while teaching agricultural education. The majority, 152 teachers (71.4%), have not taught mathematics in addition to agriculture. Table 14 displays the breakdown for mathematics teaching assignment.

Table 14.

Distribution of Mathematics Teaching Assignment (N = 213)

Mathematics Teaching Assignment	Frequency	Percentage
Yes	61	28.64%
No	152	71.36%
Total	213	100%

The distribution of gender in the study population was also determined. The majority of the agricultural educators responding to this survey were male. Male teachers comprised 152 of the respondents (71.4%) leaving 61 female teachers (28.6%) reporting. Table 15 shows the distribution of gender for the survey.

Table 15.

Distribution of Gender (N = 213)

Gender of Respondents	Frequency	Percentage
Male	152	71.36%
Female	61	28.64%
Total	213	100%

The highest degree obtained is another question that has a purpose of defining the educational status of the population surveyed. Only 2 teachers (0.9%) reported having a certificate or associates degree, 31 teachers (14.6%) earned a Bachelor’s degree in agricultural education, 8 teachers (3.8%) earned a bachelor’s degree in a major other than agricultural education, and 15 teachers (7.0%) were still completing post-baccalaureate coursework. The majority of the teachers, 156 or 73.2%, reported that they completed a Master's degree. Only 1 teacher earned a doctorate degree. Table 16 reports the data related to the highest degree obtained by survey respondents.

Table 16.

Distribution of Education Level (N = 213)

Highest Degree Earned	Frequency	Percentage
Certificate Program/Associates Degree	2	0.94%
Bachelor's Degree in Agricultural Education	31	14.55%
Bachelor's Degree Other Than Agricultural Education	8	3.76%
Post-Baccalaureate Coursework	15	7.04%
Master's Degree (M.S., Ed.M, M.A.T, etc.)	156	73.24%
EdD or PhD	1	0.47%
Total	213	100%

Agricultural educators can be certified several different ways. Implications for why teachers choose certain certification paths may have significance on their confidence toward teaching. Table 17 summarizes the results for this item on the questionnaire. Teachers certified by a traditional agricultural education preparation program totaled 176 or 82.6%. Only 10 teachers (4.7%) reported certification through alternative programs, 12 teachers (5.6%) had temporary certification while working on alternative certification, and 15 teachers (7.0%) had another type of certification not listed in the choices provided. The teachers who responded to the 'other' category had an opportunity to provide an explanation of their situation. From the responses, most teachers reported that they were either certified in biology or another subject area prior to obtaining an endorsement for agriculture, or they obtained their professional technical certification through industry experience and are working toward education licensure.

Table 17.

Distribution of Teacher Certification Status (N = 213)

Teacher Certification Status Entering Profession	Frequency	Percentage
Certified Through Traditional Agricultural Education Teacher Preparation Program	176	82.63%
Certified Through Alternative Certification Program	10	4.70%
Temporary Certification Working Toward Alternative Certification	12	5.63%
Temporary Certification With No Plans to Obtain Certification	0	0.00%
Other	15	7.04%
Total	213	100%

Another area of interest for agricultural educators is their past experiences in professional technical areas of employment. For the survey population, 121 teachers (56.8%) indicated that they have been employed in an agriculture or natural resources career other than teaching. Table 18 displays the responses for this item.

Table 18.

Distribution of Employment in An Agricultural or Natural Resources Career Other Than Teaching (N = 213)

Agriculture or Natural Resource Employment	Frequency	Percentage
Yes	121	56.81%
No	92	43.19%
Total	213	100%

Knobloch and Whittington (2003) developed four questions to be used in determining the commitment level of agricultural educators. These questions were employed in this study to determine if any correlations between teacher efficacy and career commitment perceptions existed. The majority of the teachers responded that being a high school agriculture teacher had been their long-term career goal, and they plan to continue teaching for another five years. Inversely, 168 teachers (78.9%) responded that they strongly disagree with the statement “I do not plan to be teaching next year.” The final question asking whether teaching fit the needs of their family was more distributed among the three agreement levels. For the complete breakdown on career commitment results please refer to Table 19.

Table 19.

Distribution of Career Commitment (N = 213)

Career Commitment Statement	Strongly Disagree *f* (%)	Moderately Disagree *f* (%)	Slightly Disagree *f* (%)	Slightly Agree *f* (%)	Moderately Agree *f* (%)	Strongly Agree *f* (%)
Being a high school agriculture teacher has been my long-term career goal.	4 (1.9%)	7 (3.3%)	6 (2.8%)	28 (13.2%)	61 (28.6%)	107 (50.2%)
I plan to teach for at least 5 years.	10 (4.7%)	4 (1.9%)	5 (2.4%)	12 (5.6%)	36 (16.9%)	146 (68.5%)
I do not plan to be teaching next year.	168 (78.9%)	16 (7.5%)	8 (3.8%)	4 (1.9%)	4 (1.9%)	13 (6.1%)
Teaching as a career matches my personal and family needs.	2 (0.9%)	6 (2.8%)	5 (2.4%)	33 (15.5%)	76 (35.7%)	91 (42.7%)

Structural Equation Modeling Findings

The first step in structural equation modeling (SEM) provided confirmatory factor analysis results important to verify the construct validity of the instrument used. In the second step of SEM, specific findings for the population studied can be determined. This information can be used to draw conclusions about the correlations between the three constructs being examined. The measurement model used in the confirmatory factor analysis (CFA) assumed that all factors were correlated (Needham, 2007). The structural model is explanatory in nature and replaces the covariance measurements between the factors of the CFA measurement model with regression paths.

In CFA factor variances were set to unity for estimation of the variables and their variances. Structural models attempt to explain the variance for factors therefore this standardization step is not used. In CFA measurement error estimation was important to determine covariance structure, however in a structural model measurement error is replaced by the calculation of prediction error of factors. This alteration is represented by the addition of disturbance estimates to the model.

Figure 7 provides a summary of the structural model analysis. Included in the model is the second order analysis for personal teaching efficacy and coefficient paths predicting the strength of correlations among the three factors under investigation. The illustration shows a coefficient of .203 between personal mathematics efficacy and personal teaching efficacy, a coefficient of .569 between personal mathematics efficacy and mathematics teaching efficacy, and a coefficient of .233 between personal teaching efficacy and mathematics teaching efficacy.

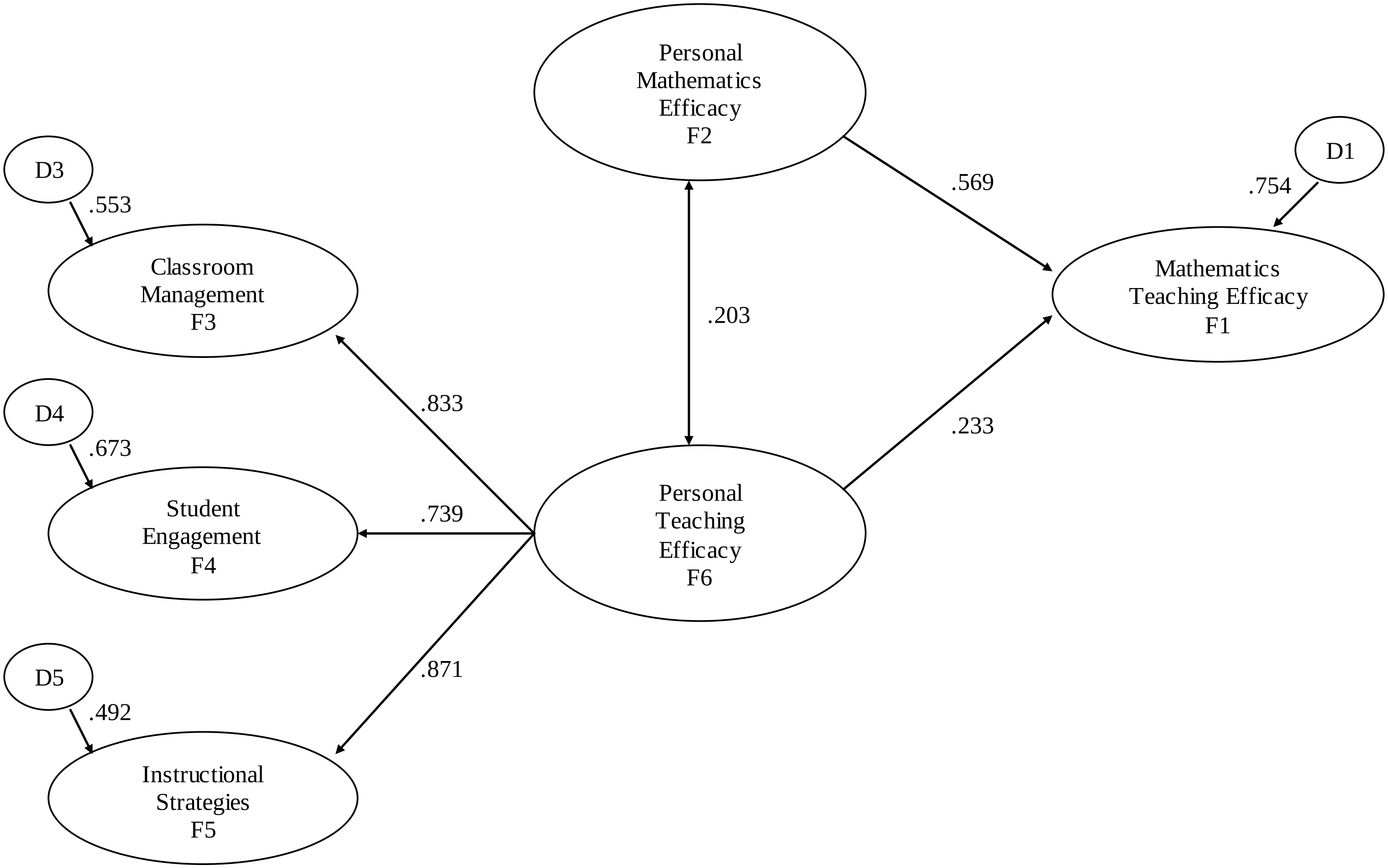

Figure 7. Structural Equation Model. The structural equation model illustrates the correlations between measured factors.

Summary

Chapter four reported the results from the data analyses for this study. The first analyses conducted were to control for non-response error. All tests for non-response error were found to have no significant difference between early and late responders. From this determination, Miller, Torres, and Lindner, (2005) provide support to generalize the results of this survey to the entire population of Oregon and Washington agricultural education teachers. SPSS® software was utilized to determine the reliability for the instrument at an alpha level of .905.

Validation of the instrument was done using both exploratory and confirmatory factor analysis methods. Exploratory factor analysis confirmed that most items did measure what they were supposed to and were consistent in measuring only their intended factor. Some suspect items were noted as they loaded into their own factor not identified from theory and loaded on multiple factors. Confirmatory factor analysis was conducted as part of the structural equation modeling process. The results from this test concluded that all items measured the *a priori* model adequately. Only one item produced a low enough coefficient value to consider it for removal from the instrument.

The survey questionnaire included ten questions used to determine demographic information for the study population. The results from these questions were summarized in provided tables. Specific findings related to the Oregon and Washington agriculture teachers' perceptions of efficacy were used to construct a structural model illustrating the correlations among each efficacy construct.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to validate an instrument used to determine teacher efficacy related to mathematics enhancement of agricultural education lessons. As part of the validation process, data was collected on demographic information and specific characteristics of efficacy relationships between mathematics, teaching, and mathematics teaching were analyzed to draw conclusions about Oregon and Washington agricultural educators. Research methods were employed to adequately measure an *a priori* model derived from theory related to teaching efficacy, agricultural education, and mathematics efficacy. The three research questions addressed in this study were:

1. Are personal mathematics efficacy and personal teaching efficacy valid constructs for determining correlations with teachers' confidence in their ability to enhance mathematics?
2. What are the demographic characteristics for agricultural educators in Oregon and Washington?
3. Which factor, personal mathematics efficacy or personal teaching efficacy, establishes the strongest correlation with a teacher's confidence in their ability to enhance mathematics in agricultural education?

The following sections in chapter five will report the conclusions drawn from the results presented in chapter four. Following the conclusions, implications for these findings and future recommendations for continued research will be discussed.

Conclusions from the Findings

The instrument was determined to be reliable and valid in assessing the intended efficacy beliefs of the study population. The study population of Oregon and Washington agricultural educators provided demographic information helpful in future correlation studies between demographic characteristics and efficacy constructs. Analyses of the data using structural equation modeling determined that significant correlations are present among the three efficacy constructs examined. Personal mathematics efficacy produces the strongest correlation with mathematics teaching efficacy. Specific details supporting these conclusions are further discussed.

Reliability

The consistency of a measurement procedure when used for repeated testing of individuals or groups defines the reliability of instrument (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999). A test with a high reliability is important for an instrument, especially if sample sizes are small (Gall, Gall, & Borg, 2003). For an instrument with the specific intent of measuring teacher populations for determining perceptions related to efficacy, small sample size may be encountered. Therefore, a strong reliability is best for instruments of this nature.

Three independent tests were combined to create the instrument used in this study. Because of alterations to wording and the combined use in one test, assessment of reliability was essential. SPSS® software was used to calculate an alpha coefficient for reliability at .905. Gall et al. (2003) indicate that a coefficient level of 1.00 is the maximum or perfect rating, but realistically a coefficient level of .80 or higher is sufficient for most tests. It is concluded that this instrument has adequate evidence to support the conclusion that it is a reliable and stable test for teacher efficacy.

Validity

Validation of instrument included face, content, construct, and discriminate validity. As reported in chapter three, face and content validity were verified by use of an expert panel of reviewers. The reviewers determined if the questions were appropriate for the population being investigated. Included in face and content validity judgments were legibility, terminology, clarity, and whether the questions were reasonable for the intended purpose. After review by the expert panel, only minor wording changes to the directions of the survey instrument were made. Construct and discriminate validity was assessed using exploratory and confirmatory factor analysis methods.

Exploratory Factor Analysis

With three instruments being used to create a new comprehensive test, exploratory factor analysis was employed to ensure the discriminate nature of each test. Exploratory factor analysis examines data and grouped items into factors. It was believed by conducting exploratory factor analysis instrument items would be initially screened for potential cross loading that could indicate the item was measuring two or more constructs. This condition would indicate that the question was not measuring its intended outcome and therefore could provide validity concerns for the instrument.

In this study, principle component analysis revealed consistencies between data and the appropriate factor loadings expected. Independent factors were clearly identified representing the Mathematics Teaching Efficacy (MTE) and Personal Mathematics Efficacy (PME) components of the instrument. Personal Teaching Efficacy (PTE) was comprised of three constructs, classroom management, instructional strategies, and student engagement. The analysis clearly defined these three constructs as independent factors.

The anomalies uncovered by exploratory factor analysis included an additional factor comprised of two PME items and one MTE item. Additionally, PTE item number 11 loaded in the incorrect construct according to the author's prescription. Because this was a preliminary analysis of items, no action was taken to control for these anomalies. A further analysis provided by confirmatory factor analysis was used to draw conclusions concerning these items.

Confirmatory Factor Analysis

The primary mode of data analysis for this study was structural equation modeling (SEM) using EQS software. The SEM method is a two stage process involving a measurement model of the items with their respective factors and secondly a structural model that establishes coefficient paths among the factors. The measurement model relies on confirmatory factor analysis (CFA) to determine if the imposed model is a good fit for the data collected. Because the factors are identified from the research and prescribed for the analysis, low coefficient values (below .4) are indicators of items that are not clearly measuring the intended factor.

In the CFA of this instrument, item MTE 1 was the only question failing to yield a coefficient value acceptable for inclusion in this instrument. MTE 1 was a suspect item identified in exploratory factor analysis as being one of three items loading into an unidentifiable factor. The results would indicate that the MTE 1 item should be removed from the instrument. However, when assessing overall model fit, the Comparative Fit Index (CFI) and Root Mean-Square Error of Approximation (RMSEA) statistics verify that the model is a good fit regardless of the inclusion of item MTE 1. It was reported in chapter four that the CFI was .945, which is above the .900 minimum for a goodness of fit index. RMSEA for the measurement model was determined to be .037, which also fell within the .05 significance level.

The final decision was to leave item MTE 1 included in further analyses because of the minor detrimental effects it had on model fit. MTE 1, although modified by minor wording changes for this instrument's purpose, was an original question proven valid and reliable for the *Mathematics Teaching Efficacy Belief Instrument* (MTEBI) developed by Enochs, Smith, and Huinker (2000).

The conclusions from the factor analysis examinations provide the evidence required to make a determination that the instrument is sound and measures the constructs it purports to measure. Additionally, covariance values among factors determined in the confirmatory factor analysis support claims of discriminate validity, meaning instrument items only measured their intended construct were determined acceptable. These conclusions address the first research question that confirms PME and PTE as valid tests for determining mathematics enhancement teaching efficacy.

Demographic Profile

The second research question examined the population of Oregon and Washington agricultural educators. Although comparisons of groups was beyond the scope of the research questions for this examination, such information may be used in conjunction with structural equation modeling to find significant differences among the efficacy levels within different demographic groups. Demographic information for Oregon and Washington agricultural educators provided evidence to conclude 20.7% of the teachers participating in the survey were novice or first year teachers. The largest grouping included the teachers with 4-10 years of experience (33.8%). Respondents were mostly male constituting over 71% of the responses.

Mathematics Experience

The majority of the teachers completed at least two or more years of high school mathematics and 2-3 terms of college mathematics. College algebra was the minimal level of mathematics completion with over 75% of the teachers successfully completing mathematics courses in Geometry, Calculus, or Trigonometry. Over 28% of the survey population had a mathematics teaching assignment while teaching agriculture.

Credentials

Of the highest degree earned, 73.2% of the Oregon and Washington agriculture teachers had obtained their Master's degree. Most were teacher certified through a traditional agricultural education teacher preparation program (83%). A slight majority (56.8%) indicated previous employment in an agriculture or natural resources career other than teaching at one time.

Career Commitment

The teacher population indicated an overwhelming agreement in regards to agriculture being their long-term career goal. The same was true for teaching commitment over the next five years. Only 13 teachers reported that they did not plan to be teaching the following year. A career in teaching matched the personal and family needs of over 90% of the teachers surveyed.

Results and Conclusions from Efficacy Scales

As reported in Table 2 presented in chapter three, Oregon and Washington agricultural educators indicated their perceived efficacy related to mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy as skewed toward the upper end of the respective scales for each test. The overall mean score for MTE was 3.71 for the provided 1-5 agreement scale. The finding suggests that teachers in this group tended to agree that they are confident in their ability to enhance mathematics.

Stronger yet was the perceived personal mathematics efficacy of agricultural educators. The overall mean for the combined eight questions for PME was 3.72 for a

1-4 scale related to level of confidence. The result of the test suggests that these teachers are very confident in their ability to solve mathematics questions related to the examples provided. This is an important finding as PME and MTE resulted in the strongest correlation between factors.

Personal teaching efficacy produced a combined mean score of 7.30 for a 9-level influence scale. Again, this is a skewed distribution toward the upper end of the influence rating scale. The range for which the mean score falls is between "Quite a Bit of Influence" and "A Great Deal of Influence." The results suggest that this group of teachers seem very efficacious in their pedagogy, specifically in regards to instructional strategies, classroom management, and student engagement.

Structural Equation Modeling

The second phase of structural equation modeling determined the coefficients for the paths among the factors being examined. From this analysis determinations can be made as to which construct of efficacy relates the strongest to mathematics enhancement teaching efficacy. Three path coefficients were constructed and represented in Figure 7. Personal Mathematics Efficacy (PME) and Personal Teaching Efficacy (PTE) produced the lowest correlation of .203. PTE and Mathematics Teaching Efficacy (MTE) produced a correlation coefficient of .233. The strongest relationship was indicated between PME and MTE with a coefficient of .569. This would suggest that personal mathematics efficacy has a greater impact on confidence to enhancing mathematics in agriculture lessons than efficacy in teaching practice alone.

Implications

Two important implications can be concluded from the findings of this study. First, the validation of the instrument provides a stable and valid measurement of teachers situated in the constructs related to efficacy of enhancing mathematics in interdisciplinary subject matter. Although the intended target was agricultural education in its original validation, it is foreseeable that this instrument could be used to assess efficacy of other subject matter areas in career and technical education.

The value for having an instrument to measure efficacy among teacher populations will aide in targeting professional development opportunities important for supporting the perceived deficiency in a teacher population as Wu and Greenan (2003) cite. Wood and Thompson (1993) support the notion focusing professional development activities based on the real conditions that teachers face in their classrooms. The tool developed in this study provides a way to determine the concerns an individual teacher may have in their teaching practice for enhancing mathematics embedded in lessons. Clement and Vandenberghe (2000) assert that context drives the need for professional development and this is specific to individual teachers. This instrument will determine the level of the specific context need associated with mathematics, and allow for professional development activities to be more effective in meeting teacher requirements.

The second important implication was determined specifically from structural equation analysis (SEM) conclusions for the agriculture educators involved in the survey. Findings from the SEM analyses suggest that efficacy to enhance mathematics in lessons was largely associated with the teacher's perceived ability in doing mathematics rather than the perceived ability in pedagogy. Pedagogy was measured with this instrument by the Personal Teaching Efficacy component that examined a teacher's confidence in three areas; classroom management, instructional strategies and student engagement.

Although a teacher may be very confident in their ability to teach, in this case, subject knowledge has a stronger implication on their confidence to enhance mathematics. As mentioned in the previous implication, this finding may provide the evidence to focus professional development activities of teachers to enhance subject area content specific to enhancement rather than pedagogical techniques and strategies. It also may challenge the level of mathematics exposure and proficiency for pre-service teaching requirements if increased teacher efficacy for mathematics enhancement is called for in interdisciplinary lessons.

Recommendations for Future Research

With all instruments, the value of utility across subject domains is important. The testing of this instrument in other subject matter areas will provide further credibility to its importance as a tool for determining professional development needs of a teacher population. It may be determined that career and technical education teachers across all domains share similar perceptions toward mathematics enhancement, or it may be specific to subject matter areas. Grade levels may also be a determining factor of the level of perceived efficacy among teachers. A hypothesis to be examined is whether teachers of lower grade levels, where lower levels of mathematics complexity is taught, will have a greater sense of efficacy than secondary teachers.

More specific to the study results of this survey, data analyses must be conducted to determine potential differences among the demographic variables. A study conducted by Enochs, Scharmann, and Riggs (1995) examined significant correlations between teacher self-efficacy and demographic variables, such as the number of college science courses taken and the amount of high school science exposure teachers had prior to their careers. Ross, Cousins, and Gadalla (1996) explored similar demographic variables and potential correlations with feelings toward teacher efficacy. Their research discovered within-teacher factors, what Bandura (1997) would classify as "personal factors", were influenced by and varied depending upon the between-teacher variables (demographics).

From preliminary analyses using MANOVA to determine if significant differences existed between demographic variables in this study, the analysis of gender indicated that females and males differed in their perceived levels of efficacy towards mathematics. The scope of this study limited investigation of literature related to gender differences among mathematics efficacy. If literature would warrant the further investigation into gender differences, this could potentially yield specific findings to target professional development strategies in more detail. Data analyses to determine if the differences between females and males would need to be analyzed using two new structural models one for each gender category and compare the two models using a chi square difference test. The same analyses can be conducted for other demographic variables to determine if the population of agricultural educators included in this study has distinct needs or unique characteristics that could impact professional development strategies for mathematics enhancement.

The line of inquiry suggested above begins to address one of the limitations identified for this study concerning collective efficacy. Collective efficacy, as defined by Bandura (1997), asserts that efficacy has many influences which are shared among the culture that people interact in. Complete isolation is usually not a realistic condition for practicing teachers, they are influenced in ways to promote or hinder efficacy by the settings, people, individual goals for attainment, and resources they encounter in their lives. Collective efficacy involves much more than subject matter content and pedagogical traits examined in this study. Alterations in teachers' culture, for example creating a professional learning community among mathematics and horticulture teachers, can produce very rapid changes in their perceptions of concerns related to the adoption of an innovation (Jansen, Enochs, & Thompson, 2006). An expanded examination of traits that define the teachers included in this population is very important to discover how best to establish confidence in teaching practices to improve mathematics enhancement of lessons.

Because of the challenges faced with researching collective efficacy, more case studies are needed to clearly grasp the complexities of agricultural educators. One important reason to warrant the call for observational studies is the value of qualitative data to support self-reported survey responses. Ross, McDougall, Hogaboam-Gray, and LeSage (2003) challenged the constraints to validity that self-reported surveys have in defining teacher habits relative to their reported self-beliefs. Their research found self-reported teacher results tended to differ from what the researchers observed first hand. By employing a qualitative assessment of mathematics enhancement activities, teacher needs toward professional development may have a more defined target.

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APPENDICES

Appendix A

Oregon and Washington Agricultural Education Teacher Perceptions of Mathematical Teaching Efficacy

Demographic Information

1. How many years have you taught agricultural education?

_____ First year
_____ 1-3 years
_____ 4-10 years
_____ 11-20 years
_____ 21+ years

2. How many years of high school mathematics courses did you successfully complete as a high school student? (1 year = 2 semesters/terms)

_____ 0
_____ 1 year
_____ 2 years
_____ 3 years
_____ 4 years
_____ 5+ years

3. How many semesters/terms of college mathematics courses did you complete as a student?

_____ 0
_____ 1 semester/term
_____ 2-3 semesters/terms
_____ 4+ semesters/terms

4. What was the highest level of mathematics you successfully completed? (select one)

_____ Basic Math Functions
_____ High School Algebra
_____ College Level Algebra
_____ Geometry
_____ Calculus
_____ Trigonometry

5. Have you ever taught a mathematics course during your professional teaching career?

_____ Yes
_____ No

6. What is your gender?

_____ Male
_____ Female

7. Please mark your highest degree earned from the following list:

_____ Certificate program/Associates degree
_____ Bachelor’s degree in agricultural education
_____ Bachelor’s degree other than agricultural education
_____ Post-baccalaureate coursework
_____ Master’s degree (M.S., Ed. M., M.A.T., etc.)
_____ EdD or PhD

8. Which of the following best describes your teacher certification status at the beginning of your first year of full time teaching?

_____ Certified through traditional agricultural education teacher preparation program
_____ Certified through an alternative certification program
_____ Temporary certification working toward alternative certification
_____ Temporary certification with no plans to obtain certification
_____ Other

Please specify other here:

9. Have you been employed for one year or more in an agriculture or natural resources career other than teaching?

_____ Yes
_____ No

Career Commitment

10. Please select the appropriate level of agreement with the following statements concerning career commitment to teaching secondary agricultural education:

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
Being a high school agriculture teacher has been my long-term career goal	1	2	3	4	5	6
I plan to teach for at least 5 years.	1	2	3	4	5	6
I do not plan to be teaching next year.	1	2	3	4	5	6
Teaching as a career matches my personal and family needs.	1	2	3	4	5	6

Mathematics Teaching Efficacy

11. Please indicate the degree to which you agree or disagree with each statement below.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
I will continually find better ways to enhance mathematics in my lessons.	1	2	3	4	5
Even if I try very hard, I will not teach mathematics as well as I will most subjects.	1	2	3	4	5
I know how to teach mathematical concepts effectively.	1	2	3	4	5
I will not be very effective in monitoring mathematics activities.	1	2	3	4	5
I will generally teach mathematical concepts ineffectively.	1	2	3	4	5
I understand mathematical concepts well enough to be effective in teaching elementary mathematics functions.	1	2	3	4	5
I will find it difficult to use manipulatives to explain to students why mathematics works.	1	2	3	4	5
I will typically be able to answer students' questions related to mathematics.	1	2	3	4	5
I wonder if I will have the necessary skills to enhance mathematics in my curriculum.	1	2	3	4	5
Given a choice, I will not invite the principal to evaluate my mathematics teaching.	1	2	3	4	5
When a student has difficulty understanding a mathematical concept, I will usually be at a loss as to how to help the student understand it better.	1	2	3	4	5
When teaching mathematics, I will usually welcome student questions.	1	2	3	4	5
I do not know what to do to turn students on to mathematics.	1	2	3	4	5

Personal Mathematics Efficacy

12. How confident do you feel about having to do the following calculations?

	Very Confident	Confident	Not Very Confident	Not At All Confident
Using a train timetable, calculate how long it would take to get from City A to City B.	4	3	2	1
Calculating how much cheaper a television would be after a 30 percent discount.	4	3	2	1
Calculating how many square feet of tiles you need to cover a floor.	4	3	2	1
Understanding graphs presented in newspapers.	4	3	2	1
Solving an equation like $3x + 5 = 17$.	4	3	2	1
Finding the actual distance between two places on a map using a 1:10,000 scale.	4	3	2	1
Solving a mathematical equation like the following: $2(x+3) = (x+3)(x-3)$.	4	3	2	1
Calculating the gasoline consumption rate of a car.	4	3	2	1

Personal Teaching Efficacy

13. Please indicate your opinion about each of the statements below.

	Nothing		Very Little Influence		Some Influence		Quite A Bit of Influence		A Great Deal of Influence
How much can you do to control disruptive behavior in the classroom?	1	2	3	4	5	6	7	8	9
How much can you do to motivate students who show low interest in school work?	1	2	3	4	5	6	7	8	9
How much can you do to get students to believe they can do well in school work?	1	2	3	4	5	6	7	8	9
How much can you do to help your students value learning?	1	2	3	4	5	6	7	8	9
To what extent can you craft good questions for your students?	1	2	3	4	5	6	7	8	9
How much can you do to get children to follow classroom rules?	1	2	3	4	5	6	7	8	9
How much can you do to calm a student who is disruptive or noisy?	1	2	3	4	5	6	7	8	9
How well can you establish a classroom management system with each group of students?	1	2	3	4	5	6	7	8	9
How much can you use a variety of assessment strategies?	1	2	3	4	5	6	7	8	9
To what extent can you provide an alternative explanation or example when students are confused?	1	2	3	4	5	6	7	8	9
How much can you assist families in helping their children do well in school?	1	2	3	4	5	6	7	8	9
How well can you implement alternative strategies in your classroom?	1	2	3	4	5	6	7	8	9

Appendix B

Email Contact to Target Study Teacher Educators

Dear Dr. Swan,

As you are aware, I am finishing up my educational endeavor soon. Currently I am preparing for the proposal phase of the research project I wish to pursue. Because I will be approaching my committee soon with this proposal, I wanted to contact you regarding the portion of the proposal involving agriculture teachers in your state. I felt any documented support you can provide related to the initial design of this research would strengthen the proposal.

It is my hope to finish up doctoral requirements by this coming spring. In order to do so, I must begin the data collection process for the study on the mathematics teaching efficacy of agricultural science teachers at the beginning of 2007. It is my hope that Oregon and Washington agriculture educators can be part of this survey to ensure there are an adequate number of participants for validity reasons.

I have chosen Washington teachers because of their inclusion with Oregon teachers in the recent study conducted by the National Research Center for Career and Technical Education regarding Math-in-CTE. This study provided the motivation for research contained in my thesis. It is accepted that teaching mathematics in context has benefits to student understanding and performance. However, what is not fully understood is whether agriculture teachers would feel proficient in their abilities to teach mathematically enhanced lessons to make meaningful connections for students.

Besides the relevant descriptive statistics for this population of Oregon and Washington agricultural educators, the survey instrument will be soliciting teachers' opinions related to their mathematics preparation, confidence, and ability. A hypothetical model has emerged from the literature related to constructs most likely to predict effective teaching. The data collected from the questionnaire will be used to validate this model and identify the most probable predictors of teaching efficacy for mathematics in this population of teachers. It is hoped that such information can later be expanded upon in efforts to enhance mathematics embedded in agricultural curricula for improved student performance in mathematics.

The survey will be offered online initially; therefore I will eventually need access to names and contact information of Washington agricultural teachers. Any other assistance you wish to volunteer would be most appreciated, but all of the facilitation would happen from Oregon State University.

For proposal documentation, a reply to this email expressing the appropriateness of including Washington agriculture teachers in this survey would be important. Additionally, I would be most interested in potential conflicts with administering this survey starting in January and finishing by March 1. Feedback related to scheduling would be valuable for efforts in achieving a high response rate.

Thank you for entertaining this request. If there are further questions or comments regarding this research please contact me anytime.

Dear Dr. Thompson,

As you are aware, I am finishing up my educational endeavor soon. Currently I am preparing for the proposal phase of the research project I wish to pursue. Because I will be approaching my committee soon with this proposal, I wanted to contact you regarding the portion of the proposal involving agriculture teachers in your state. I felt any documented support you can provide related to the initial design of this research would strengthen the proposal.

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Thank you for entertaining this request. If there are further questions or comments regarding this research please contact me anytime.

Appendix C

Pre-Notification Letter

Date

Participant
Address
City, ST Zip-Code

Dear <field>

In a few days you will be receiving an email questionnaire asking you to volunteer information for an important research project related to agricultural education. The research is being conducted to understand Oregon and Washington agriculture teachers' perceptions toward personal mathematics teaching confidence.

The information gained from this survey will be used to understand the strengths that agricultural educators have in creating meaningful experiences for student learning of mathematics embedded in agricultural education. It is important to know what your thoughts and concerns are regarding your teaching practice and more specifically, your confidence to enhance mathematical concepts in your curriculum.

If you wish to participate, information that you provide will be used as part of a dissertation project and will contribute to the body of research on teacher efficacy through subsequent publications.

Thank you in advance for your time and consideration toward this request. As the educational climate changes, it is important to our profession that we continually assess where we currently are and plan accordingly to meet the challenges of the future. Although your participation is voluntary, I hope that you will assist us with this research.

Sincerely,

Dan Jansen
Instructor and Student Researcher
Oregon State University

P.S. All effort should be rewarded, as a token of appreciation for your participation you will be automatically entered into a drawing for Cabela's® gift certificates once you have submitted your completed questionnaire via email. Again, thank you for your contributions to our profession.

Appendix D

Survey Cover Letter

Date

Participant
Address
City, ST Zip

Dear <field>,

Recently we sent you email requests for your help on a research project related to personal mathematics teaching confidence of agriculture teachers. Because many people prefer paper copies of materials, we are providing you an opportunity to give us your input via a paper questionnaire rather than an electronic submission. If you wish, please complete the questionnaire and send it back to us in the self-addressed stamped envelop provided. It is a voluntary survey, and no further contacts will be made regardless if you choose to participate or not.

If you just have not had the time to submit the questionnaire over email and feel this is an easier way for you to do so, please feel free to access the online version of the questionnaire and submit it this way. The questionnaire should take 15 minutes to complete. Here is the link once again:
http://surveys.bus.oregonstate.edu/BsgSurvey2_0/main.aspx?SurveyID=1668
You will need a log in password. Your password is <**field**>.

We truly feel this information is valuable to the agricultural education profession. I personally appreciate the time and effort you commit to teaching students about agriculture.

Please either mail or electronically submit your responses by <date>.

Sincerely,

Dan Jansen
Agricultural Education and
General Agriculture Department
Oregon State University

Appendix E

Informed Consent Document

Participant Informed Consent Information

This research questionnaire is part of a dissertation project and subsequent publications intended to gain insight into the perceptions that Oregon and Washington agricultural educators have regarding their own mathematics teaching beliefs. The responses from this research will be compiled for data analyses with the goal of assessing personal mathematics teaching confidence of agriculture teachers. All responses will be kept confidential, and no individual participant will be identified in the research process.

By entering your password on the next page, you will be providing the researcher informed consent - meaning that you agree to take part in the research study under the conditions described on this page. After selecting the "continue" button, you will automatically be forwarded to the online survey. The online questionnaire should take about 15 minutes to complete. Once completed this is the only time you will need to commit to this project – no further questionnaires or requests for information will be made.

There are no foreseeable risks and no direct benefits for your participation in this questionnaire. All of the responses will be kept confidential and each potential participant has been assigned a four digit code only for the purposes of data analyses and eliminating your name from future contacts to complete the questionnaire. The data from the questionnaire will be kept by research staff at Oregon State University for only research related to the objectives of this project.

To show our appreciation for your assistance with this project, participants in this study will have a chance to be awarded gift certificates for Cabela's® outdoor clothing and equipment catalog. Participants who complete and submit their responses to the following questionnaire will be automatically entered into a lottery drawing for these gift certificates. Code numbers will be utilized for the drawing, and cross-reference of selected code numbers will be done only to notify the winners of gift certificates. One $50.00 and two $25.00 gift certificates will be awarded to both Oregon and Washington participants respectively.

Again, we want to stress that your identity will be kept confidential and only results of collective data analyses may be used for publication. Your participation is voluntary and no loss of benefits or rights will be endured if you choose not to participate.

If you have any questions about this research project please contact Dr. Larry Enochs at 541-737-1305 or email him at enochsl@onid.orst.edu, or you may

contact Dan Jansen at 541-737-2661 or via email dan.jansen@oregonstate.edu. If you have questions regarding your rights as a participant, please contact the Oregon State University Institutional Review Board (IRB) Human Protections Administrator, at 541-737-4933 or by email at IRB@oregonstate.edu.

Directions for Completing the Questionnaire

After clicking on the "continue" button below, you will be asked to "log on" in order to enter survey. Please enter the password provided in the email that contains this survey link. If you need assistance please contact us and we can provide you with assistance.

The following questionnaire asks for perceptions related to your confidence as a teacher. Please answer these questions to the best of your ability using the designated scale for each section or question. Some of the scales vary in choices for responses, so please check the top of each section to determine the proper response.

A term that surfaces throughout the questionnaire is mathematics enhancement or enhance mathematics. This terminology refers to the strategies that you use in your lessons to purposefully teach related mathematical concepts so students understand both the mathematics principle and how the mathematics are used in the context of agriculture. Therefore, this does not merely mean that mathematics happens to be included into agriculture lessons, but you have purposefully tried to reinforce the understanding of the mathematics for student comprehension.

Once completed with the sections, please click on the “submit” button to ensure that your responses have been recorded. A thank you letter will be sent via email one week from this mailing acknowledging the survey has been received. If for some reason it was not received, an email will be sent asking for you to take the survey again. If this is an error, please contact us or resubmit your responses to the questionnaire.