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Evaluating the efficacy of the developing algebraic literacy model: Preparing special educators to implement effective mathematics practices

Sharon N. E. Ray
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Evaluating the Efficacy of the Developing Algebraic Literacy Model: Preparing Special
Educators to Implement Effective Mathematics Practices

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
Department of Special Education
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design, at-risk students, instructional framework

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Dedication

I would like to dedicate this dissertation to my family members, who have each helped me in their own way to make completing this dissertation a reality. To my brother Ryan, I would never have written this dissertation before our growing up together – you sparked my interest in special education. To my sister, you lived with me during the final months of writing this dissertation, then and always you kept me sane by reminding me to eat right, exercise (which you helped me do regularly), vent my frustrations, and stay fashionable in spite of all the work I had to complete. To my mom, you have spent my whole life encouraging me to get the most out of life and making it what I want. You convinced me from an early age that women could do anything, not just in theory but in actuality. To my dad, you have always said “life is hard work” – now I finally realize why you have worked so hard yourself – because when you work hard, you make something of your life and that is its own reward. To my husband, each and every day I have known you, you have inspired me by your example to do my best and be a better person. To my son, by having you it fundamentally changed who I was and who I am, and for that I am forever grateful. Without these special people, and the unending help of God the Father, I would never have finished this dissertation. For that reason, this finished product is dedicated to all of you because each one of you helped me more than you may ever know.

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Evaluating the Efficacy of the Developing Algebraic Literacy Model: Preparing Special Educators to Implement Effective Mathematics Practices

Sharon Ray

ABSTRACT

For students with learning disabilities, positive academic achievement outcomes are a chief area of concern for educators across the country. This achievement emphasis has become particularly important over the last several years because of the *No Child Left Behind* legislation. The content area of mathematics, especially in the higher order thinking arena of algebra, has been of particular concern for student progress. While most educational research in algebra has been targeted towards remedial efforts at the high school level, early intervention in the foundational skills of algebraic thinking at the elementary level needs consideration for students who would benefit from early exposure to algebraic ideas. A key aspect of students' instruction with algebraic concepts at any level is the degree and type of preparation their teachers have received with this content.

Using a mixed methods design, the current researcher investigated the usage of the Developing Algebraic Literacy (DAL) framework with pre-service special education teacher candidates in an integrated practicum and coursework experience. Multiple survey measures were given at pre-, mid-, and post- junctures to assess teacher candidates' attitudes about mathematics, feelings of efficacy when teaching mathematics, and content knowledge surrounding mathematics. An instructional knowledge exam and fidelity checks were completed to evaluate teacher candidates' acquisition and

application of algebraic instructional skills. Focus groups, case studies, and final project analyses were used to discern descriptive information about teacher candidates' experience while engaging in work with the DAL framework.

Results indicated an increase in preservice teachers' attitudes towards mathematics instruction, feelings of efficacy in teaching mathematics, and in the content knowledge surrounding mathematics instruction. Instructional knowledge also increased across preservice teacher candidates, but abilities to apply this knowledge varied across teacher candidates', based on their number of sessions working with students within their practicum site. Further findings indicate the desire of pre-service teachers to increase the length and number of student sessions within the DAL experience, as well as the need for increased levels of instructional support to enhance their own experience. This study provides preliminary support for utilizing the DAL instructional framework within pre-service teacher preparation experiences for future special educators.

Chapter 1

Introduction

Statement of the Problem

One of the largest difficulties facing the educational system in the United States is providing enough “highly qualified” special educators in the curriculum area of mathematics, especially in the higher level thinking skills of algebra (Bottge, Heinrichs, Chan, & Serlin, 2001; Gagnon & Maccini, 2001; Mizer, Howe, & Blosser, 1990; Witzel & Miller, 2003). According to the *NCLB Interim Report (2007)*, the current number of special educators who consider themselves “highly qualified” was reported at 52% across grade levels. Overall, special education teachers were almost four times as likely to self-report they were not “highly qualified” compared to their general education teacher peers. In the 2002-2003 school year, 57% of districts nationally reported that they expected to have difficulty recruiting “highly qualified” special education teachers in the upcoming school year, and 60% said the same for mathematics teachers (*NCLB Interim Report, 2007*). At the same time, only 12% of students with mild disabilities achieve successful outcomes by the time they reach secondary mathematics courses, which includes taking algebra classes and other higher level mathematics courses (Kortering, deBettencourt, & Braziel, 2005). Because Algebra I is a graduation requirement in most states, it is considered a secondary gate-keeping course (Chambers, 1994; Maccini, McNaughton, & Ruhl, 1999). Successful completion of Algebra I can open educational and career

options, so it is imperative that learners who struggle with mathematics be provided well-prepared instructors to meet their mathematics content and disability needs.

With the recent mandate of *No Child Left Behind* (NCLB, 2001) and the latest reauthorization of the *Individuals with Disabilities Education Act* (IDEA, 2004), special educators must be “highly qualified” in special education and in the content areas they teach. Students of all ability levels are expected to achieve at least adequate yearly progress (AYP) in all subject areas, including mathematics, and schools and districts are being held accountable for students’ achievement (NCLB, 2001). The need to prepare “highly qualified” special educators in mathematics is obvious, but how this preparation can be accomplished is not. Preparing enough “highly qualified” special educators in mathematics is a multi-faceted problem. Factors that contribute to the problem include: 1) few teachers seeking entry into the special education field; 2) limited amounts of time and program structures to integrate pedagogical knowledge and application with mathematics content during special educators’ pre-service preparation; and 3) increasing student diversity in public education classrooms around the country which requires specialized and differentiated instruction.

The first factor, recruitment, has been an ongoing issue for many years. In 2001, 26,000 new special education teachers were needed to fill open positions throughout the country. In that year, approximately 20,000 students graduated from special education teacher preparation programs nationally. However, out of these 20,000 special education graduates, about half were already employed “out-of field” as teachers. Therefore, the shortfall of needed special educators was actually 16,000 (Boe, 2006). The difficulty in recruiting special educators is in itself a multi-part dilemma. First, educators, across

instructional areas, are one of the most poorly paid groups of professionals that require a college education (Hammer, Hughes, McClure, Reeves, & Salgado, 2005). On top of salary, individuals who enter the special education profession meet with classroom and student situations that require specialized training and skills (Rice & Gossling, 2005). Third, research by Marso and Pigge (1986) suggests that many special educators enter the field because of a life experience that pivotally influences them. While these experiences motivate many individuals to become educators, they are not situations that can be replicated by institutions of higher education to increase recruitment, since these events take place by chance in everyday life. Fourth, Singh and Stollof (2007) have indicated that personal dispositions play a key role in predicting teacher commitment and preventing burnout. They have found that personal dispositions that embrace social justice, equity, and cultural sensitivity allow special educators' abilities to better cope with the amount of work responsibilities and professional challenges that result from working with learners with multiple learning and behavioral needs. These particular dispositions are not always innate in future educators, but may require time and be difficult to cultivate (Singh & Stoloff, 2007). In short, creating a fertile environment for increased special education recruitment is a definitive challenge where some aspects can be negotiated by teacher preparation programs (i.e., dispositional change) and some cannot (i.e., motivational life experiences).

Special education graduates have typically been knowledgeable in the pedagogical strategies and behavioral management techniques important for instruction with diverse learners. As the second factor in developing "highly qualified" special educators alludes, few of these graduates have been well-versed in the application of

these various strategies and techniques within content areas such as mathematics. Beyond just experience in the content areas, even fewer newly-graduated special education teachers have considered themselves content area experts (Laarhoven, Munk, Lynch, Bosma, & Rouse, 2007). Pre-service special education programs have struggled with juggling foundational educational courses with instructional classes and directed field experiences (Darling-Hammond & Ball, 1998). Adding additional content area preparation to program requirements extends the time and coursework necessary for teacher preparation, potentially acting as a deterrent to individuals selecting special education teacher preparation programs.

NCLB is slowly changing the culture and dynamics of the public education classroom; as a result, despite the aforementioned challenges, the National Council for Accreditation of Teacher Education (NCATE) (2006) is advocating for the implementation of innovative university programs that incorporate coursework, practicum, and trans-disciplinary knowledge for the future special education teachers of such classrooms. Multiple areas are now vying for undergraduate special education teacher candidates' academic time, and it is difficult to work in coursework that meets both the pedagogical and content area needs of individuals who attend university programs aimed at preparing them for K-12 certification. While graduates in special education are now being expected to be qualified across content areas, as well as grade levels, mathematics content is one of these critical areas.

Many special education teacher preparation programs already implement pre-service professional development that includes coursework across specific curricular areas in addition to special education. An ongoing challenge is to incorporate this

content knowledge gained through coursework into fieldwork and practicum experiences (Edwards, Carr, & Siegel, 2006). To address this issue, many universities have special education programs that incorporate multiple levels of practicum experiences, with increasing levels of involvement in public school settings (McInerney & Hamilton, 2007). Multiple studies have indicated the difficulty of teacher candidates in successfully transferring knowledge gained through college class work to application-based K-12 classrooms. Some of these issues stem from the university support necessary to support and scaffold undergraduates' learning in these situations (Allsopp, Alvarez-McHatton, DeMarie, & Doone, 2006). Another problem is having the type of practicum opportunities where teacher candidates have the freedom to explore ideas gained in their university setting (Sands, Duffield, & Parsons, 2007). Finally, the research-to-practice gap is a concern, because many of the strategies and practices being advocated at the university are not being taught, supported, or utilized by the schools and districts where undergraduates are placed for practicum experiences (Biesta, 2007; Bryant, Fayne, Gavish, & Gettinger, 1980; Carnine, 1997).

The diversity of students in the United States' public education classrooms is the third undeniable challenge in preparing enough "highly qualified" special educators. Throughout the country, public schools are filled with children having different cultural and ethnic backgrounds, different levels of severity and type of disabilities, and different levels of English language proficiency. In the fall of 2002, there were nearly six million students with disabilities being served in the United States. Out of these students 48.3% were diagnosed with learning disabilities, 18.7% with speech or language impairments, 9.9% with mental retardation, and 8.1% with emotional and behavioral disabilities (26th

Annual Report to Congress, 2004). The ethnic make-up of schools is increasingly diverse as well: the current total public school population is 57.9% White, 19.2% Hispanic, 17.3% African-American, 4.5% Asian, and 1.2% American Indian students (NCES, 2004). The increasing numbers of students with limited English proficiency is another concern. Currently, there are 3 million students or 7% of the school-aged population considered to be English Language Learners (ELLs) (NCES, 2001). Special education teacher preparation programs have difficulty keeping pace with these ever-increasing numbers of students with multiple learning needs.

Confronting these pre-service special education teacher preparation issues is a complex endeavor that will require multiple points of focus. One area of focus must be on ways to effectively prepare teachers to possess the pedagogical skills and content knowledge to address the varying needs of a diverse student population in content area learning. A promising approach for accomplishing this task at the pre-service level is to embed content area instruction within application-based instructional frameworks in these special education teacher preparation programs. Yet, researchers must be aware that any such frameworks within a pre-service special education teacher preparation program are not targeting one area of teacher professional development but multiple ones. Teacher candidates enter preparation programs with different levels of self-efficacy in content area instructional abilities, different attitudes about content area learning, different grasps on content-related pedagogical knowledge and its application, and different amounts and forms of content area knowledge. To this end, the current research study evaluated the instructional implications of using one such content area instructional framework, the Developing Algebraic Literacy (DAL) model, within a special education

teacher preparation program, exploring its possibilities for affecting change across the aforementioned areas within teacher candidates.

Theoretical/Conceptual Framework

The current study has its foundation in a constructivist framework. Within this type of study, the researcher implements numerous means of collecting data that incorporate multiple facets of a given problem. Using the data collected, the investigator works to interpret the data and gain an understanding of the research question by employing the many types of information gathered to facilitate the understanding and meaning-making process by comparing new information to what is already known (Cronje, 2006). According to Bruning (1995), constructivism involves “selecting information and fitting it with previously known knowledge structures”. Darling-Hammond (2000) presents this constructivist framework in an educational context. She describes the ideal modern teacher as “one who learns from teaching rather than one who has finished learning how to teach” (170). This developmental social constructivist approach to pre-service teacher preparation envisions teacher candidates constructing their instructional abilities, not through simple coursework and knowledge memorization, but directly through application-based teaching experiences, where beginning classroom situations help teacher candidates understand learning needs and grow in their instructional capabilities in future situations. Darling-Hammond (2000) indicates that teacher candidates’ construction of new instructional understandings and competencies are facilitated by an inquiry based approach to learning teaching skills. Teacher candidates’ employ this systematic inquiry through observations of their instructional impact and reflection on this impact to develop future teaching practice (Darling-

Hammond, 2000). The current study employed this developmental social constructivist approach to pre-service teacher preparation using an applied instructional framework within a special education teacher preparation program, with the goal of observing and evaluating the influence of the instructional framework on factors that have been identified in the literature as pertinent to successful pre-service professional development in content area instruction.

One factor related to teacher success in content area instruction, which has received attention in the literature, has been self-efficacy, the belief teachers have about their ability to bring about possible student outcomes (Enochs, Smith, & Huinker, 2000). In general academic studies of self-efficacy at the college level, it has been found that “the stronger the students’ beliefs in their efficacy, the more occupational options they consider possible, the greater the interest they show in them, the better they prepare themselves educationally for different career pursuits, and the greater their persistence and success in their academic coursework” (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996, p. 1206-1207; Betz & Hackett, 1986; Lent, Brown, & Hackett, 1994). At the in-service education level, high perceptions of self-efficacy correlate with positive teaching behaviors “such as persistence on a task, risk taking, and use of innovations” (Enochs, Smith, & Huinker, 2000, p. 195). Czerniak (1990) found that teachers with high levels of self-efficacy correlated with teachers’ use of student-centered and inquiry based learning, while teachers with low levels of self-efficacy were more likely to employ teacher lecture and passive student learning activities. Although self-efficacy among teachers appears to be important, the current culture of accountability and high stakes testing may have a negative impact on teachers’ sense of self-efficacy because the stressors associated with

this culture negatively impact teachers' abilities to function at their instructional best (Puchner & Taylor, 2004). Indeed, the development of flexibility and resiliency to sustain teaching self-efficacy appears to be an important area of emphasis for pre-service teacher preparation programs at the moment. In the current study, self-efficacy towards teaching mathematics was an area of inquiry when evaluating the experience of pre-service special education teacher candidates during the implementation of the DAL mathematics instructional framework.

Another factor that has received attention in the literature is teacher candidates' attitude towards and beliefs about the subject area of instruction (Charalambous, Phillipou, & Kyriakides, 2002; Dwyer, 1993). An individual's feelings about a specific body of knowledge can significantly impact the person's approach to dealing with that set of information. Negative teacher perceptions of a content area can result in it having reduced instructional time, student engagement in learning activities, and instructional decision-making, which can result in lowered student achievement. Positive teacher perceptions of the same content area can result in enhanced student achievement because of increased time spent on the same variables (Ernest, 1991). As Hersh (1998) asserts, knowing teachers' attitudes and beliefs towards mathematics instruction is essential because it impacts the way they present mathematical concepts since "the issue is not what is the best way to teach mathematics, but what mathematics really is all about" (13). The role that teacher preparation programs can have in cultivating positive teacher attitudes towards mathematics is defined by the University of Maryland System (1993) as the "development of professional teachers who are confident teaching mathematics and science using technology, who can make connections within and among disciplines, and

who can provide an exciting and challenging learning environment for students of diverse backgrounds” (p. 3-4). Dwyer (1993) suggests two primary ways for teacher preparation programs to collect these attitudinal data, “through observing subjects and/or by asking subjects what they believe” (p. 4). Therefore, it was important to consider the possible changes in teacher candidates’ attitude towards mathematics instruction during the implementation of the DAL instructional framework.

A third relevant factor is the degree to which pre-service teachers are exposed to and provided opportunities to apply effective pedagogical practices. For special educators the development of instructional knowledge is indeed a multi-faceted endeavor. Integrating special education instructional knowledge with specific content strategies, such as those practices from mathematics education, is challenging. As professionals prepared to work with students who have behavioral and learning difficulties, special education teachers must learn research-based instructional strategies for enhancing educational experiences for learners with disabilities in general, but at the same time have intimate knowledge of the strategies that particularly facilitate content specific learning in areas such as mathematics (Maccini & Gagnon, 2006). Among these accepted practices are slower-paced and more structured presentations of learning concepts; multiple modalities for instructional presentations including visual, auditory, and kinesthetic; memory aids including word books, acronyms, and classroom routines; explicit instruction with modeling; strategy instruction; graphic organizers for visual information display and organization; continuous student progress monitoring; and moving from more concrete to more abstract concepts in sequencing instructional progression (Allsopp, Kyger, & Lovin, 2006; Baker, Gersten, & Lee, 2002; Gagnon & Maccini, 2001;

Kortering, deBettencourt, & Braziel, 2005; Maccini & Hughes, 2000; Witzel, Mercer, & Miller, 2003; Witzel, Smith, & Brownell, 2001). When students with learning disabilities study mathematics, these strategies assist them in comprehending and retaining mathematics information.

As Cawley, Parmer, Yan, and Miller (1996) found, students with learning difficulties do not typically learn concepts in a sequential path of increasing difficulty, but in an erratic, gap-ridden course, where retention difficulties are problematic. Specifically in the area of algebra, students with mild disabilities often struggle with the abstract nature of the symbols and notation associated with this higher level mathematics where Witzel, Smith, and Brownell (2001) recommend the use of manipulatives to tie the abstract concepts of algebra to more concrete materials. Interventions that teacher candidates' learn in their teacher preparation programs can increase their knowledge level of instructional strategies, which can positively impact their future students' mathematics outcomes (Ashton & Crocker, 1986; Darling-Hammond, 2000). Relative to this research study, changes in teacher candidates' instructional knowledge of mathematics were evaluated during exposure to the DAL framework.

Ideally, teachers who gain instructional knowledge will transfer this information to the application stage, where they translate their instructional knowledge into actual practice. The nature of professional development practices that effectively support this important transformation has received some attention in the literature. The amount of time available to prepare teachers is one variable that seems to be important. As stated by Nougaret, Scruggs, and Mastropieri (2005), one of the greatest challenges in special education teacher preparation is having enough time within programs for teacher

candidates to transfer that instructional knowledge in the academic sense to knowledge that can be implemented flexibly in actual instructional situations in the classroom. A review of the literature by Darling-Hammond, Chung, and Frelow (2002) found that the more time and intensity spent in coursework, practicum, and student teaching, the better prepared individual teacher candidates believed they were to take on the challenges of their own classrooms.

Golder, Norwich, and Bayliss (2005) found another variable was experience with individualized instruction. Teacher candidates who were placed in school settings to teach special education students one-on-one within a larger classroom situation demonstrated improved understanding of individual student learning needs, enhanced levels of content knowledge, and increased abilities in differentiating instruction through this individualized experience. However, key areas that were reported as needing enhancement were the university-school partnership, university supervision and communication, and university guidance on school-based assignments. One goal of the current investigation was to evaluate the experience of teacher candidates with the instructional application aspect of the DAL framework. As teacher candidates implemented this mathematics framework in the practicum site, it was observed if and when teacher candidates were able to transfer mathematics strategy instruction knowledge to actual application. The researcher provided ongoing support to teacher candidates to facilitate linkages between instructional understandings and application on site, as well as maintained an open dialogue with school site administration on teacher candidate and student performance.

One of the issues in transferring pedagogical knowledge to pedagogical application is the ability of teacher candidates' to understand the underlying components of the instructional strategies well enough to implement strategy steps consistently with fidelity. According to Smith, Daunic, and Taylor (2007) fidelity is "a critical factor in determining the efficacy, effectiveness, and successful dissemination of an educational practice...ensuring that the professionals who are responsible for its implementation deliver an intervention under study with accuracy and conformity" (122). Fidelity to an intervention or framework's model is the primary way to ensure that students are consistently being exposed to the same instructional elements when a new intervention is being evaluated for its effect, applicability, and outcomes.

The idea of fidelity is integral to understanding if an intervention under investigation is responsible for increased student knowledge. Interventions that are implemented continuously and consistently with fidelity have more justification for positive student outcomes, than those outcomes being due to outside sources (Bellg et al., 2004). A key part of designing and implementing any instructional framework that will be utilized in pre-service professional preparation is developing a viable means of monitoring teacher candidates' ability to implement that instructional framework with fidelity (Duchnowski, Kutash, Sheffield, & Vaughn, 2006). For this particular study, a fidelity measure was used to monitor teacher candidate application of the DAL framework. Fidelity checks using this instrument served a dual purpose. The first was to evaluate the teacher candidates' abilities to transfer information learned about the framework to actual application. The second was to facilitate researcher understanding

of the possible relationship between student outcomes and teacher candidate implementation, if any such relationship exists.

Finally, for a framework to enable special education teacher candidates' successful instruction in the content area of mathematics, specifically elementary level algebraic thinking, there must be a mechanism for assisting teacher candidates' in obtaining proficiency in the concepts and skills for instruction. With many instructional frameworks, future teachers are expected to pick up on desired core concepts through implicit instruction and learning activities. However, in research done by the United States Department of Education (2003), a dual emphasis is advocated for teaching pre-service teachers pedagogical knowledge and subject area content explicitly. According to Boe, Shin, and Cook (2007), special education teacher education programs that concentrate on these areas of teaching intensively, have resulted in enhanced teacher preparation outcomes for future special education teachers in dealing with the formidable instructional and subject area challenges they will meet. Future teachers need not only pedagogy, but the nuts and bolts of the curriculum they must teach (NCLB, 2001). Being prepared to educate within the standards-based learning environments of the twenty-first century is imperative for all teacher candidates. The current investigation employed an initial intensive training workshop that split instruction between the content knowledge of algebraic thinking and pedagogical techniques for struggling learners. As the study progressed, ongoing training was incorporated on content matters, with the teacher candidates provided with informational PowerPoints and handouts on the content area being taught.

By grounding this exploration of the DAL framework for mathematics instruction within the context of change in teacher candidate self-efficacy, attitude, instructional strategy knowledge and application, and content knowledge, the viability of the specific instructional framework was explored. Observing DAL's application across multiple domains was considered essential to cultivating a successful framework for use in preparing future teachers, who in turn promote positive student learning outcomes. Understanding teacher candidates' experiences with the DAL model along multi-faceted lines was the core to constructing the researcher's understanding of a complex educational issue through its component parts (Cronje, 2006; Darling-Hammond, 2000).

Purpose

The purpose of the current study was to investigate teacher candidates' exposure and responses to the Developing Algebraic Literacy (DAL) instructional framework within a second semester professional development experience for undergraduate special education teachers. The scope of the investigation encompassed several elements of teacher preparation involving: 1) feelings of self-efficacy in mathematics instruction; 2) attitude towards mathematics instruction; 3) instructional knowledge and application of mathematics-based pedagogy; and 4) content knowledge for mathematics instruction. The study probed the viability of using a systematic mathematics framework, specifically in the content area of elementary level algebraic thinking, with pre-service special education teacher candidates. Through its implementation, the study aimed to inform the limited amount of knowledge currently available on preparing special educators to teach mathematics to struggling learners.

Research Questions

Overarching Question

The following research question was addressed through the current study:

What changes related to effective mathematics instruction for struggling elementary learners, if any, occur in teacher candidates during implementation of the DAL instructional framework in an early clinical field experience practicum for pre-service special education professional preparation?

Major Inquiry Areas within the Research Question

The following inquiry areas broke the research question down into investigational components:

- 1.) What changes, if any, occur in special education teacher candidates' feelings of self-efficacy about teaching mathematics from the beginning to the end of a pre-service instructional experience using the DAL framework?
- 2.) What changes, if any, occur in special education teacher candidates' attitudes towards mathematics instruction from the beginning to the end of a pre-service instructional experience using the DAL framework?
- 3.) What changes, if any, occur in special education teacher candidates' understanding of instructional strategies for struggling learners in mathematics from the beginning to the end of a pre-service instructional experience using the DAL framework?
- 4.) What changes, if any, occur in special education teacher candidates' application of instructional strategies for struggling learners in mathematics

from the beginning to the end of a pre-service instructional experience using the DAL framework?

- 5.) What changes, if any, occur in special education teacher candidates' content knowledge of elementary mathematics, including algebraic thinking, from the beginning to the end of a pre-service instructional experience using the DAL framework?

Significance of the Study

The current study provides information that informs special education teacher preparation at the undergraduate level in several capacities. First, teacher candidates were provided with an initial intensive workshop, as well as continued training throughout the semester through ongoing seminars that touched on issues related to DAL implementation and content area knowledge in mathematics. At the same time, researcher support was given to teacher candidates in the context of ongoing DAL implementation and collaboration with school site personnel. Through these measures within the study, the capability and viability of providing pre-service professional development in an ongoing and developmental manner received targeted investigation.

Furthermore, since the DAL framework was taught and applied within the context of special education coursework and practicum experiences, integration of special education and content specific instructional practice was evaluated. Traditionally, mathematics content is taught within mathematics education courses, while general instructional techniques for students with disabilities are taught within special education specific courses. By meshing the two areas in the current study, future opportunities may

be widened for integrating both areas within special education teacher preparation programs.

Lastly, since most courses are taught in the university setting, separate from the applied setting (i.e., schools), the DAL model research provided insight into the possibilities of constructing teacher preparation experiences that link course instruction to applied school experiences explicitly. Along this investigational line, information was gathered on a special education teacher preparation experience that employed coursework application imbedded in fieldwork experiences. To this end, this final element of investigation showed promise in indicating whether structured opportunities for learning and practice can scaffold increased usage of instructional strategies, through establishing a direct linkage between knowledge acquisition and implementation.

Definition of Terms

“Highly Qualified” Teachers. According to NCLB (2001), “To be deemed highly qualified, teachers must have: 1) a bachelor's degree, 2) full state certification or licensure, and 3) prove that they know each subject they teach” (sec. 1119). Existing teachers can achieve “highly qualified” status by going through a state-approved alternative method called, High, Objective, Uniform State Standard of Evaluation (HOUSSE).

Attitude. This term is defined as the emotions, feelings, and beliefs held by a teacher in regards to a particular subject area or instructional task, with a corresponding set of particular behaviors that the teacher enacts based on a specific emotional, feeling, or belief trigger.

Self-Efficacy. This dispositional concern involves the level of teachers' beliefs in their own instructional abilities and actions as adequate vehicles to effectively convey content knowledge to students.

Content Knowledge. These specific skills are the abilities and guidelines associated with a particular academic subject. It is these concepts, through instruction, that educators aim to teach students to increase their academic achievement.

Algebra. This set of skills is advocated by the National Council of Teachers of Mathematics (NCTM) as pertaining to the Algebra Standard of mathematics curriculum. Skills included within the standard are: "understanding patterns, relations, and functions; representing and analyzing mathematical situations and structures using algebraic symbols; using mathematical models to represent and understand quantitative relationships; and analyzing change in various contexts" (NCTM, 2000).

AYP. This acronym stands for Adequate Yearly Progress, which is the amount of academic progress that students are expected to make within one year with appropriate instruction. Schools must show that students with disabilities are meeting established goals for academic progress during one academic year through alternative measures when these learners do not meet criteria for state-mandated standardized assessments (NCLB, 2001).

ELLs. These students are known as English Language Learners (ELLs) because they speak a language other than English as their first language. A student is considered an ELL when he or she is in one of the acquisition stages of English language speaking and writing skills that is not yet considered comparable to typical English-speaking

classroom peers and requires supplemental educational services beyond what is offered in the regular education classroom.

Students At-Risk. Learners with this designation are ones not necessarily labeled with a disability categorization, but they could have one. Students given this label are ones that because of environmental, economic, language, or learning difficulties are considered vulnerable for having difficulty in achieving academically at the same level and at the same rate as their learning peers. Targeted instruction may result in students' not needing identification for or being removed from special education services.

Learning Disabilities. These disabilities are ones that impair the normal cognitive functioning required for basic academic tasks. This group of disabilities results from deficits in sensory, processing, or memory difficulties within a student of normal intelligence. Determination of learning disabilities is typically diagnosed through the completion of intelligence and achievement testing, indicating a significant discrepancy between a student's actual intellectual ability level and the level at which that student is currently able to achieve.

Sensory Deficits. These deficits include impairments in one or more of the senses, affecting auditory, visual, or tactile detection of information, which impedes learners from integrating sensory information from their environment within cognitive processing functions.

Processing Deficits. These difficulties impair learners' abilities to break down information into understandable pieces once that information has been activated through one of the sensory channels. The information still enters the brain from sensory functions but learners have difficulty in making meaning out of this information and then

formulating responses to it. Students with this type of disability benefit from strategies targeted at helping them break down and make sense of the information they acquire from their multiple senses.

Memory Deficits. These problems are associated with the long-term and short-term retention of information that has been obtained through sensory functions and processed through cognitive mechanisms. Another prevalent memory difficulty is with “working memory”, which is the ability of students to readily retrieve learned information for usage during application situations. Students with memory deficits benefit from the usage of memory aids for retention and retrieval of information.

Fidelity. This term is typically used when discussing the degree to which an intervention or framework is implemented along the guidelines of its designed instructional steps. Fidelity is deemed important for successfully employing interventions or instructional frameworks so they will result in the most positive student outcomes possible.

Application-Based. This idea involves any piece of knowledge that is not only retained by a teacher candidate, but applied by that pre-service teacher in a specific learning situation that involves taking the knowledge gained through instruction and employing it with actual learners in the classroom.

Developmental Social Constructivist Approach. This approach to teacher preparation is advocated by the work of Darling-Hammond (2000), and focuses on teacher candidate learning experiences that construct new instructional knowledge and abilities by building on previously learned educational ideas and practices. In the course of growth and development through structured coursework and field experiences, teacher

candidates' professional practice is established through the social interactions of instruction, collaboration, and active learning activities.

Sunshine State Standards. These standards are the State of Florida's curriculum guidelines that structure public school instruction in grades K-12. These standards provide teachers a framework for instruction with students in the general education classroom, with suggested modifications for diverse learners. These standards are the interpretation of federal mandates for curriculum advocated by *NCLB* (FDOE, 2008).

Title I Schools. These schools receive additional funding from their particular school districts because their student economic levels are below that of the district mean. When a school has 40% of its students below its district's socioeconomic mean, a school will be designated as Title I and will be given additional funding by its district to organize, fund, and facilitate programs that will benefit all students in attendance at the school (DOE, 2007).

Delimitations

The current study contained certain deliberate limitations. The participants for the study were selected based on their Level II Cohort status within the Special Education Department at a research university, which limited the individuals eligible for participation in the study. At the same time, the study also situated all teacher candidate participants inside one Title I school setting within a large urban school district in the southeastern United States. This placement was made for the manageability of the many teacher candidate participants with the time resources of the researcher, as well as the prior established partnership between the particular Title I school and the university's Special Education Department.

Limitations

Results of the study have been interpreted cautiously in view of several potential limitations. First, instrumentation posed a threat to validity. To alleviate these threats, the chief quantitative instruments employed in this study were three surveys that had previously established normative reliability and validity information. Moreover, multiple instruments were employed to collect information pertaining to the research questions, rather than relying on one measure. Additionally, for qualitative data collection, focus group probes developed by the researcher were focused on key ideas targeted in the quantitative research instruments, attempting to secure additional perspectives on an underlying core set of ideas related to teacher preparation. Triangulation was used with both quantitative and qualitative data as a strategy to address potential limitations of individual measures. Another possible threat was maturation, because during the 10 week period of the study, it would be expected that teacher candidates would experience growth in all areas of the study: self-efficacy, attitude, instructional knowledge and application, and content knowledge. However, since all teacher candidate participants were progressing through the program with the same coursework and during the same time frame, maturation would be expected to occur concurrently across teacher candidates, evenly distributing this effect across all participants.

A third possible source of validity concerns pertain to testing effects. Since the quantitative survey instruments were employed multiple times in the study, at pre-test, midpoint, and post-test, it is thought possible that teacher candidates' responses may have been impacted by the number of times the surveys were administered and the short period of time between these administrations. To combat this threat to validity, quantitative

surveys, while employed, were supplemented by qualitative information gathered through focus group responses, case study analyses, and evaluation of teacher candidate produced artifacts from the experience of this application-based intervention. Fourth, student absences may have impacted individual teacher candidates' abilities to connect their training in the DAL framework with its actual implementation with students. To minimize the impact of student absences, each teacher candidate was assigned two students for remediation using the DAL framework to provide for multiple applications of the framework each week, or allow for at least one application per teacher candidate each week in the case of one student's absence. Fifth, observation and evaluation bias were considered additional possible threats to validity. To address the observational bias, multiple observers were trained in the DAL framework with the teacher candidates, and these observers made observations of teacher candidates using a structured fidelity checklist. Additionally observers spent time together observing teacher candidates applying the framework, until 90% agreement was reached between observers. With evaluation of teacher candidates' test question responses, three independent raters also judged all teacher candidate test responses. Then, the raters regrouped and reviewed individual student response ratings for discussion and agreement purposes with the same 90% agreement level used. With focus group responses, the researcher also completed frequent member checks to ensure that teacher candidates' responses adequately portrayed their feelings and ideas.

Organization of Remaining Chapters

The remaining chapters explain the current research in more detail. Chapter 2 provides an overview of the federal and state impetus for improving special education

teacher preparation, as well as provides further depth in the exploration of the elements of self-efficacy, attitude, instructional knowledge and application, and content area knowledge as essential components of a pre-service special education teacher preparation program. The development of the DAL and its accompanying contextualized application library, the Algebraic Literacy Library (ALL), are also presented. Chapter 3 provides information on the study's methodological construction. Chapter 4 reports both quantitative and qualitative data collection results. Chapter 5 provides a discussion of the study's results, and research implications and recommendations for future research.

Chapter 2

Review of the Literature

Overview

Investigating the usage of a framework for teaching mathematics within an undergraduate special education teacher preparation program involves multiple facets of exploration. The professional development of these pre-service teachers involves the complex interaction of several variables. Preparing teachers to instruct learners who are at risk for difficulties in mathematics involves not only the instructional strategies necessitated by these students' learning needs, but also specific pedagogy targeted at acquiring mathematics content knowledge. Teacher candidates themselves must be trained in the skills and abilities associated with their specific subject area for instruction. To help students achieve successful outcomes in content area learning, such as in mathematics, teacher candidates must have an understanding of the underlying concepts associated with the subjects to be taught. Future teachers also bring with them dispositional characteristics, such as feelings and beliefs about the content of mathematics, pedagogy surrounding mathematics, and learners' aptitude in regards to mathematics that can impact their instructional effectiveness (Beswick, 2006; Dwyer, 1993; Seaman, Szydlick, Szydlick, & Beam, 2005). Thus, dispositional concerns surrounding teacher candidates' approach to instruction are also a viable dimension for study along with content area and instructional knowledge.

In addition to discussing professional development elements surrounding teacher candidates, this review also analyzes the research related to the proposed framework for mathematics instruction and its corresponding application library, the Algebraic Literacy Library (ALL). The current framework under investigation for pre-service special education teacher development, the Developing Algebraic Literacy (DAL) model, incorporates research-based elements relevant to educating diverse learners. It also includes distinctive linkages between what is known about systematic reading instruction and algebra instruction, which is the framework's targeted mathematics content area. Embedded within the DAL model is the use of a "context" for learning algebra, another concept taken directly from the research on reading and learning engagement (Blachowicz & Fisher, 2006; Chamberlain & Leal, 1999; Gipe, 2006; Hill, White, & Brodie, 2001; Richardson & Miller, 1997). The purpose of the DAL framework is to facilitate the acquisition of basic algebraic skills for struggling learners in mathematics at the elementary grade levels, using the integration of mathematics, reading, and special education pedagogy. Through the employment of the DAL in a special education teacher preparation experience using a structured, developmental social constructivist approach, the goal of this study was to evaluate teacher candidates' experiences with and responses to: feelings of efficacy about mathematics, attitudes towards mathematics, comprehension and usage of mathematics-based pedagogy for struggling learners, and mathematics content knowledge surrounding algebraic thinking.

Literature Search

A review of the literature was completed through the usage of multiple search terms and databases found through the researcher's university library. The researcher

used the following search terms for literature location purposes in the Educational Resources Information Center Online Computer Library Center (ERIC OCLC), PSYC INFO, and Wilson Omnifile databases: “pre-service teacher preparation”, “professional development + special education”, “pre-service teacher preparation + special education”, “algebraic thinking”, “algebraic thinking + disabilities”, “algebra instruction + learning disabilities”, “mathematics instruction + disabilities”, “teacher attitudes”, “teacher + mathematics attitudes”, “teacher self-efficacy”, “teacher + mathematics self-efficacy”, “reading + algebraic thinking”, “algebraic thinking + assessments”, “algebra + statistics”, “algebra + achievement”, “elementary mathematics + assessments”, “elementary mathematics + algebraic thinking”, “learning engagement + reading”, “learning engagement + mathematics”, “Caldecott Award Winners”, “Caldecott + reading”, “teacher recruitment”, “teacher recruitment + special education”, and “student population + public schools.”

Federal and State Impetus

Recent federal improvement efforts in American public education have their roots as far back as *A Nation at Risk* (National Commission on Excellence in Education, 1983). This report brought American schools’ student failure statistics to the forefront of public consciousness. Amongst the reports’ findings, teacher preparation quality was cited as one of the pivotal areas influencing improved student outcomes (National Commission on Excellence in Education, 1983). *Goals 2000: Educate America Act* (1994) took the findings of *A Nation at Risk* (1983) to a new level, providing funding to “develop clear and rigorous standards for what every child should know and be able to do.” The legislation specifically allotted funding to improve teacher preparation by increasing

training and development opportunities through attending workshops, networking, observing, and collaborating (*Goals 2000*, 1994).

The *No Child Left Behind (NCLB)* and *Individuals with Disabilities Education (IDEA) Acts* have now taken teacher preparation one step further and focused it towards special education teacher professional development in the content areas (IDEA, 2004; NCLB, 2002). In its core provisions, *NCLB* has measures targeting improved student outcomes for all learners, while *IDEA* specifically focuses on learners with disabilities. Both pieces of legislation contain teacher preparation and quality standards that target teachers' proficiency in pedagogical and content area knowledge in an effort to increase student performance (IDEA, 2004; NCLB, 2002). Even though educators are afforded increased preparation opportunities under current mandates, accountability for student content learning primarily still falls on their shoulders. While educational law is formulated by the federal government, interpreted by the individual states, and operationalized by the districts, educators must still find their own workable methods and tools for meeting all learners' needs within this demanding and rigid standards-based framework.

In 2004, Harvard University administered the *No Child Left Behind: The Teachers' Voice* survey, gathering a representative sample of teachers' views on *NCLB* (NEA, 2008). In this study, teachers from California and Virginia, were asked to share their thoughts on the key tenants of the *NCLB* legislation. The findings from this research indicated that teachers believe more funding is needed for increased resources, including curriculum and instructional materials. Other comments suggested a need for increased administration quality for leadership in instructional matters, as well as more

time for collaborating with experienced teachers. Enhanced teacher commitment and increased professional support for teachers within low-performing schools were also seen as high priorities (NEA, 2008). Rebell and Wolff (2008) from *The Campaign for Educational Equity* at Teachers College, Columbia University, assert along the same lines that NCLB still needs to actualize the number of “highly qualified” teachers. They indicate that urban and minority students, more so than other learners, tend to have teachers that are not “highly qualified.” These researchers advocate an increase in instructional resources and support for teachers at schools designated as “needing improvement.”

Content Area Learning

At the forefront of the standards movement and increased teacher preparation is a focus on student achievement gains in reading and mathematics. Public education is driving students of all levels and abilities to learn more, at faster rates, and with fuller depth than in past decades (*IDEA*, 2004; *NCLB*, 2002; *NRP*, 2000). This reality requires researchers and educators alike to more comprehensively examine those aspects of content specific learning, like elements of mathematics and reading, which are critical to success for struggling learners. To this end, researchers and educators should not be reluctant to look across content areas to learn from relevant successes and failures. For example, much might be learned about how to more effectively teach mathematics by examining recent advances in reading instruction (Jamar & Morrow, 1990; Sherwood, 1991; Von Drasek, 2006). In reading, the emphasis is on phonemic awareness, which is considered the building blocks of more advanced arenas of fluency and comprehension, necessary for written content understanding throughout the lifetime (Mercer & Mercer,

2005; NRP, 2000). In mathematics, a similarly relevant area might be algebraic thinking. In contrast to the common thinking that algebra is the manipulation of numbers and symbols that is emphasized in high school Algebra courses, algebraic thinking actually spans the K-12 mathematics curriculum targeting higher order and critical thinking skills (Cai, 1998; Carpenter & Levi, 2000; Kaput & Blanton, 2000; NCTM, 2000).

Algebraic thinking integrates number and number sense (i.e., one's understanding of what number represents and how numbers relate to one another) with the processes of analysis, reasoning, prediction, and problem solving (Gersten & Chard, 1999). Much like the interrelation between phonemic awareness, the ability to understand and manipulate the sounds of spoken language, and phonological awareness, the ability to apply phonemic awareness to print, these two important components of algebraic thinking are building blocks to greater mathematical understanding and awareness. The development of number sense is similar to the development of phonemic awareness because number sense, like the spoken word, is key to the language of mathematics. Understanding how the elements of mathematics "language" can be manipulated to represent different ideas is critical to mathematical comprehension. Using these understandings to analyze, reason, predict, and problem solve are akin to making meaning out of print in reading for the development of literacy skills. One can begin to communicate and therefore think mathematically when these skills are utilized with algebraic thinking, developing mathematics literacy (Gersten & Chard, 1999; Kaput & Blanton, 2000; NCTM, 2000).

To help their students develop such competencies in mathematics, teachers must integrate these important components of algebraic thinking within a framework that incorporates effective mathematics instructional practices. This study incorporated such a

framework for teaching algebraic thinking for struggling learners: the Developing Algebraic Literacy (DAL) model. The DAL framework takes the idea of algebraic thinking one step further, to be called “algebraic literacy”, defining competency in algebraic skills as an actual form of literacy just as comprehension is in reading.

An important component of the DAL model is the use of narratives that situate algebraic thinking concepts/skills within meaningful contexts. The Algebraic Literacy Library (ALL), a library of award-winning children’s books was used for this purpose. The integration of the DAL framework and the ALL represents a trans-disciplinary approach to presenting, redefining, and reinforcing the basic skills necessary in algebraic literacy, providing a context for student engagement in meaningful problem solving across cultural backgrounds and disability designations. The focus of this study was on the pre-service teachers’ implementation of this instructional process during a 10 week early clinical field experience that integrated features of a developmental social constructivist approach to teacher education, and the instructional framework’s possible influences on pre-service teachers’ development in the areas of self-efficacy and attitude towards mathematics instruction; pedagogical knowledge and application in mathematics instruction; and content area knowledge surrounding algebraic thinking concepts when teaching students at-risk for difficulties in mathematics.

Diverse Populations

A pedagogical framework such as the DAL has potential for improving mathematics outcomes for struggling learners, particularly given the current classroom climates in our schools. The classrooms of today look much different than the ones of yesterday. Twenty years ago, the student population in most areas was demographically

over 70% White students (Fry, 2006). Today, the situation has undergone phenomenal evolution. According to Richard Fry from the Pew Hispanic Research Center, in the 2005-06 school year, the population of Hispanic individuals composed 19.8% of the total student population in schools nationwide. This figure is a 7% jump in just 10 years, considering that Hispanic individuals made up just 12.7% of the school-aged population in the 1993-94 school year. In terms of African American students, the number has not jumped but maintained and grown slightly, rising from 16.5% in the 1993-1994 school year to 17.2% in 2005-06. In the same 10 year period, the population of White students in public schools has fallen from 66.1% to 57.1% (Fry, 2006). With these population changes, and current overall population distributions across the country, administrators and teachers have to constantly be rethinking curriculum with innovative materials and educational strategies to meet the needs of this new national student body, which is distinctly heterogeneous compared to the relatively homogeneous learners of 20 years earlier.

This call for diversified pedagogy is not just a suggestion, it is an urgent cry. In 1994, the *Goals 2000: Educate America Act* was first enacted with \$105 million assigned to improve educational outcomes on eight national goals, one of which was to increase the high school graduation rate to 90% across the country's population. While overall growth has been seen through graduation rates in the total public school population rising to 73.9% in the 2002-03 school year (CCD, 01-02, 02-03), students from minority backgrounds have not had the same positive story. In 2001, the average graduation rate for African American students was only 56% and for Hispanic students merely 52% (the Manhattan Institute, 2007). Graduation rates across the national student

population continue to be dismal, and the story may currently even be worse than the numbers show because of the lack of standardization across districts and states in collecting high school graduation and drop-out rates.

At the same time, schools are being held accountable for the reading and mathematics outcomes of students with disabilities more so than in previous years. Considering the wide variety of disabilities and the multiple ways these disabilities can impact learning for students, this current practice may seem unfair to both educators and students with disabilities alike (Gagnon & Maccini, 2001; NCTM, 2000; NRP, 2000). However, many of these learners are in the general education classroom for the majority of their instructional time, learning the same ideas and concepts as their general education peers. In fact, according to data from the 2002-03 school year, there are approximately six million students with disabilities being served in public schools, with over three million of these same students integrated into the regular education classroom for over 60% of their academic instructional time (*26th Annual Report to Congress*, 2004).

Many disability advocates welcome an emphasis on accountability for students with disabilities. For years, students with disabilities were warehoused within special classrooms in schools, where educational emphases were placed on behavioral targets while students atrophied academically. Students were not exposed to content rich environments that led to positive adult outcomes from their educational experiences (Thompson, Johnstone, Thurlow, & Altman, 2005; Wagner, Newman, & Cameto, 2004). Consistent exposure to the general education curriculum is changing this situation for learners with disabilities, and opening up opportunities for instruction that could be targeted to meet all students' learning needs within the general education classroom

(Herman, 2007; Kozik, 2007). To this end, the DAL framework has been constructed, not only incorporating instructional practices that span both reading and mathematics education, but also enveloping best practices for teaching students with diverse learning needs, including mild disabilities. While the primary focus of inquiry in this study is the DAL's possible effects when used within a developmental social constructivist approach to pre-service preparation for special educators, the DAL's influence on these students' achievement is also of high interest.

Professional Development

Increasing student outcomes is one of the primary reasons why professional development for teachers at the pre-service and in-service levels is receiving increased attention nationally. This development has come under increased scrutiny since an influential report by the United States Department of Education (USDOE) (2002) indicated that college programs targeting the preparation of future teachers have little to no impact on future educators' readiness and performance in their first classrooms. While this information caused pre-service teacher development to withstand closer scrutiny, it opened the door for further research, since the USDOE based its findings primarily only on the data provided from Title II reports of higher education colleges and universities. In the same year, Darling-Hammond and Young (2002) reviewed the empirical research base more extensively surrounding teacher preparation and discovered indications contrary to that of the USDOE study. These researchers found evidence that the impact of teacher preparation depends on several factors including duration, target skills, and professional experiences of the preparation (Darling-Hammond & Young, 2002). Programs that were structured to cultivate well-prepared educators "to teach

subject matter, develop curriculum, and handle classroom management” involved university experiences that included integrated programs that focused on instructional techniques, as well as subject matter to be taught (Boe, 2007, p. 159). Teacher candidates with programs that involved “extensive preparation in pedagogy and practice teaching obtained a much higher level of full certification” than others entering the teaching field (Boe, 2007, p. 168). Darling-Hammond, Holtzman, Gatlin, and Heilig (2005) also found that teachers who were certified produced student achievement results that were higher than their uncertified education peers. In a study conducted by Sands, Duffield, and Parson (2007), findings showed that when teacher candidates’ progress was not closely monitored by staff and targeted feedback was not given on progress, teacher candidates’ learning outcomes varied by individual student.

In better understanding the role of pre-service professional development on future special education teachers, the work of Darling-Hammond (2000) sheds light on the fundamental elements of constructing preparation programs that result in well-prepared teacher graduates. Darling-Hammond reviewed the professional development literature over the last 30 years and determined that even with teacher preparation, as imperfect as it may be, it had resulted in “fully prepared and certified teachers” that were “generally better rated and more successful with students than teachers without this preparation” (2000, p. 167). She also indicated that content area instruction had been influenced by teacher preparation “in fields ranging from mathematics and science to vocational education, reading, elementary education, and early childhood education”, and she asserted that “teachers who have greater knowledge of teaching and learning are more

highly rated and are more effective with students, especially at tasks requiring higher order thinking and problem solving” (Darling-Hammond, 2000, p. 167).

When investigating the weaknesses in pre-service teacher preparation programs, Darling Hammond (2000) cited several key issues, including the problematic time limitations on four-year preparation; the fracture between content knowledge and instructional coursework; the separation between college coursework knowledge and school-based application of this knowledge; the deficiency of systematic instructional methods taught to and employed with teacher candidates in a clinical setting; and the lack of overall resources provided to teacher preparation programs through their colleges of education. Instead of just indicating problems, Darling-Hammond (2000) provided solutions that are viable to colleges and universities. These ideas focus primarily on internal teacher candidate change through the developmental social construction of new knowledge based in the establishment of understandings and practice in education. Darling-Hammond (2000) pulls on the work from Dewey (1929), which calls on institutions of higher education to “empower teachers with greater understanding of complex situations rather than to control them with simplistic formulas or cookie-cutter routines for teaching” (p. 170). Dewey’s work calls for inquiry-based learning in teacher preparation, where teachers cultivate their instructional decision-making based on their own knowledge and application of teaching practices (1929). Darling-Hammond takes the work of Dewey a few steps forward, advocating teacher inquiry that targets student learning outcomes. Through this reflection on practice, she asserts that teachers will better understand individual learning differences, develop instruction that reaches all learners, and view knowledge from the multiple perspectives that learners bring to

today's classrooms. As Darling-Hammond (2000) indicated, teacher change through pre-service professional preparation is a developmental constructivist endeavor that must be targeted at the areas of teacher self-efficacy, attitude, and content knowledge, as well as pedagogical knowledge and practice.

Self-Efficacy

Within the context of pre-service teacher preparation programs, professional development experiences can occur within coursework, fieldwork, and supervised teaching experiences. Therefore, these areas can be targeted for the development of relevant competencies. Some aspects of teacher preparation are within the control of teacher educators, while others are not. For example, future teachers bring with them attitudes, experiences, and behaviors that stem from their life experiences and that might negatively impact their development as effective teachers. Such aspects cannot be controlled but some can be reasonable targets for change (Enochs, Smith, & Huinker, 2000). One of these domains is teacher candidate feelings of self-efficacy about teaching (i.e., instructional self-efficacy).

Instructional self-efficacy includes the feelings and beliefs that teachers have about their abilities to teach and provide information to students that enhance student learning of core skills and abilities surrounding a particular subject (Allinder, 1995; Enoch, Smith, & Huinker, 2000). Heightened levels of teacher self-efficacy have been linked to increased student learning outcomes. In a study conducted by Czerniak (1990), teachers with higher self-efficacy were more likely to employ instructional techniques that were varied and met the learning needs of their students to a greater extent compared

to teachers with lower feelings of self-efficacy, who tended to struggle more with presenting content area material and having students retain that material.

According to Bandura, Caprara, Barbaranelli, Gerbino, and Pastorelli (2003), self-efficacy plays a crucial role in many life functions, not just instructionally:

Perceived self-efficacy plays a pivotal role in this process of self-management because it affects actions not only directly but also through its impact on cognitive, motivational, decisional, and affective determinants. Beliefs of personal efficacy influence what self-regulative standards people adopt, whether they think in an enabling or debilitating manner, how much effort they invest in selected endeavors, how they persevere in the face of difficulties, how resilient they are to adversity, how vulnerable they are to stress and depression, and what types of choices they make at important decisional points that set the course of life paths. (p. 769).

Hagerty (1997) maintains that self-efficacy is so integral to teaching and learning that it is “the key element in student achievement of individual classroom tasks and mastery of subject matter in all disciplines” (p. 1). Bruning, Shraw, and Ronning (1999) characterized teachers with high levels of self-efficacy as better serving the diverse learning needs in classrooms. They described these teachers as better at structuring learning time that was adequate for all learners, more consistently employing effective behavior management strategies, and more often using praise for student efforts.

Attitude

Another construct that relates to teachers’ instructional effectiveness is attitude towards instruction. Attitudinal considerations are especially important for prospective special education teachers. Many times teachers who instruct learners with disabilities face additional challenges compared to regular education teachers, because these students require increased depth of instruction and greater teacher understanding about the impact instructional practices have on the students’ learning needs (Maccini & Gagnon, 2006;

Witzel, Smith, & Brownell, 2001). These children also typically need repeated exposures, a structured learning environment, and more time for understanding and processing key ideas (Allsopp, Kyger, & Lovin, 2006). Therefore, individuals who choose to work with these types of learners need to possess a positive and committed attitude towards these students with exceptionalities in light of the many instructional challenges involved. Many times these students have also been made to feel unwanted or inferior in the general education classroom, and special education teachers have the increased task of dealing with significant behavior and self-esteem issues in addition to instructional/learning needs (Montague, 1997). A positive teacher attitude towards the content area of instruction can result in equally positive student feelings about themselves in connection with that specific content area, as well as stave off teacher burnout (Mercer & Mercer 2005; Singh & Stoloff, 2007)

According to White, Way, Perry, and Southwell (2005/2006), researchers typically agree that:

- students enter teacher education programs with pre-existing beliefs based on their experience of school;
- these beliefs are robust and resistant to change;
- these beliefs act as filters to new knowledge, accepting what is compatible with current beliefs; and
- beliefs exist in a tacit or implicit form and are difficult to articulate (p. 36).

As a result, these researchers assert “that negative beliefs may contribute to negative classroom teaching strategies, which may in turn contribute to negative pupil beliefs,

attitudes and performance outcomes. If these pupils then go on to become teachers, a cycle of negativity may be created” (White et al., 2005/2006, p. 36).

Pre-service preparation programs aim to target and change attitudes that might interfere with instructional success, before these non-productive attitudes have the chance to impact students’ classroom achievement. Beswick (2006) has identified several features of professional development programs in mathematics education that have been found to affect change on attitudes about both instruction and the content area of mathematics. These features include: “having pre-service teachers actually engage in doing mathematics, increasing awareness of and encouraging reflection on the students’ own beliefs, encouraging reflection on their own practice teaching, the use of collaborative group work, and providing alternative models for mathematics teaching” (Beswick, 2006, p. 37). For pre-service special education professional development programs to successfully target and change negative attitudes towards mathematics instruction, an awareness of prevalently held attitudes towards mathematics instruction must be cultivated, as well as knowledge of research-based efforts to enhance positive attitudes towards this subject’s instruction accumulated.

Content Knowledge

The development of teacher subject area content knowledge is a third important component of teacher preparation. The mathematics content knowledge level of many special education teachers is particularly lacking, especially at the elementary level. According to Matthews and Seaman (2007) teachers at the elementary level often have multiple gaps in content knowledge, including the mathematics subject area. These gaps can have considerable impact on student performance when these teachers cannot

accurately convey important concepts to students in their classrooms (Matthews & Seaman, 2007). In several studies completed by researchers over the last two decades, it has been shown that most mathematics teachers at the elementary level possess only procedural knowledge (i.e., computation) for such concepts as fractions, decimals, and integers, rather than the conceptual knowledge that underlies these algorithmic procedures (Adams, 1998; Fuller, 1996; Stacey, Helme et al., 2001; Zazkis & Campbell, 1996). Interestingly, this reality appears to be more pronounced for teachers in the United States. For example, Ma (1999) found that when American teachers were compared with Chinese educators responsible for teaching the same content with story problems, American educators were 60-80% less likely to have the necessary understanding of these concepts than the Chinese teachers.

Elementary level special education teachers often possess less mathematics content knowledge than the general elementary level teacher, because of their programs' emphases on learning strategies and behavior management techniques over content knowledge (Mercer & Mercer, 2005). A key problem in effectively preparing teachers in mathematics content knowledge is the lack of time devoted to coursework in mathematics and mathematics education (McGowen & Davis, 2002). Indeed, McGowen and Davis (2002) suggest that educators must keep in mind "what is theoretically desirable for a content area course for pre-service teachers versus what might be practically obtainable in one or two semesters" (p. 1). Teacher preparation in mathematics must simply require more than the typical one or two courses in mathematics education because content knowledge in mathematics takes a great deal of time to experience and cultivate (McGowen & Davis, 2002).

To give a broader view of the breadth of this content area problem, Darling-Hammond (1997) presents disparities in levels of teacher preparation when looking at teacher's content knowledge from a state to state perspective. Some states, typically in the Southern and Western United States, had more than 50% of their mathematics teachers without even a minor in mathematics, while other states, typically in the Northeast, had a mere 15% of their mathematics educators without this credential. Strutchens, Lubienski, McGraw, and Westbrook (2004) discovered that this statistic varied across student ethnicity as well. They found that amongst eighth grade students, 80% of White students had teachers whose certification included secondary level mathematics, while only 72% of Black and Hispanic students had teachers with the same level of preparation.

On the positive side, teachers who do currently complete preparation in mathematics are being exposed to mathematics content knowledge at levels not seen in earlier times. Hill and Lubienski (2007) discuss how teachers are now being provided with two types of mathematics content knowledge: common and specialized. Common knowledge refers to the basic mathematics concepts and ways to compute answers, while specialized content knowledge incorporates multiple ways to represent and solve mathematics problems using both manipulatives and other representations (Hill & Lubienski, 2007).

With respect to the algebraic thinking area specifically, teachers typically enter professional development programs holding understandings of algebra skills taken from high school algebra courses. However, teachers are better prepared to convey algebraic learning to their students as abstract representations used in problem solving if their

professional development facilitates the more global skills involved in algebra than simply the variables and equations taught in Algebra I (Stump & Bishop, 2002). When teachers understand that algebra encompasses patterns, relations, and functions, along with representing and solving mathematical equations, as well as analyzing change in different situations, they are equipped with the content knowledge needed by their students for more complete algebraic understanding (NCTM, 2000).

Pedagogical Knowledge

Pre-service special education professional development in mathematics instruction certainly should emphasize more than content knowledge. It must also emphasize the development of teachers' knowledge and application of best instructional practices. This pedagogical knowledge is multi-faceted in the case of algebraic learning for struggling students. These learners usually respond best to instructional methods similar to ones used with students diagnosed with learning disabilities (Garcia, 2002; McKenna & Robinson, 2005; Mercer & Mercer, 2005). While not all students who are at-risk will eventually be identified with a disability, many will. Those students, who are at-risk for other reasons, including English language learning and socioeconomic risk factors, can also benefit from instruction targeting individuals with learning disabilities because this pedagogical approach differentiates instruction for individualized learning needs (Garcia, 2002). Thus, instructing struggling students in algebraic thinking necessitates knowledge about general methods for teaching students with disabilities, knowledge about general effective mathematics instructional methods, and knowledge about effective algebraic instructional methods (Jamar & Morrow, 1990; Maccini, McNaughton, & Ruhl, 2000; Mercer & Mercer, 2005; Swanson, 2001).

When addressing the learning needs of students with disabilities, there are a few core pedagogical principles to keep in mind. First, students with learning disabilities, typically have difficulties in one or more academic areas. These areas differ by student, and there is no one template for disability manifestation. Difficulties can include problems with cognitive processing, metacognition, attention difficulties, and perceptual problems (Mercer & Mercer, 2005). As a result, instruction for these learners must incorporate many different ways of assisting these students in accessing and understanding curriculum. Amongst the strategies advocated for usage with struggling learners are visual organizers, hands-on and varied materials, explicit instruction, modeling, scaffolding, mnemonic devices, multiple exposures to concepts, and strategy instruction (Fuchs & Fuchs, 1998; Mercer & Mercer, 2005; Schumm & Vaughn, 1991; Swanson, 2001).

Visual organizers present information using multiple modalities. They not only incorporate oral information, but present concepts in a visual format. These organizers do not just provide the information for students to see, but also use forms of diagramming and illustration to make connections between target concepts and previous learning, as well as target concepts and applications in every day life (Meichenbaum, 1977; Swanson, 2001). Using varied hands-on and manipulative materials is another instructional strategy that is imperative with learners who have difficulty with academic tasks. Using materials that are high-interest and tangible helps enhance student learning by engaging the students in the learning task, and making new ideas less abstract and more concrete for student comprehension (Mercer & Mercer, 2005).

Explicit instruction, modeling, and scaffolding are all instructional techniques that deal with how teachers construct their presentation of material for struggling students (Kameenui, Jitendra, & Darch, 1995; Palinesar, 1986). Many students in the general education classroom are asked to pick up on instruction implicitly through classroom interactions and activities. For students with additional learning needs, this form of instruction is not always successful because many students need specific concepts taught directly to them through explicit instruction. As a result, employing explicit instruction using a direct teacher explanation of learning concepts, does not leave students who have academic difficulties guessing at target learning ideas (Mercer & Mercer, 2005; Swanson, 2001). Modeling results in even more powerful student outcomes when connected with explicit instruction, because teachers not only explain to students exactly how to break down and access learning targets, but they physically show students how to complete academic tasks. Many students benefit from this visual demonstration, where teachers can use talk-alouds, showing not only the skill but explaining their thought process when working on that particular skill. After explicit instruction and modeling is completed by the teacher, many struggling students still need scaffolding, where independence in learning tasks is facilitated by gradually lessening levels of teacher support (Ellis & Lenz, 1996; Lenz, Ellis, & Scanlon, 1996). At-risk students are often not successful if they are allowed to simply take on academic tasks on their own after just teacher-directed instruction. These situations oftentimes result in student failure, which can cause learners to doubt their abilities as students and lead to a cycle of learned helplessness, where these learners give up on academic tasks before hardly trying them (Mercer & Mercer, 2005). Using the three-part instructional process of explicit instruction, modeling, and

scaffolding can increase students' knowledge acquisition and their abilities to retain and implement their new learning skills.

A great number of students with learning disabilities have difficulty processing and retaining concepts. Their teachers must use a variety of instructional strategies to facilitate this processing and retention. One such method is the mnemonic device. According to Nagel, Schumaker, and Deshler (2003), this instructional strategy helps students access and remember learned information by tying the concept to a mental image, keyword, or first-letter mnemonic device, which reduces strain on memory faculties. Another method that assists learners' content retention is multiple exposures to learning material. Many times struggling students cannot process and retain information that is only presented to them once or twice. These learners need a variety of activities with a particular learning concept, so that they become comfortable with the academic content presented and cannot only recite learned information but be able to flexibly apply and use that new knowledge (Scruggs & Mastropieri, 1994). A last method that can assist struggling students with learning new material is strategy instruction (Borkowski, Weyhing, & Carr, 1988; Graham & Harris, 1996). Learners in the general education classroom are expected to possess many internal metacognitive strategies that assist them in monitoring their own abilities on specific learning tasks. However, many struggling learners have not developed these mechanisms and do not possess these abilities. Teaching these learners strategies for monitoring their own thinking during learning tasks, as well as teaching them strategies for best acquiring information, has a significant positive impact on these students' abilities to comprehend new information (Borkowski, Estrada, Milstead, & Hale, 1989; Levin, 1996; Miller & Seier, 1994; Swanson, 2001).

There is a large array of instructional strategies that can be employed with struggling students in a general sense; but at the same time, these strategies can also be employed in conjunction with content specific techniques for these learners. According to Miller and Mercer (1997) learners who struggle with mathematics often have difficulties attending to details of algorithms; visual-spatial concerns that impact numerical operations; auditory processing deficits that negate abilities to follow multiple part mathematics directions or sequences; and memory concerns that can impede the retention of mathematics basic facts and more complicated algorithms. Mathematics instruction for struggling learners, like instruction in general for these students, must be multi-faceted in nature. While the aforementioned instructional practices can facilitate the enhancement of learning outcomes in general by targeting students' learning characteristics, there are also instructional practices specifically advocated for the mathematics content area for these students (Allsopp, Kyger, & Lovin, 2006; Mercer & Mercer, 2005). Strategies for mathematics instruction that have a strong research base include teaching big math ideas, using peer-assisted instruction, implementing a concrete-representational-abstract (CRA) sequence of instruction, employing authentic contexts, facilitating structured language experiences, and conducting continuous monitoring of student progress (Baker, Gersten, & Lee, 2002; Kronsbergen & Van Luit, 2002; Mercer & Mercer, 2005; Miller, Butler, & Lee, 1998).

First, teaching big math ideas is important for learners at-risk for failure because they oftentimes need to see the greater mathematics picture to understand how new mathematics learning targets fit into a larger scheme of ideas (Mercer & Mercer, 2005). This presentation format helps students make sense of overarching concepts, thereby

assisting students to see the bigger picture, how concepts are connected, before having to worry about grasping the smaller nuances of instruction (Allsopp, Kyger, & Ingram, n.d.). Peer-assisted instruction has also shown itself to be helpful to students at-risk for mathematics difficulties (Allsopp, 1997; Fantuzzo, Davis, & Ginsburg, 1995; Fuchs, Fuchs, Phillips, Hamlett, & Karns, 1995; Kroesbergen & Van Luit, 2002). This strategy has struggling students work with other learners in their classrooms to facilitate learning mathematics-related ideas. This instructional practice has individuals who understand key mathematics instruction work together with others who may struggle with the same material. Both students gain from this group work because the student who has mastered the concepts is able to internally reinforce that knowledge through explanation and example, while at the same time the student who struggles with the content is able to gain clarification, practice, and a comfortable work environment for gaining new mathematics skills (Baker, Gersten, & Lee, 2002; Kroesbergen & Van Luit, 2002; Mercer, Miller, & Jordan, 1996).

The CRA sequence of instruction builds off the general strategy of using hands-on materials, but it takes this instruction to a new level, offering a graduated progression of skills from concrete to representational to abstract (Allsopp, Kyger, & Lovin, 2007; Baker, Gersten, & Lee, 2002; Mercer & Mercer, 2005; Miller & Mercer, 1997; Witzel, Mercer, & Miller, 2003). In the CRA sequence, concepts are first presented with tangible concrete materials. Once problem-solving is mastered at this level, the student is exposed to the same mathematics ideas at the representational level through pictures and drawings. After students have gained the ability to solve problems with these representations, the targeted learning concept is finally taught using abstract numbers and

symbols. Employing this method, students are moved towards understanding a given concept using an incremental systematic process (Kroesbergen & Van Luit, 2002; Mercer & Mercer, 2005).

Using authentic contexts is another way to facilitate creative problem-solving abilities in struggling students (Allsopp, Kyger, & Lovin, 2006; Bottge, Heinrichs, Chan, & Serlin, 2001; Kroesbergen & Van Luit, 2002). With this type of mathematics learning, students are presented with learning situations which have meaningful problems for student solutions. This strategy facilitates learners' engagement in mathematics tasks, as well as assists students in understanding the particular situations that call for certain forms of application-based problem-solving (Mercer & Mercer, 2005). Another strategy, structured language experiences, opens up an element of mathematics understanding that is currently advocated by NCTM (2000), but is difficult for struggling learners to access (Montague, 1997). Mathematics standards are currently structured so that students are asked to not only understand how to solve specific mathematics problems and compute answers accurately, but how to explain and justify their problem-solving process. Some students naturally pick up these skills from mathematics dialogues that happen in the classroom; however, students at-risk for mathematics failure rarely do (Allsopp, Kyger, & Ingram, n.d.; Allsopp, Kyger, & Lovin, 2007). Providing structured language experiences allows these students opportunities to practice writing and talking about new concepts in specific ways with teacher guidance. Students are therefore given support in developing these mathematics' communication abilities (Montague, 1997).

A final strategy for increasing mathematics learning outcomes is continuous student progress monitoring (Calhoon & Fuchs, 2003; Collins, Carnine, & Gersten, 1987;

Kline, Schumaker, & Deshler, 1991; Porter & Brophy, 1988; Stecker, Fuchs, & Fuchs, 2005). In mathematics, this progress monitoring is exceptionally important, because skills are oftentimes cumulative in nature, with early learning building towards later, more complex concepts. Teachers must track struggling students' progress through concepts carefully, so that gaps or particular areas of struggle are pinpointed early on with learning new concepts. Through continuous progress-monitoring, teachers can observe where individuals are succeeding and where they need additional help, and as a result they can target instruction to the specific needs and areas of each learner (Allsopp, Kyger, & Lovin, 2006).

While many of the above general mathematics strategies can be used for instruction in algebra, Gagnon and Maccini (2001) have identified several areas of difficulty for students with learning and behavioral problems in mathematics specific to algebraic learning, which can be targeted for enhanced student outcomes in algebraic thinking:

- Difficulty in processing information which results in problems learning to read and problem-solve
- Difficulty with distinguishing the relevant information in story problems
- Low motivation, self-esteem, or self-efficacy to learn due to repeated academic failure
- Problems with higher level mathematics that require reasoning and problem-solving skills
- Passive learners – reluctant to try new academic tasks or sustain attention to task
- Difficulty with self-monitoring or self-regulation during problem-solving

- Difficulty with arithmetic, computational deficits (p. 8)

Witzel, Smith and Brownell (2001) also advocate three principles for teaching algebra to students with disabilities, including:

1. Teach through stories that connect math instruction to students' lives.
2. Prepare students for more difficult math concepts by making sure students have the necessary prerequisite knowledge for learning a new math strategy.
3. Explicitly instruct students in specific skills using think aloud techniques when modeling (p. 102).

At the same time Gersten and Chard (1999) advocate a progressive approach to teaching number and number sense, which are the building blocks of algebraic instruction. They emphasize a constructivist approach that helps students with disabilities “(a) learn the conventions, language, and logic of a discipline such as mathematics from adults with expertise; and (b) actively construct meaning out of mathematical problems (i.e., try a variety of strategies to solve a problem).” Earlier research also can guide educators regarding effective algebra instruction for struggling learners. Case and Harris (1988) worked with students with learning disabilities whose problem-solving abilities benefited from “self instruction”, where students helped themselves in problem-solving by drawing pictures as part of their problem-solving methodology. At the same time, work by Bennett (1982) showed the benefit of using graphic organizers when instructing students on basic algebraic thinking information. Montague and Bos (1986) illustrated the benefits of strategy instruction for learners with disabilities in algebra when they used strategy instruction for multi-step algebraic problems. Students who had been taught specific strategies to solve problems in this

situation fared better than those individuals who had not been taught such skills. As can be seen, the instructional base of strategies for struggling learners in algebra skills is still developing, pulling from general pedagogy targeted to learners with disabilities, mathematics pedagogy for struggling learners, and algebraic specific instruction for struggling students.

Important factors surrounding professional development, including self-efficacy, attitude, content knowledge, and pedagogical knowledge and application specific to mathematics and learners who are at risk have been explored. An examination of the content and instructional practices involved in the DAL instructional framework, and its corresponding contextual library, the ALL, will be described in the next section. In this way, a better understanding of the possible utility of this framework within a pre-service special education teacher preparation program may be gained.

The DAL Framework

Algebra Background

Some educators may view arithmetic skills as the keys to mathematics success, but in the 21st century, students must possess much more than basic skills. Students must be able to think and reason mathematically. A core curriculum strand for developing this mathematical thinking is algebra. Algebra is a critical area that spans all domains of the NCTM (2000) standards and includes an interrelated maze of “algebras” which include algebra, algebraic thinking, algebraic reasoning, and algebraic insight. Having a firm grasp of this algebra-related terminology helps not only individuals using the DAL framework for instruction, but also any teacher who wants to help her students grasp algebraic concepts. As Kaput and Blanton mention, educators who have a strong

foundation in the algebra curriculum strand can actively work on “algebrafying” curriculum for enhanced mathematics learning for all their students (2000, p. 2).

To provide clarity to algebraic vocabulary, the terms algebra, algebraic reasoning, algebraic thinking, and algebraic insight are all centered on the same core ideals, but each encompasses definitively different aspects of developing students’ mathematical reasoning. To start, when most people speak about “algebra”, they are talking about the high school coursework at the Algebra I and II levels, which are usually taken in eighth or ninth grade and tenth or eleventh grade, respectively (Gomez, 2000). In this case, the word “algebra” refers to the curriculum taught in these two secondary classes, encompassing increasingly complex manipulations of unknowns and variables using symbols and equality signs across contexts (Gagnon & Maccini, 2001). However, there are times when people generically use the term “algebra” to refer to a circumstance when someone solves a problem using an unknown or variable quantity (Bass, 1999). This second situation leads to a muddying of the waters with definitions. In this second sense, it would be more reasonable to say the person is utilizing “algebraic thinking” to solve the problem. This situation is more aptly described as “algebraic thinking” because it uses students’ higher order thinking abilities to make models and represent problems with unknown amounts, rather than simply focusing on solving equations for specific variables (Austin & Thompson, 1997; NCTM, 2000). In many cases, “algebraic thinking” will be done by students much younger than eighth or ninth grade, who have not fully developed an understanding of the concept of “variable.” Many times with “algebraic thinking”, the foundational ideas of equation construction and solution identification are initiated and practiced for later exposures with Algebra I content.

This skill set incorporated under “algebraic thinking” is typically thought to develop from a base of competencies in arithmetic processes that are cultivated in the early elementary school levels and involve numerical computations where the entities in the problem-solving process are known (Austin & Thompson, 1997; Gersten & Chard, 1999). “Algebraic thinking” can evolve from arithmetic abilities because it is also a method of problem-solving, except with a more complex approach than with arithmetic skills alone. As “algebraic thinking” is learned, a student’s critical thinking and problem approach skills change from selecting computational processes for achieving answers to understanding and analyzing currently known data to determine missing outcome information (Ortiz, 2003; Radford, 2000; Urquhart, 2000; Zazkis, 2002). After some time and exposure to “algebraic thinking” based problems, “algebraic reasoning” may subsequently develop. While “algebraic thinking” is a way of approaching a problem, “algebraic reasoning” is the ability of students to take this learned approach and generalize it to new and sometimes more complex situations and problems (Lubinski & Otto, 2002). When teachers see students approaching novel mathematics problems, and finding methods and strategies to answer these unknown questions without prompting, they can ascertain these learners have internalized the concepts of “algebraic thinking” for application as their own problem-solving tool through “algebraic reasoning” (Morris & Sloutsky, 1995; National Center for Improving Learning, 2003).

This ability to think and use the tools of “algebraic thinking” readily for “algebraic reasoning” is vital not only for the success of students in Algebra I and II courses, but for many types of everyday problems that involve unknown entities and require critical thinking to mediate and plan solution paths. In fact, Pierce and Stacey

(2007) take algebraic ideas one step further with their vision of what they call “algebraic insight”, which they depict as having two central components. They assert that “first, it [algebraic insight] involves thinking carefully about the properties of the symbols being used and the structure and key features of each algebraic expression...secondly, algebraic insight involves thinking about the possible links between algebraic symbols and alternative representations” (Pierce & Stacey, 2007, p. 3). This idea of “algebraic insight” evolves as students progress from simply reasoning and thinking algebraically to the point of comprehending and utilizing the abstract symbol system involved in formal secondary algebra and beyond.

Algebraic Literacy

Now that the terminology surrounding algebra, as well as its importance has been clarified, a new term “algebraic literacy,” a key component of the DAL intervention, will be introduced and operationalized. For the purpose of this study, “algebraic literacy” is defined as a student’s accurate and consistent ability to use language to describe algebraic concepts; employ materials to illustrate concepts; utilize graphic organizers to show connections between target concepts and other learning; provide rationales to solve issues surrounding concepts; and use problem-solving and computation to answer questions on concepts. With the addition of “algebraic literacy” to the algebraic knowledge base, the goal is to give the algebra curriculum area a developmental context, which was heretofore not included. “Algebraic literacy” seeks to combine the underlying core skills that are desired for competency by the high school level, with an understanding that these algebraic skills will progress in degrees of abstraction and complexity as students’ progress in their mathematical education. As a result, like literacy in reading, “algebraic

literacy” should be cultivated from the earliest years in school so that by the secondary level that literacy is at an advanced level.

Role of Literacy in the DAL Framework

As mentioned earlier, parallels can be observed between the content areas of reading and mathematics, specifically algebra. One such parallel discussed previously is the connection between the building blocks of reading (i.e., phonemic and phonological awareness) and the building blocks of algebra (i.e., number and number sense). An instructional emphasis on these “building blocks” can help young learners develop understandings about reading and about algebra respectively. The DAL framework places an emphasis on developing number and number sense. The DAL framework also incorporates several effective instructional practices that are advocated in reading/literacy. Interestingly, most if not all of these instructional practices are also advocated in the mathematics education literature as well, albeit applied for the purpose of learning mathematics. The purpose is not to explicitly teach reading strategies per se within the DAL framework but to use literature and certain reading instructional practices to engage learners in problem-solving, making connections, and facilitating student retention of ideas and information. Literacy instructional practices used within the DAL framework are included in Appendix A.

The first literacy instructional practice incorporated in the DAL framework is promoting learner engagement using text. For learners, to be more interested, and thus more receptive towards instruction, research has found that educational attention needs to be focused on initial instructional activities that promote ideas that are relevant and meaningful to young children (Jamar & Morrow, 1990; Von Drasek, 2006; White, 1997).

With the teaching of reading, teachers never hesitate to pull out a colorful and exciting children's book to incite this engagement for reading tasks (Gipe, 2006; Richards & Gipe, 2006). In mathematics, reading one equation after another in a mathematics textbook or looking at groups of sticks, blocks, and shapes simply does not qualify as a high interest activity for grabbing most learners' attention, neither do these activities promote concentration on learning tasks related to algebra. Thus, the DAL instructional framework employs children's literature to incorporate what Von Drasek (2006) calls the "wow factor", where students' attention is captivated for algebraic learning through the usage of colorful children's books. In order to integrate learner engagement using text into the DAL framework, Caldecott Award winning books were selected. Specific Caldecott texts were chosen based on several criteria, and 20 selected books make up the initial Algebraic Literacy Library (ALL). The DAL framework incorporates the texts of the ALL to stimulate learner interest in problem-solving situations based on the stories' contexts.

The ALL consists of 20 books selected from Caldecott Award and Honor books from the 2000-2007 timeframe. These Caldecott books were specifically chosen for the ALL for two reasons. First, Caldecott books differ from other stories in terms of their connectedness between visuals and storyline. Each book's illustrations have to be integral in depicting and developing the storyline of the book at hand. A criterion for Caldecott Award winners is that they are distinguished from other books with pictures in that the illustrations essentially provide the child with a visual experience of the story (ALSC, n.d.). Second, because of the widely recognized importance of the Caldecott

Award, using these books in the library helps students become literate in the stories and tales that embody American culture.

From the original 33 Caldecott books from the 2000-2007 time period, literature was eliminated from the final library if the book had an absence of print; a revised version of a time-old fairy tale that was believed too familiar to be engaging; or a set of non-continuous poetry that did not lend itself to a complete storyline. Since many of the target students for the ALL are from multiple cultural backgrounds and disability categorizations, particular attention was paid to selecting books from this time period that did express ideas and information that were culturally relevant or representative of cultural differences and disabilities. Student engagement has a two-fold purpose in the final 20 Caldecott books: 1) gaining students' interest through reading, and 2) accessing contexts that are ripe for algebraic problem-solving. A complete listing of the ALL books is included in Appendix B, with a sample book guide that was provided for each ALL book for teacher candidates' instructional usage.

A second literacy instructional practice employed within the DAL framework, which also has shown results in mathematics instruction, is making connections between previous learning and new concepts currently being taught (Gersten & Chard, 1999; Gipe, 2006; NRP, 2003). Reading, as an academic area, is typically seen as cumulative in nature, with one core component building off of the next, with phonological awareness growing from phonemic awareness and implicit comprehension developing from explicit comprehension abilities, as just a couple of examples (NRP, 2003). For each reading ability listed in a scope and sequence chart of skills, a learner grasps concepts more clearly if he or she can relate that particular skill to its place in the spectrum of total

reading skills he or she has already learned (Mercer & Mercer, 2005; NRP, 2003). The same is true of mathematics, topics of earlier instruction are springboards for more complex mathematical learning (Allsopp, Kyger, & Ingram, n.d.; Lee, et al., 2004). By combining instruction in the DAL that employs literature with algebraic skills, teachers can spread a wider net to not only catch those students who can connect algebraic ideas to previous mathematics learning, but also those individuals who can be engaged in mathematics through their love and understanding of reading concepts.

A third literacy instructional practice infused within the DAL through the ALL is the idea of grasping the figurative “big picture” (Richards & Gipe, 1996). Many learners, who struggle with both reading and mathematics, benefit from an instructional situation where the main goal is to see the larger concepts within the scope of the lesson (Maccini, McNaughton, & Ruhl, 1999). While this strategy lends itself well to illustrated children’s literature, reading with any type of engaging children’s literature can stimulate children’s thinking about the larger issues or themes presented in the tale, rather than reflecting on the basic component parts of reading, such as word recognition, vocabulary, and story construction (Ouzts, 1996). At the same time, learners who struggle with mathematics often need the same format for beginning content presentation, to be introduced to new concepts more holistically or as larger mathematical chunks (Allsopp, Kyger, & Ingram, n.d.). Building off the larger ideas and themes gained through reading the award winning children’s literature, the DAL introduces the “big ideas” of algebraic literacy connected to the NCTM (2000) Algebra strands.

A fourth literacy instructional practice employed is active questioning while reading, which can be used in pre-reading, during reading, and post-reading activities

while using the ALL. If a learner simply picks up a book and begins reading it without preamble, vital reservoirs of a reader's potential interaction with the text are not accessed (Raphael & Pearson, 1985). Before a student begins reading, it is important the stage be set for the particular book by stimulating a learner's knowledge on the topic at hand. While reading, an individual also needs to have specific questions that he or she wants to answer by reading the text. After reading, it is essential the student ponders which of his or her questions was actually answered. If a student approaches a reading task in this active way, he or she will understand and gain much more content from the book read (Blackowicz & Fisher, 2006; Mercer & Mercer, 2005). With the DAL's incorporation of the active questioning strategy, the end goal is to create solid comprehension of the ALL story contexts for problem-solving. Student interest is gained through questions in the area for problem-solving; and as a result, students have increased clarity on the particulars of solving the specific problems tied to the learning context. In this way, student problem-solving is enriched, because a key barrier to problem-solving, understanding the problem situation, has been broken down.

A final literacy instructional practice used in the DAL is providing structured language experiences. McKenna and Robinson (1990) advocate such experiences by asserting that "to be literate in, say, mathematics is not to know mathematics per se but to be able to read and write about the subject as effective means of knowing still more about it" (McKenna & Robinson, 1990, p. 168). In this way, the basic language arts skills of reading and writing are presented as the chief instruments of developing literacy in specific content areas such as mathematics, not just as tools simply linked to the learning of English course materials. Moreover, in the words of Vogt and Shearer "clarity in

stating problems, use of concrete examples, analysis of abstract concepts, and application of concepts to next contexts”, illustrates a clear connection between reading communication capabilities and their possible application to the complexities of mathematics (2007, p. 137). Vogt and Shearer expound on not the skills of reading itself, but the desired outcomes of the reading task for the application purposes of understanding and then communication. This idea is particularly relevant because it is nearly identical language skills that are valued in the algebra area specifically (Allsopp, Kyger, & Lovin, 2006; Steele, 1999). Before their successful completion of secondary level Algebra coursework, students are required to state algebraic problems in their own words; utilize and understand materials and problems on a continuum of levels from concrete to abstract; and finally generalize learned skills to every day situations for utilization (Steele 2005; Witzel, Mercer, & Miller, 2003). Structured language experiences cultivated within the DAL framework provide opportunities for increasing deftness at communicating mathematically relevant ideas for algebraic understanding, affording much needed practice on these skills before the secondary level (Allsopp, Kyger, & Ingram, n.d.).

Mathematics Practices within the DAL Framework

The DAL framework’s target student population is struggling learners, who are having difficulties in mathematics. Therefore, the DAL employs mathematics instructional techniques targeted to learners with individual and complex learning needs, which are similar to the instructional methods used with students who have been diagnosed with a mild learning disability. These mathematics instructional practices are

integrated with the literacy instructional practices already described. Mathematics instructional practices used within the DAL framework are included in Appendix C.

The first mathematics instructional practice employed in the DAL, Concrete-Representational-Abstract (CRA), is at the center of the DAL's instructional activities. It has been found that learners who struggle with mathematics benefit from exposure to and work on new concepts along a continuum of incremental levels which progresses from actual tactile manipulatives, to pictures or representations, to abstract symbols (Gagnon & Maccini, 2001; Witzel, Mercer, & Miller, 2003). With the use of the CRA continuum, it is important to note that learners may progress at varying rates through the levels of materials depending on their rate of understanding, requiring more time with concrete objects with one particular concept for mastery while sailing through all three levels to abstraction for another concept's full grasp (Cai, 1998; Maccini, McNaughton, & Ruhl, 1999; Mercer & Mercer, 2005). Within the DAL model, the CRA sequence of instruction is used in all of the framework's steps to facilitate in depth comprehension of algebraic concepts.

A second core mathematics instructional practice involves authentic contexts for problem-solving. When students learn mathematics, or any academic subject for that matter, this learning is facilitated when centered on a situation with which students can draw connections (Jamar & Morrow, 1990). When children are presented problems, it is much easier for them to grasp the reason for the issue or difficulty at hand when the problem has circumstances that develop purposeful associations between the child and the problem. Not only does this context ease students' understanding of novel math problems, but it also stimulates students' motivation in solving the actual problems

because they are interested in the answers and outcomes of the problems (Kortering, deBettencourt, & Braziel, 2005). If students see reasons for solving the problems and are interested in them, their involvement with the problems will heighten their responsiveness to learning problem approaches and methodologies (Allsopp, Kyger, & Lovin, 2006). For the purpose of the DAL framework and this study, texts from the ALL were used to provide authentic contexts for algebraic problem-solving in all three steps of the DAL model.

A third mathematics instructional practice used in the DAL is explicit instruction, along with teacher modeling for problem-solving. Oftentimes, students who struggle with mathematics require very detailed explanations of how to solve novel types of problems, and it is difficult for them to attempt new problems based on a few written guidelines (Witzel, Mercer, & Miller, 2003). While these students benefit from written descriptions and visual demonstrations of problems, they also gain tremendously when teachers “walk through” sample problems of the type to be solved shortly by students. This modeling is particularly effective when the teacher utilizes “talk-alouds” to explain his or her thinking, as he or she systematically shows the execution of problem-solving steps (Maccini, McNaughton, & Ruhl 1999). In truth, some mathematics teachers themselves may be against the use of solely explicit instruction for algebraic learning because of their belief that this instructional format does not allow students to attempt strategies experimentally on their own for problem-solving (Witzell, Smith, & Brownell, 2001). This firmly held belief is the reason that while modeling and explicit instruction are instructional practices that can be utilized in the DAL model’s third step for teaching new skills, their usage is recommended in conjunction with other instructional practices

that promote risk-taking and experimentation. In combination with these other strategies, students are provided a supported learning environment that promotes access to multiple mathematics concepts and processes.

A fourth effective mathematics instructional practice integrated in the DAL framework is that of scaffolding instruction, which is a structured pedagogical methodology that moves students to greater independence with problem-solving in incremental steps (Mercer & Mercer, 2005). This graduated progression of comfort and competency in mathematics skills helps learners with mathematics difficulties progress mathematically from A to B to C rather than be expected to zoom from A to Z without support. Furthermore, within the framework of scaffolding, students' toolboxes of mathematics abilities can be enhanced with work on metacognitive strategies (Maccini, McNaughton, & Ruhl 1999). These strategies involve each student thinking about the information in a problem and understanding how his or her own thought processes work and can be employed in solving this problem. By cultivating this ability, the child is increasing his or her ability to answer novel problems correctly, because he or she is better equipped to monitor cognition about mathematics problems and how to find solutions to them (Gagnon & Maccini, 2001). Many students with disabilities and other diverse learning needs benefit from having metacognitive strategies modeled and their use scaffolded for them before they are able to incorporate them independently in problem-solving (Witzel, Smith, & Brownell, 2001). The DAL model uses scaffolded instruction explicitly in its third step to help build student abilities and independence in problem-solving.

A fifth effective mathematics instructional practice incorporated within the DAL framework is the usage of visual organizers (Baker, Gersten, & Lee, 2002; Swanson, 2001). Visual organizers include Venn Diagrams, flow charts, outlines, webs, classification trees, and sketches among others. Through the use of such tools, connections between previous mathematics learning and current learning targets can be drawn (Mercer & Mercer, 2005). Following instruction, such organizers can be used again to draw ties between what students have learned algebraically and applications in their everyday life. The success of these organizers is directly tied to the instructional ideals associated with struggling learners. First, these learners benefit from being exposed to instruction that uses multiple modalities, visual being one of these modalities. Second, these students also benefit from instruction where information and connections are explicit, and are not left for students to just discern through problem-solving (Kroesbergen & Van Luit, 2003). Visual organizers arrange information in a systematic way that specifically helps learners process concepts and see pathways through this clarity of presentation (Allsopp, Kyger, & Lovin, 2006). Within the DAL model, visual organizers are employed in the third step to illustrate connections between new learning objectives and previously learned ones, as well as connections between new learning and future learning areas.

The sixth effective mathematics instructional practice that the DAL framework incorporates is providing multiple opportunities for practice of algebraic and other mathematical concepts. Many times students appear to grasp mathematical concepts when these learning points are teacher-directed in class. Additionally, students can also seem to grasp concepts directly after they have been taught the new ideas and have

practiced one or two problems (Lee, Ng, Ng, & Zee-Ying, 2004). However, it is imperative that students are given many opportunities to apply newly developing mathematical understandings so that they become proficient with them and are able to use them efficiently, as well as retain them for the future (Allsopp, Kyger, & Ingram, n.d.; Mercer & Mercer, 2005; Witzel, Smith, & Brownell, 2001). Multiple opportunities for practice are incorporated throughout all three steps of the DAL framework.

The final effective mathematics instructional practice implemented within the DAL framework is continuous student progress monitoring, which is employed within the DAL framework as the basis of instructional decision-making for each session (Allsopp, Kyger, & Lovin, 2007; Allsopp, Kyger, & Lovin, 2006). During each student session using the DAL framework, student performance data are collected on the fluency and accuracy of problem-solving through the first step, Building Automaticity. During the second step, Measuring Progress, student information is also collected in terms of learners' abilities to read, solve, answer, and justify problem solutions to algebraic problems. Using these two forms of data from a session, teacher candidates make instructional decisions for their next instructional session (Kroesbergen & Van Luit, 2002). Student information that shows learner comprehension of concepts and independence of skill application will indicate to teacher candidates to move students ahead in the algebraic concepts to be taught. Student information that indicates learner inability to grasp concepts and/or difficulty applying these skills will be used as the basis for slowing down instructional presentation of material and revisiting currently taught concepts.

The Framework's Development

While the DAL framework is a relatively new model, it had been under development by a group of researchers from special education, mathematics education, and measurement for two years prior to the current study. In its first year of development, the DAL framework's three core steps were solidified: Building Automaticity, Measuring Progress and Making Decisions, and Problem Solving the New. Building Automaticity was established as the first step in the framework as a mechanism for students to revisit key concepts and skills that had been taught, and work towards proficiency in those areas. With the second step of Measuring Progress and Making Decisions, teachers were afforded a means of presenting multiple opportunities to evaluate students' use of the problem-solving process: read, represent, solve, and justify, and as a result discern learners' levels of algebraic concept understanding via CRA. Finally, Problem Solving the New allowed teachers the time and structures within each instructional session to present new algebraic ideas to students, focusing in on connection-making, communication, and integration of different problem-solving strategies. A visual conceptualization of the DAL model is included in Appendix D.

After over a year of development, the DAL framework was piloted with a group of students in a Title I school's summer program. With this group of learners, the DAL was first implemented with students of mixed elementary school levels, ranging from second through fifth grades. From this application, changes were made in several key components of the DAL. One such element was the DAL's skills assessment and scoring rubric. This evaluation was formulated on the basis of the four skill areas surrounding algebraic thinking advocated by NCTM (2000). After field-testing, additional items and

question types were added to this initial assessment to ensure the quality and quantity of questions employed to pinpoint target skills for the DAL's application with students. Upon field-testing, other changes were made in the DAL to facilitate ease of instructor usage, as well as implement structures better refined to meet student learning needs. Based on these changes, a finalized version of the DAL Initial Session Probe, included in Appendix F, and the DAL full session framework, included in Appendix G were developed. As the result of this previous research, the current study, while exploratory in nature because of its involvement of teacher candidates for the first time, has already incorporated a firm situation on instructional strategies grounded in current literature and practice, as well as refinement and revision as a result of its application with elementary level learners.

Through this review, the rich literature base for the current study, involving the DAL model's application with pre-service special education teacher candidates, has been highlighted. The professional development literature advocates application-based undergraduate teacher preparation programs that integrate coursework with structured and supported field work experiences that target teacher efficacy, attitude, and content knowledge, in conjunction with instructional knowledge and application. The mathematics and reading strategies unfold as integral tools in assisting struggling learners to better access the higher order concepts in mathematics, specifically targeting a new form of literacy, in this case algebraic literacy. In Chapter 3, the methodology of how the current study explores the DAL's implementation with undergraduate special educators is presented.

Chapter 3

Methodology

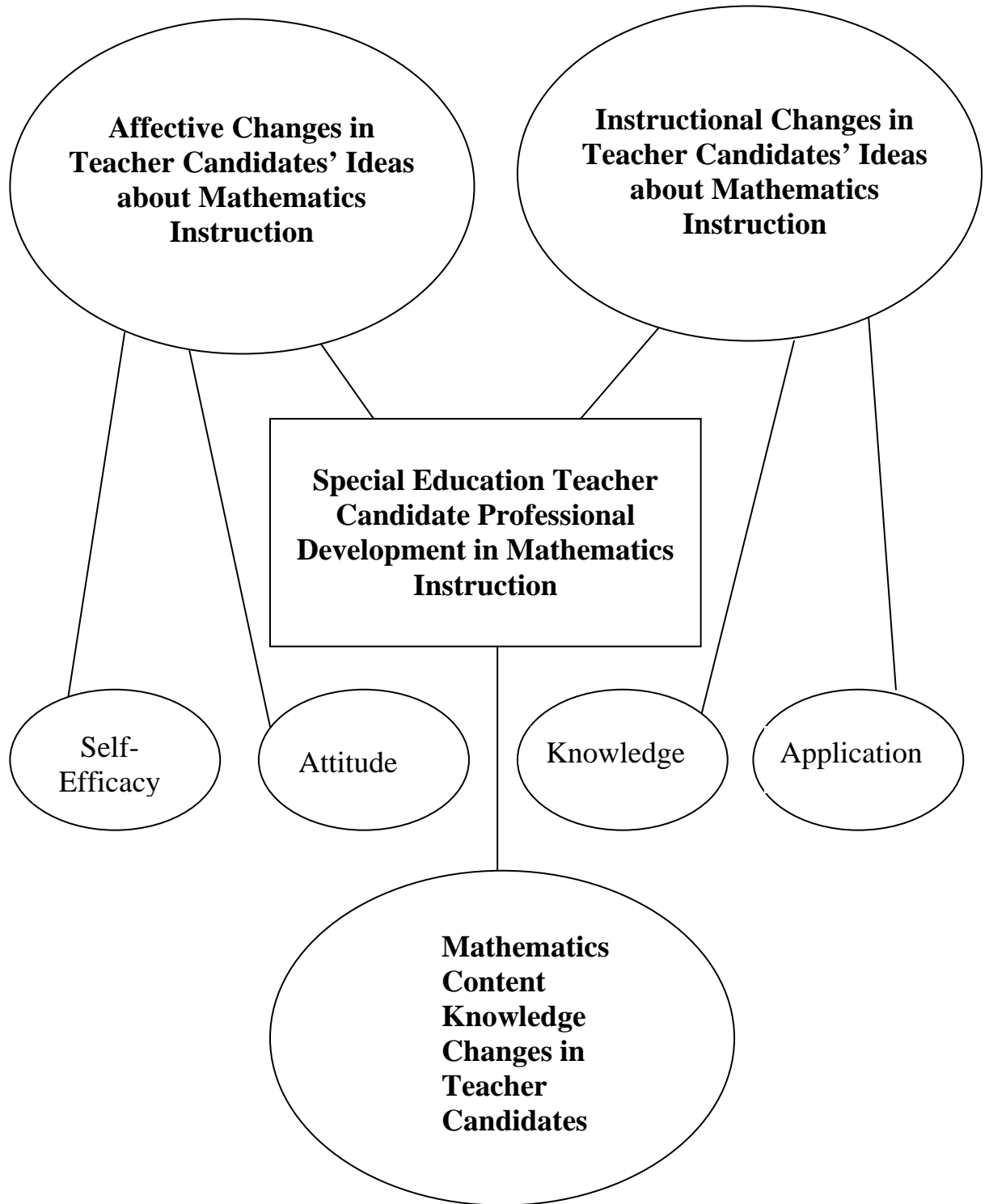
Introduction

This study, which used a mixed methods design, had the purpose of evaluating experiences of pre-service special education teachers when implementing a mathematics instructional framework for struggling learners (DAL) during an early clinical field experience, and determining how that framework and the support provided through a developmental social constructivist approach to teacher preparation may influence future teacher's professional development in several important areas. The setting of this study was a multi-campus, research university in the Southeastern United States and a Title I school site within a large, neighboring urban school district. At this particular university, the College of Education had undergone recertification by the National Council for Accreditation of Teacher Education (NCATE) in 2005. At the same time, the College of Education was ranked within the top 50 universities in the country for teacher preparation in 2007 (US New and World Report, 2007). As a result, the conceptual framework of the university's College of Education has been centered on the improvement of teacher preparation. To this end, this study was firmly aligned with the university's College of Education's role in developing exemplary pedagogical practice in higher education for the professional training of future classroom teachers.

Additionally, in the current political climate of accountability set by *No Child Left Behind* (NCLB, 2001) and the latest reauthorization of *IDEA* (2004), more than ever

colleges and universities are working towards the construction of education programs that are grounded in research-based pedagogy situated within specific content areas, such as reading and mathematics. In light of this emphasis and the “highly qualified” teacher mandate set forth by the above-mentioned legislation, this study was timely in that it addressed the important integration of research-based instruction within a critical content area, mathematics, for the purpose of improving the preparation of special education pre-service teachers. As illustrated in Figure 1, this research project’s primary goal was to investigate the experiences of pre-service special education teachers when implementing the Developing Algebraic Literacy (DAL) instructional framework for struggling learners within a highly structured early clinical field experience incorporating elements of a developmental social constructivist approach (Darling-Hammond, 2000) to teacher education. Outcomes measured included self-efficacy in teaching mathematics, attitudes toward teaching mathematics, knowledge of mathematics content, and understanding and application of research-based mathematics instructional practices for struggling learners, as shown in Figure 1.

Figure 1. Major inquiry areas.



Overarching Research Question

The following research question was addressed through the current study:

What changes related to effective mathematics instruction for struggling elementary learners, if any, occur in teacher candidates during implementation of the DAL instructional framework in an early clinical field experience practicum for pre-service special education professional preparation?

Major Inquiry Areas within the Research Question

The following inquiry areas broke the research question down into investigational components that were explored using both quantitative and qualitative research tools:

- 1.) What changes, if any, occur in special education teacher candidates' feelings of self-efficacy about teaching mathematics from the beginning to the end of a pre-service instructional experience using the DAL framework?
- 2.) What changes, if any, occur in special education teacher candidates' attitudes towards mathematics instruction from the beginning to the end of a pre-service instructional experience using the DAL framework?
- 3.) What changes, if any, occur in special education teacher candidates' understanding of instructional strategies for struggling learners in mathematics from the beginning to the end of a pre-service instructional experience using the DAL framework?
- 4.) What changes, if any, occur in special education teacher candidates' application of instructional strategies for struggling learners in mathematics from the beginning to the end of a pre-service instructional experience using

the DAL framework?

- 5.) What changes, if any, occur in special education teacher candidates' content knowledge of elementary mathematics, including algebraic thinking, from the beginning to the end of a pre-service instructional experience using the DAL framework?

Participants

This mixed methods study employed a convenient sampling technique by seeking participation from undergraduate teacher candidates enrolled in the Level II practicum within the researcher's Department of Special Education. Participants came from the Level II cohort, who began their enrollment in the Department of Special Education in the fall of 2007 and are expected to complete their professional preparation in the spring of 2009. Before participating in the study, all cohort members completed their Level I coursework and practicum, which included a foundational course in special education, a foundational course in mental retardation, a perspectives course on learning and behavior disorders, as well as a two-day weekly practicum connected with the two foundational courses. During the current study, Level II undergraduate teacher candidates participated in the following coursework linked to the Level II practicum:

Clinical Teaching in Special Education (*3 credits*)

Within this course, the focus involved "effective teaching principles, instructional management procedures, and specialized teaching techniques for exceptional students" (Department of Special Education, 2007).

Behavior Management for Special Needs and at Risk Students (*3 credits*)

The core competencies within this class were “techniques to prevent, analyze, and manage challenging and disruptive classroom behavior as well as teaching social skills” (Department of Special Education, 2007).

Both courses were linked to the Level II practicum through Key Assessments, which are departmental gate-keeping measures. These assessments evaluate teacher candidates’ progress in developing instructional/behavior management skills, professional dispositions, and field content knowledge through interactions and experiences with elementary level students. Through these key assessments students are required to demonstrate learned instructional skills, to synthesize information from various sources for the purpose of making instructional decisions, and to reflect on their professional practices. In actuality, passing the two Key Assessments in the Level II practicum is integral to teacher candidates proceeding to the final two semesters of their special education program. Individual students who do not achieve the pre-determined competency criteria are required to repeat the Level II coursework and practicum before they can continue with their program of study. As a result, the Level II student population was targeted because the Level II semester is considered a critical one in the development of pedagogical and content area knowledge for these future special educators.

The overall focus of the Level II Practicum is to provide teacher candidates with a variety of field experiences that assist them in understanding how to implement individualized instructional practices related to academic and behavior outcomes. During the semester of this study, teacher candidates participated in a clinical practicum at one school site on Mondays where they engaged in one-to-one academic instruction with

students struggling in reading and mathematics. Teacher candidates also completed a service-learning project as part of the Monday field experience. On Tuesdays, teacher candidates were assigned to individual elementary classroom sites at schools in the local school district. For this part of the Level II practicum, teacher candidates completed a behavior change project with a selected student in their particular classroom placement and assisted their supervising teacher throughout the day with instructional activities, classroom management, materials development, and other classroom and student needs. Teacher candidates participated in practicum throughout the full teacher work day on Mondays and Tuesdays (7:30am - 3:30pm). Therefore, teacher candidates worked with a variety of elementary level students in public school settings in one-on-one, small group, and whole class situations. This study was carried out during the Monday portion of the Level II practicum.

The Monday public school setting was a large, urban school district in the Southeastern United States with a diverse student body in terms of cultural, economic, and disability characteristics. This particular semester the anchor site for the Monday “clinical instruction” portion of the Level II practicum was a Title I school where 97% of students were of minority background, 95% of students were on “free and reduced lunch”, almost 10% of students were English language learners (ELLs), and 24% were students with disabilities (Hillsborough County Public Schools, 2007). Each teacher candidate engaged in individualized reading and mathematics instruction on Mondays at this school site.

Teacher candidates were initially assigned two reading students and two mathematics students for individualized instruction, and they continued to work with

these students throughout the semester unless their students withdrew from the school site. Engagement in reading preparation and instruction began at the beginning of the semester for teacher candidates using the University of Florida Literacy Initiative (UFLI) instructional framework, while mathematics preparation and instruction using the DAL framework began several weeks later. For the teacher candidates' preparation for DAL instruction, the initial training workshop and ongoing support mechanisms were structured using a similar format to that of the UFLI. This parallel form of preparation and support was followed because of UFLI's usage along developmental social constructivist lines within the Department of Special Education's Level II coursework and fieldwork experiences for at least three years. The DAL's usage within the practicum included a similar training and support sequence to the UFLI, employing the same developmental constructivist principles of meaning making through scaffolded and supported learning experiences.

The initial DAL intensive training workshop included an entire teacher-length day of presentations, discussions, and hands-on activities for learning the essential components of the algebra standard advocated by NCTM; understanding research-based instructional strategies for struggling learners; and comprehending the key steps and features of the DAL framework. For several weeks before teacher candidates began their own implementation of DAL instruction, ongoing follow-up seminars were provided for the last hour and a half of their Monday practicum day on DAL related training. Additionally, the researcher was available to teacher candidates for discussion, support, and questions all day every Monday during the training with and implementation of the DAL framework. These elements of intensive training workshop, active teacher

candidate involvement in the learning process, application of instructional framework, and university support during implementation were identical to that employed with the UFLI reading framework.

Elementary level students who worked with teacher candidates for 35-45 minute sessions weekly using the DAL framework were identified by their school's administration and teaching staff based on the criteria of being at-risk for failure in mathematics. "At-risk for failure in mathematics" was defined as having consistently received poor grades in mathematics courses or having scored a failing, or passing score of the lowest level, on the most recent state-mandated standardized mathematics assessment. Due to the particular anchor school site's 90% yearly transition and relocation rate for students, at least two elementary students were selected to receive instruction from each teacher candidate to ensure that throughout the entirety of the DAL model's application each teacher candidate would most likely have at least one student instructional session per week.

After teacher candidates began DAL instruction with these students, the researcher, as well as two university professors and three doctoral students who had attended DAL training, provided ongoing support to teacher candidates through observations with feedback, debriefing sessions, discussions, and probing questions. The researcher used a developmental social constructivist approach in structuring the supported DAL instructional experience, allowing teacher candidates to implement instruction; reflect, evaluate, and plan future instructional sessions based on learning experiences; collaborate with school personnel, other teacher candidates, and university support staff to make sense of instructional knowledge and application; and question their

understandings and experiences within the DAL instructional experience. The researcher was available to students within their Monday practicum experience, as well as through visiting the teacher candidates' Clinical Teaching course for additional support and questions.

Selection of Participants

During the study, there were originally 28 teacher candidates enrolled in the Level II practicum and coursework experience. From these 28 individuals, teacher candidates' participation was requested by the researcher within their Level II practicum and connected coursework. Out of these 28 teacher candidates, 27 agreed to participate and signed Institutional Review Board (IRB) approved informed consent forms. From the study's original 27 participants, five teacher candidates withdrew from or discontinued participation in the special education teacher preparation program during the semester, so were not included in the study's final participant group. Besides these five individuals, three other teacher candidates were excluded from the final participant group. One of these students exhibited extensive absences, and the other two teacher candidates experienced significant health issues over the course of the semester, being unable to complete course and practicum work along the same timeline as other participants. These three participants were all excluded from the study's final participant group because it was thought that their experience in the Level II cohort coursework and practicum did not represent that of the typical pre-service special education teacher. As a result, the study's final participant group contained a total of 19 individuals. In an effort to not unduly burden teacher candidates' workload, the researcher did not require the participants to

complete any projects or surveys that were not already considered a part of their requirements for Level II coursework.

From this base group of teacher candidate participants, three were chosen to have their DAL comprehensive experience and project performance evaluated as individual case studies. Selection criteria for case studies were determined by several factors. At the conclusion of the practicum, the two professors who were involved with teaching the teacher candidates' two courses and practicum were asked to individually rank teacher candidate participants as falling into one of three categories: top performing third, middle performing third, and bottom performing third. These rankings were based on the teacher candidates' achievement on course-related tests, assignments, and projects, as well as practicum feedback from their supervising teachers and observations made by their university supervisors. These professors then came together with their individual rankings to reach agreement on which students should be included in each grouping. Two possible case study participants were then chosen randomly from each of these three groupings, with one targeted for case study participation and the other as a backup in case of difficulties with the first person's participation. Case study participants were chosen based on this three-tiered ranking of performance so as to evaluate the possible differences in teacher candidate experiences within the structured and supported DAL instructional framework in relation to their achievement within the full scope of their pre-service program. Case study analysis by ability level was deemed especially important for informing future pre-service special education teacher preparation programs' development to meet the learning needs of a greater variety of future teachers, by providing information and understanding of teacher candidate experiences from a variety

of ability levels within an application-based, developmental social constructivist instructional framework.

Ethical Considerations

Before beginning the study, the current investigation was examined by the Institutional Review Board (IRB) of the researcher's university to ensure that adequate preparation for the safety and confidentiality of all teacher candidates had been completed. After the study was approved by the IRB, the researcher requested participation of all the eligible Level II teacher candidates, and obtained consent from all individuals willing to participate in the study. All Level II teacher candidates had the ability to choose not to participate in the study without penalty, academically or professionally. Teacher candidates who agreed to participate in the study did not receive any academic or personal benefits for their agreement to participate. At the same time, all Level II teacher candidates, study participants and non-participants, completed the same assessments and assignments.

Quantitative Instruments

The study utilized a mixed methods design, implementing both quantitative and qualitative assessment measures to ascertain triangulation of data for reliability and validity purposes. For the quantitative portion of this research, several types of instruments were used. First, multiple surveys gathered information pertinent to efficacy, attitude, and content knowledge from teacher candidates. The first of these surveys was a self-efficacy mathematics instruction measure. For this purpose, Enochs, Smith, and Huinker's 21-question, Likert scale, Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (2000) was employed to collect pre-, midpoint, and post-test efficacy

information from the teacher candidates, included in Appendix H. The survey did not contain sample items, but before its administration the researcher clearly explained the questionnaire's purpose and directions for completion.

The MTEBI was chosen as the instrument to assess efficacy in this research because it is a comprehensive assessment tool for pre-service teacher self evaluation of efficacy in mathematics instruction. It is constructed with Likert scale items that gather information on two types of teaching efficacy, Personal Mathematics Teaching Efficacy (PMTE), measured by 13 survey items, and Mathematics Teaching Outcome Expectancy (MTOE), measured by 8 survey items. Personal Mathematics Teaching Efficacy (PMTE) relates to the teacher candidates' perceptions of their own self-efficacy in teaching mathematics, and Mathematics Teaching Outcome Expectancy (MTOE) relates to teacher candidates' expected student outcomes based on their instruction (Enochs, Smith, & Huinker, 2000, p. 194). Moreover, this measure was also selected because of its high reliability, with an alpha coefficient of .88 for the PMTE subsection and .75 for the MTOE subsection. These alpha coefficients indicate high internal consistency reliability for survey questions in measuring the efficacy constructs they aim to evaluate. Additionally, the researcher generated alpha coefficients for this instrument based on the study population's responses. This information is included in Table 1. This instrument was presented to teacher candidates at three points in this investigation to evaluate the changes in their perceived self-efficacy in mathematics instruction abilities over the course of the study.

Table 1
Reliability Information for the Mathematics Efficacy Beliefs Instrument (Cronbach's alpha)

	Pre	Mid	Post
Mathematics Teaching Efficacy Beliefs Whole			
Instrument	.80	.82	.80
Self-Efficacy Subtest	.83	.86	.84
Outcome Expectancy Subtest	.71	.84	.83

To gain insight into how teacher candidates' attitudes towards mathematics instruction changed through an experience with the DAL framework, the Preservice Teachers' Mathematical Beliefs Survey by Seaman, Szydlik, Szydlik, and Beam (2005) was implemented and is included in Appendix I. This second instrument uses items that assess if individuals view mathematics as "creative and original" or if they perceive it as having a "rule bound and law governed nature" (Seaman et al., 2005, p. 199). The items probe the teacher candidates' views about the mathematics content area in general and mathematics instruction specifically. The overall Preservice Teachers' Mathematical Beliefs Survey is constructed from 20 Likert scale items, which have the goal of obtaining attitudinal information towards teaching mathematics to students of varying ability levels. A Rasch analysis was used by this survey's authors to determine that this instrument has a person separation reliability between .70 to .84 across items, and an item separation reliability of .98 across the four major attitudinal domains accessed through the study (Seaman et al., 2005, p. 201), indicating the survey has relatively consistent and reliable student responses across survey items and items themselves are extremely

consistent as a whole in assessing teacher candidates' attitudes towards teaching mathematics. As with the efficacy survey, the researcher generated alpha coefficients for this instrument based on the study population's responses. This information is included in Table 2. As with the MTEBI, the Preservice Teachers' Mathematical Beliefs survey was administered at three points during the research to gather pre-, midpoint, and post-test information from teacher candidates.

Table 2
Reliability Information for the Mathematical Beliefs Instrument (Cronbach's alpha)

	Pre	Mid	Post
Mathematical Beliefs Questionnaire	.83	.90	.90
Constructivist Mathematics Beliefs Questions	.69	.85	.90
Traditional Mathematics Beliefs Questions	.72	.62	.74
Constructivist Teaching Mathematics Beliefs Questions	.67	.89	.69
Traditional Teaching Mathematics Beliefs Questions	.56	.80	.68

According to studies completed by Adams (1998) and Stacey, Helme, Steinle, Baturo, Irwin, and Bana (2001), an overwhelming percentage of elementary school teachers are deficient in their basic mathematics skills. However, one essential characteristic mandated by federal legislation for "highly qualified" teachers across subject areas is that educators possess proficiency in the content knowledge of the subject

area in which they plan on teaching. In this same vein, special educators in elementary schools are now expected to possess the same amount and degree of content knowledge as their general education teaching peers. As a result, a 20-item instrument by Matthews and Seaman (2007) called the Mathematical Content Knowledge for Elementary Teachers was administered to all special education teacher candidate participants as this study's third survey, included in Appendix J. This particular survey was selected because while the DAL framework focuses on algebraic thinking at the elementary level, it was deemed important that teacher candidates' overall content knowledge be evaluated for the elementary level, as abilities in basic number and number sense from the arithmetic skill strand are the foundational competencies for learning algebraic thinking.

The Mathematical Content Knowledge assessment uses a combination of open-ended response and multiple choice items to determine the current elementary level mathematical content proficiency of the individuals taking the assessment. While the Mathematical Content Knowledge survey was originally tested by its authors using a population of elementary school teachers, it was also deemed appropriate for special education teachers at the same level, because like general education elementary level teachers, special education teachers are typically prepared as generalists, who are expected to teach a broad array of content areas. The survey developers' Cronbach's alpha for this instrument was calculated to be .80, indicating that the test has a high internal consistency reliability in collecting content knowledge in elementary mathematics across items. The researcher also generated alpha coefficients for this instrument based on the study population's responses, providing additional reliability on researcher-devised subtests of basic arithmetic and algebraic thinking. This information

is included in Table 3. As with the other two aforementioned surveys administered to teacher candidates, this content knowledge instrument was administered at pre-, midpoint, and post-test points. In total, teacher candidates were administered three survey instruments in regards to mathematics instruction: self-efficacy, attitude, and content knowledge respectively.

Table 3
Reliability Information for the Content Knowledge Instrument (Cronbach's alpha)

	Pre	Mid	Post
Content Knowledge Instrument	.74	.79	.84
Basic Arithmetic Questions	.54	.67	.71
Algebraic Thinking Questions	.58	.62	.69

Besides the three survey instruments in the current study, another important aspect of the investigation involved measures that evaluated the amount of mathematics instructional knowledge retained and applied by teacher candidates. This facet of DAL model training and implementation by participants was assessed in two ways. First, an exam administered within the Clinical Teaching course by the course instructor was used to measure the amount of information retained about effective mathematics instructional practices for struggling learners. Since DAL instruction was imbedded within the Clinical Teaching course via the model's workshops and on-going trainings through practicum and course activities, several Clinical Teaching test questions focused on the mathematics instruction content taught in connection with the DAL intervention, with the test included in Appendix K. During the particular semester under research, the Clinical

Teaching course had two foci for instruction, the teaching of reading during the first part of the semester and the teaching of mathematics during the latter, of which the DAL model was an essential aspect. As a result, the teacher candidates were evaluated on their retention of information provided on the instruction of mathematics and algebraic thinking skills as part of the course exam in the second half of their Clinical Teaching class.

Since DAL instruction included training in best instructional practices for struggling learners in mathematics generally, and algebraic thinking instruction specifically, student answers on all Clinical Teaching test questions relating to mathematics instruction for struggling learners were used as measures of teacher candidates' retention of pedagogical knowledge for mathematics instructional practice. To ensure content validity on the clinical teaching exam, the professor of the course, in conjunction with the researcher, designed the final exam questions based on the teacher candidates' experiences with mathematics instruction via the DAL framework in both the Clinical Teaching class and adjoining practicum. To this end, the course professor had written the mathematics instruction textbook used in the Clinical Teaching course, and had previously worked with the current researcher as part of the research development team in designing the DAL framework. Thus, the content of the final exam was based on both the course text and DAL framework, which overlapped in their description and usage of many instructional practices for learners at-risk for mathematics difficulties.

The second way data collection occurred in the instructional knowledge area was through observation of teacher candidates' abilities to apply their knowledge of effective mathematics instruction for struggling learners, following their training guidelines for

DAL implementation. This application was measured through DAL model observation fidelity checklists. These checklists were completed on teacher candidates during three different instructional sessions. Two types of fidelity checklists were developed and are included in Appendix L and Appendix M, respectively. The first checklist was for the DAL framework's initial session probe, which included fewer steps for implementation than a regular DAL session, because initial sessions only included one section of steps: Measuring Progress and Making Decisions. The second checklist was for a typical DAL session, which included all sections and steps: Building Automaticity, Measuring Progress and Making Decisions, and Problem Solving the New. To evaluate the abilities of the teacher candidates to apply the DAL consistently along DAL training framework guidelines, three independent raters observed the teacher candidates' one-on-one instruction with students. Ratings were used to assess both the accuracy of specific teacher candidates' implementation of effective instructional practices and the teacher candidates' implementation as a whole group. These ratings were also employed to measure how consistently teacher candidates implemented effective instructional practices across observations. Each rater used the same fidelity checklist, and all three raters observed instructional sessions together until 90% agreement was reached between raters on steps within specific observations.

After this percentage was reached, raters divided observations into three groups, with each group being relatively equal. Each group consisted of approximately four teacher candidates and was a manageable sample for observation by each of the three raters. Each teacher candidate in the observation group was observed at pre, mid, and post points in the DAL framework's implementation, unless teacher candidate or student

absence prevented the observation from occurring. In this way, the researcher triangulated quantitative data between teacher candidate surveys, test question responses, and observation fidelity checklists to more fully probe the teacher candidates' experiences implementing the DAL model within a pre-service special education teacher preparation program.

Qualitative Instruments

As part of this mixed methods study, qualitative research elements were used in tandem with quantitative means, allowing for data collection that provided rich description. The overlap in data collection between the quantitative and qualitative methods was purposeful and had the aim of providing in depth information on the multiple aspects involved in special education teacher candidates' preparation as professional educators.

Analysis of Final Papers on the DAL Experience

As part of their experience with the DAL model in their Level II practicum, all teacher candidates completed a final paper on their instructional involvement and learning through the application of the DAL model. For all study participants, this single document underwent an independent document hand review by the researcher as the study's first means of qualitative data collection. This final paper required students to reflect on their learning throughout the 10 week duration of the framework's usage, as well as reflect on any personal and professional changes that had occurred throughout the DAL training and application. The researcher evaluated all participants' final papers looking for themes, ideas, and changes that had developed through the course of the teacher candidates' progression with the DAL model, as well as the commonality of these

items across teacher candidates' papers. This review probed the large ideas and themes that emerged from the full group of participants versus specific individual experiences.

Pre and Post Focus Groups

The second qualitative tool was the employment of focus groups with the teacher candidate participants in the Level II practicum cohort. The purpose of the focus groups was to obtain a shared or group perspective on teacher candidates' ideas about mathematics instruction within a format that did not have predetermined response items. In this way, the open-ended nature of the focus group conversation allowed for the collection of clarifications on teacher candidates' ideas about mathematics instruction that were not necessarily accessible through survey responses. There were two focus groups of approximately 9-10 people, each conducted by the researcher, who is trained in focus group methodology. The specific size of the focus groups was chosen for two reasons. First, guidelines for focus group composition recommend between 6-12 participants for these groups (Morgan, 1988). Second, the current participant group consisted of 19 teacher candidates, and in terms of time constraints within teacher candidates' practicum day, it was thought most reasonable to conduct two focus groups of approximately 35-45 minutes each at both pre and post points in the study. The researcher used the same 15 foundation questions in the focus groups at both pre and post, given in Appendix N, as the basis for accessing teacher candidate self-efficacy, attitude, content knowledge, and instructional knowledge and application information in regards to mathematics instruction. All focus groups were audiotaped for accuracy of information, as well as tracked through notes taken by an assisting doctoral student in

special education. Frequent member checks were also completed to ensure that teacher candidate responses accurately reflected candidate thoughts and ideas.

Case Studies

The third qualitative technique involved the implementation of case studies. To this end, three teacher candidates, from the group who volunteered to participate in the study, were chosen to have their DAL model experience analyzed in a specific and comprehensive manner by the researcher. As mentioned previously, the two professors who taught the Level II cohort their courses and supervised their practicum ranked all study participants as in the highest performing third, the middle performing third, or the lowest performing third of the cohort for the current semester. Based on these rankings, the researcher randomly selected two case study participants from each grouping, with one being approached for participation and one being used as an alternate if the first person was not willing or available to be a case study participant. For the purpose of the case study analysis, three specific DAL framework elements were evaluated.

First, for the duration of the DAL model instructional experience, teacher candidates made and kept “session notes”, which served as their planning and instructional logs of information for their instructional periods with students. Additionally, teacher candidates reflected weekly on their instructional experience using the DAL model, focusing their responses around prompts involving how they were implementing the model, what they were learning from their experiences, and how they might use this learning in the future. In the end, teacher candidates produced a final paper that synthesized their experience, including personal and professional growth areas. While all teacher candidates produced these three forms of documents as part of their

participation in the Level II practicum and coursework, for the three teacher candidates involved in the case study component of the research, the researcher used these documents as one piece of obtaining a more complete picture of three individual teacher candidate learning situations within the entirety of the total sample of participants.

Second, to obtain more specific reflections and experiences of the three case study participants, an individual exit interview was conducted with each case study participant at the end of the study. Third, the individual results for each case study participant on the three administered surveys at all points, as well as on the course examination, were extracted from the total participant group. These individual results were then evaluated in isolation with comparison made to the larger group. While information gained through the case studies was not generalizable to other members of the study, it facilitated the exploration and understanding of the learning process that teacher candidates' undergo when experiencing professional development that integrates a research-based instructional framework within a particular content area, such as the implementation of the DAL model.

Procedures

Because the study employed both qualitative and quantitative research methodologies, multiple procedures were used to ensure proper collection of data utilizing both approaches. All data collected via surveys, exam questions, fidelity checklists, final project examination, focus group transcripts, and case study analysis were kept confidential by the researcher maintaining all data collected through the study in a locked filing cabinet. Additional procedures specific to the quantitative and qualitative methodologies were employed to enable information collection that was both

reliable and valid. By using a mixed methods approach, the researcher sought to explore, understand, and delineate the experiences of and responses to using the DAL instructional framework within a pre-service special education teacher education program.

Quantitative Procedures

The quantitative procedures of the study encompassed administering multiple surveys at pre-, midpoint, and post-test junctures, as well as collecting responses to one-time Clinical Teaching test questions, and maintaining pre, midpoint, and post fidelity observation checklists on DAL framework application. In terms of the content knowledge survey, it was administered at the beginning of the first week of training with the DAL framework, before any training or experiences had begun, because it was thought that any interaction during the DAL experience might impact the pre- time-period results for this particular survey. The other two instruments, the efficacy and attitude ones, were administered to teacher candidates during the teacher candidates' first week of training with the DAL model. In the case of teacher candidate absence, teacher candidates were assessed within one week of this initial time frame for consistency. The researcher also attempted to access absent individuals even before the next instructional period, so that exposure to practicum and course content would be equitable with the other teacher candidates for survey purposes. In this way, the data were consistently collected from the same beginning time frame for all three surveys. All midpoint survey information was gathered during the fifth week of the DAL's implementation. Finally, the surveys were administered one last time at the conclusion of the DAL framework's implementation, which was week ten of the teacher candidates' experience with the DAL

model. Using these three specific time frames allowed for consistent survey data collection across all teacher candidates during the duration of the study. Additionally, the researcher was the person administering all three of these surveys at pre, midpoint, and post junctures, allowing for standardization of administration across types of surveys, as well as across time periods for each survey.

The Clinical Teaching exam, which was used to evaluate participants' knowledge of mathematics instruction, was administered during the week immediately following the DAL framework's last application. The teacher candidates responded to exam questions within the regular spectrum of their Clinical Teaching course exam. Questions on the exam for mathematics instruction involved a combination of multiple choice and short answer questions. Three independent exam question evaluators were involved in assessing the accuracy of teacher candidate responses for reliability and validity purposes in determining the accuracy of knowledge gained by teacher candidates. Independent raters used a researcher-developed scoring rubric for evaluating all exam short answer questions. This rubric employed a 5-point scoring system for each question that defined exam question answers from 5, "a full complete answer", to 1, "an incorrect answer." All evaluators assessed an identical sampling of three teacher candidate test questions independently, and then regrouped to compare ratings. This process was completed until 90% agreement was reached with scoring these questions across raters. Following that agreement, the three evaluators each then independently scored the remaining teacher candidates' test questions on mathematics instruction and came back together to reach consensus on all teacher candidates' test evaluations. While three independent evaluators determined the accuracy of teacher candidate test responses for the purpose of this study,

the course's teaching faculty independently evaluated exam responses for the purpose of determining grades for this course assessment.

Finally, in terms of collecting quantitative data via fidelity observation checklists, teacher candidates were observed by all three raters at one time, until 90% inter-rater reliability was obtained between raters for each observation. Then, a subgroup of approximately twelve teacher candidate participants was divided into three subsections between the three raters, and each of these participants was observed at regularly scheduled intervals at the beginning, middle, and end of the framework's implementation by one of the three raters. All teacher candidates were observed for each fidelity check point within the same one-week period to ensure consistency across time-periods in data collection. Teacher candidates were also observed by one of the three raters for a standard time period, one instructional session, which ranged from 30-40 minutes, to allow for regularity across raters in the time frames allotted for observations.

Qualitative Procedures

The qualitative procedures of the study were set within a constructivist frame, utilizing focus groups, case studies, and final project analyses as tools in facilitating the researcher's knowledge construction and meaning making processes for the understanding of the DAL model's facility as an instructional framework within a special education teacher preparation program. For the focus groups, the researcher ensured reliability and validity of the data by completing both pre-point focus groups in the first two weeks of the DAL model framework's initial usage and then both post intervention focus groups during the final week of the framework's usage. Within the focus groups, the same 15 researcher-developed questions focusing on teacher candidates' attitudes,

self-efficacy, content knowledge, and pedagogical knowledge and application, were employed during pre and post points. These questions were developed based on survey items, test questions, and checklist items on quantitative measures. Focus group questions sought greater detail and specific information on teacher candidates' shared group attitudes, self-efficacy, content knowledge, and pedagogical knowledge and application that could not be obtained through quantitative means, but could inform the researcher's understanding of the larger idea of using the DAL within a teacher preparation program. For accuracy, the researcher employed the assistance of another doctoral student experienced in focus group methodology to take notes that were compared with the tape recorded comments of focus group participants. Additionally, the researcher used frequent member checks while conducting the groups to ensure that the oral responses accurately conveyed the feelings and ideas of the teacher candidates.

In regards to the case study process, participants were divided into three groups ranked on their Level II coursework and practicum achievement and performance by the Level II cohort's professors. In this way, the researcher aimed to evaluate and discern a clear picture of the DAL model experience for a participant with high level achievement, average achievement, and then low achievement within their Level II practicum and coursework. Through this process, the researcher obtained an understanding of how the DAL framework was experienced by participants across ability levels. Artifacts that were gathered from case study participants included weekly "session notes", weekly personal reflections, final cumulative projects, and exit interview transcripts and notes. Using these pieces of information, the researcher had multiple, specific written data pieces to

analyze for feelings, ideas, and changes that teacher candidates had during the course of their experience with the DAL framework.

The Atlas.ti® software program was used to help analyze qualitative data collected from written transcripts of focus groups, case study teacher candidate interviews, and final projects of all participants from the Level II practicum. Responses were transcribed and typed using a word processing program. The Atlas.ti® software program was used to facilitate the coding and categorizing of teacher candidates' thoughts and ideas. The design of the software enabled the researcher to easily code written comments and then connect these codes, so categories and trends in the data could be seen by the researcher. The open codes generated by the researcher for the focus groups and final projects were categorized into larger themes and ideas across the full group of participants. Coding employed with the case study artifacts enabled the researcher to analyze the individual experience of each case study participant. For the case study document artifacts, the researcher employed a hand review of teacher candidate session notes, weekly reflections, and final projects, looking for ideas and themes across teacher candidates' work.

Research Design

Mixed Methods Design

The study was organized as a mixed methods investigation with information obtained through quantitative surveys used in conjunction with the data collected through qualitative means. Both types of research methodologies were utilized to provide the researcher with multiple forms of data and information to best understand teacher candidates' experiences within a structured, social-developmental constructivist

preservice teacher preparation experience. The goal of the researcher was to utilize qualitative coding, categorization, and analysis, in conjunction with quantitative statistical information regarding central tendency, repeated measures over time, and effect sizes to develop an understanding of teacher candidate change in attitude, self-efficacy, content knowledge, and pedagogical knowledge and application when using the application-based DAL instructional framework.

Quantitative Design

Statistical measures used with the quantitative data included descriptive statistic calculations, as well as inferential statistics in the form of a repeated measures ANOVA. To this end, on the three survey instruments involving self-efficacy, attitudes, and content knowledge, calculations of mean, median, mode, skewness, and kurtosis were generated to provide descriptive information on the teacher candidates' responses at three points: pre, midpoint, and post-test. The repeated measures ANOVA was employed to detect significant changes in survey scores for the participant group over time. Cohen's D was used to generate effect sizes based on the statistical calculations of the repeated measures ANOVA for each survey. The researcher looked for changes in statistical data as the teacher candidates' progressed through their DAL experience. For all statistical survey data, a comparison of information was made across pre, midpoint, and post-test administrations, as well as across participants.

For the Clinical Teaching test questions, descriptive statistics were generated for teacher candidates' responses on individual questions. Comparisons of data were made for each participant between types of test questions, multiple choice versus essay questions and descriptive versus application-based essay questions, as well as

comparisons done for test questions across the teacher candidate sample. For the fidelity checklists several forms of analysis were used. Percentages were calculated for each teacher candidate's fidelity in implementing the steps of the DAL framework. Since each teacher candidate was observed three times, fidelity percentages were then compared across time periods for each teacher candidate, as well as across the group of participants at each time period. For each set of observations, the fidelity percentages were totaled for the participant group as a whole, and the mean calculated for each observation set (i.e., first set of observations, second set of observations, third set of observations).

Qualitative Design

With multiple qualitative measures employed in the current study, it was necessary to use several tools for data collection and analysis purposes. For the case study portion, session notes, weekly reflections, final projects, and exit interviews were analyzed using a combination of researcher hand review and electronic review using the Atlas.ti® software. For session notes, the researcher copied, hand-reviewed, and highlighted teacher candidate planning and strategy implementation, since these session notes were written on pre-designed DAL lessoning planning forms. The researcher evaluated these session notes in regards to ideas and themes that emerged from teacher candidate writing on instructional knowledge and implementation, as well as attitude, efficacy, and content knowledge. Weekly reflections were also copied and hand-reviewed like the session notes, using a highlighting system to code similar ideas and themes. Final projects, focus groups, and case study exit interviews were scanned into the researcher's computer, so they could be uploaded to the Atlas.ti® qualitative analysis software. A similar process was employed with these data pieces, as with the hand-

reviewed ones, but with the researcher using the electronic software to assist in coding, categorizing, and theme analysis. Specific teacher candidate expressions related to attitude, self-efficacy, content knowledge, and instructional knowledge and application were identified and analyzed.

A grounded theory approach was used to develop theoretical understandings and conclusions, where collected data were used as the basis of theory development for the investigated research question (Glaser & Strauss, 1965). The researcher used the qualitative themes that emerged to construct a greater understanding of the Level II cohort's experiences and responses to the DAL framework in regards to attitude, self-efficacy, instructional knowledge and application, and content knowledge in mathematics. A complete listing of major inquiry areas, quantitative and qualitative data collection measures, and data analysis methods are provided in Table 4. In Chapter 4, results collected by the different quantitative and qualitative data collection methods are presented, along with accompanying analysis.

Table 4
Alignment of Research Key Questions and Instruments

Specific Questions	Data Collection Instruments	Analysis
1.) What changes, if any, occur in special education teacher candidates' feelings of self-efficacy about teaching mathematics from the beginning to the end of a preservice instructional experience using the DAL framework?	<i>Quantitative</i> ~Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) by Enochs, Smith, and Huinker (2000) at Pre, Midpoint, and Post-Test Points	<i>Quantitative</i> ~Descriptive statistics involving mean, mode, median, skewness, and kurtosis, Repeated Measures ANOVA
	<i>Qualitative</i> ~Pre and Post-test focus groups with teacher candidates on feelings of self-efficacy related to mathematics instruction	<i>Qualitative</i> ~Document Hand Review
	~Weekly reflections on feelings of self-efficacy from 3 case studies ~Analysis of feelings of self-efficacy about mathematics instruction from final papers of all students on the DAL model experience	~Transcription of Teacher Candidate Comments ~Open Coding of Ideas ~Usage of Inductive Reasoning in Identifying Categories and Themes

Table 4 (cont. 'd)

Specific Questions	Data Collection Instruments	Analysis
		<i>Quantitative</i> ~Descriptive statistics involving mean, mode, median, skewness, and kurtosis, Repeated Measures ANOVA
	<i>Quantitative</i> ~Preservice Teachers' Mathematical Beliefs Survey by Seaman, Szydlik, Szydlik, and Beam (2005) at Pre, Midpoint, and Post-Test Points	<i>Qualitative</i> ~Document Hand Review
2.) What changes, if any, occur in special education teacher candidates' attitudes towards mathematics instruction from the beginning to the end of a preservice instructional experience using the DAL framework?	<i>Qualitative</i> ~Pre and Post-Test focus groups ~Weekly reflections on attitude towards mathematics instruction from 3 case studies ~Analysis of attitude towards mathematics instruction from final papers of all teacher candidates on the DAL model experience	~Transcription of Teacher Candidate Comments ~Open Coding of Ideas ~Usage of Inductive Reasoning in Identifying Categories and Themes

Table 4 (cont. 'd)

Specific Questions	Data Collection Instruments	Analysis
3.) What changes, if any, occur in special education teacher candidates' understanding of instructional strategies for struggling learners in mathematics from the beginning to the end of a preservice instructional experience using the DAL framework?	<i>Quantitative</i> ~Clinical teaching short answer test questions on mathematics pedagogical strategies (evaluated for correctness by 3 parties for reliability purposes)	<i>Quantitative</i> ~Percentage of accuracy between and across test questions ~Descriptive statistics involving mean, mode, median, skewness, and kurtosis <i>Qualitative</i> ~Document Hand Review
	<i>Qualitative</i> ~Pre and Post-Test focus groups ~Weekly reflections on instructional knowledge from 3 case studies	~Transcription of Teacher Candidate Comments ~Open Coding of Ideas
	~Analysis of instructional knowledge from final papers of all teacher candidates on the DAL model experience	~Usage of Inductive Reasoning in Identifying Categories and Themes

Table 4 (cont. 'd)

Specific Questions	Data Collection Instruments	Analysis
4.) What changes, if any, occur in special education teacher candidates' application of instructional strategies for struggling learners in mathematics from the beginning to the end of a preservice instructional experience using the DAL framework?	<i>Quantitative</i> ~Fidelity measures utilized for mathematics strategies within the DAL model, as well as fidelity measures for the DAL implementation process (baseline: 3-5 teacher candidates evaluated by all 3 raters with 90% agreement)	<i>Quantitative</i> ~Fidelity percentages between DAL steps and across DAL participants ~Descriptive statistics involving mean, mode, median, skewness, and kurtosis, Repeated Measures ANOVA
	<i>Qualitative</i> ~Pre and Post-Test focus groups ~Weekly reflections on instructional application from 3 case studies	<i>Qualitative</i> ~Document Hand Review ~Transcription of Teacher Candidate Comments ~Open Coding of Ideas
	~Analysis of instructional application from final papers of all teacher candidates on the DAL model experience	~Usage of Inductive Reasoning in Identifying Categories and Themes

Table 4 (*cont. 'd*)

Specific Questions	Data Collection Instruments	Analysis
		<i>Quantitative</i> ~Descriptive statistics involving mean, mode, median, skewness, and kurtosis, Repeated Measures ANOVA
	<i>Quantitative</i> ~Mathematical Content Knowledge for Elementary Teachers by Matthews & Seaman (2007) at Pre, Midpoint, and Post-Test Points	<i>Qualitative</i> ~Document Hand Review
5.) What changes, if any, occur in special education teacher candidates' content knowledge of elementary mathematics, including algebraic thinking, from the beginning to the end of a preservice instructional experience using the DAL framework?	<i>Qualitative</i> ~Pre and Post-Test focus groups ~Weekly reflections on attitude towards mathematics instruction from 3 case studies ~Analysis of attitude towards mathematics instruction from final papers of all teacher candidates on the DAL model experience	~Transcription of Teacher Candidate Comments ~Open Coding of Ideas ~Usage of Inductive Reasoning in Identifying Categories and

Chapter 4

Results

Overview

In the current study, the Developing Algebraic Literacy (DAL) model, a structured instructional framework for teaching algebraic thinking to at-risk learners, was implemented with a group of undergraduate special education teacher candidates during an early clinical field experience. The purpose of the study was to explore teacher candidates' experiences as they received training in the DAL model, as they provided one-to-one instruction using the DAL model, and as they received structured support and feedback from practicum faculty in their Level II clinical practicum. Five key elements of teacher preparation were investigated: 1) self-efficacy for teaching mathematics, 2) attitudes toward teaching mathematics, 3) knowledge of mathematics content, 4) knowledge and understanding of research-based mathematics instructional practices for at-risk learners, and 5) application of research-based mathematics instructional practices for at-risk learners.

During the course of this study, participants engaged in Clinical Teaching and Behavior Management coursework, as well as participated in a two-day a week practicum experience. One day each week of this practicum was at a Title I school site, within a large urban school district in the Southeastern United States, where the teacher candidates received training and support while implementing the DAL framework. Data were collected from 19 teacher candidates using both quantitative and qualitative research

methods. Moreover, three participants were selected for the purpose of conducting case study analyses. In order to select case study participants, all participants were divided into three ranked subgroups based on their overall Level II achievement based on their performance on course-related tests, assignments, and projects, as well as practicum feedback from their supervising teachers and observations made by their university supervisors. One student from each of these ranked groups was chosen as a case study participant to gather more specific and detailed information on teacher candidates' experiences while using the DAL framework.

Demographics of Participants

In this study, the 19 teacher candidate participants varied across age, university status, years in college, and ethnicity as shown in Table 5. All teacher candidates were female students enrolled in the Level II special education undergraduate coursework and practicum. In terms of age, a majority, 63.2%, were between the ages of 20 and 24, which is the typical age of undergraduate upperclassmen within most universities. There were also clusters of participants in their later twenties, with approximately 15.7% between 25 and 29, and between 35 and 44, respectively. One participant was an outlier on the age variable, and she fell between 55 and 59. The teacher candidates were split between holding Junior and Senior status within the university. Slightly more participants indicated they were Seniors at 52.6%, and one student did not indicate her status at all. The teacher candidates varied in the number of years they had attended college or university, but most of the overall participant group, 88.6%, had been in college for three years or more. One person reported herself as in college for only one year, and another indicated she had been in college for just two years. The number of

participants in college for three and four years was equal at 26.3% for each year. The largest group of teacher candidates, 36.8%, reported that they had been attending college for five years. The ethnic background of participants was primarily white (63.2%), with minority participants including Hispanic/Latino (15.7%), Black/African American (10.5%), Native American/Alaskan Native (5.3%), and Other (5.3%).

Table 5
Demographic Characteristics of Teacher Candidate Participants (N=19)

	<i>F</i>	<i>%</i>
Gender		
Female	19	100
Male	0	0
Age		
20-24	12	63.2
25-29	3	15.7
30-34	0	0
35-39	2	10.5
40-44	1	5.3
45-49	0	0
50-54	0	0
55-59	1	5.3
Cohort Status		
Level 2	19	100
University Status		
Junior	8	42.1
Senior	10	52.6
Not Indicated	1	5.3
Number of Years Spent in College		
One Year	1	5.3
Two Years	1	5.3
Three Years	5	26.3
Four Years	5	26.3
Five Years	7	36.8
Ethnicity		
Hispanic/Latino	3	15.7
American Indian/Alaskan		
Native	1	5.3
Black/African American	2	10.5
White	12	63.2
Other	1	5.3

Description of Case Study Participant Selection

Within the overall participant sample, three students were chosen as case studies. Each of these individuals was selected randomly from one of the three ranked groupings of teacher candidates: upper performing third, middle performing third, and lower performing third. This selection of individuals for case study was done so the researcher could gather specificity of information on individual experiences with the DAL model for participants with different academic performance levels. Case study participants were considered representative of the typical individual, and her experiences and achievements, for a particular ranked grouping.

Format of Results Information

The current study involved data collection using both quantitative and qualitative methodologies. Quantitative information was collected via three survey instruments, a course exam, and fidelity checklists. Qualitative information was gathered using pre and post focus groups, final project reviews, and case study analysis. For ease of understanding, resulting data from the current study is presented by data collection methodology, with case study analysis being presented in its own section because of the length of data and analysis provided. Each of these methods gathered information on one of the five aforementioned key elements for teacher preparation identified by the researcher. These five elements were believed to be critical investigation areas when exploring the study's overarching research question.

The main research question of this study was:

What changes related to effective mathematics instruction for struggling

elementary learners, if any, occur in teacher candidates during implementation of the DAL instructional framework in an early clinical field experience practicum for preservice special education professional preparation?

Quantitative Findings

In this section, data collected through quantitative measures will be presented and analyzed. This information includes findings from pretest, midpoint, and posttest administrations of survey instruments involving self-efficacy for teaching mathematics, attitudes toward teaching mathematics, and knowledge of mathematics content. In statistical calculations involving these survey instruments, participant numbers may vary slightly between administrations. There are two reasons for these differences: 1) at times teacher candidates were absent for a given survey administration and they could not be accessed within a similar time period as other participants for that administration, or 2) survey results were only included for participants when they completed over 75% of a particular survey's questions. Additionally, results from an instructional knowledge course exam and fidelity checklist findings are included and interpreted.

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

The first survey instrument explored teacher candidate perceived efficacy when teaching mathematics to elementary level students. The MTEBI (Enochs, Smith, & Huinker, 2000) was employed to collect this efficacy information using a total of 21-Likert scale items, divided between two subtests. On this efficacy measure teacher candidates were asked to respond to "I" statements about their feelings of efficacy in

mathematics instruction using a 5-point scale. The response options included: (1) Strongly Disagree, (2) Disagree, (3) Uncertain, (4) Agree, and (5) Strongly Agree.

The instrument's first subtest, Self Efficacy, included questions involving teacher candidates' perceptions of their abilities to currently teach, as well as develop their teaching abilities (ie., I will continually find better ways to teach mathematics.). The instrument's second subtest, Outcome Expectancy, included questions about teacher candidates' perceptions of anticipated student responses to their mathematics instruction (ie., The teacher is generally responsible for the achievement of students in mathematics.). Enochs, Smith, & Huinker (2000) assert that "behavior is enacted when people not only expect specific behavior to result in desirable outcomes (outcome expectancy), but they also believe in their own ability to perform behaviors (self-efficacy)" (p. 195-196). These ideas assist teacher educators in understanding the importance of efficacy development in any teacher preparation program. While the survey's items were worded both positively and negatively to assess teacher candidate perceptions, all items were recoded so that a rating of "5" indicated high perceptions of efficacy in teaching and affecting student responses through instruction, and a "1" rating indicated low perceptions of the same ideas.

Descriptive Statistics for the MTEBI

For analysis of teacher candidates' responses on the efficacy instrument, SPSS was employed by the researcher to generate statistical data. When completing this analysis, information on mean, median, range, standard deviation, skewness, kurtosis, and standard error of mean were generated. Descriptive statistics are given in Table 6.

For the most part, these statistics supported a normal distribution of the efficacy instrument's results.

Table 6
Descriptive Statistics for the MTEBI

<i>MTEBI</i>	Mean	Median	*Gain Score	Range	SD	Skewness	Kurtosis	Standard Error of Mean
Full Survey								
Pre (N=15)	3.37	3.48		1.38	0.42	-0.35	-0.56	0.11
Mid (N=18)	3.64	3.69	16.56%	1.62	0.38	-1.06	2.06	0.09
Post (N=19)	3.72	3.67	21.47%	1.95	0.46	-0.27	0.96	0.11
Self Efficacy								
Pre (N=15)	3.35	3.31		2.00	0.53	-0.20	0.42	0.14
Mid (N=18)	3.60	3.69	15.15%	2.31	0.51	-0.97	2.24	0.12
Post (N=19)	3.49	3.62	8.48%	1.62	0.48	-0.20	-1.09	0.11
Outcome Expectancy								
Pre (N=15)	3.39	3.63		1.75	0.56	-1.05	-0.03	0.14
Mid (N=18)	3.70	3.81	19.25%	2.25	0.56	0.01	0.50	0.13
Post (N=19)	3.58	3.63	11.80%	2.50	0.52	0.52	2.19	0.12

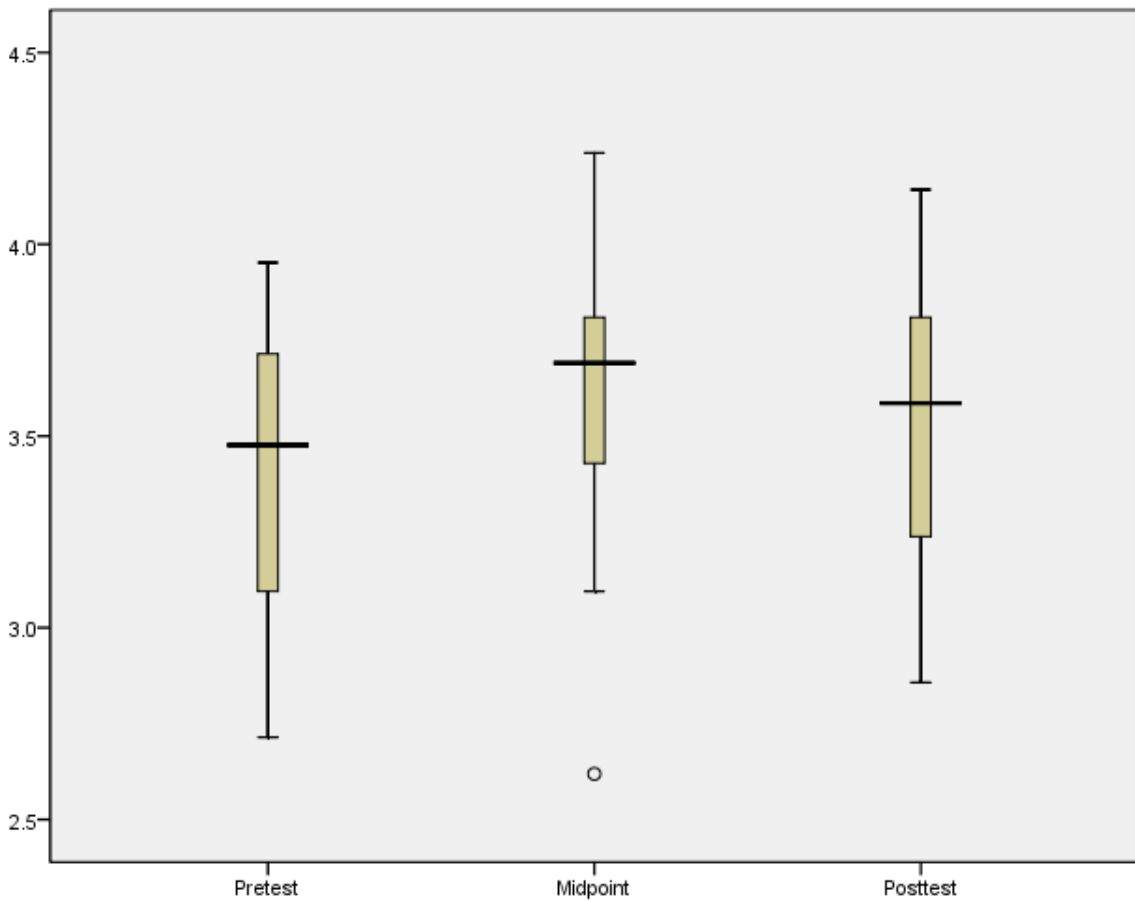
*Gain scores are reported as percentage differences from pretest scores.

Mean scores from teacher candidate responses indicated that overall perceptions of efficacy increased slightly from pretest to posttest on the full survey, moving from a

starting mean of 3.37 to an ending mean of 3.72. On the full survey, gain scores also show a rise from pretest to midpoint with a 16.56% increase and from pretest to posttest with a 21.47% increase. The means of both subtests showed increases at midpoint, but saw decreases from midpoint to posttest on these subtests. Even with this downward movement from midpoint to posttest on these subtests, an overall increase was still seen between pretest and posttest. On the self-efficacy subtest, the gain score was 15.15% between pretest and midpoint and 8.48% between pretest and posttest. Mean scores on the outcome expectancy subtests were higher than on the self-efficacy subtests, showing that teacher candidates held more positive perceptions about effective instructional practices being linked to positive learning outcomes than about their own actual instructional abilities to affect this change. Gain scores supported these findings on the outcome expectancy subtest with a 19.25% increase from pretest to midpoint, and a 11.20 rise from pretest to posttest.

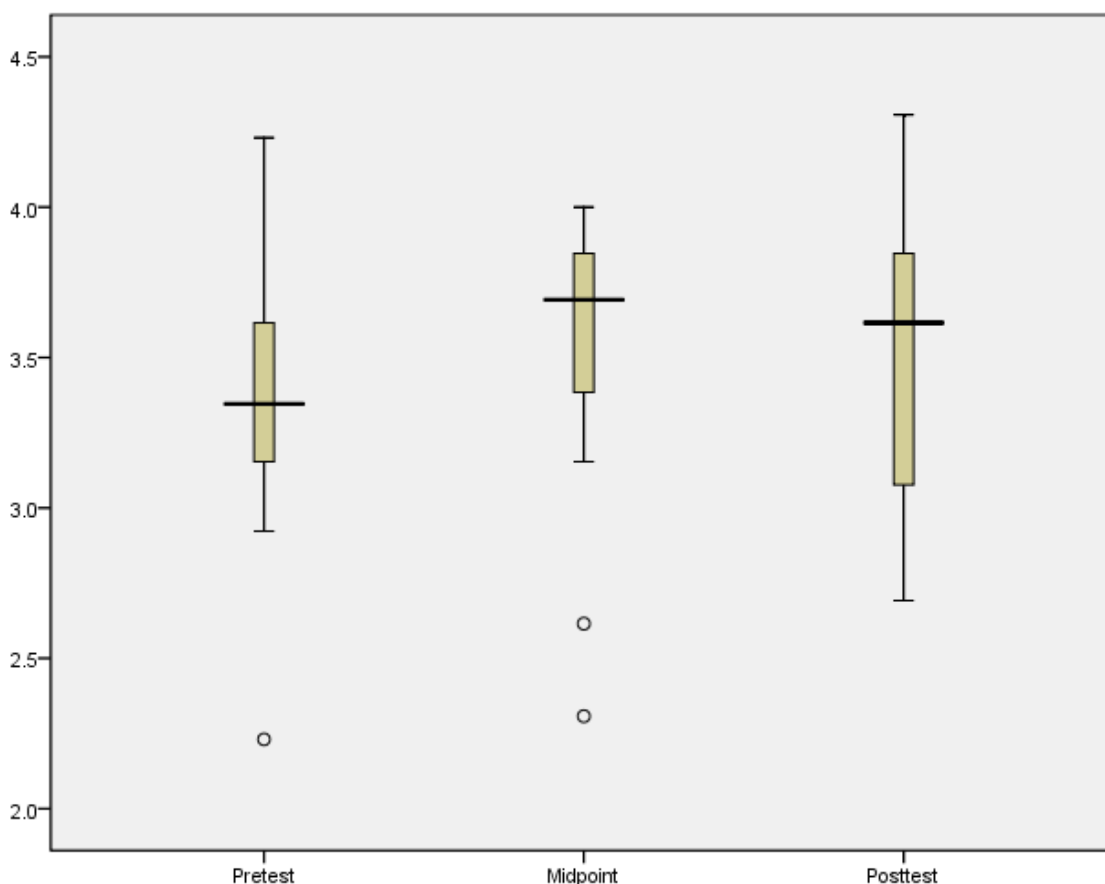
Box plots of the mean scores for the full efficacy instrument in Figure 2 give a visual picture of the score distributions and the data movement from pretest to midpoint to posttest for participants. Box plots of pretest and posttest scores are similar normal distributions. Posttest scores show a decrease from midpoint scores, but posttest scores have a higher median as well as range of scores, than scores at pretest. The midpoint box plot illustrates a distribution that has an outlier in the lower range, but also shows participants' scores increased considerably from pretest, with the interquartile range of all scores nearly all at or above the median point of pretest scores.

Figure 2. Efficacy full survey box plots.



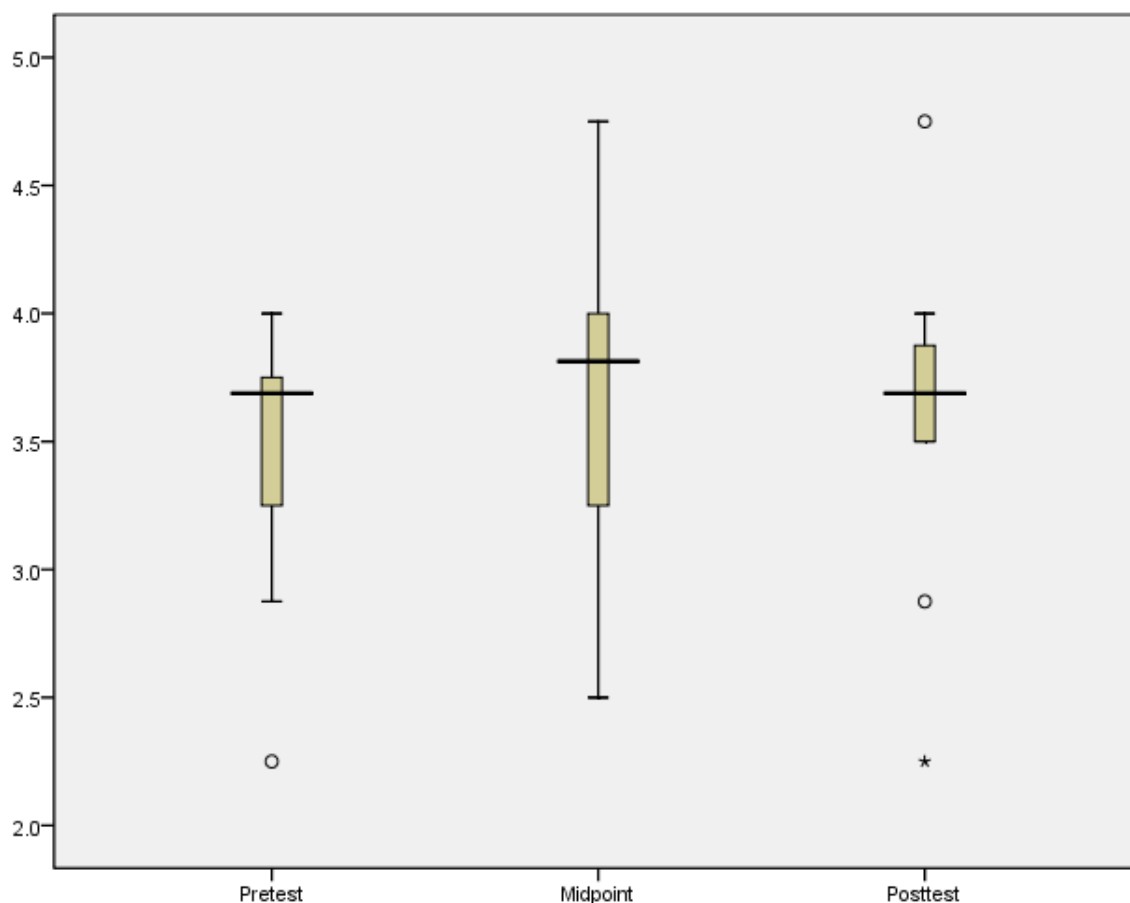
Box plots for the self-efficacy subtest in Figure 3 show pretest scores with an outlier in the lower range, as well as midpoint scores with two outliers in the lower range. At midpoint, except for the two outliers, the scores have a much more compact range and higher median than at pretest. While the plots show posttest scores decreasing from midpoint, these final scores evidenced no outliers and the median remained above the pretest median level.

Figure 3. Self-efficacy subtest box plots.



Box plots of the outcome expectancy subtests in Figure 4 show high variability between participant scores at each administration. Of the three sets of scores, the midpoint ones have the most normal distribution. The scores at posttest show the greatest variability with outliers in both the upper and lower ranges. While these posttest scores must be interpreted carefully in light of these outliers, median scores can be seen to move only slightly from pretest to posttest, with a rise at midpoint and then a dip back to pretest level at posttest.

Figure 4. Outcome expectancy subtest box plots.



When looking at individual questions' descriptive statistics, it was found that item 2, "I will continually find better ways to teach students mathematics" had the highest mean score (4.35) from teacher candidates at pretest. This statistic indicated teacher candidates' answered between "Agree" and "Strongly Agree" levels that they will actively seek out resources to improve their mathematics instruction. Item 17, "I wonder if I will have the necessary skills to teach mathematics" received the lowest mean response (2.00), indicating that many teacher candidates' did not question that they would have the abilities to teach mathematics effectively. At posttest, the highest mean score

was for item 15, “I will find it difficult to use manipulatives to explain to students why mathematics works”, showing that teacher candidates thought that teaching learners using manipulatives would be a hard task for them. The lowest mean score at posttest was shared between Item 17 and Item 18, “Given a choice, I will not invite the principal to evaluate my mathematics teaching”. These results indicate that teacher candidates’ continued to have faith in their ability to learn how to teach mathematics, and would even invite their future principals into their future classrooms while engaging in this instruction.

Inferential Statistics for the MTEBI

Since the efficacy survey was administered to teacher candidates on three occasions during the semester, a repeated measures analysis was completed to see whether there were any statistically significant differences between results of the different administrations for the full efficacy survey and its subtests. Results from the repeated measures analysis are presented in Table 7. For the full survey, self-efficacy, and outcome expectancy results, no statistically significant differences were found between response scores at pretest, midpoint, or posttest because significance for all measures was indicated at the $p > .05$ level.

Table 7
Repeated Measures Analysis of the Mathematics Teaching Efficacy Beliefs Instrument

Measure	Source	df	SS	MS	<i>F</i>	<i>p</i>
Efficacy Whole	Time	1	0.215	0.215	1.839	0.198
	Within Group Error(Time)	13	1.517	0.117		
Self-Efficacy	Time	1	0.101	0.101	0.464	0.508
	Within Group Error(Time)	13	2.832	0.218		
Outcome Expectancy	Time	1	0.492	0.492	2.014	0.179
	Within Group Error(Time)	13	3.175	0.244		

The final statistical analyses on the efficacy instrument involved evaluating correlations for relevant within test and between test correlations across the three administration time points for the full efficacy instrument and its subtests. Within test correlations were completed to see if there was any relationship between the multiple administrations of the full instrument, as well as any associations between the multiple administrations of each subtest. Between subtest correlations were performed to assess possible connections between teacher candidate self-efficacy and outcome expectancy responses at each administration.

Results for the full efficacy instrument indicated a moderate correlation ($r = .759$, $p < .001$) between the midpoint and posttest administrations of the full efficacy instrument as seen in Table 8. This finding depicts a possible connection between how teacher

candidates responded to efficacy items at midpoint and how they responded to these items at posttest. No other statistically significant correlations were found between administrations of the full efficacy instrument.

Table 8
Correlation Matrix for Full Efficacy Instrument Across Pretest, Midpoint, and Posttest

		Efficacy 1	Efficacy 2	Efficacy 3
Efficacy 1	Pearson Correlation	1	0.535	0.575
	Sig. (2-tailed)		0.049	0.025
	N	15	14	15
Efficacy 2	Pearson Correlation	0.535	1	0.759
	Sig. (2-tailed)	0.049		0
	N	14	18	18
Efficacy 3	Pearson Correlation	0.575	0.759	1
	Sig. (2-tailed)	0.025	0	
	N	15	18	19

When correlation analyses were run on the self-efficacy subtests, a moderate correlation was also found between midpoint and posttest administrations of the self-efficacy subtest ($r=.754$, $p<.001$), while a strong correlation was also found between midpoint and posttest on the outcome expectancy subtest ($r=.818$, $p<.001$) as shown in Tables 9 and 10. These results indicate possible connections between how teacher candidates answered self-efficacy questions at midpoint and posttest, with an even

stronger possible connection seen between midpoint and posttest for outcome expectancy. The other within test correlation analyses did not yield statistically significant results.

Table 9
Correlation Matrix for Self-Efficacy Subtest Across Pretest, Midpoint, and Posttest

		Self 1	Self 2	Self 3
Self 1	Pearson Correlation	1	0.447	0.560
	Sig. (2-tailed)		0.109	0.030
	N	15	14	15
Self 2	Pearson Correlation	0.447	1	0.754
	Sig. (2-tailed)	0.109		0
	N	14	18	18
Self 3	Pearson Correlation	0.560	0.754	1
	Sig. (2-tailed)	0.030	0	
	N	15	18	19

Table 10
Correlation Matrix for Outcome Expectancy Subtest Across Pretest, Midpoint, and Posttest

	Outcome 1	Outcome 2	Outcome 3
Outcome 1			
Pearson Correlation	1	0.583	0.498
Sig. (2-tailed)		0.029	0.059
N	15	14	15
Outcome 2			
Pearson Correlation	0.583	1	0.818
Sig. (2-tailed)	0.029		0
N	14	18	18
Outcome 3			
Pearson Correlation	0.498	0.818	1
Sig. (2-tailed)	0.059	0	
N	15	18	19

Between test correlation analyses indicated no statistically significant relationships between the self-efficacy and outcome expectancy subtests at pretest, midpoint, or posttest as seen in Tables 11-13.

Table 11
Correlation Matrix for Self-Efficacy and Outcome Expectancy Subtests at Pretest

		Self 1	Outcome 1
Self 1	Pearson Correlation	1	0.182
	Sig. (2-tailed)		0.515
	N	15	15
Outcome 1	Pearson Correlation	0.182	1
	Sig. (2-tailed)	0.515	
	N	15	15

Table 12
Correlation Matrix for Self-Efficacy and Outcome Expectancy Subtests at Midpoint

		Self 2	Outcome 2
Self 2	Pearson Correlation	1	-0.021
	Sig. (2-tailed)		0.935
	N	18	18
Outcome 2	Pearson Correlation	-0.210	1
	Sig. (2-tailed)	0.935	
	N	18	18

Table 13
*Correlation Matrix for Self-Efficacy and Outcome Expectancy
 Subtests at Posttest*

		Self 3	Outcome 3
Self 3	Pearson		
	Correlation	1	0.013
	Sig. (2-tailed)		0.957
Outcome 3	N	19	19
	Pearson		
	Correlation	0.013	1
	Sig. (2-tailed)	0.957	
	N	19	19

Overall, correlation results on the full efficacy instrument indicated that teacher candidate responses throughout the entire efficacy instrument at midpoint were associated with their responses on the instrument at posttest. A similar association was seen between midpoint and posttest results for the self-efficacy and outcome expectancy subtests. These associations indicate that how teacher candidates felt about their efficacy of mathematics instruction at midpoint was connected to how they felt about this efficacy at posttest. However, teacher candidates' perceptions of self-efficacy and student outcome expectancy did not evidence a connection at any of the administrations.

Mathematical Beliefs Questionnaire

The second survey investigated teacher candidate attitude towards mathematics in general, as well as mathematics instruction. The importance of collecting attitudinal information towards mathematics instruction is summarized by “teachers’ beliefs about subject matter and about the nature of teaching indicate something about the culture of the educational system that produced them” (Seaman, Szydlik, Szydlik, & Beam, 2005).

Since in most teacher preparation programs university faculty are attempting to change or “undue” many of these attitudes, it is important that these stakeholders have an idea of what these attitudes entail. The Mathematical Beliefs Questionnaire (Seaman, et al., 2005), which consists of 40-Likert scale items on a 6-point scale, was used to collect attitudinal information. Since this survey instrument uses the term “beliefs” for what the researcher has operationalized as “attitudes” in this study, these two terms will be used interchangeably in this analysis and be considered to have the same meaning. The questionnaire’s response options include: (1) Strongly Disagree, (2) Moderately Disagree, (3) Slightly Disagree, (4) Slightly Agree, (5) Moderately Agree, and (6) Strongly Agree.

Questionnaire items are organized according to two subtests: the Mathematics Beliefs Scale (MBS) and the Teaching Mathematics Beliefs Scale (TMBS). Each subtest incorporates items along two themes within its response statements, including: ones that address constructivist attitudes about mathematics (ie., The field of math contains many of the finest and most elegant creations of the human mind [MBS], Children should be encouraged to invent their own mathematical symbolism [TMBS]) and ones that present traditionalist views about mathematics (ie., Solving a mathematics problem usually involves finding a rule or formula that applies [MBS], Teachers should spend most of each class period explaining how to work sample specific problems [TMBS]). The purpose for the inclusion of constructivist and traditionalist items was to discern an overall theoretical perspective on teacher candidate attitudes about mathematics in general and mathematics instruction. Results for the attitude instrument are reported by subtest (MBS or TMBS) and response item perspective (constructivist or traditional) for a

total of four areas of information for each Mathematical Beliefs Questionnaire administration. .

Descriptive Statistics for the Mathematical Beliefs Questionnaire

Statistical analysis of teacher candidates' responses on the Mathematical Beliefs Questionnaire was completed using the SPSS. For the purpose of descriptive statistical analysis, data on mean, median, range, standard deviation, skewness, kurtosis, and standard error of mean were generated. Descriptive statistics are given in Table 14. These data indicated a fairly normal distribution of results.

Table 14
Descriptive Statistics for the Mathematical Beliefs Questionnaire

<i>Math. Beliefs Questionnaire</i>	Mean	Median	*Gain Score	Range	SD	Skewness	Kurtosis	Standard Error of Mean
Full Survey								
Pre (N=18)	3.57	3.58		1.38	0.37	0.18	-0.45	0.09
Mid (N=18)	3.85	3.85	11.11%	1.92	0.49	0.67	0.51	0.12
Post (N=19)	3.72	3.67	7.00%	1.95	0.46	-0.27	0.96	0.11
MBS – Construct. Worded								
Pre (N=18)	3.81	3.90		2.15	0.55	-0.15	-0.21	0.13
Mid (N=18)	4.03	3.95	10.05%	3.00	0.74	1.22	1.86	0.18
Post (N=19)	3.94	4.20	5.94%	3.20	0.76	-0.94	1.58	0.17
MBS – Tradition. Worded								
Pre (N=18)	3.23	3.20		1.80	0.55	0.28	-0.97	0.13
Mid (N=18)	3.41	3.45	6.50%	2.00	0.53	0.34	-0.18	0.12
Post (N=19)	3.41	3.60	6.50%	2.10	0.61	-1.04	0.18	0.14
TMBS – Construct. Worded								
Pre (N=18)	4.11	4.16		2.05	0.52	-0.63	0.35	0.12
Mid (N=17)	4.31	4.20	10.58%	2.50	0.79	-0.10	-1.13	0.19
Post (N=19)	4.16	4.10	2.64%	1.60	0.49	-0.14	-1.10	0.11

Table 14 (cont.'d)

<i>Math. Beliefs Questionnaire</i>	Mean	Median	*Gain Score	Range	SD	Skewness	Kurtosis	Standard Error of Mean
TMBS – Tradition. Worded Pre (N=16)	3.31	3.39		1.70	0.48	-0.29	-0.67	0.12
Mid (N=17)	3.62	3.50	11.52%	2.60	0.66	1.44	2.85	0.16
Post (N=19)	3.38	3.30	2.60%	1.70	0.51	0.42	-0.71	0.12

*Gain scores are reported as percentage differences from pretest scores.

Mean scores of teacher candidates' responses to the overall attitude instrument revealed an increase from pretest (3.57) to midpoint (3.85) with a slight decrease at posttest (3.72). These results indicate that teacher candidates' overall responses on the items fell between the "Slightly Agree" and "Slightly Disagree" ratings. During the course of this study, this agreement rose slightly. The gain score on the overall instrument from pretest to midpoint was 11.11% and from pretest to posttest was 7.00%. Within the different subtest areas, constructively worded items on both the MBS and TMBS had higher means of agreement than traditionally worded items. These scores show that teacher candidates had a stronger identification with a constructive approach to mathematics learning and teaching. The gain score for constructively worded items on the MBS were 10.05% between pretest and midpoint and 5.94% between pretest and posttest. For the TMBS, constructively worded items had a gain score of 10.58% and 2.64% between pretest and midpoint and pretest and posttest respectively. However, while means for the constructively worded items fell between 3.80 and 4.30, traditionally

worded items' ratings were not far below that level with scores between 3.20 and 3.60. The gain scores for traditionally worded items on the MBS were consistently 6.50% between pretest and midpoint and between pretest and posttest. On the TMBS, traditionally worded items had gain scores of 11.52% between pretest and midpoint and 2.60% between pretest and posttest. These mean ranges show that although traditionally worded items had lower "agreement" levels than constructively worded items, but the difference between the two mean ranges was not large. On constructively worded items of both the MBS and TMBS subtests, teacher candidates' agreement increased at midpoint but then decreased at posttest. While posttest agreement levels were lower than at midpoint, they were still higher than at pretest.

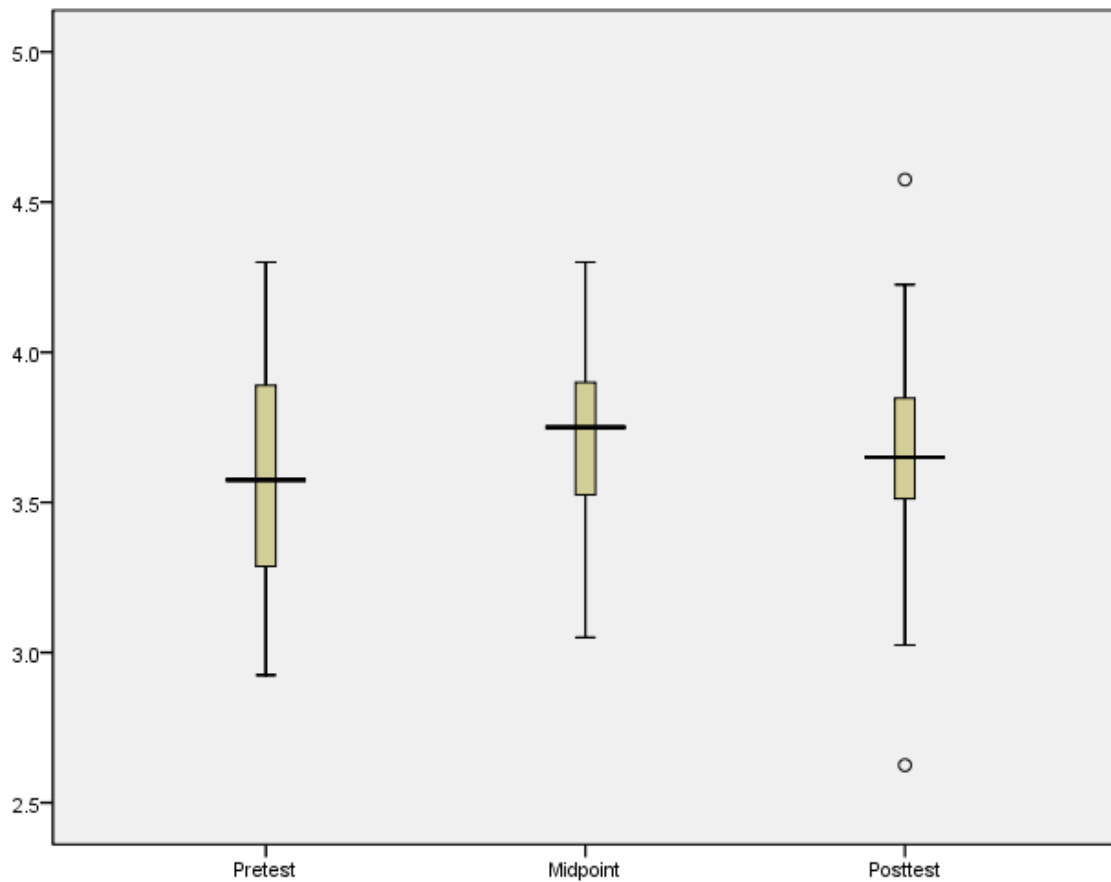
On traditionally worded items on both the MBS and TMBS, teacher candidate response patterns over the three administrations differed between the two subtests. With the traditionally worded items on the MBS, teacher candidates' responses increased in agreement from pretest (3.23) to midpoint (3.41), and then maintained the same level from midpoint (3.41) to posttest (3.41). The response consistency between midpoint and posttest indicate that traditionalist views of mathematics in general did not diminish over the latter part of the study. Teacher candidate responses on the TMBS traditionally worded items reveal a pattern similar to the constructively worded items, beginning at 3.31 at pretest, increasing to 3.62 at midpoint, and decreasing to 3.38 at posttest. These results showed a minimal increase in agreement with the traditionalist approach to mathematics instruction over the course of the study.

Mean score results from the full beliefs instrument and its subtests indicate that while students' means rose or fell slightly throughout the study, they maintained fairly

similar ratings from pretest to posttest on items worded both traditionally and constructively. On all item types, except MBS traditionally worded items, increases were seen in agreement levels between pretest and midpoint, with slight decreases between midpoint and posttest. With the MBS, an increase in agreement was seen between pretest and midpoint, which was then maintained at posttest. This information illustrates the possible resistance to change of the long-held traditionalist beliefs that teacher candidates have about mathematics in general.

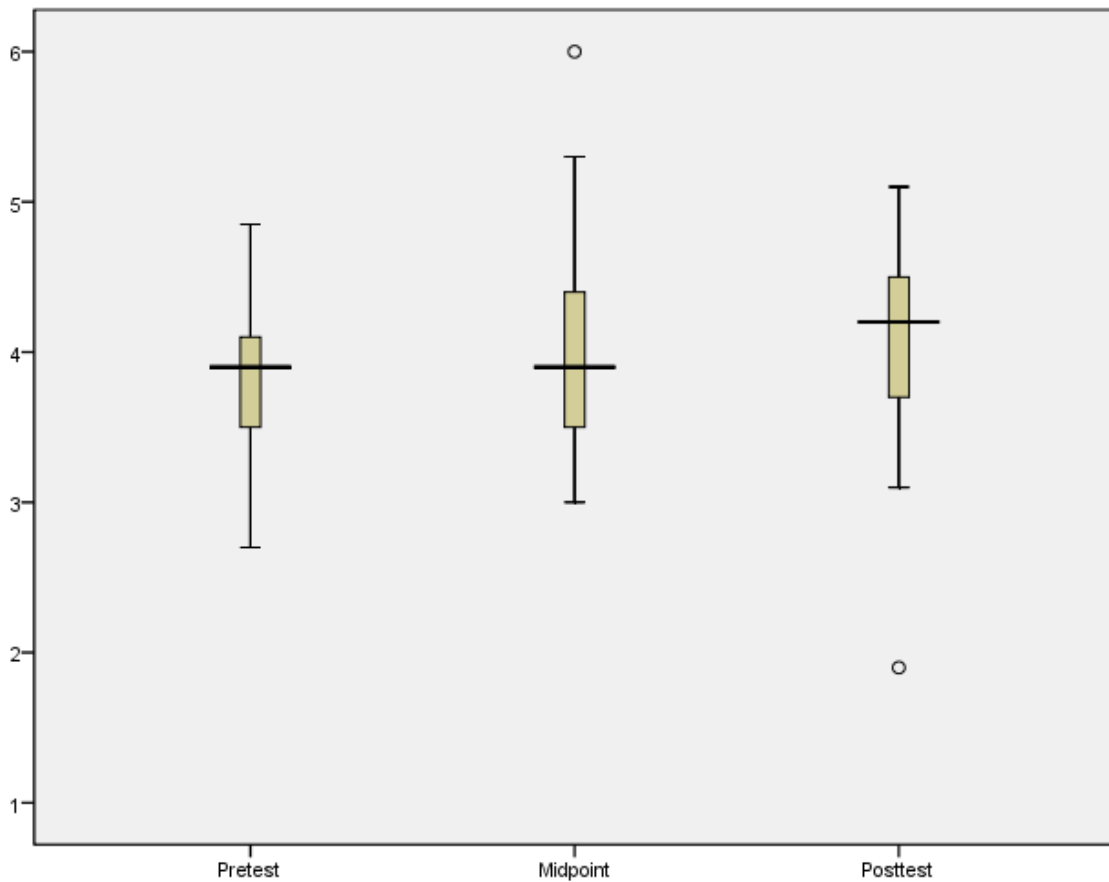
Box plots of the full beliefs instrument scores in Figure 5 show normal distributions at both pretest and midpoint administrations. Posttest scores evidence outliers in both the upper and lower score ranges, which indicate high variability in participant responses at this administration. The box plots also show slight score movement from pretest to midpoint to posttest, with midpoint scores depicting a small increase before falling to pretest level at posttest.

Figure 5. Mathematics beliefs questionnaire full survey box plots.



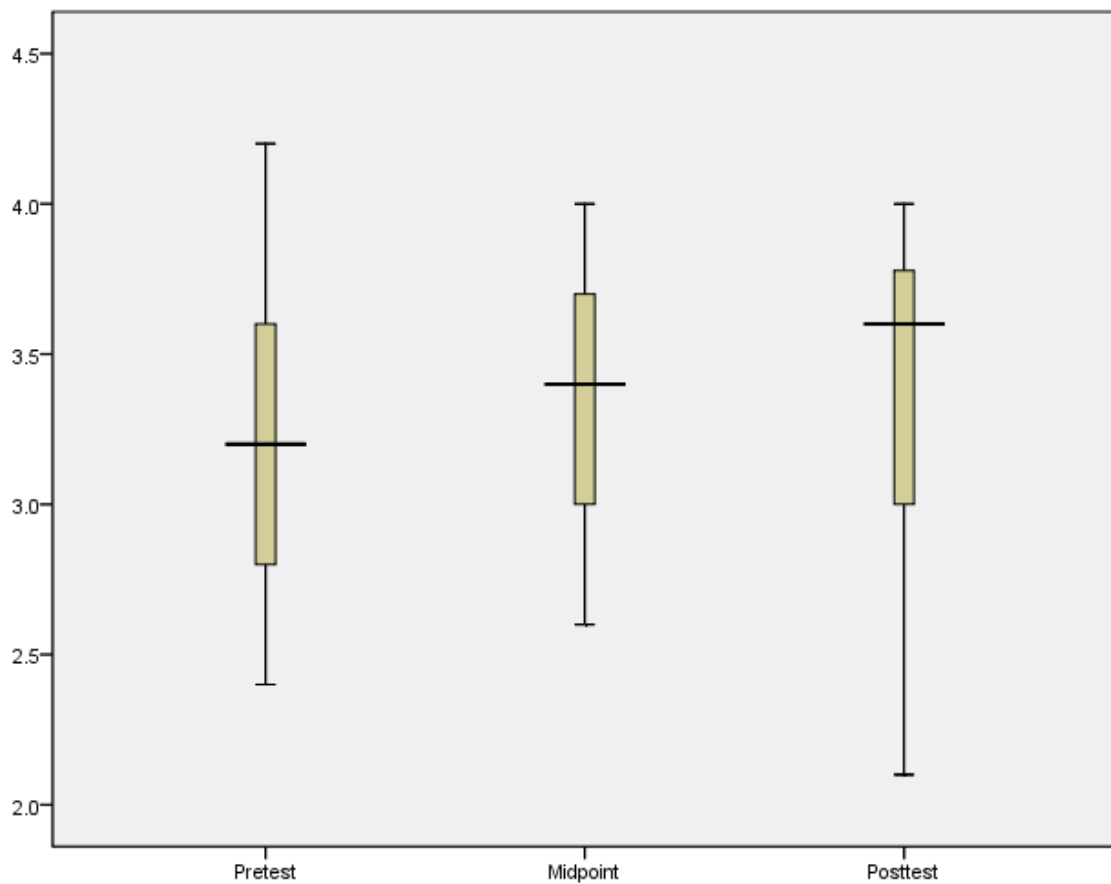
In Figure 6, box plots of constructively worded items on the MBS section show a normal distribution at pretest, while midpoint shows an upper level score outlier and posttest depicts a lower level score outlier. While all three box plots have similar compact interquartile ranges, the median score at posttest shows an increase from both pretest and midpoint levels.

Figure 6. MBS - constructively worded items box plots.



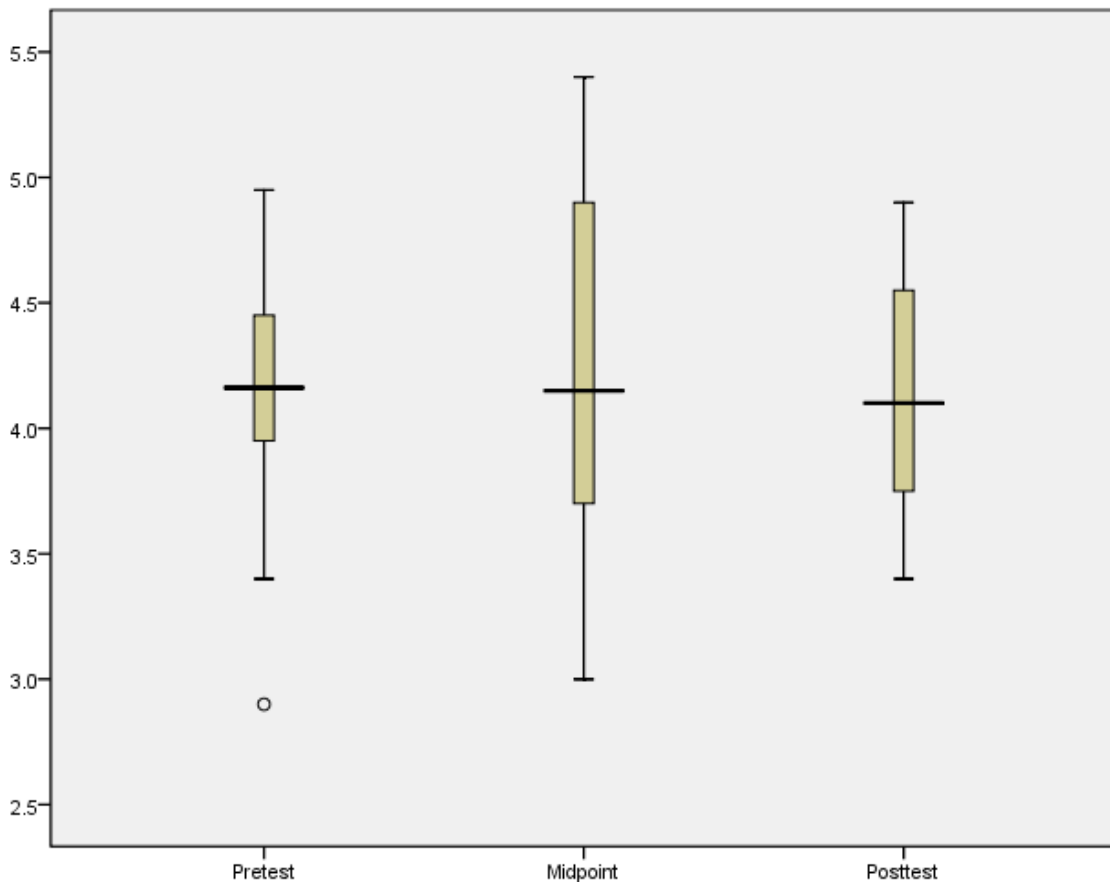
Box plots in Figure 7, show all three administrations of traditionally worded items on the MBS section having normal distributions but with larger interquartile ranges at all three administrations than constructively worded items on the same section. While the plots illustrate median scores that increase at each subsequent administration, posttest scores show the highest median level with the greatest variability of score distribution. Posttest scores show the largest amount of variability particularly in the lowest 25% of scores. This highest median score level coupled with the largest range of scores of all three administrations illustrates that while the median scores rose at posttest, there was a large difference in the response levels amongst participants at this administration.

Figure 7. MBS - traditionally worded items box plots.



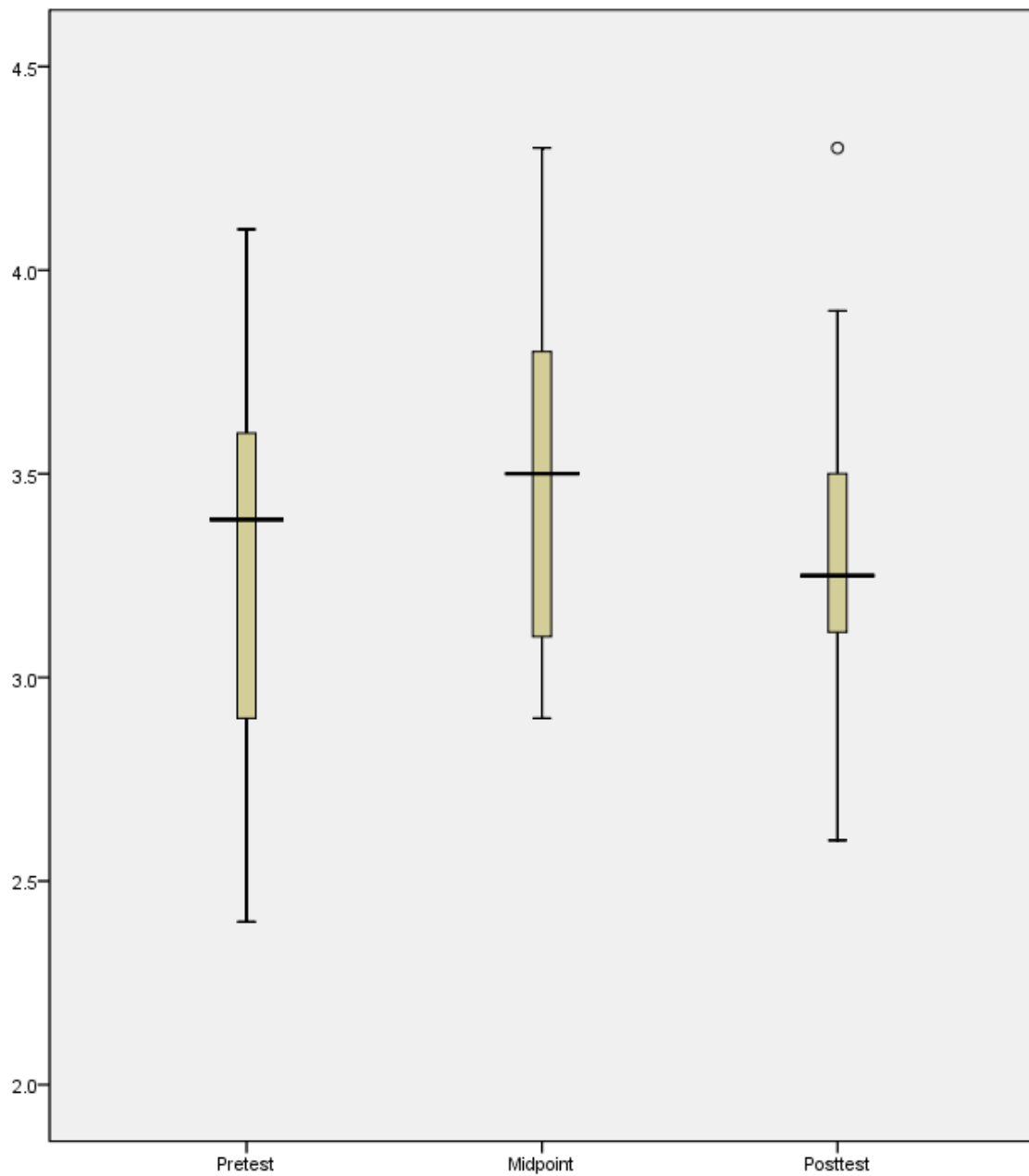
On the TMBS constructively worded item box plots in Figure 8, midpoint and posttest scores evidence normal score distributions. Pretest scores have a lower range score as an outlier in their distribution. Another important visual seen in the box plots is the larger interquartile range of scores at midpoint than at either pretest or posttest. Median score levels are stable across all three administrations with a slight dip at both midpoint and posttest.

Figure 8. *TMBS - Constructively worded items box plots.*



In Figure 9, box plots show that the pretest and midpoint administrations of the traditionally worded items on the TMBS have normal distributions. While the median score level shows an increase at midpoint and then a decrease at posttest, it is at the posttest administration that an upper level score is seen as an outlier. This information depicts that while participants' overall agreement with traditionally worded items on the TMBS decreased at posttest, this lower level of agreement was not seen across all participants.

Figure 9. TMBS - traditionally worded items box plots.



When evaluating teacher candidate means for individual questions at pretest, item 7, “There are several different but appropriate ways to organize the basic ideas in mathematics” and item 36, “Teachers must frequently give students assignments which

require creative or investigative work” had the same highest mean scores (both at 4.92). This mean score indicated that teacher candidates rated these constructively worded items at approximately the “Moderately Agree” level. Item 1, “Solving a mathematics problem usually involves a rule or formula that applies” had the lowest mean score (1.92), showing that teacher candidates on the whole chose “Moderately Disagree” on this traditionally worded item. At posttest, the highest mean score (4.61) was on item 26, “Teachers should provide class time to experiment with their own mathematical ideas. Item 21, “The teacher should always work sample problems for students before making an assignment” received the lowest mean score (2.06). As at pretest, on the posttest administration the item with the highest mean was constructively worded, and the item with the lowest mean was traditionally worded.

Inferential Statistics for the Mathematical Beliefs Questionnaire

Due to the multiple administrations of the beliefs instrument throughout the study, a repeated measures analysis was completed to see whether there were any statistically significant differences between administrations of the full beliefs instrument, and between administrations of its four subareas. Results from the repeated measures analysis are presented in Table 15. For the full attitude survey and all four subtests, no statistically significant differences were found between pretest, midpoint, or posttest teacher candidate responses because significance for all measures was indicated at the $p > .05$ level.

Table 15
Repeated Measures Analysis of the Mathematical Beliefs Questionnaire

Measure	Source	df	SS	MS	<i>F</i>	<i>p</i>
Attitude Whole	Time	1	0.163	1	2.039	0.175
	Within Group Error(Time)	14	1.122	0.08		
MBS - Constructivist	Time	1	0.343	0.343	0.793	0.386
	Within Group Error(Time)	16	6.925	0.433		
MBS - Traditional	Time	1	0.199	0.199	0.841	0.373
	Within Group Error(Time)	16	3.785	0.237		
TMBS - Constructivist	Time	1	0.136	0.136	0.421	0.526
	Within Group Error(Time)	15	4.85	0.323		
TMBS - Traditional	Time	1	0.439	0.439	2.136	.168
	Within Group Error(Time)	13	2.671	0.205		

The last statistical analyses performed on the beliefs instrument used correlational analyses for determining possible relationships from within test and between test correlations across the three administrations of the full beliefs instruments and its four subareas (MBS – traditionally worded, MBS – constructively worded, TMBS – traditionally worded, MBS – constructively worded). As with the efficacy instrument, within test correlations were completed to see if there was any relationship between the

multiple administrations of the full instrument, as well as any associations between the multiple administrations of each subarea. Between subarea correlations were performed to assess possible connections between teacher candidate attitudes about mathematics in general and teaching mathematics.

For the full beliefs instrument, a strong correlation was found between teacher candidate responses at pretest and midpoint ($r=0.88$, $p<.001$) and a moderate correlation was found between pretest and posttest ($r=.751$, $p=.001$) as shown in Table 16. These results indicate that how teacher candidates responded on the pretest survey were closely associated with how they responded on the midpoint and posttest surveys. This association may indicate a possible resistance to change for teacher candidates' attitudes about mathematics. Other correlations on the full beliefs survey showed no statistically significant relationships.

Table 16
Correlation Matrix for Full Beliefs Instrument Across Pretest, Midpoint, and Posttest

		Beliefs 1	Beliefs 2	Beliefs 3
Beliefs 1				
Pearson	Correlation	1	0.88	0.751
	Sig. (2-tailed)		0	0.001
	N	17	15	17
Beliefs 2				
Pearson	Correlation	0.88	1	0.546
	Sig. (2-tailed)	0		0.023
	N	15	17	17
Beliefs 3				
Pearson	Correlation	0.751	0.546	1
	Sig. (2-tailed)	0.001	0.023	
	N	17	17	19

The next correlation analysis was performed on the MBS constructively worded items as seen in Tables 17 and 18. For these response items, a strong correlation was found between pretest and midpoint ($r=.805$, $p<.001$). However, no other significant correlations were found for this subtest's administrations. This information shows that teacher candidates' constructive beliefs about mathematics in general midway through the study have a possible association between their beliefs at the outset of the study. For the traditionally worded items of the MBS, a moderately strong correlation was found between pretest and midpoint ($r=.722$, $p=.001$) and pretest and posttest ($r=0.654$, $p=.003$). Other correlations between administrations of the TMBS were not found to be statistically significant. In regard to responses to traditionally worded items on the MBS,

there appears to be a consistent relationship between responses at pretest and other administrations, indicating that traditionally held attitudes towards mathematics in general may be resistant to change.

Table 17
Correlation Matrix for MBS – Constructively Worded Items Across Pretest, Midpoint, and Posttest

		MBS-Con1	MBS-Con2	MBS-Con3
MBS-Con1	Pearson Correlation	1	0.805	0.521
	Sig. (2-tailed)		0	0.027
	N	18	17	18
MBS-Con2	Pearson Correlation	0.805	1	0.474
	Sig. (2-tailed)	0		0.047
	N	17	18	18
MBS-Con3	Pearson Correlation	0.521	0.474	1
	Sig. (2-tailed)	0.027	0.047	
	N	18	18	19

Table 18
Correlation Matrix for the MBS – Traditionally Worded Items Across Pretest, Midpoint, and Posttest

		MBS-Trad1	MBS-Trad2	MBS-Trad3
MBS-Trad1	Pearson Correlation	1	0.722	0.654
	Sig. (2-tailed)		0.001	0.003
	N	18	17	18
MBS-Trad2	Pearson Correlation	0.722	1	0.552
	Sig. (2-tailed)	0.001		0.018
	N	17	18	18
MBS-Trad3	Pearson Correlation	0.654	0.552	1
	Sig. (2-tailed)	0.003	0.018	
	N	18	18	19

Correlations for the TMBS were also generated and analyzed for both constructively and traditionally worded item areas shown in 19 and 20. For constructively worded items, a moderate correlation occurred between pretest and midpoint ($r=.695$, $p=.003$). This result indicates an association between constructive attitudes towards mathematics instruction at the beginning and midpoint of the study. Other correlations between administrations of the TMBS constructively worded items did not yield any statistically significant relationships. For traditionally worded items on the TMBS, a moderate correlation was found between pretest and posttest responses ($r=.669$, $p=.005$). Analysis of the remaining data for the traditionally worded items of the TMBS

did not indicate any other statistically significant correlations. The information gathered from the TMBS correlation analysis indicate that teacher candidates' traditional beliefs about teaching mathematics at the beginning of the study may have some relationship with their traditional beliefs at the conclusion of the study.

Table 19
Correlation Matrix for TMBS – Constructively Worded Subtest Across Pretest, Midpoint, and Posttest

		TMBS-Con1	TMBS-Con2	TMBS-Con3
TMBS-Con1	Pearson Correlation	1	0.695	0.589
	Sig. (2-tailed)		0.003	0.01
	N	18	16	18
TMBS-Con2	Pearson Correlation	0.695	1	0.197
	Sig. (2-tailed)	0.003		0.448
	N	16	17	17
TMBS-Con3	Pearson Correlation	0.589	0.197	1
	Sig. (2-tailed)	0.01	0.448	
	N	18	17	19

Table 20
Correlation Matrix for TMBS – Traditionally Worded Item Subtest Across Pretest, Midpoint, and Posttest

		TMBS-Trad1	TMBS-Trad2	TMBS-Trad3
TMBS-Trad1	Pearson			
	Correlation	1	0.494	0.669
	Sig. (2-tailed)		0.072	0.005
	N	16	14	16
TMBS-Trad2	Pearson			
	Correlation	0.494	1	0.516
	Sig. (2-tailed)	0.072		0.034
	N	14	17	17
TMBS-Trad3	Pearson			
	Correlation	0.669	0.516	1
	Sig. (2-tailed)	0.005	0.034	
	N	16	17	19

Within test correlation analyses were completed between the MBS and TMBS subtests, for both constructively and traditionally worded items, at pretest, midpoint, and posttest in Tables 21-23. At pretest and midpoint, no relevant correlations between subtests were evident. At posttest, a moderate correlation was found between the traditionally worded items on the MBS and TMBS ($r=.649$, $p=.003$). On the whole, this information shows a lack of association between traditional and constructivist attitudes about either mathematics in general or mathematics instruction. The one exception is the association between traditional attitudes about mathematics between the two subtests at posttest. This association may be partly due to the fact that statistics showed that

traditional beliefs about mathematics in general rose between pretest and midpoint, and then maintained constant through posttest, indicating that teacher candidates beliefs about mathematics in general may be deeply rooted.

Table 21
Correlation Matrix for TMBS and MBS Subtests at Pretest

		MBS-Con1	MBS-Trad1	TMBS-Con1	TMBS-Trad1
MBS-Con1	Pearson Correlation	1	0.429	0.417	0.339
	Sig. (2-tailed)		0.076	0.085	0.199
	N	18	18	18	16
MBS-Trad1	Pearson Correlation	0.429	1	0.369	0.35
	Sig. (2-tailed)	0.076		0.131	0.184
	N	18	18	18	16
TMBS-Con1	Pearson Correlation	0.417	0.369	1	0.444
	Sig. (2-tailed)	0.085	0.131		0.085
	N	18	18	18	16
TMBS-Trad1	Pearson Correlation	0.339	0.35	0.444	1
	Sig. (2-tailed)	0.199	0.184	0.085	
	N	16	16	16	16

Table 22
Correlation Matrix for TMBS and MBS Subtests at Midpoint

		MBS-Con2	MBS-Trad2	TMBS-Con2	TMBS-Trad2
MBS-Con2	Pearson Correlation	1	0.429	0.417	0.339
	Sig. (2-tailed)		0.076	0.085	0.199
	N	18	18	18	16
MBS-Trad2	Pearson Correlation	0.429	1	0.369	0.35
	Sig. (2-tailed)	0.076		0.131	0.184
	N	18	18	18	16
TMBS-Con2	Pearson Correlation	0.417	0.369	1	0.444
	Sig. (2-tailed)	0.085	0.131		0.085
	N	18	18	18	16
TMBS-Trad2	Pearson Correlation	0.339	0.35	0.444	1
	Sig. (2-tailed)	0.199	0.184	0.085	
	N	16	16	16	16

Table 23
Correlation Matrix for TMBS and MBS Subtests at Posttest

		MBS-Con3	MBS-Trad3	TMBS-Con3	TMBS-Trad3
MBS-Con3	Pearson Correlation	1	0.492	0.563	0.5
	Sig. (2-tailed)		0.032	0.012	0.029
	N	19	19	19	19
MBS-Trad3	Pearson Correlation	0.492	1	0.215	0.649
	Sig. (2-tailed)	0.032		0.376	0.003
	N	19	19	19	19
TMBS-Con3	Pearson Correlation	0.563	0.215	1	0.378
	Sig. (2-tailed)	0.012	0.376		0.111
	N	19	19	19	19
TMBS-Trad3	Pearson Correlation	0.5	0.649	0.378	1
	Sig. (2-tailed)	0.029	0.003	0.111	
	N	19	19	19	19

Overall, the results of these correlational analyses show some relationship between how teacher candidates responded at pretest to attitude items and how they responded on other administrations. However, the association between traditionally

worded items seemed to be more consistent throughout the length of the entire study than constructively worded items. This information indicates that traditional beliefs about mathematics may be more firmly held and resistant to change when held by teacher candidates than constructive beliefs, which appeared more open to change.

Mathematical Content Knowledge for Elementary Teachers

The third instrument evaluated teacher candidates' content knowledge of elementary level mathematics. Teacher candidates' accuracy of mathematics knowledge at their target grade level for instruction was believed important in the light of current "highly qualified" teacher mandates, which require special education teacher candidates to be prepared in the subject area of instruction, as well as in the pedagogical techniques for at-risk learners (IDEA, 2004). The Mathematical Content Knowledge for Elementary Teachers (Matthews & Seaman, 2007) survey was used to assess teacher candidates' content knowledge proficiency. This measure utilizes a total of 20 questions involving basic arithmetic and algebraic thinking skills at the elementary school level. Questions are a mixture of open-ended calculation and multiple choice items. For scoring purposes, items were marked as either correct or incorrect with no partial credit given for responses. While teacher candidates' responses were scored for the entire test originally, the researcher then divided questions into two groupings, basic arithmetic and algebraic thinking, and scored these questions as two different subtests, with 11 questions relevant to basic arithmetic and 9 questions pertaining to algebraic thinking.

Descriptive Statistics for the Mathematical Content Knowledge for Elementary Teachers

For teacher candidates' responses on the Mathematical Content Knowledge for Elementary Teachers survey, SPSS was used to generate descriptive and inferential

statistics. In terms of descriptive statistics, mean, median, range, standard deviation, skewness, kurtosis, and standard error of mean were generated. Descriptive statistics are given in Table 24. These statistics indicate a normal distribution of results.

Table 24
Descriptive Statistics for Mathematical Content for Elementary Teachers

<i>Math. Content for Elem. Teachers</i>	Mean	Median	*Gain Score	Range	SD	Skewness	Kurtosis	Standard Error of Mean
Full Survey								
Pre (N=19)	0.36	0.35		0.50	0.16	0.33	-0.87	0.04
Mid (N=18)	0.42	0.40	9.38%	0.60	0.18	-0.02	-1.16	0.04
Post (N=18)	0.38	0.30	3.12%	0.65	0.20	0.30	-1.03	0.05
Basic Arithmetic								
Pre (N=18)	0.41	0.41		0.73	0.21	0.40	-0.61	0.05
Mid (N=18)	0.45	0.46	8.47%	0.64	0.18	0.09	-0.34	0.04
Post (N=18)	0.41	0.41	0.00%	0.73	0.21	0.40	-0.61	0.05
Algebraic Thinking								
Pre (N=18)	0.34	0.28		0.67	0.21	0.16	-1.22	0.05
Mid (N=18)	0.38	0.39	9.09%	0.67	0.22	-0.08	-1.37	0.05
Post (N=18)	0.34	0.28	0.00%	0.67	0.21	0.16	-1.22	0.05

*Gain scores are reported as percentage differences from pretest scores.

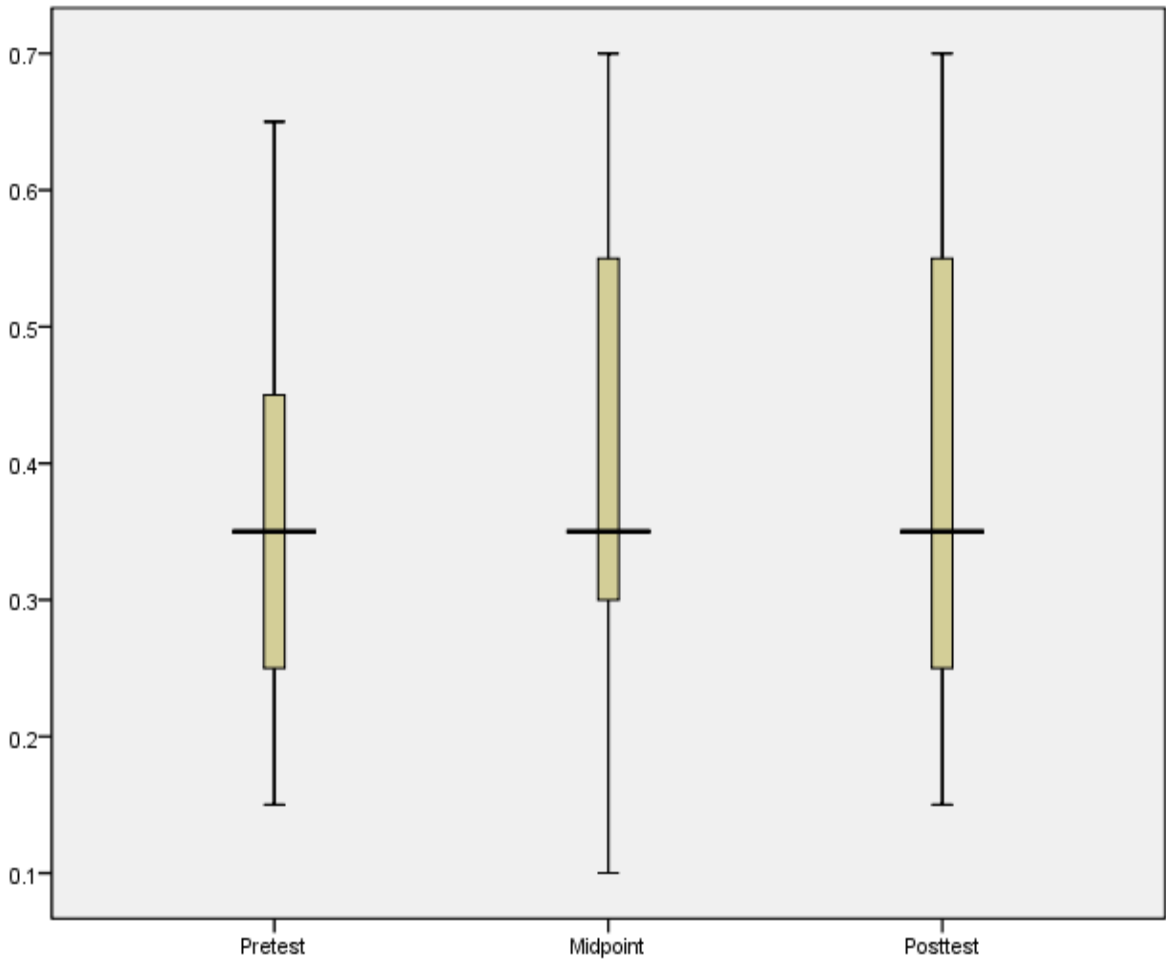
When evaluating the content knowledge measure, the teacher candidates' overall mean scores for the entire survey and its subtests were calculated for the pretest,

midpoint, and posttest administrations. For this purpose, all correct answers were coded as 1s and all incorrect answers were coded as 0s. On the full content knowledge survey, the pretest mean score was 7.11, which was just slightly over 35% of problems correct, with individual scores ranging from 3 to 13. The midpoint mean score was 7.95, which was just slightly under 40% of problems correct, with individual scores ranging from 4 to 14. The posttest mean score was 6.31, which is just over 30% of problems correct, with individual scores ranging from 0 to 13. Looking at the overall means for items by the full survey, the basic arithmetic subtest, and the algebraic thinking subtest, the fluctuation of these means follows a similar manner at each administration point. From pretest to midpoint, the mean on the full content survey increased from 0.36 to .42, and from midpoint to posttest the mean decreased from .42 to .38. These scores indicate that teacher candidates were more likely to achieve an item score of 1, a correct score, at midpoint than at any other administration. The gain score from pretest to midpoint was 9.38% and from pretest to posttest only 3.12%. On the basic arithmetic subtest, mean scores followed the same pattern from pretest to midpoint to posttest, moving from .41 to .45 back to .41. Algebraic thinking subtest scores also had this increase/decrease pattern as well, going from .34 to .38 back to .34. Gain scores on these two surveys showed an 8.47% increase on the general arithmetic subtest from pretest to midpoint and a 9.09% increase on the algebraic thinking subtest from pretest to midpoint. Both subtests evidenced no gain between pretest and posttest. Between the two subtests and the full survey, the basic arithmetic subtest had the highest mean scores during each administration, indicating that teacher candidates marked correct answers for basic arithmetic questions somewhere between 41% and 45% of the time versus between 36-

42% of the time for the full survey and 34-42% of the time for the algebraic thinking subtest. In terms of the overall results for elementary level mathematics skills, teacher candidates scored in the deficient range in overall accuracy in solving elementary level mathematics problems, having the most trouble with algebraic thinking questions across administrations.

Box plots in Figure 10 show the content knowledge full survey scores at all three administrations as having normal distributions. While median score levels show little movement between administrations, it is seen through the interquartile ranges that the differences between scores that make up the inner 50% increased at each administration. This increase in variability illustrates that while the median level of scores remained similar, the level of difference among individual scores of participants rose.

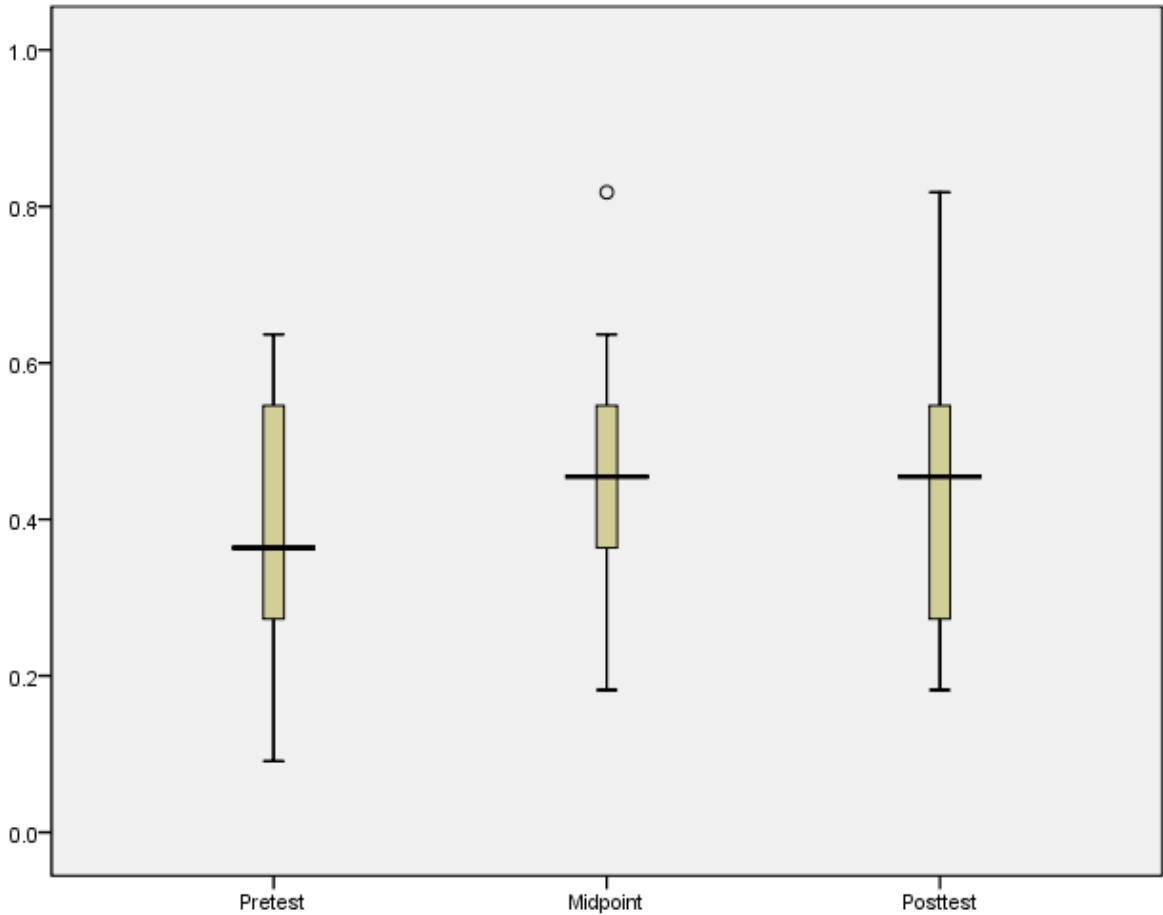
Figure 10. Mathematics content for elementary teachers full survey.



In Figure 11, box plots show pretest and posttest scores with normal distributions on the basic arithmetic subtest. Midpoint scores contained one upper level outlier. Median scores show little movement across all three administrations. The interquartile range of participant scores is more compact at midpoint than at either pretest or posttest. At pretest, the lower 25% of scores shows a larger range, while at posttest the upper 25% of scores shows a greater span. The variability at pre- and posttest shows that

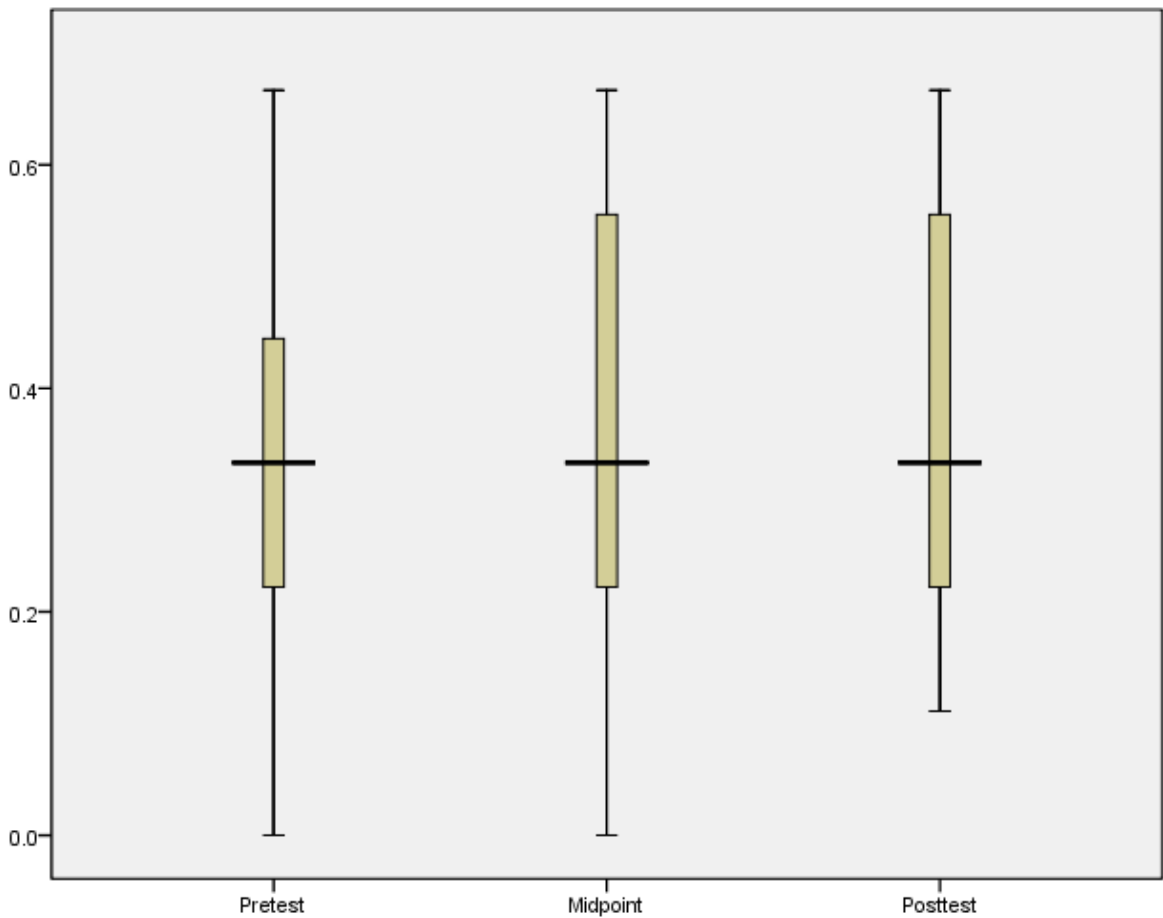
participants' performance was less consistent across the group at both the beginning and end of the study than at its middle.

Figure 11. Basic arithmetic subtest box plots.



The box plots in Figure 12 depict extremely similar median scores across all three administrations of the algebraic thinking subtest. All administrations also show a normal distribution of participant scores. A large difference in interquartile range scores was seen at both midpoint and posttest, with these scores being more closely clustered at pretest. However, the upper and lower 25% of scores showed the greatest variability at pretest.

Figure 12. Algebraic thinking subtest box plots.



When evaluating teacher candidate means for individual questions at pretest, it was found on item 3, all teacher candidates scored a 1, or correct answer. This question was a basic arithmetic multiple choice problem, which involved selecting the correct number sentence that represented 43×38 to the nearest 10. While every teacher candidate achieved a correct answer on item 3, the question with the lowest mean was item 19, also a basic arithmetic problem, for which none of the teacher candidates obtained a correct answer. This problem involved selecting the correct conceptualization

for explaining the process behind a two-digit multiplication problem. On the posttest administration, item 3 remained the item with the highest mean, while the lowest mean of 0, where no teacher candidates answered correctly, was shared between items 7 and 20, both algebraic thinking problems. Item 7 was a multiple choice question, where students had to figure out a range of number values for two unknown numbers in an averaging problem. Item 20 was also a multiple choice item where students had to determine the theoretical conceptualization of subtraction with regrouping.

Inferential Statistics for the Mathematical Content Knowledge for Elementary Teachers

Since the content knowledge survey, like the attitude and efficacy measures, was administered at pretest, midpoint, and posttest, a repeated measures analysis was run to determine if there were any statistically significant differences between the results of the full survey and two subtests for the three administration points. Results from the repeated measures analysis are presented in Table 25. For the full content knowledge survey and its two subtests, no statistically significant difference was found between pretest, midpoint, or posttest teacher candidate responses at the $p > .05$ level.

Table 25
Repeated Measures Analysis for Mathematics Content for Elementary Teachers

Measure	Source	df	SS	MS	<i>F</i>	<i>p</i>
Content Whole	Time	1	0.022	0.022	0.837	0.374
	Within Group Error(Time)	16	0.418	0.026		
Basic Arithmetic	Time	1	0.025	0.025	0.79	0.387
	Within Group Error(Time)	16	0.499	0.031		
Algebraic Thinking	Time	1	0.019	0.019	0.449	0.512
	Within Group Error(Time)	16	0.672	0.042		

As a final part of the data interpretation for the content knowledge instrument, correlational analyses were performed on the full content knowledge survey and its two subtests to evaluate within test and between correlations. As with both the efficacy and beliefs instruments, within test correlations were completed to see if there was any relationship between the multiple administrations of the full instrument, as well as any associations between the multiple administrations of each subtest. Between subtest correlations were completed to determine possible connections between teacher candidate levels of basic arithmetic skills and algebraic thinking abilities.

Initially, a correlational analysis was completed between the three administrations of the full content knowledge survey as seen in Table 26. These results showed there was a moderately strong correlation ($r=.745$, $p<.001$) between the pretest and midpoint administrations of the content knowledge survey. This information indicates a possible

relationship between the teacher candidates' accuracy of content knowledge at pretest and midpoint. However, other correlations for the full content knowledge instrument did not yield statistically significant correlations.

Table 26
Correlation Matrix for Full Content Knowledge Survey Across Pretest, Midpoint, and Posttest

	Content 1	Content 2	Content 3
Content 1			
Pearson Correlation	1	0.745	0.488
Sig. (2-tailed)		0	0.04
N	19	18	18
Content 2			
Pearson Correlation	0.745	1	0.591
Sig. (2-tailed)	0		0.013
N	18	18	17
Content 3			
Pearson Correlation	0.488	0.591	1
Sig. (2-tailed)	0.04	0.013	
N	18	17	18

When analyzing correlations across administrations of the two subtests, a moderate correlation ($r=.652$, $p=.003$) was seen between the pretest and midpoint administrations of the basic arithmetic subtest and the algebraic thinking subtest ($r=.641$, $p=.004$) in Tables 27 and 28. These results are indicative of a probable association across pretest and midpoint administrations for both basic arithmetic and algebraic thinking

items. Other correlations performed on the two subtests across administrations were not statistically significant.

Table 27
Correlation Matrix for Basic Arithmetic Subtest Across Pretest, Midpoint, and Posttest

		Basic Arithmetic1	Basic Arithmetic 2	Basic Arithmetic 3
Basic Arithmetic 1	Pearson Correlation	1	0.652	0.432
	Sig. (2-tailed)		0.003	0.073
	N	19	18	18
Basic Arithmetic 2	Pearson Correlation	0.652	1	0.56
	Sig. (2-tailed)	0.003		0.019
	N	18	18	17
Basic Arithmetic 3	Pearson Correlation	0.432	0.56	1
	Sig. (2-tailed)	0.073	0.019	
	N	18	17	18

Table 28
Correlation Matrix for Algebraic Thinking Subtest Across Pretest, Midpoint, and Posttest

		Algebraic Thinking 1	Algebraic Thinking 2	Algebraic Thinking 3
Algebraic Thinking 1	Pearson Correlation	1	0.641	0.419
	Sig. (2-tailed)		0.004	0.084
	N	19	18	18
Algebraic Thinking 2	Pearson Correlation	0.641	1	0.511
	Sig. (2-tailed)	0.004		0.036
	N	18	18	17
Algebraic Thinking 3	Pearson Correlation	0.419	0.511	1
	Sig. (2-tailed)	0.084	0.036	
	N	18	17	18

Correlation analyses were then completed between the subtests at each administration of the content knowledge measure as shown in Tables 29-31. Unlike other instruments in this study, the content knowledge instruments' subtests, the basic arithmetic and algebraic thinking skills had correlations at all three administrations. At pretest and midpoint, the two subtests had moderate correlations with ($r=.662$, $p=.002$) and ($r=.687$, $p=.002$) respectively. At posttest, the correlation was strong between the two subtests ($r=.819$, $p<.001$). These results show a probable relationship between

teacher candidates' abilities to accurately answer basic arithmetic and accurately answer algebraic thinking items.

Table 29
Correlation Matrix for Basic Arithmetic and Algebraic Thinking Subtests at Pretest

		Basic Arithmetic 1	Algebraic Thinking 1
Basic Arithmetic 1	Pearson Correlation	1	0.662
	Sig. (2-tailed)		0.002
	N	19	19
Algebraic Thinking 1	Pearson Correlation	0.662	1
	Sig. (2-tailed)	0.002	
	N	19	19

Table 30
Correlation Matrix for Basic Arithmetic and Algebraic Thinking Subtests at Midpoint

		Basic Arithmetic 2	Algebraic Thinking 2
Basic Arithmetic 2	Pearson Correlation	1	0.687
	Sig. (2-tailed)		0.002
	N	18	18
Algebraic Thinking 2	Pearson Correlation	0.687	1
	Sig. (2-tailed)	0.002	
	N	18	18

Table 31
Correlation Matrix for the Basic Arithmetic and Algebraic Thinking Subtests at Posttest

		Basic Arithmetic 3	Algebraic Thinking 3
Basic Arithmetic 3	Pearson Correlation	1	0.819
	Sig. (2-tailed)		0
	N	18	18
Algebraic Thinking 3	Pearson Correlation	0.819	1
	Sig. (2-tailed)	0	
	N	18	18

Overall correlation results indicated that there was a relationship between teacher candidates' ability to correctly answer questions between pretest and midpoint administrations on the full survey, basic arithmetic subtest, and algebraic thinking subtest. This association illustrates a possible connection between the teacher candidates' content knowledge abilities at the start of the study and how they performed at the midway point. Linkages were also seen at each administration between the content knowledge and algebraic thinking subtests, providing support to the literature (Baker, Gersten, & Lee, 2002) that suggests connections between learners' abilities in fundamental mathematics skills and higher order algebraic thinking skills.

Instructional Knowledge Exam

The fourth area of investigation was teacher candidates' knowledge of research-based mathematics instructional practices for struggling learners. The instructional knowledge that was assessed consisted of information relevant to mathematics instruction for at-risk learners in conjunction with the DAL framework that was presented in the practicum by the researcher, and reinforced in the Clinical Teaching course by the professor. The researcher conducted the trainings and support for the DAL framework within the practicum, while the course professor utilized his self-written course textbook and his knowledge of the DAL framework (he was one of the designers of the DAL along with the researcher) in class. The professor designed the course exam to assess teacher candidate instructional knowledge on several levels.

The exam consisted of two sections: multiple choice and short answer essay. The multiple choice section contained 25 questions, 15 on instructional strategy knowledge and 10 on learning characteristics. The short answer essay section contained 8 questions,

with a total of 21 sections, on elements of effective instructional practices and application of these effective instructional practices within the DAL framework. 10 of the sections of the essay questions pertained to effective practices alone, and 11 of the sections involved their application within the DAL framework. For scoring purposes, each multiple-choice question was given 1 point if correct, and 0 if incorrect. For short answer essay questions, each subsection of each essay question was scored on a 5 point scale, with (5) indicating a complete answer to the question and a (1) indicating an answer that was not directed at the question asked or was incorrect. The instructional knowledge exam was scored as a whole, as two subsections of multiple choice and essay, and as four subsections: instructional practices (multiple choice), learning characteristics (multiple choice), instructional practices (essay), and instructional practices application (essay). The scoring process was implemented by the researcher and two outside raters trained in the DAL framework for the purpose of this study, but grading of the exam was done separately by the professor and was not included in the research. Raters each scored a random sampling of 5 tests, and regrouped to compare results. Since 90% agreement between scoring was seen from these 5 tests, this level of agreement was considered sufficient and raters then scored the rest of the tests independently. After completion of all scoring, the raters came back together and discussed their individual evaluations of each question for each participant to reach agreement on any scoring differences among raters.

Descriptive Statistics for the Instructional Knowledge Exam

For statistical analysis of teacher candidates' responses on the instructional knowledge exam, the researcher used SPSS to generate descriptive and inferential

statistics, as with the other measures employed. As with other quantitative measures employed in the study, data on mean, median, range, standard deviation, skewness, kurtosis, and standard error of mean were generated. Descriptive statistics are given in Table 32. These statistics indicated a normal distribution of results, with the exception of the multiple choice test. On this section of the instructional exam, most students answered correctly on most items.

When evaluating the instruction exam, the first item analyzed was the full exam's score for each teacher candidate. The mean score total for teacher candidates on the whole exam was 80.82 out of a total possible 130 points, or 62% of questions answered correctly. Within the test, multiple choice and essay questions were scored using two different scales. Multiple choice questions were either scored as 1 for correct, or 0 for incorrect. Short answer essay questions were scored on a 0 to 5 point scale, with 5 being a fully correct answer and 0 being an incorrect answer. As a result, the different types of items must be interpreted separately. For multiple choice questions, the mean score was .91. This result is close to 1, indicating that many teacher candidates performed well in this section with most of them scoring a 90% or above on items. Dividing the multiple choice questions into two categories, instructional practices and learning characteristics, students achieved a mean of 13.74 out of 15, or 92%, on instructional practice questions and 9.00 out of 10, or 90% on learning characteristic questions. For all essay questions, the mean score was 58.11 out of 105, or approximately a 55%. Breaking the essay questions into effective instructional practices and application of these strategies, teacher candidates had a mean score of 31.53 out of 50, or 64%, on effective instructional practices, and 26.58 out of 55, or 49%, on application of these strategies. For questions

scored under the effective instructional practices essay category, the mean score was 3.15, indicating that teacher candidates often received a score of “a few main parts included.” On application essay questions the mean score was 2.43, indicating that teacher candidates achieved “a small part” correctly on items but missed most major points. This exam was only administered at the end of the semester, so there were not multiple administrations with which to compare teacher candidates’ results. However, overall results from the content exam were indicative that instructional strategy and learning characteristics multiple choice questions were answered at proficiency levels. Essay questions as a whole were answered just under beginning competency at 55%, but when broken down into instructional practices and application of these practices, it was found that questions on the instructional practices themselves were answered with a beginning competency level while application questions were below this level of beginning competency.

When appraising individual answer responses on the multiple choice questions, several items received a mean of 1, both on instructional strategies and learning characteristics. The multiple choice item with the lowest mean score for instructional strategies was item 3, which asked teacher candidates to correctly identify a mathematics instructional practice not emphasized for teaching problem solving strategies. The multiple choice item with the lowest mean score for learning characteristics was item 24, which involved teacher candidates’ correctly identifying learning characteristics using an individual in a golfing context. In the essay section on instructional practices, the question with the highest mean (3.63) involved stating “the overall purpose of an instructional strategy”, from a choice of: the CRA sequence of instruction, structured

language experiences, monitoring and charting student performance/progress monitoring, and explicit teacher modeling. On this question, teacher candidates were most likely to choose CRA for the overall purpose description. The instructional practice essay question with the lowest mean (2.68) included describing “how the language experience instructional practice for struggling learners is applied within the Developing Algebraic Literacy (DAL) instructional process”. For application essay questions, the question with the highest mean (3.26) was on describing “what effective mathematics instruction practice for struggling learners is exemplified by a strategy that is implemented during the third step of the DAL process and involves the use of the LIP strategy.” The application essay question with the lowest mean (2.43) included describing “what effective mathematics instruction practice for struggling learners is exemplified by a strategy that is implemented during the second step of the DAL process and is used to evaluate student abilities to read, represent, solve, and justify given a narrative context that depicts an algebraic thinking concept.”

In summary, teacher candidates achieved proficiently on multiple choice questions, with the most frequently incorrect questions involving determining which instructional practice had not been taught as an effective practice for problem solving and determining learning characteristics within a golf-based context. With essay questions, teacher candidates achieved just below beginning competency rate, indicating more work needed in both understanding instructional practices and their application. On the effective instructional practice essay questions, the question that was scored highest was one where students were asked to describe the purpose of one instructional strategy, out of a choice of four possible ones. The lowest mean score involved describing the

structured language experience strategy for use with struggling learners. With application essay questions, the item with the highest mean score involved identifying the effective instructional practice used in the instructional strategy within the LIP section of the DAL, while the question with the lowest mean surrounded doing the same for a strategy that involved using narrative text.

Table 32
Descriptive Statistics for the Instructional Knowledge Exam

<i>Instructional Knowledge Exam</i>	Total Mean	Item Mean	Median	Range	SD	Skewness	Kurtosis	Standard Error of Mean
Pre (N=19)								
Full Survey**	80.84	1.76	85.00	79.00	0.44	0.50	0.05	4.68
*Multiple Choice**	22.74	0.91	23.00	5.00	0.07	-1.21	0.71	0.10
	13.74							
-Instruct. Practices		0.92	0.93	0.27	0.07	-1.32	2.36	0.15
-Learn. Barriers	9.00	0.90	1.00	0.40	0.07	-1.0	2.36	0.03
*Essay**	58.11	2.77	61.00	76.00	0.94	0.43	-0.09	0.22
-Effective Practices	31.53	3.15	3.10	3.00	0.91	0.25	-0.79	0.21
-Applic.	26.58	2.43	2.45	4.18	1.10	0.37	0.05	0.25

***These items have median and range calculated on the total mean versus the item mean. All other medians and ranges are calculated based on item mean.*

Inferential Statistics for the Instructional Knowledge Exam

After descriptive statistics were analyzed, correlational analyses were completed between the instructional exam and the three other instruments also administered at approximately the same time, which were the posttest surveys for efficacy, attitude, and content knowledge. These correlations were completed to evaluate possible relationships between instructional knowledge and the other teacher preparation factors of efficacy, attitude, and content knowledge. These findings are presented in Table 33. No significant correlation was found between these other surveys and the instructional exam. Correlational analyses were also completed between the full multiple choice, learning characteristic (MC), instructional practice (MC), full essay, instructional strategies (Essay), and application (Essay) sections of the instructional exam. A moderate correlation was found between the full battery of multiple choice questions and the ones on instructional practice ($r=.671$, $p=.002$), and a strong correlation was seen between the full battery of multiple choice questions and the learning characteristic ones ($r=.822$, $p<0.001$). These results indicate there is an association between how teacher candidates performed on the full group of multiple choice questions and how they performed on the two specific types of questions within it. For the essay portion of the exam, very strong correlations were found between the full battery of essay questions, and ones on both effective instructional practice ($r=.907$, $p<.001$) and application ($r=.948$, $p<.001$). These data indicate an extremely strong association between how teacher candidates performed on the full group of essay questions and the two different types of questions. The data generated between the types of questions and the two different subtests depicts a

relationship between how teacher candidates answered on the subtest as a whole and how they answered on specific question types in the subtest.

Table 33
Correlation Matrix for the Instructional Knowledge Exam and Efficacy, Attitude, and Content Knowledge Posttests

		Efficacy 3	Beliefs 3	Content 3	Instruction
Efficacy	Pearson Correlation	1	0.003	0.465	0.152
	Sig. (2-tailed)		0.989	0.052	0.533
	N	19	19	18	19
Beliefs	Pearson Correlation	0.003	1	0.21	0.047
	Sig. (2-tailed)	0.989		0.402	0.848
	N	19	19	18	19
Content	Pearson Correlation	0.465	0.21	1	0.511
	Sig. (2-tailed)	0.052	0.402		0.03
	N	18	18	18	18
Instruction	Pearson Correlation	0.152	0.047	0.511	1
	Sig. (2-tailed)	0.533	0.848	0.03	
	N	19	19	18	19

Table 34
Correlation Matrix for the Instructional Knowledge Exam Subsections and Question Types

	Multiple Choice	MC-Inst. Prac.	MC-Learn. Char.	Essay	Essay-Inst. Prac.	Essay-App.	
Multiple Choice	Pearson Correlation	1	0.671	0.822	0.362	0.52	0.198
	Sig. (2-tailed)	0	0.002	0	0.127	0.022	0.417
	N	19	19	19	19	19	19
MC-Inst. Prac.	Pearson Correlation	0.52	0.305	0.462	0.907	1	0.727
	Sig. (2-tailed)	0.022	0.204	0.046	0		0
	N	19	19	19	19	19	19
MC-Learn. Char.	Pearson Correlation	0.198	0.207	0.105	0.948	0.727	1
	Sig. (2-tailed)	0.417	0.395	0.667	0	0	
	N	19	19	19	19	19	19

Table 34 (cont.'d)

		Multiple Choice	MC-Inst. Prac.	MC-Learn. Char.	Essay	Essay-Inst. Prac.	Essay-App.
Essay	Pearson Correlation	0.362	0.268	0.279	1	0.907	0.948
	Sig. (2-tailed)	0.127	0.267	0.247		0	0
	N	19	19	19	19	19	19
Essay-Inst. Prac.	Pearson Correlation	0.671	1	0.13	0.268	0.305	0.268
	Sig. (2-tailed)	0.002		0.595	0.267	0.204	0.267
	N	19	19	19	19	19	19
Essay-App.	Pearson Correlation	0.822	0.13	1	0.279	0.462	0.13
	Sig. (2-tailed)	0	0.595		0.247	0.046	0.595
	N	19	19	19	19	19	19

Fidelity Checks

The fifth area of investigation was teacher candidates' abilities to implement instructional practice knowledge for teaching mathematics to struggling learners within the DAL framework at their practicum site. To evaluate teacher candidates' abilities to convert their knowledge about effective mathematics instructional practices into actual practice, observations were conducted using fidelity checklists. These checklists were employed during observations of a subgroup of teacher candidates within the full participant group. Two different types of observation checklists were developed. The first checklist was for the DAL initial session probe, which is a shortened version of the full DAL session. This initial probe uses only 7 sections of the full DAL process, which fall under Step 2: Measuring Progress & Making Decisions in a full DAL session. The second checklist was for the DAL full instructional session, which includes a total of 34 implementation sections. In both types of DAL fidelity checklists, most sections of DAL implementation are required to use the model in accordance with framework guidelines. However, there are a few steps that may be considered "Not Applicable" because of student learning needs. For example, students may not require "problem-solving assistance" in a particular step, so that section would be marked "NA" and not included in the total number of sections required for fidelity calculations.

Within the study, three evaluators observed teacher candidates' implementation of DAL instruction until at least 90% agreement was reached on section ratings between evaluators. Three observation sessions were required for agreement purposes. Then, raters independently observed teacher candidates performing instruction. The original

goal of the study was to have raters observe approximately one-third of teacher candidate participants through three sessions: one observation at the start of DAL instruction, one at midpoint, and one at the end of DAL instructional implementation. Several intervening variables prevented the researcher from attaining this goal. The reasons for difficulties in collecting observational fidelity checklist data were manifold. Many teacher candidates were not able to hold three sessions that included an initial session probe and two full sessions, which would have been ideal for data collection purposes. With the study being only ten weeks, unexpected challenges were met with school issues and programs, student illness and withdrawal from school, and teacher candidates' absences from practicum. During the course of the study, two instructional days were lost because of a "lock-down" for safety reasons on one day, and scheduling issues over picture day on another. Additionally, elementary school student absence was high including several students withdrawing from school. At the same time, on at least two instructional days, 4-5 teacher candidates were absent from practicum due to illness or personal reasons, which is typically an unusual occurrence. Finally, the initial DAL assessment for instruction took many teacher candidates 3-4 instructional sessions to complete, reducing the overall number of instructional sessions they completed. All of these reasons decreased the number of teacher candidates who were able to conduct three instructional sessions above and beyond the initial DAL assessment. As a result, the possibilities for observing instructional sessions for fidelity checks were greatly diminished.

Fidelity data on initial instructional sessions is contained in Table 35. It includes observations of 9 teacher candidates. Fidelity of implementation of the DAL framework was high in these initial sessions, with a mean of 95% fidelity on all sections in the DAL

initial session probe, with all but two teacher candidates showing 100% fidelity to the instructional model. Additionally, teacher candidates were able to complete all sections contained within the initial probe during their instructional sessions. Only one teacher candidate did not have the same number of “total initial probe sections completed” because her student had one section, which included teacher candidate assistance with problem solving, that was not needed in the instructional process because the student had no difficulty with any problem presented. As a result, that particular section was omitted by the teacher candidate, and was marked “Not Applicable” by the observer, and was not counted in fidelity calculations.

Table 35
Fidelity Checklist Results on Initial Instructional Sessions

Participant Number	Initial Probe Sections Accurately Completed	Total Initial Probe Sections Completed	Total Sections in Initial Probe	Initial Probe Fidelity Percentages (Accurately Completed Sections/Sections Completed)
2	7	7	7	100.0%
3	5	7	7	71.4%
4	7	7	7	100.0%
5	7	7	7	100.0%
6	7	7	7	100.0%
9	7	7	7	100.0%
11	7	7	7	100.0%
17	5	6	7	83.3%
19	7	7	7	100.0%
Total:	59	62	63	95.0%

From the initial observation group of 9 participants, midpoint observations then involved a reduction in approximately half the participants, as seen in Table 36. Participants who were observed showed a noticeable decrease in their ability to implement DAL instruction along framework guidelines. This difficulty with implementation may have been due to the fact that the framework contains a total of 34 sections of implementation at the full session level. Teacher candidates may have had difficulty in remembering the order and component parts for sections for implementation.

At the same time, the number of “session sections completed” can be seen to vary across participants for the first full session because for fidelity calculations the total of 34 DAL sections was not included, but simply the number of sections that were covered in that DAL instructional session by that particular teacher candidate. None of the teacher candidates completed all 34 sections in their first session. Since the DAL framework is cyclical in nature, teacher candidates were not expected to complete all 34 sections in one session, especially while just learning the model. Teacher candidates were taught to move through sections in order until the end of an instructional session and then pick up where they had left off in the next instructional session.

When observing during this second round of observations, raters noted that teacher candidates had difficulties implementing the model. The main reason for the decrease in fidelity was that many teacher candidates did not cover the sections in order or left out key parts of sections for a variety of reasons. Some teacher candidates told raters they could not remember how to accurately implement the key parts of certain sections. Others mentioned they thought they could eliminate “unimportant” parts of sections for time purposes. A few teacher candidates deleted whole steps (i.e., all the sections under Step I: Building Fluency) because they felt they had spent too much time on a particular earlier section and should move forward towards the end of the process, which involved introducing a new skill. When teacher candidates actually attempted the key parts of a particular instructional section, they typically employed pedagogy accurately and in accordance with DAL guidelines. As a result, the chief issue with fidelity was teacher candidates omitting key parts of sections, entire sections, and even whole steps during implementation. For all participants observed, a mean of 60.3%

fidelity to the model’s guidelines was seen across implementation of the full DAL session.

Table 36
Fidelity Checklist Results on 1st Full Instructional Sessions

Participant Number	1 st Full Session Sections Accurately Completed	Total 1 st Full Session Sections Completed	Total Sections in Full Session	1 st Full Session Fidelity Percentages (Accurately Completed Sections/Sections Completed)
2	6	10	34	60.0%
3	12	20	34	60.0%
4	13	15	34	86.7%
9	2	4	34	50.0%
11	10	20	34	50.0%
17	4	9	34	44.4%
Total:	47	78	204	60.3%

In Table 37, the final table of fidelity implementation information is presented, with only two teacher candidates being observed. In this particular session, one teacher candidate spent a considerable amount of time reading the context for problem solving with her student. Due to instructional session time limits, there was only enough time for the teacher candidate to implement two sections of the DAL process in her session, which she did with fidelity. The other teacher candidate was able to implement most of the full DAL session, but said she became confused during the sections of Step 3: Problem Solving the New, while trying to employ the making connections instructional strategy.

As a result, she ended up skipping several sections. As a result, the mean fidelity to the DAL instructional framework for these two participants was 90.3%, which may not be totally accurate in reflecting the average fidelity, since it involved only two teacher candidates, one of which only made it through only two DAL sections.

Table 37
Fidelity Checklist Results on 2nd Full Instructional Sessions

Participant Number	2 nd Full Session Sections Accurately Completed	Total 2 nd Full Session Sections Completed	Total Sections in Full Session	2 nd Full Session Fidelity Percentages (Accurately Completed Sections/Sections Completed)
2	2	2	34	100.0%
17	19	26	34	73.1%
Total:	31	28	34	90.3%

Summary of Quantitative Findings

Quantitative results revealed an increase relationship between all survey instruments on efficacy, attitude, and content knowledge between pretest and midpoint, with a decrease seen on all of these instruments between midpoint and posttest. Subtests on these instruments also exhibited a similar pattern. This information indicates that while teacher candidates increased agreement with items on these surveys, or accuracy in the case of the content knowledge, at the midway point of the study, these increases were not sustainable for the full length of the study. Instructional knowledge exam results indicated proficiency in identification of instructional practices and learning

characteristics, with continued work needed on the articulation of both instructional practice components and their application within the DAL framework. Fidelity checks showed that teacher candidates clearly could implement initial probe sessions of the DAL framework with fidelity, but needed continued practice in this fidelity for full length DAL sessions.

Qualitative Findings

In this section, data collected through qualitative measures will be presented and analyzed. This information includes findings from final DAL project paper analysis for all teacher candidate participants, and two sets of pre and post focus groups. Within final DAL projects, the researcher coded teacher candidates' ideas along the key elements identified within the study for special education teacher preparation in mathematics instruction, involving attitude, efficacy, content knowledge, and instructional knowledge and application. For focus groups, transcribed discussions were used to identify teacher candidates' thoughts and ideas along the same key elements.

Final Project Analyses

To achieve greater clarity on teacher candidates' experiences with the DAL framework in all five areas of investigation, teacher candidates' final DAL projects were evaluated. These final analysis projects resulted from a cumulative DAL assignment where teacher candidates were asked to complete a summative paper on their learning. The writing assignment's completion was guided by four prompts:

- a) what you have learned through your experiences receiving training in K-5 algebraic thinking, training in the DAL instruction process and assessing and teaching your students using the DAL instruction process;

- b) how you will use what have learned for the future as a teacher;
- c) how (if at all) it has impacted how you feel about teaching mathematics;
- d) what areas of mathematics instruction (teaching mathematics to struggling learners) you believe you need to target for further professional development and why.

Based on these guidelines, 17 of the 19 participants successfully completed this analysis paper. For the two participants who did not complete the paper, they chose not to turn this final DAL document in to the Clinical Teaching professor for grading purposes and so the researcher did not have access to final documents for these two participants. The products of the 17 papers that were turned in varied in length from 1 to 17 pages, as well as in the content presented, even though the above written content guidelines were provided. All teacher candidates' papers were scanned into the Atlas.ti® analytical software to assist the researcher in coding teacher candidate writing. During this analysis, candidates' written statements were coded along four general themes: efficacy in teaching mathematics, attitude towards mathematics instruction, content knowledge, and instructional knowledge and application of instructional practices. Instructional knowledge and application were included as one theme because of the self-disclosing nature of the assignment. As a result, it was unknown whether many of the discussed instructional practices were implemented, implemented effectively, or just conceptualized by participants. In Table 42, the number of descriptor codes for each theme is given, along with the types of codes under each theme, and frequency of occurrence of themes, as well as intensity of effect size for each type of quote.

Table 38
Final Analysis Paper Themes and Codes

Theme	Number of Descriptor Codes in Theme	Frequency of Occurrence	Types of Descriptor Codes in Theme	Intensity Effect Sizes (Percentage of Total)
Efficacy	4	97	*Positive Self-Efficacy *Negative Self-Efficacy *Positive Student Outcomes *Negative Student Outcomes	17.1%
Attitude	4	69	*Constructivist Mathematics Instruction (CMI) *Traditional Mathematics Instruction (TMI) *Constructivist Mathematics Learning (CML) *Traditional Mathematics Learning (TML)	12.2%

Table 38 (cont.'d)

			<ul style="list-style-type: none"> *Manipulatives *Patterning *Student 	
			<ul style="list-style-type: none"> Performance *Equations *CRA *Explicit *Making 	
			<ul style="list-style-type: none"> Connections *Mathematics 	
			<ul style="list-style-type: none"> General Knowledge *Teacher Candidate 	
			<ul style="list-style-type: none"> Knowledge *Resources *Reasons *Progress *Standards *Structured 	
Content Knowledge	14	76	<ul style="list-style-type: none"> Language Experience 	13.4%
			<ul style="list-style-type: none"> *Resources *Strategies *Learner 	
			<ul style="list-style-type: none"> Characteristics *Learning 	
			<ul style="list-style-type: none"> Environment *Individualized 	
			<ul style="list-style-type: none"> Instruction *Collaboration *Pacing 	
Instructional Knowledge and Application	8	325	<ul style="list-style-type: none"> *Development 	57.3%
Totals:	30	567		100%

During the analysis and coding process, 567 different participant statements were coded using a total of 30 specific codes along the 4 major themes believed to be crucial in undergraduate special education teacher preparation in the content area of mathematics. Statements regarding efficacy in mathematics instruction were coded under

4 categories: positive self-efficacy, negative self-efficacy, positive student outcomes, and negative student outcomes to parallel the type of information gathered through the Mathematics Teaching Efficacy Beliefs Instrument. Under the 4 efficacy categories, 97 specific comments, 17.1% of all coded statements, were analyzed and coded as involving efficacy concerns. Statements regarding attitudes and beliefs towards teaching mathematics were also coded under 4 categories: constructivist mathematics instruction (CMI), traditional mathematics instruction (TMI), constructivist mathematics learning (CML), and traditional mathematics learning (TML). These coding categories were selected to parallel the attitudinal data collected via the Mathematical Beliefs Questionnaire. Using the four attitudinal coding categories, 69 teacher candidate statements, 12.2% of all coded comments, were analyzed and coded as involving teacher candidates' attitudes towards mathematics instruction.

Statements regarding content knowledge were coded under 14 categories including patterning, student performance, equations, CRA, explicit, making connections, mathematics general knowledge, teacher candidate knowledge, resources, standards, structured language, manipulatives, reasons, and progress. Coding was not limited to match the Mathematical Content Knowledge for Elementary Teachers survey, because it was believed that there were many relevant teacher candidate comments that were made that did not specifically touch on just basic arithmetic or algebraic skills, which were the categories on the content survey. Many content knowledge codes involved types of content knowledge, influences on what content knowledge is taught, and how students demonstrate particular forms of content knowledge, which were all considered valuable points to be considered for analysis on this critical preparation element. Items were

coded under one of the 14 categories if they pertained to content knowledge described by teacher candidates within their instructional sessions or in their own learning process. Using the 14 content knowledge coding categories, 76 teacher candidate statements, 13.4% of all coded comments, were analyzed and coded as pertaining to content knowledge involving the teacher candidates' DAL model experience. Statements regarding instructional knowledge and application were coded under 8 categories including resources, strategies, learner characteristics, learning environment, individualized instruction, collaboration, pacing, and development. Statements were coded as involving instructional knowledge if they discussed specifics of instructional strategy implementation, mentioned external factors relevant to instruction, or depicted relevant student learning characteristics for instruction. Using the 8 instructional knowledge coding categories, 325 statements, 57.3% of all coded comments, were analyzed and coded as related to some form of understanding or usage of instruction for struggling learners in mathematics.

Efficacy Theme

Specific comments made about efficacy in mathematics instruction made up the second most significant coding category overall. Statements coded under this theme included 57 comments which indicated positive perceptions of self-efficacy or student outcomes. The 40 remaining comments were coded as negative views on the same two variables, showing teacher candidates expressing negative views less often than positive ones. Some teacher candidate statements evidenced student perceptions that the DAL framework had made an immediate impact on their efficacy, such as “With the practice utilizing this framework and studying the strategies used during the DAL sessions, I feel I

have learned an effective process to teach skills and concepts related to mathematics.”

Another similar comment remarked, “I believe it has given me some good ideas on strategies to use when teaching math. I found the CRA, justification, and making connections to outside material very important.”

A number of efficacy comments were focused in on teacher candidates looking positively forward to ways in which they could further enhance their mathematics instructional efficacy. In this vein, one student stated, “Going through the DAL training and working one-on-one with math students has made me more comfortable with teaching this subject. I feel I still have much to learn about understanding and teaching mathematics. I have never been very sufficient in this subject and I have a hard time being enthusiastic about teaching the material. This also makes it difficult for me to relate its importance to experiences outside the classroom.” Negative comments about efficacy tended to focus on teacher candidates’ lack of comprehension of the DAL framework, deficiencies in training and preparation with the DAL, and outside factors that detracted from teacher candidates being able to facilitate instruction. One such articulate comment along these lines included, “At the beginning of the DAL process I was apprehensive about its effectiveness in helping struggling learners in mathematics. Although we were given training on how to implement the process I was not confident with it. I could not grasp the concept of how we were going to teach algebraic concepts by using a book. I understand the point that was made numerous times about how math and reading is inter-related; I just cannot figure out how.”

Comments involving student outcomes as a result of instructional efficacy focused on the reasons why teacher candidates felt instructional strategies affected

positive change in student learning. Negative student outcomes were often attributed to a lack of mathematics instructional efficacy resulting from factors outside the control of teacher candidates, such as a “lack of the right tools”, “supervisor modeling”, “instructional time constraints”, and “student attendance”.

Attitude Theme

Statements about attitudes regarding mathematics instruction were framed around two different approaches. The first approach was a more traditional, rigid, and memorization-based view, which many teacher candidates felt they had experienced at some time during their k-12 school experiences. The second approach was a more creative, flexible, and developmental and constructivist view of mathematics. For the attitude theme area, statements that involved teacher candidate attitude about the mathematics subject area in general, as well as teaching mathematics, were coded as either constructivist or traditional. Attitudinal comments involving constructivist DAL framework experiences with mathematics instruction far outweighed the formal comments made about teaching mathematics. This constructivist emphasis in teacher candidates’ statements may have been due to the fact that the DAL framework was designed based on current developmental NCTM process and curriculum standards, as well as the DAL experience being structured using a social-developmental constructivist approach to teacher preparation. Along these lines, one student said, “I was able to see the benefits of breaking things down and representing them first on a concrete level, then the representational level, and finally the abstract level. I could see how this benefited both the students I was working with. It seemed that they suddenly had “aha” moments when they suddenly understood a concept once it was represented on a different level.”

Another student explained her recent changes in her formerly traditional views of teaching mathematics with, “Before we started this program, I felt that only people with a math degree should be teaching math. However, I know now that this is not true. Teaching math requires a teacher who can scaffold and provide information that is meaningful to students.”

Ideas that exhibited more traditional views of teaching mathematics included, “I did not have a chance to do a “get to know you” activity because I was too rushed to make up for lost time”, indicating the teacher candidate’s rigid belief that a certain number of mathematics target concepts had to be covered during a certain amount of instructional time. Another teacher candidate indicated that one of her students “needed a thorough review each session of the previous session” presenting this review as wasted instructional time and material that the teacher candidate had to direct the student through, rather than present as further mathematics exploration and discovery material for the student.

Teacher candidates’ expression of attitudes about the general subject area of mathematics tended to concentrate on either their enjoyment of mathematics learning with statements such as, “I love mathematics” or their learning characteristics that thrived from building their own mathematical understandings, with “I am one that feels at times that I am not learning anything, until I sit down and try to complete a paper or project showing or telling what I learned.” More formal ideas about general mathematics learning seemed to stem from a general dislike of mathematics that had developed from early mathematics learning experiences, a belief that mathematics content should be “delivered” to them as well as students, and a lack of seeing connections between

mathematics and everyday life. As one teacher candidate mentioned, “I have never been very sufficient in this subject and I have a hard time being enthusiastic about teaching the material. This also makes it difficult for me to relate its importance to experiences outside the classroom.”

Content Knowledge Theme

Teacher candidate statements about content knowledge in their final analysis papers focused primarily on their students’ performances on algebraic thinking related content during DAL sessions. Most of these statements were made in reporter-like fashion about students’ grappling with and mastering concepts, which were presented during instruction. For instance, one teacher candidate commented on her student’s content knowledge with, “In our initial session together, Demarcus demonstrated the ability to read, represent, solve, and justify growing patterns at the representational level. Based on this information, we started our next session at the concrete level of patterning to help build automaticity.” The overwhelming content area of discussion was patterning, specifically growing patterns. The reasons for this focus may be due to the DAL’s initial skills assessment, which all teacher candidates administered to their students, and the fact that patterning was the first area addressed by this assessment. Teacher candidates were trained to target their initial DAL instructional sessions on the first area on the initial assessment where students produced incorrect answers. For a majority of the students involved in the practicum, this area consisted of growing patterns. Following growing patterns, the second most discussed content area was setting up mathematical representations and finding their solutions, which are the subsequent skills assessed after patterning in the initial DAL evaluation measure. One teacher

candidate's comments about her student setting up multiplication problems illustrates this point, with "Student B learned that multiplication tables represent groups of numbers and she learned how to group them."

While many comments identified a particular mathematical area by name (i.e., growing patterns), other comments focused on students' means of expressing current mathematical understandings: "using a level of CRA", "explicitly demonstrating", "by connections between previous learning", "employing resources", and "providing their answers and justification orally." The teacher candidates' recognition of these different forms of expression for content knowledge were deemed important, because they showed that teacher candidates saw direct connections between the content knowledge students were actually learning and their abilities to articulate their understanding of this content using the instructional methods the teacher candidates had employed with them when teaching.

Instructional Knowledge and Application Theme

Comments made by teacher candidates in regards to instructional knowledge incorporated the majority of coded statements made throughout the final analysis papers. The teacher candidates' papers were filled with examples of their usage and understanding of practices taught within the DAL framework. As part of their preparation in using the DAL model, strategies for reading and mathematics instruction presented in Appendix A and C respectively, were explicitly taught to teacher candidates to facilitate instruction in algebraic learning. To this end, within their final analysis papers teacher candidates discussed the strategies of "modeling, explicit instruction, active learner engagement, authentic contexts, explicit instruction, progress monitoring

and instructional decision making, metacognitive strategy instruction, structured language experiences, connection making across content areas, connection making between concepts in the same content area, and scaffolding”. Additionally, teacher candidates included many statements regarding instruction that were not discussed explicitly within the framework, but may have been more implicitly presented. These surrounding ideas included, “differentiated instruction, collaboration, pacing of instruction, safe learning environments, external learning barriers, flexibility, and planning”.

The most discussed area of instruction included the usage of CRA, which is the one instructional strategy incorporated in every step of the DAL process. Most of the comments surrounding the usage of CRA were positive, including statements linking understanding of instructional practices to their implementation within the practicum, such as, “Through my teacher, and especially with Sunflower (student pseudonym), I was able to understand what concrete, representational, and abstract levels of understanding are, and how to deliver instruction at each level.” Another example included, “CRA is a great concept that a teacher should use when teaching mathematics to at-risk learners. I never understood the importance of breaking down into these 3 components until I actually started to do it with my students.” The second instructional strategy that drew the most student comments was the use of oral language abilities to build and convey mathematical understandings. Interestingly, teacher candidates were taught explicitly to use structured language experiences within the DAL framework, in the written form within the student notebook. However, many teacher candidates showed through their final projects that they considered the oral language abilities exercised during the problem solving process (ie., read, represent, justify, solve) as valuable structured oral

language experiences that developed communication abilities in mathematics. One teacher candidate described this experience through, “Another thing I loved about the DAL (and I plan to implement in my classroom) is for people to justify their answers. It did seem silly to ask ‘why is that pattern considered a growing pattern’ and wait for ‘because you are adding more each time’ but it was helpful to see their thought process. Once we got into more complex problems, I saw it was harder for them to explain and that is when I found it imperative that they provide an explanation.”

Summary of Final Project Analyses

Throughout the entirety of their final analysis papers, and the statements within these papers, teacher candidates described their ideas and development through their instructional experience. While ideas involving instructional strategies were expounded upon at length, many pertinent teacher candidate ideas about mathematics instructional efficacy, attitude towards mathematics, and content knowledge gave an indication of the teacher candidates’ thought processes while teaching students mathematics within their practicum experience with the DAL. This information indicated that teacher candidates on the whole had more positive feelings of efficacy than negative ones, and constructivist views about mathematics and mathematics teaching outnumbered traditional attitudes. A focus on patterning skills and student means of expressing content knowledge were the main ideas presented in the area of mathematics content knowledge.

Focus Groups

Focus groups were completed with all teacher candidate participants at two different points within the study. This data collection method was used to complement information gathered through the survey instruments, course exam, final paper analysis,

fidelity checks, and case studies employed in the study. The purpose of the focus groups was to obtain a more holistic perspective of the full group of teacher candidates on the five elements of teacher preparation under investigation: efficacy about mathematics instruction, attitudes towards mathematics instruction, content knowledge for mathematics instruction, instructional knowledge about teaching mathematics to at-risk learners; and application of instructional knowledge for teaching mathematics to at-risk learners. The first groups, the pre focus groups, were conducted after the initial week of training with the DAL framework. The second set of groups, the post focus groups, took place on the very last day of the study, after the teacher candidates had completed their final instructional sessions with their students. The total group of 19 teacher candidate participants was split randomly between the two focus groups, with one group having 9 people and the other 10. The members of Focus Group 1 were the same at pretest as at posttest, and the case was the same for Pre-Focus Group2. For each round of focus groups, the teacher candidates were pulled at the end of their instructional day at their practicum site during their usual seminar time.

For each of the five elements identified as relevant to special education teacher preparation in mathematics, “big ideas” expressed in each focus group are listed by focus group administration and focus group number (either 1 or 2). These “big ideas”, listed in figures, were determined from analyzing transcribed focus group sessions, as well as notes taken in each session. The ideas presented are ones that received multiple mention within each group or multiple agreement by participants in each group. Analysis of these ideas is presented by key element at each administration.

Efficacy – Pre Focus Groups

Figure 13. Efficacy – Pre Focus Group 1.

- Encouraged about teaching algebra, since did not know before training that it started with patterns
- Need to learn more strategies to facilitate problem solving
- Learning to teach mathematics will be a continuous process
- Comfortable teaching mathematics, because like mathematics
- Feel ready to teach concepts of algebraic thinking have learned in training
- Comfortable teaching mathematics, because have middle school children at home who have learned the type of mathematics we've been talking about
- When you have to teach something, you do what you have to do to learn it
- Collaboration between peers (especially through this cohort experience) helpful in developing instruction
- Think will be challenging to teach, but excited to try it
- Learned helplessness can develop from poor math teaching

Figure 14. Efficacy – Pre Focus Group 2.

- Feel uncomfortable talking to students about algebraic concepts, because don't really understand them
- Apprehensive about working with 4th and 5th grade students
- Hard when been out of elementary school for a long time, and don't use those math skills everyday
- We were not taught mathematics in an application based way in school, so we will have a hard time teaching it that way
- Okay teaching mathematics if have curriculum or written material to go from
- Comfort level depends on type of students we are teaching
- If had to teach regular algebra, couldn't do it
- Comfortable teaching the highest skills on the DAL assessment, but not comfortable beyond the assessment
- Have confidence from taking mathematics education course and learning mathematics strategies (student who had taken the mathematics education course)
- Feel don't know any strategies for teaching mathematics effectively
- Word problems a challenging area to teach
- Most comfortable teaching concepts learned most recently
- Feel could teach patterns and basic equations
- Have to feel comfortable with specifics of content to teach it to people
- Feel like don't have a good grasp on math, because always have struggled with math

Figure 14. (cont.'d)

- Feel at a disadvantage teaching mathematics right now, because haven't had mathematics education course yet
- Comfortable with regular mathematics

During the pre-focus groups, teacher candidates voiced a mixture of feelings in terms of efficacy and their instructional abilities at the outset of the study. Many of the teacher candidates made comments about feeling uncomfortable with mathematics instruction because they had never taught mathematics or used the DAL model previously. For instance, one specific comment included, "I get some of it, but not all or it and that's not good enough for my kids." Other common comments were ones of excitement, such as, "I think it will be challenging, but I'm excited." While teacher candidates seemed aware of their own lack of experience, they also appeared to be looking forward to the instructional challenge at hand. While the majority of teacher candidates presented feelings of apprehension about performing mathematics instruction, especially with the use of mathematics strategies, the second group evidenced specific concerns about mathematics instruction being different than when they were in school with, "I was taught differently so I don't understand how they are being taught now." They viewed this possibility as a drawback to easily learning to teach mathematics skills.

Attitude – Pre Focus Groups

Figure 15. Attitude – Pre Focus Group 1.

- Allow multiple ways of problem-solving
- Openmindedness – be willing and able to learn from your students
- To be successful in mathematics, students need the right tools
- Requires some rote memorization of multiplication facts
- Mathematics develops logical, problem-solving skills
- Promotes higher level (critical) thinking skills
- Promotes abstract concept development
- For best mathematics learning, application to real life situations needed
- Early school experiences influenced now poor views of mathematics
- Students must develop problem-solving skills incrementally, teachers should not just give students answers
- Having mathematics knowledge is very important
- Sometimes how you get to a math answer not valued, but that's actually the most important part
- More important to know the math process than the outcome
- Math almost like another language
- Flexibility is important

Figure 16. Attitude – Pre Focus Group 2.

- You don't use mathematics every day like you use reading
- Need to think outside the box when teaching mathematics
- Need multiple methods of problem-solving to find answers
- Own experience math was not positive, because did not learn multiple ways to solve problems
- Math is important because it is in every part of life
- Do not have a positive view of math because not confident in it
- Really like math, because had really good instructors
- Practical application of math when learning it, helped student really like it
- Foundation of how they were taught math influences how they now feel about math
- At-risk students need effective math instruction to beat cycle of failure
- Algebra is something you have to learn to get through school, never going to use it
- Algebra encourages higher level thinking skills
- Can't stand math – if don't see connections will give up
- There's always one right answer with math
- Don't see creativity in math

Attitude towards the mathematics subject area, and mathematics in general, seemed to vary across teacher candidates. Some teacher candidates spoke about their fear or dislike of mathematics that was taught to them in k-12 classrooms, “My own

experience learning math was not positive, because I did not learn multiple ways to solve problems.” These feelings seemed to stem from their own experiences learning mathematics when they were younger, some of which were traditionally-based. Others, who mentioned they liked mathematics, stated the reason as being either because they found math easy or they had experienced teachers who had positively influenced their mathematics learning experiences through constructivist learning activities, “I had a great mathematics teacher, who was always open-minded and willing to learn from her students.” Either positive or negative, teacher candidates’ own childhood school learning experiences had a large impact on how they currently viewed teaching mathematics. Most of the teacher candidates also saw the value in effective mathematics instruction for all learners, including students at-risk for mathematics difficulties, but emphasized that connections must be made between mathematics and real life situations. For instance, one teacher candidate said, “Math is important because it is in every part of life.” As a whole, teacher candidates’ current attitudes voiced about mathematics instruction seemed more constructivist with comments made about how “students should develop skills incrementally” and needing to “think outside the box” when teaching mathematics. However, at the same time, a few more traditional views of instruction were presented, including, “there’s always one right answer in math” and “math is very rule-based.”

Content Knowledge – Pre Focus Groups

Figure 17. Content Knowledge – Pre Focus Group 1.

- | |
|--|
| <p>General Mathematics</p> <ul style="list-style-type: none">➤ Students need to be able to justify their answers➤ Math is a computational process➤ Need to teach students basic skills for everyday life, but doesn't have to be through rote – counting up is one such strategy➤ Answers in mathematics are either right or wrong➤ Word problems need to be taught more <p>Algebra</p> <ul style="list-style-type: none">➤ Algebra is balancing equations➤ Algebra is symbols & numbers➤ Patterning➤ Some algebra skills applicable to real life➤ Other algebra skills just seem like learn for test➤ Patterns are everywhere in everyday life➤ Used to think algebra was a bunch of formulas and gibberish, not involving other things like patterning➤ Builds upon basic arithmetic skills➤ Formula based➤ Algebraic skills in the DAL assessment are understandable |
|--|

Figure 18. Content Knowledge – Pre Focus Group 2.

- | |
|--|
| <p>General Mathematics</p> <ul style="list-style-type: none">➤ When you're just talking about numbers, that's basic math➤ Fractions are a trouble area for a lot of people➤ Don't understand 5th grade math of children at home➤ Basic skills like balancing checkbook and consumer math important for students➤ Math should focus on what you're going to use most often, not what never going to use➤ Math has basic rules➤ There are steps to be learned for problem solving <p>Algebra</p> <ul style="list-style-type: none">➤ Algebra is when you are talking about variables➤ Algebra is when there's letters in math➤ A big part of algebra is the FOIL method➤ Don't understand concepts of algebraic thinking➤ Think algebra content should be exposure only at the elementary level, not counted as part of grading➤ Repeating and growing patterns➤ Problems involving Xs and Ys➤ Equations |
|--|

Comments about content knowledge were split between algebra and basic mathematics. Teacher candidate remarks about general mathematics learning tended to

focus on mathematics “without variables” that involved computation and skills that could be applied in every day life. One teacher candidate actually expressed general mathematics skills as “when you’re just talking about numbers.” Most views on what algebra entailed focused on very traditional algebraic ideas based on balancing equations and usage of variables, such as “algebra is when you have variables” and “problems involving Xs and Ys”. A few statements were made about algebraic thinking involving the new skills the teacher candidates had learned in the DAL training with specific mention of “repeating and growing patterns”. Of these DAL-related algebraic thinking skills, the one specific concept that teacher candidates honed in on was patterning, even though at this point they had already been exposed to developing patterns, functions, and relations; representing and solving equations, and analyzing change in various contexts. The reason for the focus on this skill may be because it was the first aspect of algebraic thinking at the elementary level taught to teacher candidates. Another reason may be that from their reactions and comments during the training workshops, teacher candidates seemed most comfortable with learning patterning from among all of the skills taught during the training sessions.

Instructional Knowledge – Pre Focus Groups

Figure 19. Instructional Knowledge – Pre Focus Group 1.

- Must teach students at their level with ways they can understand
- Present multiple ways of problem-solving
- Making connections is important, but can be difficult based on the setting of your school
- Writing problems on the board – singling out students to answer them – doesn't work
- Teachers need to understand math concepts, to be able to explain them to others
- Math should be taught as a process
- Key to understanding math as language is developing the vocabulary to go with it
- No reinforcement for getting partial answers in most of mathematics
- Important to relate mathematics to outside interests of students
- Use of manipulatives helpful
- Don't rush instruction – no point in doing
- Intimidation doesn't work with students to help them learn
- Make it okay to make mistakes
- Can tie in own experiences of learning math to help break down skills for students – because can relate to their struggle
- Planning for individual needs important to teach at student's level
- Using marker boards can be helpful for individual students
- Drawing your way out of a problem works

Figure 20. Instructional Knowledge – Pre Focus Group 2.

- Explicit instruction is helpful for mathematics learning
- Need to know multiple ways of teaching concepts
- Base 10 blocks and other manipulatives helpful
- Have learned how to break down skills and use CRA from the DAL assessment
- Learner engagement – make algebraic thinking fun
- Need calculators for some types of math
- Make problems applicable to real world using money and shopping
- Should use assessment to see if students can handle algebra
- Multiplication charts – strategy that won't work
- Sometimes math songs are helpful
- Group work and cooperative learning helpful in math – because can see things from different perspectives
- Students need to have explanations behind methods they are using

With instructional knowledge, teacher candidates volunteered a large variety of strategies they thought important for usage with at-risk learners, including: CRA, making connections, explicit instruction, using a variety of materials, learning the “mathematics” language, and learner engagement. Even after just the initial training, which came before these two pre-focus groups, and no direct application with students, teacher candidates spoke about many of the strategies presented as key instructional practices within the DAL model. The reason may have been that these practices were still fresh in teacher candidates’ minds. Additionally, besides specific strategies, an emphasis of the first

group was that teacher candidates felt that support for student efforts in problem-solving, whether right or wrong, should be encouraged. One teacher candidate mentioned, “There’s usually no reinforcement for partially correct answers, but there should be.” Another suggested supported problem solving through “the usage of cooperative learning groups to see different problem solving perspectives.” There was a definitive emphasis on using praise with the building blocks of student mathematical efforts, just as teachers often use with student attempts at sounding out long, multisyllabic words in reading, whether the final attempts at these words are correct or not. As one participant mentioned, “There’s always praise for sounding out parts of words correctly, but rarely any for getting partway to a math answer.” Teacher candidates felt that this incremental praise, for students mastering small parts of problem-solving, should merit more positive attention from teachers.

Instructional Application – Pre Focus Groups

Figure 21. Instructional Application – Pre Focus Group 1.

- Right now, so much to learn at once – trying to apply coursework to student sessions, but need more time with learning and more time with student
- Practice in practicum setting helps not with content application, but more how to work with children and their behaviors
- Really learn mathematics concepts by teaching them
- Our planning and reflection helps us to better meet the needs of our students
- Cohort setting valuable for support in teaching mathematics
- Small group environment for instruction is helpful
- In future, will seek out additional coursework to help in content knowledge for instruction
- For instruction, will seek out Internet resources and textbooks
- Need to learn the standards
- Question whether what we are learning here will apply at other schools

Figure 22. *Instructional Application – Pre Focus Group 2.*

- Need more time learning to teach mathematics, because harder than teaching reading
- Think this practicum experience teaching reading and mathematics will give them more to go on their first year of teaching
- Difficult because what doing in practicum and final internship cannot prepare you for every type of mathematics learning situation between K-12
- Important to think about what you're doing – plan and reflect on how you're teaching is going with your students
- Previous experiences teaching algebra have made teaching mathematics in the current practicum easier
- Need the learning of mathematics instruction spread out over a semester before engage in teaching it
- DAL training helping them to learn how to plan and organize instruction, and track student progress
- Relating mathematics to real world and purpose for it – current strength of teacher candidates
- Feel hands-on experience will help them to teach mathematics
- Will seek out mathematics strategies text for teaching mathematics

In the area of instructional application, many of the teacher candidates' comments were more theoretical than anything else, since they had not begun working with students in algebraic thinking. However, many teacher candidates voiced that they thought the

application aspect of the mathematics instructional strategies within the DAL framework would be helpful in them knowing better how to work with students in their first classrooms. Along these lines, one teacher candidate said “DAL is helping me better learn how to plan and organize instruction”, while another indicated, “I feel hands-on experience will help me in teaching mathematics.” Additionally, many of the teacher candidates seemed eager to explore resources as future aids in instruction, such as curriculum texts and peer or mentor support relationships. These comments expressed a willingness by teacher candidates to reach out for assistance in the area of mathematics when actually applying instructional knowledge with ideas such as, “I will seek out mathematics strategies texts for teaching mathematics” and “The cohort aspect of this practicum is very helpful in terms of learning how to teach mathematics. Teacher candidates voiced a desire to expand their knowledge gained from their coursework and related experiences, as they had more opportunities to apply skills in the classroom. In fact, one candidate mentioned that she planned to seek out “more mathematics courses for learning content knowledge.”

Efficacy – Post Focus Groups

Figure 23. Efficacy – Post Focus Group 1.

- Feel still need to develop the mathematics language skills to explain anything higher than patterning
- Wouldn't use the DAL model for instruction again, because it's too cumbersome trying to make the connections between algebraic thinking concepts and the texts that we're using within the process
- Feel the steps in the DAL process are good for learning mathematics, for instance, making connections between different ideas
- Have good feelings about teaching math
- Still feel like I don't know anything about teaching math, except for patterns
- Feel like preparation in the special education program in teaching the content areas, like mathematics, has a big impact on children because we can speak their (children's) language now
- Don't feel like really have any strategies for teaching mathematics, because just introduced to them and not really sure of them
- Feel defeated using the DAL framework, because feel like never going to make it through all the steps and students will now be stuck on patterning
- Feel not enough time during DAL for student learning
- I know as much about mathematics and teaching mathematics now as when I started with the DAL

Figure 23. (Cont.'d)

- I have the theory that if I know it, I can make someone else know it by using my way or inventing a new way
- Feel still need to know better how to teach math to other people

Figure 24. Efficacy – Post Focus Group 2.

- Just don't know if I can teach math to at-risk learners
- Still confused and not comfortable with the DAL, but think it could be valuable for at-risk students, if we knew how to use it better
- DAL model was difficult to understand – felt the problem was in the design of the program
- Hope that by taking the teaching mathematics course this summer, will better understand how to teach mathematics to at-risk learners
- DAL model good for activating what kids already know about concepts and how can extend that usage and learning
- Do not feel prepared to teach students at risk for difficulties with mathematics at this point
- Still difficult to explain math concepts to other people
- I'm not good at the mathematics strategies, I'm not getting them
- Do feel more comfortable working with students one-on-one from DAL and UFLI experiences
- Didn't feel like was teaching students a skill through DAL

During the post focus groups, different types of comments were heard about efficacy in mathematics instruction then in pre focus group meetings. At this point, the teacher candidates had been involved in preparation with and implementation of the DAL framework for a ten-week period. Compared to the comments on efficacy from the pre-focus groups, which were filled with apprehension and excitement about the unknown, this later round of comments was spoken from the frame of experience. Many teacher candidates voiced concern that having attempted instruction using the DAL, they were now more aware of all the aspects of mathematics instruction that they still did not understand. More than one teacher candidate said that she, “did not feel prepared to teach at-risk learners at this point.” For several teacher candidates, this feeling was converted into the desire to seek out further learning with, “I hope by taking the mathematics methods course this summer that I will better understand how to teach mathematics to at-risk learners”, while others had internalized difficulties with instruction by doubting their own overall abilities as educators by saying, “I’m not good at mathematics strategies, I’m not getting them.” Still others voiced that they thought the difficulty with instruction was due to the design of the DAL framework itself, “The DAL model was difficult to understand, I felt it was due to the design of the program.”

Attitude – Post Focus Groups

Figure 25. Attitude – Post Focus Group 1.

- Math is very important for a child at-risk for mathematics failure
- Basic concepts like patterning are important to higher level mathematics further down the road
- It's important to cultivate students' understanding of basic concepts in general mathematics
- Sometimes children have memorized formulas, which is not good, because when they really need to understand what's going on behind those things they don't
- I used to have a great fear of math, but now that I've worked with it, I've lost some of that fear
- To be a good math teacher, you have to know it, and be able to understand and explain it
- Feel like you have to be a math teacher to be able to explain math to people (*some* focus group members)
- Feel like you have to know the language of the people you're talking to, and be able to explain ideas to these people (*other* focus group members)
- A lot of bad experiences in math were because teachers knew math, but couldn't explain it
- Helping fill in students gaps with mathematics learning can be like figuring out a puzzle
- I like math, so math really comes easily to me

Figure 25. (Cont.'d

- Math is strict and has a lot of rules
- Math is like a puzzle that works out
- I'm not going to teach math, so I'm not going to plan on it or worry about it – I chose the population I want to work with based on the fact that I won't have to teach math
- Want to be a math teacher who's always trying to learn from and be open to students

Figure 26. Attitude – Post Focus Group 2.

- Think mathematics important to at-risk learners
- Mathematics learning has to be active for at-risk learners
- With at-risk students, not sure about the value of learning algebraic properties in their overall mathematics learning
- I'm not strong in math, so feel like I needed to be prepared to teach mathematics like an at-risk learner because my weakness is in math
- Wish had been taught math instruction more prescriptively than trial and error method for students' needs
- Afraid of negatively impacting student learning and perspectives on mathematics
- Just because you know math, doesn't mean you can teach math – just may have some skill with higher level concepts

In terms of teacher candidate attitude towards mathematics and mathematics instruction, some comments from the pre focus groups resurfaced, while new issues also appeared. First, the importance of mathematics instruction for at-risk learners was still valued, as well as the significance of cultivating a positive student outlook on mathematics seen through, “Mathematics is very important to at-risk learners” and “Basic patterning skills are important to higher level mathematics learning further down the road.” Many of the teacher candidates again reflected on how it was their own traditional experiences at the elementary level with mathematics that had turned them off from mathematics learning with, “A lot of my bad experiences in math were because knew teachers math but could not explain it.” They were determined as a group not to “do” the same to the students they now teach. An additional concern included that many teacher candidates were concerned about teaching mathematics because they realized how students are now taught math is much different, more constructive, from the way they were taught mathematics themselves. They had found it difficult to teach in this “new” conceptual way because they needed to know “the language of mathematics” and “the language of their students” to teach mathematics effectively. A second new topic was that many teacher candidates thought the language element of mathematics, being able to explain concepts to students and then having students do the same, was integral to students’ mathematics learning with “To be a good math teacher, you have to be able to explain mathematics.” Many felt they had gained this new concern about “explaining mathematical ideas” as they had attempted to demonstrate seemingly simple mathematics concepts to students within the DAL, and found it was not an easy task. Both a mixture of constructivist and traditional attitudes about teaching mathematics were still presented

with a few teacher candidates expressing that “math is like a puzzle that you have to figure out”, while others thought of math as “strict with a lot of rules.”

Content Knowledge – Post Focus Groups

Figure 27. Content Knowledge – Post Focus Group 1.

- I can teach patterning, but still have a hard time justifying answers
- Graphing – graphing is an area of knowledge strength
- Everything else but graphing is a weakness
- Statistics – it’s a different type of thinking, you can relate basic mathematics skills more easily with it
- I’m going to get a tutor to help me understand concepts I don’t get that I’m still trying to understand – to refresh my memory

Figure 28. Content Knowledge – Post Focus Group 2.

- Taught patterns because comfortable with patterns
- In my future teaching, I’m going to follow the curriculum and what I should do – and then I will be okay
- Think scope and sequence of skills is important for mathematics instruction
- Understand algebraic thinking skills – confident to teach them

One of the interesting developments from the pre to post focus groups was the narrowing of the discussion on content knowledge. In the first focus groups, extensive comments were made about the different elements of basic arithmetic and algebraic type problems. However, in the second round of focus groups, very little time was spent by

teacher candidates discussing the nature of these areas, but primarily time was spent on one of the DAL's content focal areas, patterning. This change in teacher candidate comments may be due to the way the question or phrase was asked in post focus groups. It could also be due to the fact that many of the teacher candidates almost exclusively focused on patterning skills while working with their students within the DAL framework, because patterning is one of the most basic algebraic skills assessed for proficiency in the DAL initial assessment and is where many students had exhibited difficulty.

At the same time, teacher candidates did make comments about the connectedness of mathematics curriculum, stated with "I think the scope and sequence of skills is important for mathematics instruction." Teacher candidates also mentioned other mathematics areas which they felt they were proficient in such as statistics and graphing. These comments seemed to stem from their frustration with the current algebraic thinking they were teaching, as well as difficulties with other areas of content. One such comment included, "I like statistics – it's a different type of thinking. You can relate basic mathematics skills more easily with it."

Instructional Knowledge – Post Focus Groups

Figure 29. Instructional Knowledge – Post Group 1.

- In math, it's important to teach kids ways to remember things, so they can do it again
- CRA is useful
- Use of manipulatives is a good idea
- Planning and reflection are important because they help you make connections between ideas and concepts
- Think it's necessary to relate mathematics in a way that students will understand
- If you reflect on your instruction, easier to see where students struggling with content and where you too may be struggling with content or going wrong
- Language you use to explain ideas to students is very important
- Instruction can really impact the way a child understands concepts
- Copying from the board is not a good mathematics strategy
- Kill and Drill – doesn't work for teaching mathematics
- Connecting learning to past experiences is helpful
- Building on strategies students already know is a good instructional technique
- Sometimes schools and administrative staff will have mathematics resources that will help and guide you in your learning about mathematics curriculum – these resources would be great to have at your school when you are a new teacher
- Being well-prepared and getting extra resources is important to good mathematics instruction

Figure 30. Instructional Knowledge – Post Focus Group 2.

- Planning and reflection in teaching mathematics helps you know what you should be doing and keeps you from making so many mistakes
- Explicit instruction important for individuals who are at-risk learners
- We needed more modeling to better understand the DAL process, more reiterations too
- Needed to be more explicitly taught DAL and have it broken down into steps/parts
- Important to be flexible and base instruction off of students' individual interests
- CRA is a great tool
- Making connections between learning topics/areas in mathematics is important
- Manipulatives are valuable to use in mathematics
- Relating mathematics to kids' own lives is essential
- Individualized instruction is an important tool for students at-risk for difficulties in mathematics
- One strategy is not going to work for all kids, so need to have a bag of tricks full of instructional strategies

With the instructional knowledge piece, teacher candidates also approached this topic from a different angle than in pre focus groups. Teacher candidates again spoke extensively about strategies that were taught through the DAL, as they did in the pre focus groups as well, including “CRA is useful” and “Use of manipulatives is a good idea.” However, a few other ideas that corresponded with these strategies were also

discussed, including instructional flexibility, using students' individual interests, and differentiating instruction while teaching. As one teacher candidate said, "One strategy is not going to work for all kids, so you need to have a bag of tricks full of instructional strategies." The other shift in focus for instructional knowledge was teacher candidates' statements about what strategies best helped them learn and retain mathematics instructional strategies. It was interesting that many of the same strategies used within the DAL framework itself, were ones that teacher candidates felt would enhance their actual learning process of teaching mathematics. For instance, one participant said, "I needed more modeling to understand the DAL process" and another mentioned, "I needed to be taught the DAL more explicitly." The last shift in emphasis was on planning and reflection. Teacher candidates voiced ideas that these two concepts were integral to facilitating instructional sessions and improving the quality of these sessions. One candidate stated this idea succinctly with, "Planning and reflection in teaching mathematics helps you know what you should be doing and keeps you from making so many mistakes."

Instructional Application – Post Focus Groups

Figure 31. Instructional Application – Post Focus Group 1.

- I've learned teaching math can be fun
- Think needed more time to work with students on math to be able to explain it to the students better
- Needed more time with the DAL to be able to teach with it effectively
- Through this practicum experience, feel have learned to relate to kids
- Needed more time spent on explicit strategy learning for us to be able to apply these strategies with students
- Found out by teaching math in this practicum that the “having to explain” piece is very helpful, because found out where I am having trouble and need help with mathematics when trying to explain it
- Going to use textbooks to try and access content when have to teach mathematics in the future
- Very helpful to be taking teaching mathematics and practicum at the same time – helpful for thinking of ideas for practicum

Figure 32. Instructional Application – Post Focus Group 2.

- Hard to teach mathematics through reading, if child is a struggling reader as well
- Scope and sequence chart would be a good tool to use with the DAL
- Didn't have peer support while teaching DAL, as with UFLI, because peers didn't understand the DAL
- DAL would be easier to apply in a classroom or resource setting, than with one-on-one instruction
- After this experience, still have more things that I want to know about mathematics instruction, so I can better teach students in their classrooms
- During the practicum, did a lot of research on the Internet on algebra, so would be comfortable in telling students how to do things with algebra
- The more you do something like teaching math, the easier it is to do it
- In the future, I will find a mentor to help me with my mathematics instruction
- I will continue to learn more about teaching math
- Think would have been helpful with this practicum to have had teaching mathematics class beforehand so would have had background knowledge for instruction
- In the future, workshops will be helpful in gaining help with instruction
- Through this process, I think I better understand the process of students' thinking and why they think that way – know better where kids are coming from
- Through this experience, feel comfortable with K-5 instruction, but not 6th grade and up

Lastly, teacher candidate responses had a much different vein and tone to them for instructional application. Many of the issues brought up about instructional application concerned items that teacher candidates struggled with during their application of the DAL model, such as the amount of time for mathematics instruction and how much they felt they still needed to learn about teaching mathematics in such a structured and systematic manner. One such comment included, “After this experience I still have more things that I want to know about mathematics instruction, so I can better teach students in their classrooms.” There were also suggestions made about the DAL model itself, and concerns with the DAL framework’s implementation, with “DAL would be easier to implement in a classroom or resource setting than with one-on-one instruction.” These ideas included more time and support for understanding the model, as well as a different setting, such as classroom or small group, for application. One teacher candidate stated that she “needed more time with DAL to be able to teach it effectively”, while another mentioned she “didn’t have peer support when teaching with the DAL” because her peers did not understand the process.

Focus Groups Summary

Overall, comments in the pre focus groups seemed to be positive yet anxious about efficacy in terms of learning a new form of instruction, DAL, and how teacher candidates were going to apply this knowledge in practicum. After the DAL experience, the bulk of teacher candidates’ comments were filled with frustration and a new realism about the problems associated with actually working with and applying the DAL framework. Attitudes about mathematics instruction tended to be more constructivist at both pre and post, but traditional views were also presented. A large impact on attitude

also seemed to be early mathematics learning experiences in k-12 environments. Content knowledge was focused on traditional ideas of algebra and basic mathematics skills during pre focus groups, and changed to primarily encompass patterning and related algebraic learning ideas during post focus groups. The post focus groups had more specifics about the DAL framework and instruction versus the pre focus groups, where teacher candidates had not really begun to implement instruction. The second set of focus group comments seemed to have less idealism, and more of the voice of the “experienced” teacher after he or she has undergone a real-life teaching experience and realized the issues connected to instruction for at-risk learners.

Summary of Qualitative Findings

Final project analysis and focus groups provided valuable insights into the efficacy, attitude, content knowledge, and instructional knowledge and application elements identified as pertinent to teacher preparation in mathematics instruction. Throughout teacher candidates’ statements and comments, it was seen that feelings of efficacy were higher before actual instruction was begun with students. It appeared that working with students, and perhaps being faced with different challenges as a result, negatively impacted teacher candidates’ feelings about their instructional abilities in mathematics. While both constructivist and traditional attitudes were presented by candidates, their comments were predominantly constructivist and these views were maintained through the end of the study. Many teacher candidates indicated their ideas about attitude towards mathematics and mathematics instruction had their foundation in k-12 learning experiences. Content knowledge was viewed traditionally, as numbers being involved in basic mathematics and symbols and letters being the root of algebra,

until after experiences working with the algebraic thinking concepts within the DAL model. This experience expanded candidates' ideas most in algebraic thinking pertaining to patterning and representing mathematical situations. For instructional knowledge, teacher candidates expressed familiarity with the pedagogical practices taught within the DAL framework; but in terms of instructional application, some teacher candidates voiced some difficulty applying them with students. However, other teacher candidates explained that their students made large gains in content understanding through learning facilitated through these instructional practices.

Case Studies

Case study data were collected on the three individuals selected from within the ranked groups of overall participants as part of the qualitative data collection and analysis process. The aim of this data collection was to clarify individual learning experiences within the total group of participants, as well as capture more specific information not available through quantitative methods on teacher candidate self-efficacy for teaching mathematics, attitudes toward teaching mathematics, knowledge of mathematics content, knowledge and understanding of research-based mathematics instructional practices for at-risk learners, and application of research-based mathematics instructional practices for at-risk learners. For the purposes of this study, the participant from the high achieving group will be called Olivia, the participant from the mid achieving group will be called Kari, and the participant from the low achieving group will be called Taylor. For each case study participant, several types of data were accumulated including individual quantitative data on the three surveys and course exam. Additionally, qualitative data were amassed in the form of complete DAL project artifacts, final analysis papers, and

research exit interviews. The data for each case study participant are presented below by participant and data collection method.

Olivia

Mathematics Teaching Efficacy Beliefs Instrument - Overall Efficacy. For the Mathematics Teaching Efficacy Beliefs Instrument pretest, Olivia was absent because of illness and was not able to make up the test in the available time period. However, she was present for both midpoint and posttest administrations. At midpoint, on the overall efficacy measure, Olivia did not mark any items as “Strongly Disagree” or “Disagree”, indicating that she did not view any of her mathematics related teaching abilities negatively in terms of efficacy. She did mark “Uncertain” and “Agree” an equal number of times, with both having 28.6%. Olivia also noted that she “Strongly Agreed” with statements about efficacy in mathematics just under half of the time (42.8%). At posttest, there was some change in Olivia’s responses. She indicated a decrease in her overall feelings of efficacy, with 4.8% of her responses “Disagreeing” or showing negative feelings of efficacy compared to none of these responses on the midpoint survey. While at the same time her “Agree” response level went up slightly to 33.3%, but her “Strongly Agree” responses evidenced a considerable decrease to 23.8%. Olivia’s results on the full Mathematics Teaching Efficacy Beliefs Instrument show a slight decrease in her feelings of efficacy in teaching mathematics from midpoint to posttest. Table 39 shows data on Olivia’s overall efficacy survey.

Table 39
Olivia: Mathematics Teaching Efficacy Beliefs Instrument - Overall

	Pretest	Midpoint	Posttest
Strongly Disagree		0.0%	0.0%
Disagree		0.0%	4.8%
Uncertain		28.6%	38.1%
Agree		28.6%	33.3%
Strongly Agree		42.8%	23.8%

Self-Efficacy. At the midpoint administration, on the survey items directly related to self-efficacy in mathematics instruction, Olivia indicated only positive feelings of self-efficacy. She did not respond to any items as “Strongly Disagree”, “Disagree”, or even “Uncertain”. The majority of her midpoint self-efficacy responses were “Strongly Agree”, showing this highest efficacy rating 61.5% of the time. At posttest, results were much more spread out across ratings, with a small amount of negative feelings of self-efficacy (7.7%) and “Uncertain” indications (15.3%). While Olivia maintained her level of “Agree” statements, her “Strongly Agree” statements fell sharply to 38.5%. The results of the self-efficacy questions show a decrease in Olivia’s feelings from midpoint to posttest. Table 40 presents the data on Olivia’s self-efficacy subtest.

Table 40
Olivia: Mathematics Teaching Efficacy Beliefs Instrument – Self-Efficacy

	Pretest	Midpoint	Posttest
Strongly Disagree		0.0%	0.0%
Disagree		0.0%	7.7%
Uncertain		0.0%	15.3%
Agree		38.5%	38.5%
Strongly Agree		61.5%	38.5%

Outcome Expectancy. Olivia did not indicate any negative feelings of efficacy in affecting student outcomes in mathematics at midpoint or posttest. However, she did respond with a high level of uncertainty about her feelings, selecting 75% of her answers on both administrations as “Uncertain”. During the midpoint administration, Olivia’s positive feelings for outcome expectancy were equally split between “Agree” and “Strongly Agree”, while at posttest, all of her positive responses had fallen slightly to “Agree” with no “Strongly Agree” responses indicated. The results for the outcome expectancy subtest indicate a slight decrease in the strength of Olivia’s positive feelings from midpoint to posttest. Olivia’s outcome expectancy subtest results are shown in Table 41.

Table 41
Olivia: Mathematics Teaching Efficacy Beliefs Instrument – Outcome Expectancy

	Pretest	Midpoint	Posttest
Strongly Disagree		0.0%	0.0%
Disagree		0.0%	0.0%
Uncertain		75.0%	75.0%
Agree		12.5%	25.0%
Strongly Agree		12.5%	0.0%

Summary. An evaluation of Olivia’s efficacy results indicate that her feelings of overall efficacy declined slightly on the full survey. Her agreement with self-efficacy and outcome expectancy subtest items also decreased from midpoint to posttest. On the overall survey and the self-efficacy subtest, at least some of Olivia’s responses moved into the negative efficacy range. However, on the outcome question portion, while Olivia’s strength of efficacy decreased to a small degree, none of here responses shifted to indicate negative feelings.

Kari

Mathematics Teaching Efficacy Beliefs Instrument - Overall Efficacy. Kari’s pretest scores on the overall Mathematics Teaching Efficacy Beliefs Instrument indicated a slight negative sense of efficacy with 9.5% of responses marked “Disagree” as seen in Table 42. Approximately a third of her answers indicated she had feelings of uncertainty

in regards to her efficacy, while slightly more than half (57.2%) were responses that noted positive perceptions about her efficacy. At midpoint, there was a considerable increase in Kari’s feelings of efficacy, where she indicated 90.5% positive “Agree” statements for efficacy. At posttest, Kari’s scores had fallen considerably, with an equal 4.8% rate for both “Strongly Disagree” and “Disagree”. Additionally, she marked more items as “Uncertain” than at midpoint, and her positive feelings dropped considerably to only 61.9%. On the overall instrument, Kari’s results indicated that while her feelings of efficacy rose at midpoint, they fell back to below pretest levels at posttest.

Table 42
Kari: Mathematics Teaching Efficacy Beliefs Instrument – Overall

	Pretest	Midpoint	Posttest
Strongly Disagree	0.0%	0.0%	4.8%
Disagree	9.5%	0.0%	4.8%
Uncertain	33.3%	9.5%	28.5%
Agree	57.2%	90.5%	61.9%
Strongly Agree	0.0%	0.0%	0.0%

Self-Efficacy. Kari’s pretest results on the self-efficacy questions indicated that she held some negative perceptions of her self-efficacy with 15.4% of her responses, shown in Table 43. At the same time, she also had almost as many responses of “Uncertain” as she did positive feelings of efficacy. At midpoint, Kari’s responses changed considerably with 84.6% of her responses indicating positive perceptions of self

efficacy, and no responses that were negative. At posttest, Kari maintained a high level of “Agree” statements at 53.8%, but her number of “Uncertain” responses increased. Kari also responded 7.7% of the time as “Disagree”, indicating negative efficacy perceptions at posttest. These self-efficacy results indicated that while Kari’s feelings of self efficacy rose considerably from pretest to midpoint, they then declined slightly again at post-test.

Table 43

Kari: Mathematics Teaching Efficacy Beliefs Instrument – Self-Efficacy

	Pretest	Midpoint	Posttest
Strongly Disagree	0.0%	0.0%	7.7%
Disagree	15.4%	0.0%	0.0%
Uncertain	38.5%	15.4%	38.5%
Agree	46.1%	84.6%	53.8%
Strongly Agree	0.0%	0.0%	0.0%

Outcome Expectancy. At pretest, Kari indicated predominantly positive feelings of efficacy towards student outcomes with 75% of her responses. The remaining responses were “Uncertain” and did not show negative feelings of efficacy towards outcome expectations. At midpoint, 100% of Kari’s responses were “Agree”, showing a high level of efficacy in expected student responses to her mathematics instruction. At posttest, Kari’s results had changed slightly, with not only a decrease in positive feelings of efficacy, but also 12.5% of her responses marked as “Uncertain” or “Disagree”.

Outcome expectancy agreement results show a considerable rise at midpoint, with a slight decrease at posttest, included in Table 44.

Table 44
Kari: Mathematics Teaching Efficacy Beliefs Instrument – Outcome Expectancy

	Pretest	Midpoint	Posttest
Strongly Disagree	0.0%	0.0%	0.0%
Disagree	0.0%	0.0%	12.5%
Uncertain	25.0%	0.0%	12.5%
Agree	75.0%	100.0%	75.0%
Strongly Agree	0.0%	0.0%	0.0%

Summary. On the entire efficacy instrument, as well as the two subtests, Kari showed positive growth in her perceptions of efficacy for teaching mathematics from pretest to midpoint. At posttest, Kari’s scores experienced a decline on both subtests, as well as the whole instrument. On the self efficacy subtest, Kari’s score decreased, but not below pretest levels. However, on the overall instrument and outcome expectancy portion, Kari’s scores decreased below pretest levels at posttest.

Taylor

Mathematics Teaching Efficacy Beliefs Instrument - Overall Efficacy. On the full Mathematics Teaching Efficacy Beliefs Instrument, Taylor responded in an almost even split between total negative feelings of efficacy (47.6%) and total positive feelings of efficacy (52.4%), with no indications of “Uncertain” feelings. At midpoint, her scores

had risen considerably with a majority of responses (90.5%), indicating positive feelings of efficacy. However, there was still a small percentage, 9.5% of responses, showing negative feelings of efficacy. At posttest, Taylor’s scores fell to a marked degree, with a drop to 52.4% in positive feelings and a rise in overall negative feelings to 38.1%.

“Uncertain” responses also appeared at 9.5%, after not being indicated on either previous survey administration. Overall efficacy results showed a gain at midpoint and then a sharp decrease at posttest, as seen in Table 45.

Table 45
Taylor: Mathematics Teaching Efficacy Beliefs Instrument – Overall

	Pretest	Midpoint	Posttest
Strongly Disagree	4.8%	0.0%	4.8%
Disagree	42.8%	9.5%	33.3%
Uncertain	0.0%	0.0%	9.5%
Agree	47.6%	90.5%	52.4%
Strongly Agree	4.8%	0.0%	0.0%

Self-Efficacy. At pretest, Taylor indicated 38.5% negative perceptions of self-efficacy when teaching mathematics compared to the majority of her responses which were positive perceptions (61.5%), shown in Table 46. At midpoint, a large change in responses occurred with 100% of her responses indicating agreement, meaning that all of her responses were marked positively for her perceptions of her self-efficacy in teaching mathematics. Posttest results showed a slight decrease from midpoint results with 15.4%

of responses indicated as “Uncertain” and a small percentage of responses (7.7%) marked as negative feelings of self-efficacy. Taylor’s results indicated positive growth in perceptions of self-efficacy towards math instruction, which were stronger at midpoint than at posttest.

Table 46
Taylor: Mathematics Teaching Efficacy Beliefs Instrument – Self-Efficacy

	Pretest	Midpoint	Posttest
Strongly Disagree	7.7%	0.0%	7.7%
Disagree	30.8%	0.0%	0.0%
Uncertain	0.0%	0.0%	15.4%
Agree	61.5%	100.0%	76.9%
Strongly Agree	0.0%	0.0%	0.0%

Outcome Expectancy. In terms of her perceived instructional efficacy on student learning at pretest, Taylor indicated a predominantly negative view with 62.5% of her responses marked as “Disagree” and only 37.5% marked positively. At midpoint, Taylor, evidenced a large change in her perceptions, with 75% of her responses being “Agree” or positively related to her instructional efficacy. A shift in the opposite direction occurred for Taylor’s results at posttest, with 87.5% of her responses indicating negative feelings about her efficacy in affecting student responses through her instruction. The results show a shift from predominately negative outcome expectancy views at pretest to

predominantly positive views at midpoint. At posttest, results made a major shift, indicating even more negative views than at pretest, included in Table 47.

Table 47
Taylor: Mathematics Teaching Efficacy Beliefs Instrument – Outcome Expectancy

	Pretest	Midpoint	Posttest
Strongly Disagree	0.0%	0.0%	0.0%
Disagree	62.5%	25.0%	87.5%
Uncertain	0.0%	0.0%	0.0%
Agree	25.0%	75.0%	12.5%
Strongly Agree	12.5%	0.0%	0.0%

Summary. Results of the Mathematics Teaching Beliefs Instrument indicate an increase in perceptions of efficacy across the total instrument, as well as the subtests from pretest to midpoint. However, from midpoint to posttest, all results decreased. Outcome expectancy showed the most marked decrease, followed by the total instrument, and then the self efficacy subtest, which experienced a minor decrease.

Comparison of Case Study Efficacy Instrument Results. During the course of the study, the three case study participants' individual results on the efficacy survey instrument paralleled the quantitative data collected on the total participant group as a whole, showing an increase on the full efficacy instrument and its subtests between pretest and midpoint, but then a decrease between midpoint and posttest. Looking at the

individual results between case study participants, Olivia's decreases at posttest were minimal on the full instrument, as well as self-efficacy and outcome expectancy subtests. Kari and Taylor's results were different, showing considerable decreases, especially in the area of outcome expectancy which dropped below pretest levels. These results indicate that Kari and Taylor's feelings that they could positively affect student learning outcomes in mathematics diminished during the latter half of the study.

Olivia

Mathematical Beliefs Questionnaire – Overall Beliefs: Constructively Worded Items. Both the Mathematics Teaching Efficacy Beliefs Instrument and the Mathematical Beliefs Questionnaire were administered on the same day. As a result, Olivia was also absent for the Mathematical Beliefs Questionnaire pretest and was not able to make up the test in the available time period. Along with the previous instrument, she was present for both midpoint and posttest administrations. At midpoint, for all items worded constructively and flexibly about mathematics, Olivia marked primarily responses that indicated her agreement with these beliefs. However, this agreement was somewhat tentative because 70% of her responses noted only "Slight" or "Moderate Agreement". Posttest results showed a considerable change in Olivia's overall constructivist beliefs towards more traditional attitudes with 60% of her responses indicating some form of disagreement with more informal and flexible ideas about mathematics. While Olivia's views shifted towards more formal ideas about overall mathematics teaching at posttest, she still evidenced no instances of "Strongly Agreeing" with these more traditional ideas, seen in Table 48.

Table 48
*Olivia: Mathematical Beliefs Questionnaire – Overall Beliefs:
 Constructively Worded Items*

	Pretest	Midpoint	Posttest
Strongly			
Disagree		0.0%	0.0%
Moderately			
Disagree		0.0%	15.0%
Slightly Disagree		5.0%	45.0%
Slightly Agree		25.0%	25.0%
Moderately			
Agree		45.0%	10.0%
Strongly Agree		25.0%	5.0%

Overall Beliefs – Traditionally Worded Items. With all items on the Mathematical Beliefs Questionnaire which were worded more traditionally towards mathematics, Olivia noted fairly strong disagreement (90%) at midpoint, shown in Table 49. This disagreement is consistent with her responses when compared to the overall constructively worded statements, with which she predominately agreed (95%). At posttest, Olivia showed more agreement with more formal ideas about mathematics, with 70% of her responses indicating some form of agreement with these views. These results are again consistent with her responses to constructively worded items, where 60% of her responses were in disagreement with these more developmental beliefs.

Table 49
*Olivia: Mathematical Beliefs Questionnaire – Overall Beliefs:
 Traditionally Worded Items*

	Pretest	Midpoint	Posttest
Strongly			
Disagree		50.0%	0.0%
Moderately			
Disagree		20.0%	30.0%
Slightly Disagree		20.0%	40.0%
Slightly Agree		5.0%	25.0%
Moderately			
Agree		5.0%	5.0%
Strongly Agree		0.0%	0.0%

MBS – Constructively Worded Items. On the MBS subtest at midpoint, Olivia indicated 90% agreement with ideas supporting more flexible and creative ways of approaching the learning of mathematics, included in Table 50. At posttest, her beliefs had shifted to an equal split between agreement and disagreement with this constructivist approach. However, within her agreement responses, Olivia had 10% of items where she “Strongly Agreed” compared to no items where she “Strongly Disagreed”. While her results, indicated that Olivia’s ideas became more traditional, her ideas were still slightly more constructivist towards the mathematics subject area.

Table 50
Olivia: MBS – Constructively Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree		0.0%	0.0%
Moderately			
Disagree		0.0%	30.0%
Slightly Disagree		10.0%	20.0%
Slightly Agree		50.0%	20.0%
Moderately			
Agree		40.0%	20.0%
Strongly Agree		0.0%	10.0%

MBS –Traditionally Worded Items. With items on the MBS worded in a more traditional and rigid approach towards the academic area of mathematics, Olivia indicated disagreement with 90% of items at midpoint, seen in Table 51. These results are exactly opposite and consistent with items worded positively towards constructivist views at midpoint on the same subtest. At posttest, Olivia’s views did not shift towards more agreement with traditional views. However, her disagreement became less strong with 60% of her responses “Slightly Disagreeing” with formal ideas about mathematics. While Olivia’s responses to traditionally worded items is not in opposition to her responses on constructivist items, her answers indicate less inclination towards formal mathematical ideas than is shown through her disagreement with constructivist ideas.

Table 51
Olivia: MBS – Traditionally Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree		20.0%	0.0%
Moderately			
Disagree		30.0%	30.0%
Slightly Disagree		40.0%	60.0%
Slightly Agree		10.0%	10.0%
Moderately			
Agree		0.0%	0.0%
Strongly Agree		0.0%	0.0%

TMBS – Constructively Worded Items. On the TMBS at midpoint, Olivia indicated beliefs that consistently agreed with instructing math in a constructivist manner, with 100% of her responses as “Moderately Agree” or “Strongly Agree”. At posttest, Olivia’s responses on this subtest notably decreased showing only 30% agreement with constructivist ideas about teaching mathematics and 70% disagreement. These results indicated that Olivia’s views about mathematics instruction became more traditional during the latter part of the study, included in Table 52.

Table 52
Olivia: TMBS – Constructively Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree		0.0%	0.0%
Moderately			
Disagree		0.0%	0.0%
Slightly Disagree		0.0%	70.0%
Slightly Agree		0.0%	30.0%
Moderately			
Agree		50.0%	0.0%
Strongly Agree		50.0%	0.0%

TMBS –Traditionally Worded Items. With items involving more formal approaches towards mathematics instruction, Olivia answered with “Strong Disagreement” for 80% of the items at midpoint. These responses match Olivia’s responses to constructively worded items on the same subtest that indicated 100% agreement with more flexible and creative views about teaching mathematics. At posttest, Olivia’s disagreement with formal instruction decreased to 50% of her responses, with also a decrease in the degree of this disagreement to “Moderate” and “Slight” rather than “Strong”. While these responses are consistent with Olivia’s results towards constructivist items, the strength of agreement with formal instruction ideas (50%) is less than that indicated by her disagreement with the positively worded

constructivist items (70%). These results show a slight shift towards more traditional mathematics teaching attitudes in the later half of the study, seen in Table 53.

Table 53
Olivia: TMBS – Traditionally Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree		80.0%	0.0%
Moderately			
Disagree		10.0%	30.0%
Slightly Disagree		0.0%	20.0%
Slightly Agree		0.0%	40.0%
Moderately			
Agree		10.0%	10.0%
Strongly Agree		0.0%	0.0%

Summary. At midpoint, Olivia’s responses across survey items indicated a strong agreement with informal, constructivist views on the overall attitude survey, and on the general mathematics and teaching mathematics subtests. At posttest, Olivia’s responses on all positive statements about flexibly and creatively approaching mathematics on both subtests and the full survey indicated a decrease in these views. While Olivia’s agreement with constructively worded items considerably decreased, her agreement with positively worded statements about formal mathematics instruction did not increase to the

same extent, indicating that while her agreement with constructivist ideas did wane she could not then agree with positively framed traditional views instead.

Kari

Mathematical Beliefs Questionnaire – Overall Beliefs: Constructively Worded Items. On the overall Mathematical Beliefs Questionnaire, Kari initially showed 70% agreement with constructivist ideas about mathematics. At midpoint, this agreement increased to 90%, with 25% of her responses indicating “Strong Agreement” with these ideas. At posttest, agreement with this informal approach towards mathematics decreased slightly with only 60% agreement. Responses at posttest that disagreed with constructivist views rose to 40%. Kari’s results indicated that during the middle of the study her attitudes towards mathematics took a decidedly more constructivist turn, but by posttest these feelings had decreased to approximately match pretest responses, included in Table 54.

Table 54

Kari: Mathematical Beliefs Questionnaire – Overall Beliefs: Constructively Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree	0.0%	0.0%	0.0%
Moderately			
Disagree	0.0%	0.0%	0.0%
Slightly Disagree	30.0%	10.0%	40.0%
Slightly Agree	55.0%	30.0%	45.0%
Moderately			
Agree	15.0%	35.0%	15.0%
Strongly Agree	0.0%	25.0%	0.0%

Overall Beliefs – Traditionally Worded Items. With items worded towards more traditional views of mathematics on the full Mathematical Beliefs Questionnaire, Kari marked 85% of her responses in agreement with more formal views of mathematics at pretest. This indication contradicts her responses to positively worded constructivist statements, to which she responded positive agreement 70% of the time, seen in Table 55. At midpoint, her views grew more strongly positive for traditional views, with disagreement at 15% and only in the “Slightly Disagree” category. Again, this agreement with traditional views is in opposition to her responses to items worded more constructively where she indicated 90% agreement with those statements. At posttest,

Kari's agreement with traditional views of mathematics decreased showing 55% disagreement with these ideas and only 45% agreement. This decrease in agreement with traditional views moved her results to be parallel with her responses to positively worded constructivist items that showed 60% agreement with this more flexible approach and 40% disagreement. Kari's results on the overall Mathematical Beliefs Questionnaire indicated the appeal of both constructivist and traditional items for Kari at pretest and midpoint. At posttest, her views seemed to be equally split between approaches, and for the first time her responses consistent between the two types of items. The dual positive emphasis on the two types of items may be due to Kari's attitudes towards mathematics not being stabilized at pretest and midpoint, and developing to a more solidified state at posttest to be slightly more constructivist.

Table 55

Kari: Mathematical Beliefs Questionnaire – Overall Beliefs: Traditionally Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree	0.0%	0.0%	0.0%
Moderately			
Disagree	5.0%	0.0%	20.0%
Slightly Disagree	10.0%	15.0%	35.0%
Slightly Agree	40.0%	55.0%	25.0%
Moderately			
Agree	45.0%	25.0%	20.0%
Strongly Agree	0.0%	5.0%	0.0%

MBS –Constructively Worded Items. On the MBS subtest, Kari indicated strong agreement with positively worded creative statements about approaching mathematics with 70% agreement. At midpoint, this agreement jumped up to 100%. At posttest, Kari’s agreement fell noticeably. Her responses shifted to 60% disagreement with constructivist ideas, and remained only at 40% agreement with them. Additionally, the strength of this agreement decreased with all agreement only at the “Slightly Agree” level. These results indicated a considerable increase in constructivist ideas about mathematics content at midpoint, but a decrease to below pretest levels at posttest, shown in Table 56.

Table 56
Kari: MBS – Constructively Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree	0.0%	0.0%	0.0%
Moderately			
Disagree	0.0%	0.0%	0.0%
Slightly Disagree	30.0%	0.0%	60.0%
Slightly Agree	60.0%	10.0%	40.0%
Moderately			
Agree	10.0%	40.0%	0.0%
Strongly Agree	0.0%	50.0%	0.0%

MBS –Traditionally Worded Items. For items worded positively towards a more formal approach towards mathematics, Kari showed 90% agreement at pretest, shown in Table 57. These results are in opposition with her 70% agreement with constructivist ideas, also at pretest. At midpoint, Kari showed an increase in the strength of her agreement with traditionally worded items, showing that 10% of her responses rose to “Strongly Agreeing” with these ideas. Again, these results are contradictory to her responses on positively worded constructivist items about mathematics, which actually rose to 100%. By posttest, Kari’s agreement with traditional views decreased to only 30%. This shift, while not in complete agreement with her responses to constructivist statements, is noticeably more balanced between the constructivist and traditional

approaches at posttest. The results indicated that both constructivist and traditional views of the mathematics subject area appealed to Kari at pretest and midpoint. Her responses indicated that she had perhaps not definitively established her own beliefs and thoughts on the mathematics content area at those administration points. At posttest, her results from the two types of items on this subtest were in greater agreement, and seemed to be fairly equally balanced between the two approaches.

Table 57
Kari: MBS – Traditionally Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree	0.0%	0.0%	0.0%
Moderately			
Disagree	0.0%	0.0%	30.0%
Slightly Disagree	10.0%	10.0%	40.0%
Slightly Agree	50.0%	50.0%	20.0%
Moderately			
Agree	40.0%	30.0%	10.0%
Strongly Agree	0.0%	10.0%	0.0%

TMBS – Constructively Worded Items. Between pretest and midpoint, Kari’s responses to items indicating agreement with constructivist approaches to mathematics instruction rose slightly from 70% to 80% agreement, included in Table 58. At posttest, her percentages of agreement remained the same from midpoint (80%). These results indicated a decided and stable agreement with constructivist ideas about teaching mathematics over the course of the study.

Table 58
Kari: TMBS – Constructively Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree	0.0%	0.0%	0.0%
Moderately			
Disagree	0.0%	0.0%	0.0%
Slightly Disagree	30.0%	20.0%	20.0%
Slightly Agree	50.0%	50.0%	50.0%
Moderately			
Agree	20.0%	30.0%	30.0%
Strongly Agree	0.0%	0.0%	0.0%

TMBS – Traditionally Worded Items. On the more traditionally worded statements on mathematics instruction, Kari showed 80% agree at both pretest and midpoint, shown in Table 59. These results do not align with her answers on constructivist items that showed 70% and 80% agreement with constructivist items on pretest and then midpoint. At posttest, agreement with more formal views of teaching mathematics had decreased to 60%. These posttest results indicated a more even distribution between her agreement with formal and constructivist ideas. While not in total agreement with her responses on constructively worded items at posttest, they are not contradictory. Kari’s results indicated that the constructivist approach towards teaching mathematics appeals to Kari, but at the same time, so does the more traditional

approach. Only at posttest did Kari’s strength of agreement with traditional views of mathematics instruction begin to lessen.

Table 59
Kari: TMBS – Traditionally Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree	0.0%	0.0%	0.0%
Moderately			
Disagree	10.0%	0.0%	10.0%
Slightly Disagree	10.0%	20.0%	30.0%
Slightly Agree	30.0%	60.0%	30.0%
Moderately			
Agree	50.0%	20.0%	30.0%
Strongly Agree	0.0%	0.0%	0.0%

Summary. Results of Kari’s responses to the overall Mathematics Beliefs Questionnaire and the MBS subtest, indicate some inconsistency in Kari’s views about mathematics. This inconsistency may be due to her ideas in the area being still in the developmental stage. By posttest, her ideas seemed to be more stabilized with equal agreement between the two sets of ideas. However, on the TMBS subtest, the constructivist approach to mathematics instruction had consistent appeal to Kari across administrations, while traditional approaches held strong across all three administrations as well. She experienced only a slight decrease in agreement with traditional items at

posttest. These results possibly indicated that Kari's ideas about engaging in mathematics instruction did not fully develop towards one approach or the other during the course of the study, but remained where her beliefs started in between the traditional and constructivist approaches.

Taylor

Mathematical Beliefs Questionnaire – Overall Beliefs: Constructively Worded Items. On the full Mathematical Beliefs Questionnaire, Taylor showed 80% agreement with constructivist mathematics ideas at pretest, seen in Table 60. At midpoint, this agreement increased slightly to 85%. At posttest, this agreement increased to 100%, with 85% of her responses being “Moderately Agree” or “Strongly Agree”. Across administrations, Taylor indicated no responses of “Strongly Disagree”, and during posttest she exhibited no form of disagreement at all. These results indicated Taylor's inclination towards constructivist views about mathematics.

Table 60
*Taylor: Mathematical Beliefs Questionnaire – Overall Beliefs:
 Constructively Worded Items.*

	Pretest	Midpoint	Posttest
Strongly			
Disagree	0.0%	0.0%	0.0%
Moderately			
Disagree	15.0%	10.0%	0.0%
Slightly Disagree	5.0%	5.0%	0.0%
Slightly Agree	10.0%	0.0%	15.0%
Moderately			
Agree	55.0%	70.0%	70.0%
Strongly Agree	15.0%	15.0%	15.0%

Overall Beliefs – Traditionally Worded Items. On the overall survey, items that were worded more traditionally in their approach received only 40% agreement from Taylor’s responses at pretest, included in Table 61. This agreement decreased to 30% at midpoint, showing consistency between her responses on constructivist items where she indicated 85% agreement. At posttest, her agreement with more formal views of mathematics had decreased even further to 25%. While these results show very little agreement with traditional views of mathematics, they were not in complete accord with Taylor’s 100% agreement with constructivist items. The results indicated that while

agreement with formal approaches to mathematics decreased incrementally throughout the study, agreement with constructivist views increased considerably.

Table 61

Taylor: Mathematical Beliefs Questionnaire – Overall Beliefs: Traditionally Worded Items.

	Pretest	Midpoint	Posttest
Strongly			
Disagree	30.0%	0.0%	5.0%
Moderately			
Disagree	30.0%	40.0%	55.0%
Slightly Disagree	0.0%	30.0%	15.0%
Slightly Agree	0.0%	5.0%	5.0%
Moderately			
Agree	40.0%	25.0%	15.0%
Strongly Agree	0.0%	0.0%	5.0%

MBS – Constructively Worded Items. On the MBS subtest, Taylor indicated a majority (70%) of her pretest responses in agreement with creative and flexible attitudes about the mathematics subject area, included in Table 62. At midpoint, this agreement rose by 10% to 80% agreement. At posttest, this agreement increased to 100%, with no responses indicating disagreement with constructivist beliefs about mathematics. The results show an incremental increase over the course of the study in Taylor’s alignment with constructivist views about mathematics in general.

Table 62
Taylor MBS: Constructively Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree	0.0%	0.0%	0.0%
Moderately			
Disagree	20.0%	10.0%	0.0%
Slightly Disagree	10.0%	10.0%	0.0%
Slightly Agree	0.0%	0.0%	10.0%
Moderately			
Agree	50.0%	70.0%	70.0%
Strongly Agree	20.0%	10.0%	20.0%

MBS –Traditionally Worded Items. With items worded more traditionally towards mathematics learning, Taylor’s initial responses at pretest showed 60% disagreement at the “Strongly Disagree” or “Moderately Disagree” level. At midpoint, this disagreement decreased to only 50%, with the degree of disagreement moving to only “Moderately Disagree” or “Slightly”. These responses are in opposition to both Taylor’s pretest and midpoint responses on constructivist items, to which she responded with 70% and 80% agreement respectively. Responses at posttest to traditional items indicated a decrease in agreement with these views, with 70% of responses marked as “Moderately Disagree” or “Slightly Disagree”. These posttest results are more in line with Taylor’s responses on posttest constructivist items, which were in 100% agreement at posttest with these ideas. The results of this subtest indicated that while the

constructivist approach held strong appeal to Taylor across the study, at pretest and midpoint so did formal ideas about mathematics. These results could be due to Taylor’s lack of development in her own thinking about mathematics at these two time points. Taylor’s development of mathematics views showed some stabilization at posttest. While traditional views never held the same level of appeal as constructivist ones for Taylor, it was only at posttest where she showed 100% agreement with informal and developmental constructivist ideas, and a decrease in her agreement with traditional views at the same time to 30%, seen in Table 63.

Table 63
Taylor: MBS – Traditionally Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree	30.0%	0.0%	0.0%
Moderately			
Disagree	30.0%	40.0%	60.0%
Slightly Disagree	0.0%	10.0%	10.0%
Slightly Agree	0.0%	10.0%	0.0%
Moderately			
Agree	40.0%	40.0%	30.0%
Strongly Agree	0.0%	0.0%	0.0%

TMBS – Constructively Worded Items. On the TMBS at pretest, Taylor indicated 90% agreement with constructivist statements about teaching mathematics, included in

Table 64. At midpoint, the overall percentage of her agreement remained the same but strengthened in the amount of agreement, with “Strongly Agree” statements increasing from 10% to 20%. At posttest, Taylor’s agreement with informal and developmental statements about mathematics instruction rose to 100% agreement. These results indicated an incremental increase of Taylor’s constructivist views throughout the course of the study in regards to teaching mathematics.

Table 64
Taylor: TMBS – Constructively Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree	0.0%	0.0%	0.0%
Moderately			
Disagree	10.0%	10.0%	0.0%
Slightly Disagree	0.0%	0.0%	0.0%
Slightly Agree	20.0%	0.0%	20.0%
Moderately			
Agree	60.0%	70.0%	70.0%
Strongly Agree	10.0%	20.0%	10.0%

TMBS –Traditionally Worded Items. Taylor’s agreement with formal mathematics instruction statements began at 40% at pretest, seen in Table 65. However, a noticeable decrease in agreement was seen at midpoint (10%). While Taylor’s responses to constructivist items and traditional items are not contradictory at pretest, the

formal items did receive more agreement than would have been expected from Taylor's level of agreement with constructivist items. At midpoint, Taylor's responses to traditional items with 10% agreement were in accordance with her responses (90%) of agreement on informal and developmental items. At posttest, levels of agreement with formal items increased slightly to 20%, but for the most part showed an overall maintenance of 80% disagreement, with 10% being "Strongly Disagree". These results indicated some agreement with formal mathematics instruction at pretest, with a considerable decrease in agreement with traditional mathematics instruction ideas from pretest to midpoint, with this decrease maintained at posttest.

Table 65
Taylor: TMBS – Traditionally Worded Items

	Pretest	Midpoint	Posttest
Strongly			
Disagree	30.0%	0.0%	10.0%
Moderately			
Disagree	30.0%	40.0%	50.0%
Slightly Disagree	0.0%	50.0%	20.0%
Slightly Agree	0.0%	0.0%	10.0%
Moderately			
Agree	40.0%	10.0%	0.0%
Strongly Agree	0.0%	0.0%	10.0%

Summary. The overall Mathematical Beliefs Questionnaire showed that Taylor’s agreement with constructivist views increased considerably over the study, while her formal views showed an incremental decrease. At the same time, Taylor’s views on the MBS subtest showed agreement with both constructivist and traditional views at pretest and midpoint, but posttest evidenced a noticeable decrease in her responses towards formal beliefs. This dual attraction of formal and constructivist statements at pretest and midpoint may have been due to Taylor’s still developing views on mathematics, which seemed more definitive at posttest with both sets of statements indicating a more constructivist belief about mathematics learning. On the TMBS, Taylor showed stronger agreement with constructivist items across all administrations, but did not evidence

considerable disagreement with formal instruction until midpoint, which was retained at posttest as well. Again, this initial agreement with both formal and developmental views of teaching mathematics may be due to Taylor's own learning and construction of her ideas regarding mathematics teaching.

Comparison of Case Study Beliefs Instrument Results. Throughout the study, Olivia's responses on the full beliefs instrument and its subtests was similar to that of the total group of participants. Her results illustrated an increase in agreement with items between pretest and midpoint, and a decrease between midpoint and posttest. However, Kari and Taylor's response patterns were different than Olivia's and the larger participant group. Kari's attitudes about mathematics and mathematics instruction did not appear to have been firmly established in her mind as constructivist or traditional at pretest or midpoint, because her responses on the two different types of items were often contradictory to one another. However, at posttest, Kari's ideas, while still not decidedly constructivist or traditional, appeared to have stabilized to an equal combination of both approaches. At the same time, Taylor's attitude responses showed a similar lack of establishment to Kari's, with her responses to constructivist and traditionally worded questions often being in opposition to one another. However, Taylor's responses differed from Kari's. Even though Taylor had this same contradiction between her responses to constructivist and traditional statements, throughout the study she maintained consistently high agreement with constructivist statements even when she showed agreement with traditional statements. At posttest, Taylor's views also seemed to have stabilized, similar to this occurrence with Kari. A marked difference with Taylor was that her attitudes

toward general mathematics and mathematics instruction became decidedly constructivist.

Olivia

Mathematical Content Knowledge for Elementary Teachers. On the Mathematical Content Knowledge for Elementary Teachers survey, Olivia exhibited difficulty with the overall content of the measure (60%), as well as both the arithmetic (54.5%) and algebraic thinking (66.7%) subsections. At pretest, her algebraic thinking accuracy level was slightly higher than her basic arithmetic skills. Olivia's accuracy on the overall survey fell with each administration, being 35% at midpoint and 25% at posttest. Her basic arithmetic results fell from 54.5% at pretest to 36.4% at both midpoint and posttest. Olivia's algebraic thinking score fell considerably from pretest (66.7%) to midpoint (22.2%), with another decline seen at posttest with an 11% score. These results indicated that Olivia started the study at beginning competency level in content knowledge, and her abilities actually decreased to the deficient level over the course of the research, included in Table 66.

Table 66
Olivia: Content Knowledge Results

	Overall	Basic Arithmetic	Algebraic Thinking
Pre	60.0%	54.5%	66.7%
Mid	35.0%	36.4%	22.2%
Post	25.0%	36.4%	11.1%

Kari

Mathematical Content Knowledge for Elementary Teachers. Kari experienced difficulty on the Mathematical Content Knowledge for Elementary Teachers survey at pretest, achieving only 15% accuracy on the full survey, seen in Table 67. Her responses were slightly more accurate on basic arithmetic questions (18.2%) than algebraic thinking ones (11.1%) for her subtest results. At midpoint, Kari scored slightly higher on the overall measure (20%), while increasing her basic arithmetic level to 27.3%. Her algebraic thinking skills remained steady at 11.1%. Kari's overall content knowledge accuracy increased again at posttest to 25%. However, her score on basic arithmetic questions fell to her pretest level (18.2%), while her responses on algebraic thinking items increased to 33.3%. These results indicated that Kari began the study with deficient overall levels of content knowledge. Her basic arithmetic skills did not show consistent gains throughout the study, but algebraic thinking skills did show some improvement. While her overall achievement on the content knowledge measure increased during the study, as well as her algebraic thinking performance, her accuracy levels remained deficient across all areas.

Table 67
Kari: Content Knowledge Results

	Overall	Basic Arithmetic	Algebraic Thinking
Pre	15.0%	18.2%	11.1%
Mid	20.0%	27.3%	11.1%
Post	25.0%	18.2%	33.3%

Taylor

Mathematical Content Knowledge for Elementary Teachers. Taylor began the study with 40% accuracy at pretest on the total Mathematical Content for Elementary Teachers survey, included in Table 68. At pretest, her highest score was on basic arithmetic skills (54.5%) with a lower score on algebraic thinking items (22.2%). During the midpoint administration, Taylor’s overall accuracy increased to 50%, while her basic arithmetic and algebraic thinking levels also increased to 63.6% and 33.3% respectively. At posttest, Taylor’s overall accuracy remained consistent with her midpoint accuracy, but basic arithmetic accuracy decreased (45.5%) and algebraic thinking accuracy increased to its highest level of 55.6%. These results indicated that Taylor had a minimal level of overall content knowledge at the start of the study, which rose slightly over the course of the research. Her basic arithmetic skills did not show any noticeable improvement over the study, while her algebraic thinking skills showed a steady increase from deficient to minimal levels.

Table 68
Taylor: Content Knowledge Results

	Overall	Basic Arithmetic	Algebraic Thinking
Pre	40.0%	54.5%	22.2%
Mid	50.0%	63.6%	33.3%
Post	50.0%	45.5%	55.6%

Comparison of Case Study Mathematical Content for Elementary Teachers

Results. The overall results for all three case study participants indicated they began the study without competency in the content area of elementary level mathematics and completed the study with the same skill level. Case study participant results were consistent with the total participant group's results in that deficient levels of content knowledge were seen in both case study participants and in the larger participant group. However, while the total participant group experienced an increase in content knowledge from pretest to midpoint, and a decrease from midpoint to posttest, the case study participants did not experience the same pattern of movement in their content knowledge. Olivia actually decreased in all areas of the content, including her overall score and the subtest areas. Kari increased her scores in both the overall content and algebraic thinking area over the course of the research, but she started at such deficient levels of content knowledge that even with her improvements she remained in the deficient range for all content areas. Taylor also increased in both the overall content and the algebraic thinking area, with her level of algebraic thinking showing considerable growth. Yet, her levels of

content knowledge remained just below beginning competency level at the conclusion of the study.

Olivia

Instructional Knowledge Exam. Olivia’s overall performance on the instructional knowledge exam resulted in a score of 58%, included in Table 69. On the subtests, her results showed high variability. Olivia evidenced proficiency in understanding multiple choice items with a 92% score, with scores on the instructional practice and learning characteristic questions being nearly equal . However, knowledge levels on both effective practice and application essay areas indicated that Olivia had only minimal abilities to explain her ideas on these points accurately. These results indicate that while Olivia can recognize correct ideas on learning characteristics and instructional practices, she has difficulty with explicitly articulating the specifics of these effective practices and their application within the DAL framework.

Table 69
Olivia: Instructional Knowledge Exam

	Total Exam	MC Total	Eff. Prac. (MC)	Learn. Char. (MC)	Essay Total	Eff. Prac. (Essay)	App. (Essay)
Raw Score	76/130	23/25	14/15	9/10	53/105	25/50	28/55
Percentage	58%	92%	93%	90%	50%	50%	51%

Kari

Instructional Knowledge Exam. Kari’s overall achievement on the instructional knowledge exam indicated a 48% accuracy level, shown in Table 70. On the multiple

choice questions, Kari showed a high level of competency with 92% accuracy, with her scores almost equivalent between learning characteristics and instructional practices. However, on the essay portion of the exam, Kari had difficulty effectively explaining the particulars of these practices and their application within the DAL framework. With the effective practice essay questions, Kari showed beginning levels of competency in articulating her ideas (60%), while on application questions Kari was deficient in her conveyance of understanding. These results indicate that Kari can recognize correct ideas about learning characteristics and instructional practices, when directly presented with these ideas, but still struggles with mastering and describing these instructional practices on her own. In terms of instructional strategy application within the DAL framework, Kari is unable to perform this task with any level of accuracy. Kari's results indicate a firm ability in identifying relevant learner characteristics and instructional practices, with further work needed on being able to describe those practices herself. She evidenced little knowledge of the ability to apply her knowledge within the DAL instructional framework.

Table 70
Kari: Instructional Knowledge Exam

	Total Exam	MC Total	Eff. Prac. (MC)	Learn. Char. (MC)	Essay Total	Eff. Prac. (Essay)	App. (Essay)
Raw Score	62/130	23/25	14/15	9/10	39/105	30/50	9/55
Percentage	48%	92%	93%	90%	37%	60%	16%

Taylor

Instructional Knowledge Exam. Taylor’s performance on the instructional knowledge exam indicated a 65% accuracy level, seen in Table 71. On multiple choice items, she evidenced a high level of mastery with a 96% score, with her scores on learning characteristic and instructional practice questions being nearly equivalent to one another. On the essay portion, Taylor demonstrated beginning competency with understanding instructional practices with a 70% score. However, with the application questions in the essay portion, further work was needed in describing the implementation of effective practices within the DAL framework, as indicated by Taylor’s score of 52%. While Taylor’s results showed that she needs continued work on articulating information about effective instructional practices and their application, she does evidence some understanding of instructional practices and a beginning grasp of their application within the DAL framework.

Table 71
Taylor: Instructional Knowledge Exam

	Total Exam	MC Total	Eff. Prac. (MC)	Learn. Char. (MC)	Essay Total	Eff. Prac. (Essay)	App. (Essay)
Raw Score	85/130	24/25	14/15	10/10	61/105	35/50	9/55
Percentage	65%	96%	93%	100%	58%	70%	16%

Summary. All three teacher candidates achieved at different levels on the content knowledge exam as a whole. Kari’s overall performance was the lowest at 48%, followed by Olivia at 58%, and then Taylor at 65%. These scores evidence a deficient

grasp on overall instructional concepts by Kari, with beginning understandings presented through Olivia's achievement. Taylor shows the most familiarity with the instruction content, but her results still indicate a need for increased overall competency. In the subareas, there were much different results. In the multiple choice area, all teacher candidates scored above 90%, showing mastery at the identification level for learning characteristics and instructional practices. On the effective instructional practices essay section, Taylor responded with some degree of competency, while Kari showed beginning levels of competency and Olivia indicated additional assistance in grasping these ideas. On the last section of applying these strategies within the DAL framework, Taylor and Olivia scored fairly equally, at 51% and 52% respectively, indicating needing continued help to fully understand the application of instructional strategies within the DAL. At the same time, Kari scored a 16%, noting a need for re-teaching these concepts for her grasp of these ideas.

Olivia

Review of Entire DAL Project – Efficacy. During the DAL experience, Olivia voiced positive comments in her work about her ability to teach mathematics in a way that was engaging for her students and where she felt that she had helped them each gain a greater understanding of targeted concepts. One example of such a comment was during a reflection on a weekly instructional session where she mentioned, "I pointed out the oranges to my student and she had an aha moment. I learned the significance of connecting to the text and she was learning what times table[s] are representing." Olivia's positive feelings of efficacy may have been impacted by the fact that she had two students for instruction throughout the entire study. Not all teacher candidates within

the study had two students during the entire semester, because of student attendance and school withdrawal. Each of Olivia's students was present at all instructional sessions, except for one absence for each. Another outside factor that may have supported Olivia's efficacious perceptions was she was present for all DAL framework training and implementation, except for one time early on in the training process before implementation had begun.

According to Olivia's DAL framework artifacts, there were other factors unique to Olivia's instruction that may also have contributed to her positive feelings of instructional efficacy. When reviewing Olivia's initial DAL assessment of her students, her summaries of the assessment results clearly indicated that one student missed assessment items beginning with creating and extending patterns, and the other first missed items involving representing mathematical models involved with multiplication based problems. Olivia followed the guidelines of the DAL training explicitly, and began instruction for both students at the concept which they had both first missed on the assessment. As a result, she was able to implement mathematics teaching at the student's instructional level, and both of her students evidenced gains in proficiency on target skills. One of her students showed 100% accuracy with patterning skills at the representational level, and the other student demonstrated 87.5% accuracy with multiplication problem set up and solution at the representational level. A final aspect of her instruction that may have caused Olivia positive feelings of efficacy was that she assisted her students in progressing incrementally in their understandings of concepts by moving them up through the levels of abstraction in CRA accurately, rather than jumping between concepts without a leveled progression.

Attitude. Through her experience with the DAL framework, Olivia approached mathematics using a constructivist/developmental attitude towards instruction. This approach was evidenced through several of Olivia's documented actions. While Olivia could have followed some parts of the DAL process and skipped other parts based on time constraints or the need to move her students through the continuum of algebraic thinking skills, she did not and followed the DAL's developmental and structured approach throughout her instruction. Instructional decisions to do otherwise would have indicated her belief in possibly more traditional views of mathematics instruction. Additional constructivist belief indicators included Olivia's usage of student progress monitoring during each step of the process. She did not move her students forward in terms of skill level (ie., CRA) or type of skill unless this information was indicated through the required mastery percentages in Step I: Building Automaticity and Step II: Measuring Student Progress. It was only when students had gained successful proficiency levels with targeted skills in Step I or could successfully complete the problem solving steps (i.e., read, represent, justify, solve) on a concept that she moved forward in the skills she targeted through her instruction in Step III.

Content Knowledge. Olivia's description of her grasp and usage of algebraic thinking content knowledge within the DAL framework, evidenced her understanding of the scope and sequence of algebraic skills, as well as specific comprehension of the intricacies surrounding patterning and representing multiplication equations. A reflection statement that indicated her content knowledge understandings was "I decided the objective for the session was growing patterns at the representational level because in the Initial Probe the student could clearly use manipulatives and representations to extend

patterns.” Olivia also showed she had a handle on decision-making with content knowledge through completing the initial DAL assessment with each of her students, and then successfully used those results to ascertain where instruction should begin. This content knowledge decision-making was illustrated through one of her assessment result summaries where she noted, “Student B understands patterns, including sorting, identifying and describing patterns, and extending and creating patterns. The first skills that needs improvement in the hierarchy of the given assessment are representational multiplication and division therefore I will begin instruction at this point.” Olivia provided succinct descriptions of student performance on the initial assessment, and then used those results for her initial session probe content. Additionally, from the initial assessment, Olivia decided to only target one algebraic thinking skill at one level within each DAL framework step, so broke down each target skill into its individual levels of conceptualization for its greater understanding. An example is shown through her comment about her goal for one student’s instruction, “I decided the objective for the session was growing patterns at the representational level.” Olivia’s successful utilization of algebraic thinking content knowledge within DAL sessions is contrary to the results of her own content knowledge survey. Her ability to understand content knowledge within her instructional experience may have been due to the limited nature of the content she taught, which included just patterning and representing multiplication problems. It could be also due to her disclosure that she sought out ways of learning and understanding the concepts on her own, such as through Internet research and discussions with university support staff, before instructional sessions.

Instructional Knowledge and Application. Olivia's DAL project documents show that her understanding of instructional knowledge and its applications within DAL are tied intimately to the way she taught her students their target skills. For both students, Olivia's project included examples of multiple practice opportunities at both the representational and abstract levels of CRA. Her weekly reflections also provided descriptions of using concrete manipulatives involving plastic shapes to illustrate problems. Additionally, Olivia's reflections also illustrated how she used learner engagement with concepts and student practice within a self-decorated student notebook to motivate students' learning. These same ideas are ones that she spoke most descriptively about in her exit interview and scored most highly on during the instructional knowledge exam.

Olivia evidenced further instructional application through her usage of *The Man Who Walked Between the Towers* book as an authentic context for instruction. Olivia used this text with both of her students, but devised different types of instructional activities for each student. For one student, she implemented the book as a source of different types of patterns found in the main character's experience in New York. With her other student, Olivia used the same text for sources of multiplication problems to be devised and solved. This dual context usage illustrated Olivia's ability to think about the context to be implemented, and how it could be incorporated with multiple learning targets to individualize instruction. In another instance of instructional connection making, Olivia attached a "Mathematics Strategy" sheet within her DAL project that she designed herself, modeled after the reading strategies sheet that was handed out by the researcher for assisting students with UFLI's beginning reading strategies. This

“Mathematics Strategy” sheet incorporated 9 mathematics strategies involving levels of representation, language experiences, and mathematics resource utilization, as well as metacognitive strategies. This chart was one that Olivia presented to both her students in their last instructional session to have and use in future mathematics situations. This mathematics strategy chart showed Olivia’s connection making between reading and mathematics strategy instruction.

Kari

Review of Entire DAL Project – Efficacy. In several places within her reflections during the DAL framework, Kari made statements about being unsure of how to implement the DAL model and voiced negative feelings about her instructional efficacy. One such comment in one of her reflections included, “Today we did the initial session probe during our session. It was really interesting because I did not really understand what I was suppose to be doing so I had to go with what I thought I was suppose to do and make a lesson that.” Through her comments, it seemed that her greatest difficulty was in understanding the steps in implementing the process, as she mentioned in her final analysis paper with, “I feel like I need a lot more work in the project to understand the concept completely. I have a very general knowledge of what I thought I was suppose to be doing and even though I went and asked numerous people about how to do this DAL process it never really came to me completely.” This difficulty may have been due to the fact that Kari had a limited number of sessions with both of her students because of her own absence due to illness one time, and then one of her students being out on another occasion. While Kari indicated difficulty in understanding and implementing the DAL, her notes within her project did not show efforts to seek clarification from university

support staff within the practicum as Olivia's did. Additionally, her implementation difficulties may have also been related to the fact that her reflections on her weekly experiences were very concrete, focusing on what happened in sessions and what could be done in the future, rather than probing her own understanding of student responses to instruction, her own comprehension of the DAL process, and honing her problem-solving abilities for student learning difficulties. For instance, one of her reflections focused on the following information for what she learned in her session, "After completing the initial session probe I decided based on what I did with my student that she was at an instructional level and at the representational level of growing patterns. She really understood the concept of concrete but was still not at the independent level on the representational level of growing patterns so that's why I think I should start there next week for our session. I think that with a little more help and hands on lessons she will be able to really understand and get the concept of growing patterns and what they really are doing."

Attitude. Kari's overall attitude towards instructional implementation through the DAL framework was formal in nature, focusing on step completion and navigating through the sequence of instructional skills. Through her session notes and weekly reflections, Kari indicated that her goals for her students were to "move" them through the instructional content to be learned. A specific instance of this attitude was seen through a reflection about one of her students' progress through the initial assessment with, "I will continue with the assessment hopefully we will finish it because he is moving rather slow through the test." In several of her reflections, Kari noted the length of time it was taking her students to complete their problems. At the same time, she

commented on the fact that when her students questioned their own problem solving processes, it further slowed the flow of problem completion. For example, Kari noted about one of her students, “I learned that she takes a long time to finish a problem when it comes to something that she not understand. She questions everything she does which in the end takes her longer to complete the problems.” This particular statement was indicative of a very traditional view of mathematics instruction where Kari saw herself as the director of curriculum points for student learning. At the same time, she seemed frustrated by her student’s constructivist efforts to make sense of her methods of finding solutions. While the attitudinal survey that Kari completed indicated her valuing constructivist statements about mathematics and mathematics instruction, feelings evidenced through her project artifacts showed her instructional practices as being primarily teacher-directed and traditionally structured.

Content Knowledge. In terms of content knowledge, Kari’s project documents indicated difficulty in accurate instructional decision-making based on student content knowledge performance, as well as trouble understanding the scope and sequence of skills to be taught in algebraic thinking. Both of Kari’s students showed their first difficulties on the DAL initial assessment with concrete growing patterns at the creating level. While her students appeared to still need further instruction on that skill at that same level after the initial probe was also completed, Kari noted that she moved one student on to the representational level. Kari’s instructional decision-making at this juncture leaves a question to whether Kari understood the patterning content or required DAL proficiency percentages enough to make accurate data-based decisions on when and why to move students up to the next representation level or skill to be taught. At the

same time, while Kari's reflections and notes indicated that she planned on moving one of her students up from the concrete to representational level, in actuality Kari's examples and materials showed that she persisted in having both of her students work on the same skill at the same level, concrete growing patterns, through both Steps 1 and 2 in her next instructional session. This lack of instructional follow through, as well as failing to employ the CRA sequence accurately from Steps 1 to 2, may indicate that Kari did not clearly understand the connections and differences between the levels of understanding (i.e., CRA) and the component parts of patterning concepts.

Instructional Knowledge and Application. Throughout her sessions, Kari utilized both learner engagement and CRA to facilitate her instruction. Because of her failure to use specific incremental increases in representational levels with patterning at the growing pattern level, little to no student progression in learning skills was seen. Kari taught her students both identifying growing patterns at the concrete level during all sessions. Her greatest difficulty seemed to surround the use of CRA, which is used explicitly within each step of the DAL framework. This difficulty was evident when she continued to teach both of her students within each step of the DAL framework at the identifying growing pattern level using concrete manipulatives. Additionally, based on Kari's notes, her goal for the second step of her last instructional session with students was to employ high interest materials involving candy for student engagement. In her effort to use learner engagement, Kari failed to follow the graduated levels of CRA, which her documents indicate should have been picture or drawing representations for Step 2. Kari's instructional efforts also failed to show individualized instruction, with her

implementation of the same book, at the same skill level, and with the same type of manipulatives with both of her students.

Taylor

Review of Entire DAL Project – Efficacy. Throughout her instruction using the DAL framework, Taylor's notes on student performance, as well as her reflections, indicated her inability to effectively teach and help her students progress in understanding algebraic thinking concepts. Her students' lack of success in algebraic learning may be due in some part to outside factors. In Taylor's situation, one of her students had excessive absences that allowed Taylor to only complete the beginning assessment and the initial session probe with this student. At the same time, Taylor's own absence during the intensive full day of DAL model training, as well as again during one of her instructional days, may have further affected her level of instructional effectiveness. It also reduced the number of instructional sessions she completed with both of her students and her number of opportunities for affecting learner outcomes in algebraic thinking.

Even in the face of these challenges, Taylor did write that she felt she had positively affected her students' learning by solidifying the differences between growing and repeating patterns with them. However, this feeling of efficacy was not supported by any data, because Taylor's project indicated no specific notes on her first student's skill performance during his initial session. After this initial session, Taylor was unable to see the student again because of student absence. With Taylor's second student, she collected data during the initial session probe that indicated further work was needed with growing patterns. When she taught her first full session with the student, she conducted Step 1: Building Automaticity on creating repeating patterns. While her data collected

during this step indicated positive student performance with 5/5 items completed successfully at the abstract level, the number of required accurate items for proficiency indicated continued work needed on this level to raise the accuracy and fluency rate to at least 9/10 in one minute. Unfortunately, Taylor's session ended early because of student needs, and Taylor was unable to continue her instruction. Again, as with the first student, Taylor mentioned that she saw limited student progress with this second student, this time in the development of language abilities to describe the formation of growing and repeating patterns. However, her limited collected data and observations simply indicated her student was working towards proficiency level on creating repeating patterns.

Attitude. While Taylor had limited opportunities to engage in instruction with her students, her project artifacts indicated that she employed a constructivist approach to instruction to facilitate student learning within the sessions she did have. Her project notes depicted her usage of CRA to help students develop their ideas on concepts involving growing patterns. She also stressed the use of language with oral discussion and student justification during the multiple opportunities for practice that she provided her students. Taylor's one main instance of more traditional instruction was seen within one of her weekly reflections' emphasis on direct instruction when beginning teaching on growing patterns with, "I explained that a repeating pattern was the same set over and over but a growing pattern grew each time it repeated. Once I explained this to Rodniqua, I asked to complete some growing patterns."

Content Knowledge. The bulk of Taylor's reflection comments focused on her work with her students in the patterning skill area. Both of Taylor's students evidenced

difficulties on growing patterns at the creating level. Taylor was able to successfully use the DAL initial assessment results to accurately pinpoint these difficulties and begin instruction on this skill with both students. During instruction using the DAL's initial session probe, Taylor targeted instruction on creating growing patterns for each of her students. When Taylor's second student did progress to his first full session, Taylor chose creating repeating patterns to begin Step 1: Building Automaticity. This skill level is several levels under where the student evidenced his instructional level of creating growing patterns. A more appropriate instructional choice would have been extending growing patterns or describing growing patterns, which are one and two levels below the student's instructional level, respectively. This jump backwards in skills for Step 1, indicated Taylor's possible difficulty in understanding the scope and sequence of skills in the patterning area of algebraic thinking

Instructional Knowledge and Application. While Taylor tried to employ CRA, explicit instruction, and oral structured language experiences in her teaching, her limited sessions and number of steps completed in each session impeded her from having more opportunities to use many of the possible instructional strategies that can be used within the DAL framework. Through Taylor's instructional session notes, she indicated introduction of target learning concepts with growing patterns through explicit instruction with modeling, which is appropriate for at-risk learners. At the same time, she tied concrete manipulatives to the context of problem-solving, which involved patterning using beans and bread. Additionally, Taylor indicated specific instances where she afforded students opportunities to develop oral language abilities to explain their problem-solving during pattern formation. Unfortunately, Taylor was never able to

implement the student language notebook for written structured language experiences because she did not make it to Step 3: Problem Solving the New with either of her students.

Comparison of Case Study Entire DAL Final Projects. Each of the case study participants presented a uniquely different experience through their DAL project artifacts. Olivia's illustrated one of growth in efficacy and employment of a constructivist approach towards instruction, using diverse methods of instruction and multiple ways to understand content knowledge for her instruction. Kari's project showed her confusion with the DAL framework's steps, instructional practices, and content, resulting in poor perceptions of self-efficacy, lack of student progress, and employment of few different forms of instruction. Taylor's project highlighted a lack of efficacy and student progress due to the outside factor of absence. However, Taylor maintained a mostly constructivist approach to instruction, attempting to employ multiple forms of instructional practice within her limited sessions. Taylor's lack of understanding of the scope and sequence of algebraic skills may have also influenced her students' lack of progression in algebraic skills. Results from these analyses indicated that the top-achieving participant grasped the key pieces of the DAL experience and was able to develop her abilities along identified critical elements for teacher preparation in mathematics. Yet, the mid-achieving teacher candidate, struggled in grasping the DAL framework, as well as content knowledge and instructional practices, while the low-achieving participant struggled primarily with her lack of session experiences and in depth understanding of algebraic thinking content.

Olivia

Final Analysis Paper – Efficacy. Within her final analysis paper, Olivia had 6 specific instances of speaking directly about her feelings of efficacy when using the DAL framework and its related instructional practices, shown in Table 72. Her comments were equally balanced between positive and negative comments about her efficacy in facilitating instruction. One specific negative efficacy comment included “outside factors affecting the number of sessions we were able to conduct hindered her (referring to her student) learning and mine”. On the other hand, one of her positive statements included that the “DAL was an organized process of teaching” which she felt helpful in facilitating her instructional abilities.

Attitude. Olivia also made statements regarding her attitude towards mathematics instruction on a total of 6 occasions. Within these comments, she had 5 instances of a constructivist nature and 1 instance of a more traditional approach to mathematics. One of her comments along constructivist lines mentioned “goal setting invites students to actively engage in their education”, showing her attitude of encouraging student involvement in and enjoyment of mathematics learning. The only formal statement that she made regarding mathematics instruction was that she viewed herself as having to “teach strategies to (her) students” rather than viewing strategy knowledge and application as a guided discovery process explored by students.

Content Knowledge. Within her paper, Olivia discussed 2 specific items involving content knowledge, each on a different topic. One of these comments was regarding her first student’s grasp of patterning, and the second comment was about her other student’s conceptualization of multiplication model problems. In one of her

statements, Olivia mentioned that her student working on multiplication eventually began to comprehend multiplication as a way of “forming groups”, showing Olivia’s realization that while multiplication understanding had first escaped her student, he then developed a way of comprehending the ideas behind that specific skill.

Instructional Knowledge and Application. The majority of comments that Olivia made in her final analysis of the DAL experience referred to instructional knowledge, with 7 codes and a total of 10 statements. Within her statements, she included the ideas of “progress monitoring”, “systematic structured instruction”, “planning”, “making connections across content areas”, “CRA”, “multiple practice opportunities”, and “building student confidence through instruction”. Many of these quotes identified instructional practices explicitly covered in the DAL process, including CRA, making connections, multiple practice opportunities, and progress monitoring.

Table 72
Olivia: Final Analysis Paper Themes

Element	Number of Descriptor Codes in Theme	Frequency of Occurrence	Intensity Effect Sizes (Percentage of Total)
Efficacy	2	6	25.0 %
Attitude	2	6	25.0%
Content			
Knowledge	2	2	8.3%
Instructional			
Knowledge	7	10	41.7%

Kari

Final Analysis Paper – Efficacy. During her final analysis paper, Kari made 5 specific comments about her efficacy in teaching mathematics, seen in Table 73. Her comments had only 1 code because they were only negative in regard to her abilities to teach mathematics. However, the reasons for these negative feelings of efficacy were not focused in on her own abilities, but on outside factors related to her preparation, such as “not being given the tools” to facilitate mathematics instruction successfully, and external environmental factors such as “not having nearly enough instructional time”.

Attitude. Kari’s attitudes towards mathematics and mathematics instruction were presented 6 times during her paper. The majority of her attitudinal comments were constructivist in nature, consisting of 4 statements, while traditional statements about teaching mathematics were only indicated 2 times. For instance, Kari viewed instruction within the DAL as a shared or constructed learning experience between her and students when describing instructional aids as “the tools I needed to complete the process with my student.” However, at another point Kari mentioned “having to teach concepts to her students”, noting a more formal and directive approach to instructing mathematics.

Content Knowledge. During her writing, Kari made no mention of ideas directly regarding content knowledge in conjunction with her own understandings or her students. This finding is consistent with her scores on the mathematics content area survey, where she exhibited low levels of content knowledge across all areas of elementary level mathematics. It is not surprising that she would not discuss mathematics content knowledge, with which she had evidenced difficulty in grasping.

Instructional Knowledge and Application. Kari’s statements about instructional strategies and knowledge covered 3 coding areas: “modeling”, “planning”, and “multiple practice opportunities”. “Modeling” and “multiple practice opportunities” are specific instructional strategies taught directly within the DAL framework. Planning, while not specifically taught, is emphasized within the DAL as integral in having successful student sessions. An interesting spin on these techniques was that Kari thought that more opportunities for practice and more modeling demonstrations for the DAL framework should be utilized by the faculty in preparing the teacher candidates to implement the DAL framework. As a result, the strategies taught within the model were ones that she felt needed to be employed for her own learning rather than her advocating their direct usage with students.

Table 73
Kari: Final Analysis Paper Themes

Element	Number of Descriptor Codes in Theme	Frequency of Occurrence	Intensity Effect Sizes (Percentage of Total)
Efficacy	1	5	33.3%
Attitude	2	6	40.0%
Content			
Knowledge	0	0	0.0%
Instructional			
Knowledge	3	4	26.7%

Taylor

Final Analysis Paper – Efficacy, Attitude, and Content Knowledge. Within the final analysis paper of the DAL experience, Taylor wrote an extremely short one page evaluation of her experience with the framework, included in Table 74. There was no specific mention as to her efficacy in mathematics instruction within her writing. Also, no statements about her attitude towards mathematics instruction were evident. Additionally, Taylor did not state any information in regards to the content knowledge element of mathematics instruction.

Instructional Knowledge and Application. The only comments that Taylor made in her final analysis paper were in regards to instructional practices. Within her statements, she spoke about 3 distinctive instructional strategies: “explicit instruction”, “structured language experiences”, and “learner engagement”. Each of these strategies was taught to teacher candidates within the DAL framework’s initial instruction and ongoing support. One specific feature that Taylor focused on was ensuring her instructional efforts make “the most basic of ideas” detailed and engaging, so that students do not lose interest in learning more fundamental concepts.

Table 74
Taylor: Final Analysis Paper Themes

Element	Number of Descriptor Codes in Theme	Frequency of Occurrence	Intensity Effect Sizes (Percentage of Total)
Efficacy	0	0	0.0%
Attitude	0	0	0.0%
Content			
Knowledge	0	0	0.0%
Instructional			
Knowledge	3	4	100.0%

Comparison of Case Study Final Analysis Papers. The final analysis paper of each case study student was different. With Olivia, the student with the highest overall Level II course and practicum achievement, her comments covered the breadth of professional development elements covered within this study. On the other hand, Kari, the mid-achieving participant, focused in on external factors affecting her abilities to efficaciously execute instruction, while never mentioning the content she taught. Her depth of comments on content knowledge also seemed in line with her deficient scores on the content knowledge survey. At the same time, Taylor, who was from the low-achieving group of participants, turned in the shortest of the three final analysis papers, which seemed in accordance with her overall performance evaluation from her professors in Level II coursework and practicum. Interestingly, she only wrote about instructional practices in her paper. These instructional concepts were ones directly taught to the

teacher candidates within the scope of the DAL experience and training. Taylor did not mention any concepts, ideas, and experiences that were implicit within her exposure to the DAL framework. These results indicate that the person most completely affected across identified critical elements for mathematics instruction for at-risk learners was Olivia, the high performing teacher candidate. Kari, the mid-performing teacher candidate, appeared to have gained mostly surface level understandings across these critical elements, except for content knowledge that appeared to have not been affected by the DAL experience. Taylor, the low performing teacher candidate, articulated learning in explicitly taught instructional practices in both the instructional knowledge and application realms, but other areas were not recognized as experiencing gains.

Olivia

Exit Interview – Efficacy. Within the exit interview process, some key ideas impacting Olivia's feelings of efficacy in teaching mathematics were illustrated by her comments. For the most part, Olivia maintained a high perception of her efficacy in her instructional abilities and her instructional effects on her students. She mentioned that she had entered the DAL experience comfortable with elementary mathematics, having two of her own children in middle school. As we began the DAL training, this feeling of comfort increased, because as she said, "I had no idea that patterns were part of algebraic thinking, and I was thinking 'patterns, whoo-hoo'! You know, I just didn't think it was that important."

As her experience with DAL continued, Olivia noted that during the middle of the study, she had doubted her abilities to teach her students more than before starting with the DAL framework, for two reasons. First, she realized she did not know or could not

remember how to represent multiplication problems. As she stated, “I had gaps definitely, as far as representing multiplication. I had to learn that myself... Now, how I felt about implementing it, I felt a little uneasy because it was new and I had to learn how to do it.” While this first issue momentarily raised concerns in her head about her abilities to teach the multiplication concept to her one student, she resolved these concerns by accessing resources at her disposal, including university support staff and peers. Second, Olivia discovered that she had misinterpreted her other student’s abilities with patterning, which she described as, “I thought she breezed through the patterns, but then I misjudged that and I reassessed her. She had already told me that she had problems with math... And when I reassessed her, I realized she didn’t have patterns.” In terms of helping Olivia develop her instructional efficacy, she said that at the same time she was participating in the Level II practicum, she was also taking a mathematics education course that focused on pedagogical ideas surrounding mathematics instruction. She stated she used the mathematics education course’s text as a resource with, “the teaching math book had some great suggestions for books (indicating sources for authentic contexts)”. Olivia also mentioned conferencing with the practicum support staff, including myself the researcher, as means that developed her instructional efficacy with multiplication.

Time constraint was the only real detracting outside factors that Olivia mentioned as influencing her abilities to teach her students algebraic thinking. Both of her students were absent on one occasion during the process; and another time, she had a shortened session with one student because she felt bad about pulling the student from a “preferred” computer activity. Olivia mentioned she had made her greatest realizations in developing

her instruction in the last five minutes with each student, which again left her wanting more time in the overall DAL experience. She described this experience with, “It all came together at that “aha” moment, like in the last five minutes that I was with the student, I was like what strategy can I teach the student, and I thought partitioning, it just like came to me... Just like came to me in the last five minutes that I had left with her. And, I wish I could have like really taught her that, that was like the “aha” moment.”

Attitude. In regards to her attitude towards mathematics and teaching mathematics, comments made in Olivia’s exit interview were decidedly constructivist in her approach to learning mathematics instruction and facilitating her students’ abilities to gain new mathematical ideas. Olivia’s remarks focused in on multiple ways to help students learn mathematics strategies. She also emphasized that these strategies had to be ones that motivated and engaged students in their own learning, such as, “In the UFLI, we were never up to the goal setting because we had the lower level books. So, when I did it for the math and I got to see how excited the student was to set a goal... and, that helped motivate them.”

Throughout her interview, Olivia stressed the idea that she was still forming her own understandings about mathematics instruction and this process was an ongoing one, not thoughts that had been traditionally taught and memorized by her. In terms of her current mathematics learning, she stated, “I think what I got most out of it (the DAL training) was concrete, representational, and abstract, and actually showing this is concrete, this is representative, this is abstract.” Within our conversation, she mentioned specific strategies that helped her learn mathematics included visual and kinesthetic learning activities, modeled demonstrations of ideas, as well as application and

discovery-based experiences with new instructional practices to gauge her ability to use them. She specifically said, “I am not an audio person, I have to see it and do it. So, that’s why I’ll write the whole time the teacher’s talking, because otherwise I won’t process.” Olivia also went on to say her DAL training would have been enhanced by tapping into technology to meet her multiple modality learning needs through, “...even like a visual podcast to see the interaction with the teacher and the student, the professor and the student.” Olivia’s description of both her mathematics instructional activities with students and her own mathematics learning show a developmental-constructivist perspective.

Content Knowledge. During the interview, there were two main focal points of discussion about the content area of the DAL experience: patterning and representing mathematics multiplication-based problems. The reason for this emphasis was most likely because these areas were ones she worked on with her students in DAL sessions. With the patterning concept, originally Olivia had thought the content was not that complex or important. However, as she became involved in instruction, she realized the complexities of this skill area and the helpfulness of using manipulatives, especially with one student on patterning. She mentioned that with, “...one of them (of her students), the manipulatives, the concrete manipulatives, they were definitely helpful.” In terms of multiplication, one of Olivia’s chief realizations was that she herself was still grappling with fully understanding ways to conceptualize the ideas behind the automatic process involved in answer finding. However, she described her time learning a conceptual understanding of multiplication as “a very helpful experience”. She also spoke about her

growth with mathematics over the semester with, “Just as we were just wrapping up, I was just getting it. Like I was just getting on my game.”

Instructional Knowledge and Application. When asked about instructional knowledge gained through the DAL experience, Olivia stated that CRA was the most significant of these ideas. She also mentioned that she understood this method of instruction, and she felt that during the preparation with the DAL, it had been clearly explained by, “I think what I got most out of it (the DAL model training) was concrete, representational, and abstract. Those were like the major components that I got out of it and that was obviously represented well if that’s what I got out of it.” Additionally, she indicated that she valued the DAL framework as an instructional tool because, “I think it’s a good experience, I think it’s a good process only because I don’t know of any other process. So, it’s nice to have a process.” Olivia voiced a desire to learn “processes” for teaching mathematics, and this framework was her first towards that goal. While in general she advocated the use of having a structured approach to teaching at-risk learners mathematics in a systematic and incremental way, she noted that there were aspects of the DAL framework that she thought could be streamlined for instructional purposes. She said, “Session notes. The session notes sheet was a bit busy for me. I think if it was simplified a little bit, I think I could have followed it a little bit more. And, I know it wasn’t complicated... the way it was set up, I guess it just wouldn’t be the way I would set it up. I would want even simpler.”

Summary. Overall Olivia expressed the learning of instructional practices and structured mathematics teaching methods as positive experiences through the DAL framework. She also described her journey towards mathematics as continually

developing, along with her abilities to effectively teach and understand mathematics. While she mentioned needing more time to develop her mathematics instructional abilities further, she felt she had grown in her current abilities through the DAL experience in conjunction with her mathematics education class.

Kari

Exit Interview – Efficacy. When talking with Kari about her feelings of efficacy in teaching algebraic thinking within the DAL framework, she focused on two key elements that she felt had negatively impacted her ability to instruct her students more fully in their learning: time and preparation. In terms of time, in general she felt there was not enough of it for either her preparation with the model or her implementation of it. She explained that after the initial trainings with the DAL, which included several 1-2 hour seminars and a whole day workshop, she still felt “confused.” Consequently, she thought that lengthened training time would have improved her understanding. She believed this change would have significantly helped her, because she knew that in general she really liked math, as she mentioned, “I’m strong in math personally.” As a result, she felt the reason she was “confused” with the process was not the content but the use of the framework. Overall, she voiced that she did not feel she knew what she was doing with, “I really didn’t do that many sessions, and I really didn’t get what I was supposed to be doing...so I was kind of just winging it.”

In other issues involving her time concern, Kari felt that besides greater preparation time, more instructional session time would have also been beneficial. She thought the period of time for implementation was too short, since it was begun with students nearly halfway through the semester. Additionally, she had fewer sessions than

other individuals because she was out sick with the flu and then one of her students had been sick. Kari felt that more instructional sessions would truly have been helpful, because she said that with UFLI, the reading program also learned and implemented by the teacher candidates, she had felt confused with its application and usage in the beginning of the semester. However, her feelings about UFLI had changed over the many weeks of the semester, when she had time to implement the process and learn from her mistakes, and also to make connections with her students. She believed that her mathematics instruction would have been more effective with both students if she had increased opportunities to work with them as with her UFLI students. As she stated, “I really don’t think I knew what I was supposed to do or I wasn’t confident in it, so I didn’t really know what to do, and then it kind of ended. So I didn’t get to like grow or anything like with the UFLI, where ‘oh I kind of made mistakes, oh I shouldn’t have done that, oh I should have done this’, and gone from there.” It is pertinent to mention that even though Kari felt that time was one of the major barriers in her efficacy of implementation with the DAL, she was the case study participant who had struggled on the content knowledge assessment, scoring deficient on the whole content knowledge measure, as well as the subtests of both basic arithmetic and algebraic thinking skills. These results do not match her perceptions of strength in the content area of instruction, and may have had some effect on her efficacy in instruction.

Attitude. Kari’s ideas of how she could have been better prepared with the DAL model shed light on her attitudes about teaching and learning mathematics. One of the main deficiencies that Kari felt was elementary to her difficulties with using the DAL was the lack of explicit instruction during DAL training. Her comments reflected quite a

traditional view of how she and the other teacher candidates should have been prepared to use the DAL framework, by “being told exactly” how it should be implemented with students. Kari commented on this idea by mentioning that faculty should have approached DAL preparation with teacher candidates as, “like this is what you should do.” She voiced that if this type of training would have been provided, then she could have turned around and done the same for her students, “explicitly taught the learning targets to them.” Kari’s ideas along these lines included, “I think the math should be more directed like how the UFLI was. I think the UFLI was explicitly taught to us, I kind of think the DAL was not explicitly taught to us.”

At the same time that Kari expressed this desire for a more formal type of preparation, she did also mention a few key constructivist ideas about her approach to learning and teaching mathematics. One of these thoughts included that she felt it was the normal learning process for her and other teacher candidates to be somewhat confused about the DAL framework when they were taught about it in training sessions. Kari seemed to value the use of applying a process to help internalize learning its parts and intricacies more completely. Her second thought along these lines was that increased time for the framework’s application, allowing a developmental time period for learning the process, was critical for both her absorption and understanding of the DAL and her students benefiting from it. Third, Kari had felt it was valuable to have the DAL framework in a setting where all teacher candidates and university supervisors were together during the practicum day in a resource room type setting, where clarifications could be made and understandings developed on an ongoing basis. She mentioned, “It was like a class and I liked having you and the other professors there to be like, well this

is what everybody is saying, well let's just go ask them and let's see what the correct answer is and how to do it, instead of waiting until class or three days later when it's not that important any more."

Content Knowledge. In regards to the area of content knowledge, Kari's comments centered on the fact that she had felt at first that both of her students struggled with basic concepts in algebraic thinking, but she had been mistaken in one of these cases. She mentioned that her female student had come to their sessions saying she knew she needed additional assistance in mathematics. However, the second student simply mentioned he liked coming with her because he did not like his teacher. In the situation with the first student, Kari had been happy that at one point in the semester the student had come back to her saying that she had used a concept in the classroom that week, which she had learned with Kari in their previous session. Kari had thought this comment very positive, and she realized she had actually taught the student a key idea with which she had been having trouble. With Kari's second student, she had believed his difficulties had been with not understanding some key ideas with growing patterns. Yet, she said when she began working with him she realized that the student actually did understand these concepts much better than she initially had thought. When asked how she dealt with this situation, she said she proceeded with her lesson with the student on the concepts, but had presented the instruction to him as more of a review than anything else. She said she handled it with the student as, "We went off on 'like you know this'. This is a review then." She felt that the reason the student performed better on patterning in the session than on the assessment was due to the wording of some of the assessment items. While the assessment did not have a formal script, she said the guidelines for

introducing the items were what had guided her instructions, and she felt that this language and vocabulary were difficult for the student. In the first few sessions, she realized that with further probing and discussion with the student, he really did understand patterning ideas but perhaps just needed these ideas activated in his own language.

Instructional Knowledge and Application. Taking Kari's content knowledge findings with this last student into account, it is important to remember from the Entire DAL Project review that the researcher had discovered that although Kari found her initial assessment's results were not completely accurate appraisals of her student's abilities, she had difficulty in actually implementing instructional changes. When she conducted her initial probe in the target area of the assessment, she had noted she would elevate the student one level, from the concrete to the representational in the next session, based on her findings that he actually understood the material at the concrete level. However, in her next session, Kari continued to target creating growing patterns still at the concrete level, during both steps 1 and 2. Kari's actions are a reflection of two key parts of her instructional difficulties with the DAL, implementing data-based decisions focused on student performance and correctly using the levels of CRA for instruction. As Kari realized her student had a better grasp of patterning material than she had thought, her instructional decision was to move the student up to the next level of representation for the skill. However, because of possibly faulty understanding of how to apply and use CRA, Kari did not actually implement the instructional change she had intended. While Kari mentioned that she thought explicit instruction and CRA were valuable instructional

strategies with her students, it appears that she needed continued work on understanding and implementing CRA.

Summary. Kari's remarks throughout her interview voiced frustration with her experience with the instructional framework because of time constraints and the design of its initial assessment's instructions. She also emphasized the need for greater preparation with the DAL process. Additionally, Kari felt that more formal means of instruction with her own preparation would have aided in her usage of the framework.

Taylor

Exit Interview – Efficacy. When completing the exit interview with Taylor, she honed in on some key aspects that affected her self-efficacy in instruction, and the ability of that instruction to impact student learning outcomes. Before beginning training with the DAL framework, Taylor mentioned that she felt confident in her abilities to teach algebraic thinking at the elementary level, because of what she perceived as the “low level content” of the instruction. She stated, “As far as anything in elementary school, I felt like I had a pretty good handle on it.” However, from the start of the DAL training and implementation, Taylor indicated that being absent for health reasons during the one full-day of DAL training at the start of the experience, left her feeling uncertain about her abilities to teach mathematics. While she had spent some individual time playing “catch up” with the researcher, she did not feel she grasped the process from the start, she felt this situation negatively impacted her ability to implement algebraic thinking instruction. She stated these ideas with, “I don't think I ever really got a concrete handle on what the process was exactly. I don't think it ever really became clear, like I think I'm one of those people that needs to understand why I'm doing what I'm doing. I need to know

what the purpose is for something and if I didn't understand how something benefited the whole process or if I didn't understand why something was being done, then, it just wouldn't stick in my brain, it just wouldn't retain that. There's a lot of things, I think I just don't understand the application of them, and why we do that." Additionally, when she mentioned she had asked other teacher candidates about implementing the process, she said they could not help her because they were also "lost". Other variables that she gave as affecting her instructional efficacy were a low number of sessions for implementation because of student absences, as well as what she called a "mini-crisis" at the school every time she came to the school site for the practicum experience.

Attitude. In terms of her attitude towards mathematics instruction, Taylor displayed a combination of constructivist and formal approach ideas. She felt discouraged when she saw her upper-level elementary students evidence gaps in their understanding of patterns. Upon working with her students, who were in grade levels far beyond patterning, she felt that these gaps were due to their teachers not developing conceptual understandings of skills, but simply having students memorize abstract concepts. On this topic she mentioned, "It kind of reinforced to me the thought that math teachers are teaching, okay this is $A + B = C$, and this is what you do to get your answer, but they don't ever explain why that is. Or what the significance is." Taylor voiced dissatisfaction with this traditional method of teaching mathematics that had been occurring for a long time, and she mentioned that she had experienced it 15 years before in her own schooling. She also discussed the inability of her students to explain their own understandings of concepts, and their desire to just give her the answer rather than explaining how they arrived at the answer or completed the problem-solving process.

One this idea, she said, “They could do it, and they could extend or repeat a pattern or whatever but they didn’t, when they went to explain what was going on...they didn’t know.” Taylor’s ideas are consistent with constructivist ideas of building mathematical understandings by constructing knowledge through the comprehension of one’s own thought processes and means of finding solutions.

At the same time, Taylor seemed to still describe herself engaging in thought processes and practices that were more in accordance with formal instruction methods too. She found little merit in the amount of instruction she completed with her students, because she felt she was simply “reviewing concepts” rather than facilitating understanding and retention through this work. She also described student deficiencies in skills as “gaps” in their learning. Yet, when she talked about designing instruction to meet student needs in these gaps, her description of how to accomplish this feat was akin to someone shoveling information into these holes rather than students bridging these “gaps” through connection building and guided discovery experiences. This duality of perspectives on teaching mathematics was similar to her views collected on the attitude questionnaire, which showed her inclination towards both types of instructional approaches.

Content Knowledge. With the content knowledge area, Taylor spoke about how she had spent all of her time with both students on the “most basic” algebraic learning area of patterning, which she felt they really should not have had as a target area for instruction since they had only missed a couple of questions on that skill area. Taylor felt that expecting 100% accuracy on certain areas of the DAL assessment were too high of expectations for any learner, and she felt resulted in students receiving instruction in

basic areas where small clarifications, such as with vocabulary, were all that was needed. She lamented the fact that her students could actually do more complicated, as well as abstract levels of algebraic problem-solving, but struggled with understanding the concrete and representational levels of skills. Taylor said that before beginning the DAL instructional process, she was unaware that these types of gaps and difficulties could happen in learning what she considered “foundational skills”. Another key problem that she saw specifically with the DAL framework and algebraic thinking instruction was that time spent on integrating reading instruction and related target skills detracted from students’ abilities to focus on mathematics content. Taylor viewed the combination of reading and mathematics instructional strategies, as not facilitating further mathematics content comprehension, but placing a dual emphasis on unrelated reading content. Additionally, Taylor felt she had spent too much time on gathering materials and planning rather than focusing on the actual algebraic content ideas for instruction. She mentioned, “I think I would have like[d] to have spent less time on making sure that I had the stuff, [and] more time on making sure that my lesson made sense and was kind of you know logical and applicable the student’s life, because I spent so much time making documents with like pictures that I could cut out, and all that.”

Instructional Knowledge and Application. According to Taylor, her usage of instructional practices included her implementation of explicit instruction with modeling, CRA, the problem-solving process, and structured oral language experiences, which she felt were all helpful in student learning. However, she remarked that her own understanding of the DAL framework was negatively impacted by the instructional format of being “told about the process” rather than having her other own modalities for

learning accessed. Taylor vocalized these ideas through, “I mean you can only say this so many more times before you say this isn’t going to do any good saying it. So, I don’t want to say add you know another day of instruction in, because I don’t know if that’s gonna do anything. I guess just making sure that everyone has the opportunity to do the entire process as the tutor standpoint, and then again as the student standpoint.”

The other ideas that Taylor mentioned that had impacted her abilities to use the DAL framework for instruction included the model’s difficulty in implementation because of its open-endedness and demands for teacher candidates to engage in large amounts of outside planning. When she compared the DAL model to the UFLI, which was the framework taught in the same practicum for reading instruction, she also remarked that the DAL was “less intuitive” in its application and experiences because the model did not facilitate greater understanding of instruction through multiple exposures to it. She evidenced concerns about the detailed nature of the DAL process for implementation with, “I think there were things I just forgot. Like some steps, and maybe I’m wrong, that just didn’t have something on the form, I would forget, like on the first part, you time the activity that you do, but I don’t know, but when it came time to do it, I couldn’t remember what to do. What do I write in? Do I write in the time? Do I write in what they got wrong?” Lastly, in terms of instructional overlap between reading and mathematics strategies, Taylor did not think they were readily apparent and that she found herself trying to make arbitrary connections between the literature books used with the DAL and the concepts for instruction.

Summary. Within her full DAL experience, Taylor felt that she struggled considerably with executing efficacious instruction with students due to a lack of DAL

training and her inability to remember all the pieces in the DAL process. However, Taylor did mention that she thought her students made qualitative gains in understanding and were able to explain specific patterning concepts through her instruction. While Taylor mentioned specific instructional strategies that she learned through the DAL experience that helped her students make meaning of mathematics concepts, she felt that many improvements could be made within the framework itself.

Comparison of Case Study Exit Interviews. Olivia, Kara, and Taylor's comments each depicted unique experiences with the DAL framework that affected the development of their mathematical instructional abilities in different ways. One common theme across all participant remarks was the need for greater amounts of time for both instruction and training, as well as the employment of more diversified pedagogy with teacher candidates for their preparation to use the DAL framework for instruction. While Olivia enjoyed the social-developmental constructivist approach to the DAL instructional experience, and seemed to grow across the identified critical elements in mathematics instructional abilities, Kara and Taylor felt differently and at the same time exhibited key areas of difficulty in growth. Kara felt that she needed more direct instruction and experiences with the model, and Taylor believed that she simply needed more understanding of the model, which would be facilitated by hands-on instructional activities. Kara's remarks focused on outside factors influencing her abilities to learn and use the DAL framework, while Taylor looked at both her own learning style and personality in conjunction with other factors for difficulty in learning the framework. Kara's greatest barrier in increasing mathematics instructional abilities seemed to be a lack of understanding of her own deficits and needs in learning to teach mathematics. Taylor's challenges with

mathematics teaching appeared to stem from a lack of mathematics content knowledge and understanding of the instructional practices and structure of the DAL model.

Overall Case Studies Summary

Through the DAL framework, Olivia, the top-achieving teacher candidate, seemed to experience the most well-balanced growth across the five identified elements relevant to mathematics instruction preparation for at-risk learners. The reasons for this growth seemed to stem from her constructivist approach to instruction and learning, rather than solely academic ability. Kara, the mid-achieving teacher candidate, appeared to experience limited growth in instructional knowledge understanding and content knowledge with the DAL framework. It is probable that Kara's abilities did not experience even growth across the five identified elements relevant to mathematics instruction preparation for at-risk learners because of her view that her challenges with mathematics instruction were primarily related to external forces outside of herself. As with Olivia, academic abilities did not seem to be the sole factor affecting Kara's mathematics instruction abilities. Taylor, the low-achieving participant, appeared to have experienced greatest growth in the critical elements of content knowledge and instructional strategy knowledge. Taylor seemed focused in on explicitly taught elements of the DAL framework, and seemed to experience gains in all areas taught specifically within the context of the training experience. Taylor's greatest challenges with mathematics instruction progress appeared to be at least partly academic, with her inability to grasp the reasoning behind many of the pieces that facilitate effective mathematics instruction. However, upon receiving instruction and application

experiences, Taylor's primarily constructivist approach to learning seemed to facilitate gains in her content and instructional knowledge.

In Chapter 5, conclusions based on the results and analysis from this chapter, are discussed. Possible limitations of the current study are also addressed. The chapter ends with implications for research and practice with suggested directions given for future study.

Chapter 5

Discussion

This research investigated an application-based instructional framework for elementary level algebraic thinking instruction within a preservice special education program. Unique to this study, the goal was the integration of content-based knowledge and instruction within the coursework and practicum of an undergraduate special education preparation experience employing a social-developmental constructivist approach. The purpose of the study was to inform the usage of the Developing Algebraic Literacy (DAL) framework as an instrument for facilitating preservice special education teachers' development in mathematics content area instruction.

Specifically, the current investigation explored the teacher candidate experience with the DAL framework as part of their Level II practicum and coursework, where students took Clinical Teaching and Behavior Management courses in connection with a two-day a week practicum experience. The teacher candidates were exposed to instruction and preparation with the DAL framework through an initial intensive workshop and ongoing support seminars within the school site where they implemented one-to-one mathematics instruction one day per week. In conjunction with this preparation, further instruction and support were provided on site through informal observations and individual feedback throughout the practicum day, and by researcher visits and guest lectures during the Clinical Teaching course. At the same time, the Clinical Teaching professor collaborated with the researcher to provide additional support

to teacher candidate participants. The investigation involved a total of 19 participants from which the researcher collected data to inform the exploration of the key research question:

What changes related to effective mathematics instruction for struggling elementary learners, if any, occur in teacher candidates during implementation of the DAL instructional framework in an early clinical field experience practicum for preservice special education professional preparation?

To best evaluate the changes that occurred in teacher candidates through their DAL experience, pivotal elements identified by the researcher through the literature base of mathematics, language arts, and special education were used as key factors in monitoring teacher candidate change. These elements included teacher candidates' attitudes towards mathematics instruction, feelings of efficacy about teaching mathematics, pedagogical understanding and application for at-risk learners in mathematics, and actual mathematics content knowledge for instruction. These elements of the research question were explored under the major inquiry areas:

- 1.) What changes, if any, occur in special education teacher candidates' attitudes towards mathematics instruction from the beginning to the end of a preservice instructional experience using the DAL framework?
- 2.) What changes, if any, occur in special education teacher candidates' feelings of self-efficacy about teaching mathematics from the beginning to the end of a preservice instructional experience using the DAL framework?
- 3.) What changes, if any, occur in special education teacher candidates'

understanding of instructional strategies for struggling learners in mathematics from the beginning to the end of a preservice instructional experience using the DAL framework?

- 4.) What changes, if any, occur in special education teacher candidates' application of instructional strategies for struggling learners in mathematics from the beginning to the end of a preservice instructional experience using the DAL framework?
- 6.) What changes, if any, occur in special education teacher candidates' content knowledge of elementary mathematics, including algebraic thinking, from the beginning to the end of a preservice instructional experience using the DAL framework?

The remainder of this chapter is organized by: 1) conclusions that were reached through the data collected; 2) possible limitations to the current study; and 3) significance and implications of the research. The findings of the study are presented in the conclusions section of this chapter by data collection method.

Conclusions

The current study was devised to further the research base for preservice special education professional development experiences, which have the goal of preparing “highly qualified” special education teachers, prepared to not only teach learners at-risk for academic difficulties but the specific content of the mathematics curriculum area (NCLB, 2001; NCTM, 2002; Maccini & Gagnon, 2002). The ongoing need for greater understanding of instructional interventions, frameworks, and methods employed within preservice teacher preparation programs is imperative for enhancing the preparation

experiences of future special education teachers so that they are better positioned to help their future students achieve positive academic outcomes (Gagnon & Maccini, 2001; Baker, Gersten, & Lee, 2002). The literature demonstrates that learners who are at-risk for academic failure because of disability, economic, or social causation are more likely to engage in positive learning experiences and school success when they are taught by teachers that are prepared to both meet their diverse educational characteristics and who possess the content area and pedagogical knowledge to teach specific subject areas, such as mathematics, effectively (Bottge, et al., 2001; Darling-Hammond, 2000; Darling-Hammond, 1999). In the current climate of *NCLB* (2001) and *IDEA* (2004), combined with the increasing diversity of the K-12 student population (Fry, 2006) the need for such teachers is even more pressing.

Because of the wide emphasis on reading instruction research in recent years, the current study incorporated findings of this research base with the existent mathematics and special education literature to inform its development. The DAL instructional framework also integrates practices supported by these research bases. While employing the DAL framework as an applied instructional experience within a social-developmental constructivist special education practicum, the investigation found that overall teacher candidate agreement with constructivist attitudinal statements about mathematics and mathematics instruction increased during the course of the study, as well as candidates' levels of content knowledge in algebraic thinking. Identification of learner characteristics and effective mathematics instructional practices for at-risk learners was mastered, while the articulation of instructional practice specifics showed beginning competency. However, deficiencies in understanding how to apply these instructional practices within

the context of the DAL framework were evidenced. While teacher candidates' perceptions of their instructional efficacy in mathematics was low at the end of the study, teacher candidates' were able to implement the steps of the DAL framework with fidelity over 50% of the time. At the same time, teacher artifacts indicated that teacher candidates had beginning understandings of differentiated instruction and effective mathematics instruction, but needed continued work on understanding specific elements of targeting effective mathematics instruction specifically to individual student's needs.

Mathematics Teaching Efficacy Beliefs Instrument

The Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) was used to collect quantitative information on teacher candidates' sense of self efficacy in regards to their mathematics teaching abilities, as well as their beliefs that effective mathematics instruction can impact positive student mathematics learning outcomes. Results from this full instrument showed that teacher candidates had a mean score ranging from between 3.37 and 3.72 out of a possible 5 from pretest to posttest, indicating that teacher candidates' agreement with statements regarding efficacy fell between "Uncertain", which was a score of 3, and "Agree", which involved scoring an item as 4. Overall results on this instrument were consistent with the norming groups of the MTEBI and the Science Teaching Efficacy Belief Instrument (STEBI) (Enochs, Smith, & Huinker, 2000), on which the mathematics survey was based. While these results indicate that the current study's teacher candidates did not have negative views about their efficacy, which would have involved scores between 1 and 2, these numbers did not indicate a significant change in levels of efficacy between pretest and posttest. However, the level of positive

agreement with efficacy statements did show some minimal increase from pretest to posttest.

Mean scores for the MTEBI's two subtests, self efficacy and outcome expectancy, also increased from pretest to posttest, means were between 3.35 and 3.49 for self efficacy and 3.39 and 3.58 for outcome expectancy. Both of these subtests showed upward movement between pretest and posttest for levels of agreement with statements involving personal effectiveness in instruction and student responsiveness to effective instruction. However, neither set of results showed statistically significant growth in feelings of efficacy in mathematics instruction.

At the same time that growth was seen between the pretest and posttest for the self-efficacy and outcome expectancy subtests, the greatest gains on both subtests were actually seen between pretest and midpoint. While posttest results were higher than pretest results, a noticeable dip in mean efficacy scores was seen between midpoint and posttest. This decrease could be due to a couple of reasons: 1) teacher candidates initially felt greater levels of efficacy when beginning newly learned instruction, but these feelings began to decrease over the latter course of the semester as teacher candidates saw the difficulty in affecting student change in mathematics through their instructional efforts and/or 2) teacher candidates' stress level may have been elevated at the time of the posttest administration of the survey because it was the week before final examination week at their university.

In terms of specific response items, it was encouraging to see that the highest agreement in terms of efficacy at pretest was on item 2, "I will continually find better ways to teach students mathematics", which shows an inherent dedication to seeking out

more effective instructional methods for students who struggle in mathematics. On the other end of the spectrum, at pretest teacher candidates had the lowest agreement with item 17, “I wonder if I will have the necessary skills to teach mathematics”, which indicates that teacher candidates thought they would in fact be able to develop these skills. Item 17’s response mean shows that teacher candidates entered the study with some level of confidence in their ability to learn how to teach mathematics. At posttest, teacher candidates had the highest agreement with item 15, “I will find it difficult to use manipulatives to explain to students why mathematics works”. This result was surprising considering that one of the emphases of the DAL instructional framework was using the CRA sequence of instruction, where concrete materials are essential for breaking down the complexities of new algebraic concepts. The lowest mean responses at posttest were shared with item 17 and item 18, “Given a choice, I will not invite the principal to evaluate my mathematics teaching.” Responses to items 17 and 18 give evidence to some sustained feelings of efficacy throughout the study, since teacher candidates maintained a positive outlook about their abilities to learn mathematics instruction, and could even see themselves inviting school principals to observe their instruction. their In comparison to the norming group, the current study produced consistent results for scores on items 2 and 8, but not item 15 involving the use of manipulatives. This difference may be due to the special education background of the teacher candidates, which was elementary education for the norming group, or the teacher candidates’ difficulty with their diverse student population, which also differed for the norming group (Enochs, Smith, & Huinker, 2000).

Preservice special education programs are typically generalist preparation experiences where future teachers are prepared with instructional practices that can meet student learning needs across subject areas (Boe, Shin, & Cook, 2007; Darling-Hammond, 2000). To this end, this preparation typically involves only one or two courses specifically in reading instruction and mathematics instruction while most elementary education programs require several courses in both reading and mathematics (Boe, 2006). With the study participants, two reading courses and one mathematics education course are required as part of their special education preparation program, but the teacher candidates were scheduled to take their mathematics education course the semester following this study. As a result, teacher candidates may not have felt comfortable teaching students with manipulatives as fully as those individuals in the instrument's norming group simply because the majority of them had not taken their mathematics education course at this point and had limited knowledge and experiences with mathematics instruction. This could explain the low rating on the survey item about manipulatives. Previous learning with manipulatives through their special education program may not have specifically covered the targeted use of manipulatives for mathematics learning, while the current study only had limited time to do so with them. Additionally, the student population of the current study participants included only students at-risk for mathematics failure, while the norming group had participants whose target students were typical learners. While the at-risk student population requires usage of diversified pedagogy, each student's learning needs are different and specific teacher candidates may not have employed manipulatives with their students, depending on individualized instructional needs. All of these factors may have resulted in the low

rating of manipulative usage by teacher candidates in this study (Gagnon & Maccini, 2001).

Mathematical Beliefs Questionnaire

The Mathematics Belief Questionnaire was employed to collect quantitative data on teacher candidates' attitudes towards mathematics in general and the teaching of mathematics (Seaman, et al., 2005) . The questions on the survey were broken down into four categories: traditional beliefs about mathematics, traditional beliefs about teaching mathematics, constructivist beliefs about mathematics, and constructivist beliefs about teaching mathematics. Results of the instrument indicated that teacher candidates had greatest attitudinal agreement with items involving constructivist ideas about teaching students mathematics, followed by agreement with items involving constructivist ideas about mathematics in general. Through the course of the study, this agreement with constructivist mathematics principles increased from pretest to posttest, with the mean of constructivist teaching mathematics ideas moving from 4.112 to 4.157 on a scale of 6 and the mean of general constructivist mathematics beliefs moving from 3.811 to 3.942. The rating of 3 on the measure indicated "slightly disagree", and the rating of 4 on the measure indicated "slightly agree". While both constructivist mean score tendencies indicated that teacher candidates tended to "slightly agree" with constructivist attitudes, these ratings were not far from tending to "slightly disagree." It also bears mentioning that agreement with traditionalist views on mathematics in general and mathematics instruction was not far from the same level of agreement, with the mean of traditionalist teaching beliefs moving from 3.311 to 3.382 and general traditionalist mathematics beliefs moving from 3.233 to 3.409 during the course of the study. These overall results

of the Mathematics Beliefs Questionnaire are consistent with the normative data of the instrument (Seaman et al., 2005), although actual agreement levels with constructivist views of general mathematics and teaching mathematics are slightly less than that of the norming population. This lower agreement level of study participants may be due to the norming population consisting of general education classroom teachers, who typically experience more courses in mathematics education than do special educators. At the same time, special education preparation programs as a whole tend to focus more on instructional pedagogy involving knowledge acquisition, repetition, retention, and application to meet the learning challenges that at-risk and students with disabilities face, versus the exploration, discovery, and formulation advocated emphasized in elementary and mathematics education programs (Golder, Norwich, & Bayliss, 2005; Mercer & Mercer, 2005).

As with the MTEBI, gains in attitudinal agreement were seen across all four domains of beliefs between pretest and midpoint, while agreement levels experienced a drop across all four domains from midpoint to posttest. The reasons for this decrease are thought to be due to the same reasons as noted previously for efficacy score decreases in the latter part of the study including teacher candidate challenges in affecting student learning outcomes in mathematics through their instruction and the stress level experienced by teacher candidates at the end of their academic semester.

On the specific response items of highest agreement, teacher candidates indicated the highest attitudinal agreement at both pretest and posttest with item 21, “The teacher should always work sample problems for students before making an assignment”, which showed a more traditionalist viewpoint for teaching mathematics. While the lowest

agreement at both pretest and posttest was seen for item 37, “Students should be expected to use only those methods that their text or teacher uses”, indicating a more constructivist viewpoint for student learning of mathematics. This dichotomy of thought is indicative of the mixture of both traditionalist and constructivist ideals that were held by the special education teacher candidates at this point in their professional development in regards to mathematics instruction. The norming population from the Mathematics Belief Questionnaire had higher agreement with the latter statement, and less agreement with the former. Indeed, the highest rating of the norming group dealt with items 24-26 on the survey, which involved students building their own mathematical ideas and problem-solving abilities (Seaman et al., 2005). The differences between the current study’s viewpoints and the norming group may be due to the norming group consisting of teachers involved in elementary education, while the current group included special education teachers’ whose student population needs are different and require more individualized consideration. While teacher candidates in elementary education are often taught to employ inquiry-based instruction with their students, preservice special education teachers are often taught that the usage of explicit instruction with modeling assists retention of new concepts for students with processing and memory deficits (Boe, Shin, & Cook, 2007). Along these lines, the teacher candidates in the study may have rated item 21 higher than other responses based on their professional preparation as a whole emphasizing explicit instruction with modeling, or as a result of this instructional method being advocated within the scope of the DAL instructional experience itself.

Out of all the elements evaluated for teacher change using the DAL framework, attitudinal beliefs of the teacher candidates appeared the most consistent and resistant to

change. This quality was indicated by the highest and lowest agreement items for mathematical beliefs remaining the same from pretest to posttest. At the same time, correlations were seen between administrations on each subtest area of the instrument, where earlier scores on specific subtests correlated with posttest scores on the same instrument. This information is crucial for teacher preparation programs' development of subject area preparation for special educators, because it is indicative of the difficulty in affecting change in teacher candidate attitudinal beliefs about mathematics in general and mathematics instruction. In response to this knowledge, special education teacher preparation programs can ask perspective teacher candidates targeted questions about mathematics attitudes to gauge whether these individuals possess attitudes that are more reflective of constructivist ideals before accepting them into preparation programs. At the same time, programs can also focus more specific course objectives on teacher candidates' abilities to reflect, understand, and develop constructivist attitude towards mathematics learning through an emphasis on reflective writing, discussion, exploratory activities, and cooperative learning.

Mathematics Content Knowledge for Elementary Teachers

The Mathematics Content Knowledge for Elementary Teachers survey was the instrument used to collect quantitative data on the teacher candidates' understanding of elementary level mathematics knowledge in general mathematics and algebraic thinking (Matthews & Seaman, 2007). Results on this measure indicated that this group of special education teacher candidates had deficiencies in overall mathematical knowledge, including the areas of general mathematics and algebraic thinking. Mean results included a 35% accuracy rate on the overall measure, and 40% and 34% on the two subtests

respectively. While small gains were seen with each of these scores from pretest to midpoint, none of the scores reached near 60%, which could be considered beginning competency with these mathematics content skills. Additionally, all scores fell to approximately pretest levels at the posttest administration.

While the current study explicitly taught elementary level algebraic thinking skills to teacher candidates through its initial training workshop, and supported these skills through seminars throughout the study, it is evident that future research endeavors should dedicate a greater amount of seminar time and activities to the area of content knowledge enhancement in teacher candidates. In this investigation, initial and ongoing training and support were split between the five domains deemed essential to special education teacher candidate development in mathematics instruction. Yet, current results indicate a specific need for more attention in content knowledge preparation. While the teacher candidates' levels of content knowledge when entering this training experience is discouraging, it does provide valuable information to teacher preparation programs by indicating a great need for intensive time spent on content area knowledge within special education teacher preparation programs. With little to no movement seen in posttest scores from pretest, it is also indicative that a different and possibly more extensive approach must be taken for teacher candidates to absorb and apply this content knowledge. Current teacher candidate results are consistent with the normative control group for the instrument, and slightly below the scores of the normative treatment group. So, while the teacher candidates in the current study had low scores in terms of content knowledge, similar ability levels were also seen in the norming group which consisted of elementary level educators (Matthews & Seaman, 2007). Facilitating enhanced content

knowledge acquisition appears to be a time intensive process, and it is recommended through special education and mathematics education literature alike that content knowledge be targeted through increased coursework requirements in mathematics, as well as extended learning periods for this coursework for developmental learning experiences over time (Carnine, 1997; Charalambous, Phillipou, & Kyriakides, 2002). From this study's results, benefits including connection-making have been seen through integrating pedagogical and content knowledge preparation in mathematics. Further exploration may indicate increased positive results if this integration is employed throughout entire teacher preparation programs versus just a single ten-week period.

As with the MTEBI and the Mathematics Belief Questionnaire, gains in content knowledge were seen in both basic mathematics and algebraic thinking from pretest to midpoint, but then scores dropped across both areas from midpoint to posttest. In fact, unlike the two previous instruments, drops in scores at posttest brought teacher candidate scores back to actual pretest levels rather than evidencing any overall gains. While the main reasons for the decrease are thought to be due to similar factors to the decrease in efficacy and attitude scores experienced by the teacher candidates in the latter part of the study, a few additional variables may be responsible. First, because of the complex nature of the content knowledge element, it is thought that instruction in this area may have needed more time during ongoing preparation experiences for understanding and retention of information. Another factor may have been the type of instruction used with teacher candidates in learning content knowledge skills. For instance, the researcher provided lecture and PowerPoint materials in conjunction with hands-on application and practice activities. From comments in focus groups about what helps the teacher

candidates best learn new information, teacher candidates self-disclosed that using multimodal and hands-on methods best meets their learning needs. Future training efforts may want to focus primarily on hands-on activities, targeting more kinesthetic methods than used in the current study, while providing teacher-directed lecture and Powerpoints more as supplementary aids. Additionally, the focus of explicit instruction for the teacher candidates in this study was the particular set of algebraic thinking skills that were needed for student instruction within the DAL framework. Content knowledge results indicated a need for more in depth instruction and experiences with general arithmetic skills as well, since content knowledge skills were low in this area as well. A last factor that may have affected teacher candidate learning of content knowledge was external variables such as teacher candidate absence, scheduling issues at the school site, and number of instructional sessions. All of these variables were external issues during the current ten-week study that may have influenced teacher candidates' ability to retain content knowledge because they impacted teacher candidates' ability to learn and practice new content information. Further exploration of content knowledge learning through the DAL experience in another study, could examine these important variables more closely.

In terms of specific response items, teacher candidates' area of strength involved question 2, which consisted of converting a numerical model into a word representation of the same idea. Questions that evidenced specific difficulty were ones that involved a more conceptual and abstract understanding of mathematical concepts. While these results are not identical to the highest and lowest scored items in the normative data, they

are consistent with items that were generally answered correctly or incorrectly (Matthews & Seaman, 2007).

Instructional Knowledge Exam

An instructor-made instructional knowledge exam was utilized to obtain data on teacher candidate understanding of pedagogical knowledge taught within the context of the DAL instructional framework. Questions of two varieties were presented: multiple choice and short answer essay. The items on the test covered three types of information: identification of learning characteristics and instructional strategies; articulation of component parts of and instructional strategy usage; and application of instructional strategies within the context of the DAL instructional framework.

The mean overall scores of teacher candidates on the content knowledge exam was approximately 62%, indicating beginning competency in understanding of teaching at-risk learners using effective and research-based practices. Strength was seen in teacher candidates' abilities to identify learning characteristics and instructional strategies through multiple choice questions, with an accuracy rate of 91%, indicating mastery in this particular area. The ability to explain component parts of instructional practices, which was assessed through exam essay questions, was at the beginning competency rate across participants with a mean score of 60% accuracy. Application essay questions, involving the strategies' usage within the DAL model, were answered correctly by teacher candidate participants less than 60% of the time, which is below competency level for applying these research-based instructional strategies for at-risk learners in mathematics in the context of this instructional framework.

These results indicate that teacher candidates have mastered the recognition of student learning characteristics and instructional strategies at the identification level. However, it shows that teacher candidates may have difficulty when asked to personally articulate elements of instructional strategies, when using their own words to explicitly explain the components of strategies. Teacher candidates' difficulties with application-based questions, which involve relating the strategies to the DAL framework itself, illustrate that while teacher candidates can identify and explain instructional strategies to some extent, they continue to need further instruction and support on the usage of this knowledge in applied situations. While teacher candidates' performance on the instructional knowledge exam might at first seem discouraging, the results may actually demonstrate promise given that the current research study was conducted in the teacher candidates' second semester (out of five semesters) in the program. Teacher candidates, being early on in their program, may not yet have fully developed the study habits necessary for retention of instructional knowledge. At the same time, these future teachers recently entered their special education teacher preparation program at different professional levels of development, and some may need additional time in making sense of instructional practices for application purposes because they may be in the beginning acquisition stage of these skills (Boe, 2006; Darling-Hammond, 2000). Additionally, this semester represented teacher candidates' first direct instructional experience with students where they were responsible for assessment, planning, and the delivery of instruction in a specific content area. Finally, the relationship of higher scores on multiple choice identification items and lower scores on essay application items is expected due to the nature of the difficulty of essay versus multiple choice questions, as

well as the more in depth and specific nature of application-based questions (Darling-Hammond, 1999).

Fidelity Checks

During the course of the study, a subgroup of teacher candidates was monitored for their ability to implement the DAL framework and its imbedded instructional strategies with fidelity. For the purpose of the fidelity checks, the researcher developed an observational fidelity checklist in conjunction with the DAL framework's primary development expert for independent raters to monitor teacher candidates' abilities to implement the DAL instructional framework using the steps they were taught during their preparation and training with the DAL model.

Results from this fidelity monitoring indicated teacher candidates' abilities to implement shorter initial DAL sessions, called the Initial DAL Session Probe, with a high rate of fidelity, approximately 95%. During these observations, teacher candidates appeared to have mastered the majority of the session steps. This mastery may have been evident for several reasons. First, the initial session includes only a total of 7 possible steps, which limits the number of elements that need to be remembered and used within the session. Second, the goal of the initial session probe is to further explore students' mathematical understandings to ensure that initial assessment results accurately reflect students' algebraic thinking abilities and needs. Teacher candidates, who spent 2-3 sessions conducting initial DAL skill assessments, may have found themselves more comfortable with the informal assessment nature of this initial session than with the subsequent longer and more instructional full length DAL sessions. Third, teacher candidates may simply have had a high rate of fidelity in these first sessions because the

initial session probe was taught earlier on in the preparation process than the full DAL session, which was taught further on in the preparation sequence because of its later implementation in the DAL process, as well as the multiple training sessions needed to fully explain and teach the 34 steps in the full session.

After initial session probe fidelity observations, midpoint and post fidelity observations yielded results with sizable decreases in fidelity. Midpoint sessions, which included all teacher candidates implementing the full DAL session, rather than the Initial Session Probe, saw fidelity levels decrease to 60%. This decrease indicated only beginning levels of competency in implementing the entire DAL framework with fidelity. This decrease must be interpreted cautiously for several reasons. Initially, it must be noted that the number of teacher candidates that were actually observed decreased by one third from the initial to the midpoint observation. This decrease was caused by multiple factors, including student absences, teacher candidate absences, school site scheduling, and the length of time needed to get through the initial DAL assessment. It is also important to note that the full session employed at the midpoint observation included many more steps, approximately five times as many components as the Initial Session Probe. Lastly, the full session probe did not merely include informal assessment of student skills, with which teacher candidates had practice through implementing the DAL initial assessment, but also instructional practices with which the teacher candidates had limited practice.

Final fidelity observations experienced an increased mean accuracy rate from midpoint levels, with a percentage of 90%, but these data must be interpreted guardedly. For the previously noted reasons included under the midpoint fidelity observations, the

final sessions again showed a decrease in the number of teacher candidates that were observed. In the case of final fidelity checks, the availability of teacher candidates for observation was reduced to two individuals from the initial and midpoint observation groups. At the same time, because of the 10-week time period of the study, many teacher candidates' pre, midpoint, and post observations were conducted one week after another, instead of having several week gaps for practice and developmental growth of teacher candidates. As a result, large generalizations about the abilities of teacher candidates to implement the steps of the DAL framework with fidelity could not be made for the group of participants, except that there was minimal evidence that teacher candidates' abilities to implement the framework rose once they were more familiar with the implementation process.

Other important findings from fidelity observations and teacher candidate debriefings on those observations were the influence of outside factors on teacher candidates' implementation of DAL session elements. One of these factors was that teacher candidates felt they should skip certain steps to "catch up" and get to a certain point in the DAL framework during each session. Another variable included teacher candidates' belief that some steps were more crucial than others, and they thought it was up to their discretion to omit steps they thought were unimportant or not as relevant to the particular skill being taught. Teacher candidates also mentioned difficulty remembering key DAL elements because of the amount of assignments and expectations made of them in the context of their coursework and practicum experiences. Finally, teacher candidates indicated that they were more inclined to skip steps in the process entirely rather than implement those steps incorrectly and possibly providing misinformation or instruction to

students. Since teacher candidates' experience in implementing instruction of any kind is new to this semester, the development of beginning decision-making abilities can be seen through their choices. Further guidance and ongoing dialogue with university educators may help to guide these individual teacher candidates in making more informed decisions about the process of effectively implementing mathematics instruction (Darling-Hammond, 2000). While faculty support within the current DAL experience was available for this purpose, it appears that teacher candidates may need further training and assistance in seeking out support and collaboration on specific issues that arise during instruction (Betz & Hackett, 1986; Czerniak, 1990).

Final Project Analyses

As part of the completion of their instructional experience with the DAL framework, teacher candidates were asked to complete a final written project on what they learned, how they felt, and how they would apply their abilities gained through the DAL instructional experience. When qualitative coding in the form of thematic analysis was completed on all teacher candidates' final papers, teacher candidates' comments were coded along the major elements of professional development involved in the study, including attitude towards mathematics instruction, self-efficacy about mathematics instruction abilities, content knowledge in elementary mathematics, and instructional knowledge and application for teaching mathematics to at-risk learners.

Along these lines, the majority of teacher candidate project statements referred to instructional practices and their application for teaching at-risk students algebraic thinking. This result was not surprising, since the core emphasis of the teacher candidates' DAL experience involved training and support on how to implement

mathematics-based instructional strategies and the actual DAL framework itself. An interesting connection between teacher candidate instructional knowledge and the content knowledge possessed by students was that the focus of teacher candidate content knowledge statements encompassed students' expressions of their developmental understandings of content knowledge using the same methods and modalities employed by the teacher candidates as instructional strategies to assist students in learning that content. For instance, one teacher candidate expressed how a student explained his understanding of patterning concepts using the different levels of the CRA sequence. Another indicated that her student was able to explicitly explain and then model the difference between growing and repeating patterns. Through their understanding of mathematics instructional strategies, teacher candidates were able to specifically articulate aspects of student curriculum abilities, that without knowledge of this mathematics-based vocabulary, the teacher candidates may not have been able to identify.

Another important aspect of teacher candidate content knowledge statements was their lack of reasoning or analytic explanation behind the students' mathematics abilities or lack thereof. Additionally, the focus of many content knowledge comments was the area of patterning, which may be due to the fact that teacher candidate preparation using the DAL framework first targeted student deficiencies in patterning knowledge. It is also indicative that teacher candidates possibly focused on patterning when teaching their students, because it was the algebraic concept with which they were most familiar because of its elementary nature to algebraic thinking or the fact that it was the first skill

taught in the scope of the DAL framework content knowledge and possibly most easily remembered.

Teacher candidate comments about efficacy in regards to content knowledge were more positive than negative in regards to mathematics teaching abilities with struggling learners. Negative comments may be attributed to the fact that this particular practicum experience was teacher candidates' first in regards to teaching mathematics to their target student population. In fact, the actual mathematics methods course that will be taken by special education teacher candidates will not occur until the semester following the current study. This being the case, teacher candidates may have had stronger feelings of efficacy at midpoint, after they had initially begun and gotten accustomed to implementing the DAL framework. However, these feelings of efficacy may have dwindled by the end of the study when final analysis projects were completed due to teacher candidates' experiencing frustration with their own instructional abilities or their students' progress. This idea of decreased feelings of efficacy at the time of the final analysis papers is also supported by the fact that posttest scores on the quantitative efficacy measure decreased from midpoint to posttest. According to the literature base on instructional efficacy, sustainability of high self-efficacy is difficult within the current school climate, as well with the challenges of today's students and classrooms (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Dwyer, 1993; Enochs, Smith, & Huinker, 2000). Pinpointing specific experiences and learning activities that positively impact efficacy during applied instructional situations may shed further light on the difficulty of maintaining self-efficacy in instructional practice.

Teacher candidates' comments on their attitude towards mathematics in general and mathematics instruction followed along the lines of the constructivist mathematics culture that has been cultivated during the teacher candidates' own k-12 learning experiences with mathematics. The majority of teacher candidate participants fell between the ages of 20 and 30 years old, which indicates that most of these individuals attended schools and learned mathematics during the time of instructional emphasis on developmental and meaning-making experiences for stimulating growth in mathematics knowledge. Thus, it seems that since most of the teacher candidates learned mathematics initially through constructivist methods, they may have been more apt to entertain these attitudes now as a special education teacher (Seaman et al, 2005; Darling-Hammond, 2000).

As evidenced by the quantitative survey, teacher candidates' attitudes and beliefs about instruction seemed especially resistant to change. This idea was reinforced by many teacher candidates' final projects mentioning ideas and feelings about teaching mathematics that stemmed from their own elementary mathematics experiences. This information is helpful to teacher preparation programs in two regards. First, it emphasizes the need to create positive, active, and meaningful mathematics learning experiences for students that have the possibility of affecting students' lifelong relationship with mathematics learning outcomes. While teacher preparation programs cannot actualize these long term types of experiences for current teacher candidates, they can work to facilitate these ideas for learners currently in k-12 schools through the development of teacher candidate instructional practices. In turn, these instructional practices may positively affect future teachers that are currently attending our public

schools. Second, it emphasizes the need for ongoing cultivation of specific constructivist instructional beliefs throughout entire teacher preparation programs for these ideas to truly be impacted and changed for the longterm through program experiences (Marso & Pigge, 1986). Teacher preparation programs need to evaluate their courses and field work to best determine if these programs have incorporated experiences for teacher candidates that involve meaningful learning activities that assist them in making sense and constructing new knowledge through their professional preparation.

Case Studies

For the case study portion of the research, three teacher candidates were selected to have their DAL experiences explored on a more individual and specific level. Each of these individuals was selected based on their achievement in academic coursework and fieldwork experiences during their Level II semester. One person was representative of the top-achieving third of the participants, one for the mid-achieving third of the participants, and one for the lowest-achieving third of the participants. For all three of the case study individuals, quantitative survey results and the instructional exam were analyzed in conjunction with final analysis projects, overall DAL project artifacts, and exit interviews.

Using these data, some general information about teacher candidate experiences with the DAL framework were gleaned. First, a common comment by all three teacher candidates was that more time was needed with the preparation and training aspects of the DAL framework, as well as the amount of time teacher candidates had with students. This comment bears consideration because of its mention across all three case study participants, as well as other evidence of increased time needs found when fidelity checks

were difficult to complete, which was caused by unexpected time barriers during the study's duration. Second, the mid and low achieving participants, Kara and Taylor, both voiced issues involving understanding and implementing the DAL framework because of the pedagogical techniques used to prepare the teacher candidates for DAL instructional usage. Both of these teacher candidates affirmed that they needed more hands-on practice with elements of the DAL model before actual implementation with students. This adaptation of training activities should be considered in light of all three teacher candidates individually scoring below competency level on the application essay questions on the instructional exam, as well as the mean score of all participants being below competency level. These results indicate a possible need for a different pedagogical emphasis being used with teacher candidates' training with the DAL framework. While multiple modalities and hands-on learning were incorporated in conjunction with lecture presentations during the DAL training, it appears that perhaps these instructional strategies need increased usage while teacher-directed presentations may need to be employed more as supplements.

For the top-achieving participant, Olivia, findings from her complete DAL project review, final analysis paper, case study interview, and final instructional exam indicated that she was successfully able to understand the DAL framework and related instructional practices. Her qualitative results also showed that her feelings of efficacy increased because of her ability to understand the instructional project and see change in her students' performances. While her quantitative results indicated that Olivia experienced a decrease in efficacy from midpoint to posttest, her pretest information was not available because of her absence at the pretest administration, so it is not known whether an overall

increase in efficacy would have been seen from pretest to posttest quantitatively. In other quantitative survey results, Olivia hailed more to the constructivist framework in her beliefs, indicating she is more likely to facilitate student-centered learning activities and support student exploration of mathematics ideas. Content knowledge results indicated a weakness in the subject area of basic elementary mathematics and algebraic thinking, but from Olivia's comments about seeking out help within the DAL experience through collaboration, as well as individual research, it is believed that as a future special educator in mathematics, Olivia would use multiple methods to access specific content knowledge to overcome these content deficits. Since seeking outside resources and assistance from faculty and staff was unique to Olivia, it may be a variable warranting further exploration, considering her growth in all critical elements of mathematics instructional abilities. Although university and faculty staff were available to teacher candidates during every practicum day using the DAL framework, it appears that developing self-advocacy skills in seeking out this help may be a necessary component in furthering teacher candidates' instructional abilities in mathematics.

For the mid-achieving participant, Kara, findings from her DAL experience indicated that she will need continued targeted experiences in developing her abilities to teach at-risk learners mathematics. The reasons for this need are several. First, her feelings of efficacy rose and then fell from the beginning to the end of the study according to her quantitative efficacy survey, indicating a need for her continued development of effective mathematics pedagogy. At the same time, attitudes and beliefs about mathematics had not stabilized to be either decidedly traditional or constructivist, flip-flopping back and forth between survey administrations. These mixed results

indicate a need for more in depth exploration and reflection on her feelings about mathematics and mathematics instruction. Results from Kara's content knowledge exam showed extremely deficient understandings of all areas of elementary level mathematics, which indicated a need for further instruction in light of Kara's concurrent low levels of instructional practice understanding, collaboration and other resource finding skills, feelings of efficacy, and attitudinal foundation towards mathematics instruction of at-risk learners. She has not developed many of the other identified critical elements necessary to support her development of content knowledge skills. Kara's final paper analysis provided supporting evidence for this lack of content knowledge. While other critical elements of special education teacher development in mathematics instruction received attention within her final analysis paper, no references were made to content knowledge, indicating a lack of comprehension of the importance of understanding these concepts for instruction. Statements made in Kara's exit interview and throughout her entire DAL project also included comments involving her lack of understanding of instructional practices and the scope and sequence of skills within the DAL context.

One dichotomy that was evidenced through data collection methods was the difference between Kara's perceived competence with general mathematics and algebraic thinking content, and her performance with content on the content knowledge exam. Kara felt that she had a good grasp on mathematics, considering that she "liked" mathematics, felt it came easily to her, and had tutored students in mathematics previously outside of her professional training. Kara's success as a special educator in mathematics would be improved through further exposure to fieldwork experiences specifically geared towards teaching mathematics. A special emphasis should be placed

on content knowledge enhancement since that appears to be a key area of need, especially in developing Kara's awareness of what types of concepts she still needs to master.

For the low-achieving participant, Taylor, results showed a teacher candidate that is open-minded about learning to teach mathematics, but currently needs extensive preparation to teach mathematics successfully. Her fear of mathematics, as well as her limited view of what elements construct effective practices for teaching mathematics to students with disabilities, seem to be current barriers in her mathematics instruction abilities. During the study, qualitative data collected from Taylor indicated that she viewed mathematics with some anxiety. A specific comment, "I chose my target population for future teaching (students with severe or profound mental retardation) based on the fact that I won't have to teach them math", explained her strong feelings about mathematics. At the same time, her comments indicated that she felt comfortable with basic elementary level mathematics.

Throughout the course of the study, it was found through Taylor's performance on the content knowledge survey administrations that though she started participation in the study with deficient levels of both basic arithmetic knowledge and algebraic thinking skills, her ability level gradually increased through the course of the DAL experience. This progress shows that part of her trepidation about teaching mathematics may be due to her lack of understanding and exposure to mathematics skills, which appears amenable to change through remediation. Additionally, Taylor's results on the efficacy survey instrument indicated that while the beginning of the DAL experience increased her feelings of efficacy, these feelings changed in the latter part of the study. These results illustrated that Taylor would need further exposure to teaching mathematics to encourage

sustainable change in her feelings of efficacy when teaching mathematics. However, like the content knowledge component, Taylor's attitude towards mathematics in general and mathematics instruction also seemed amenable to change. Within the research, her initial views of teaching mathematics were more traditional, but by posttest had shifted to consistently more constructivist.

Taylor's final DAL project most extensively showed her very limited ideas of what constructs effective mathematics instruction for at-risk learners. All of her comments in this project involved instructional knowledge and application versus any comments on attitude, efficacy, or content knowledge. This information, coupled with the fact that Taylor had limited interaction with her DAL students because of students' absences and sessions cut short because of student scheduling, indicate that increased experiences with the ideas surrounding mathematics teaching preparation would highly benefit Taylor's future abilities to teach mathematics successfully

Focus Groups

Focus groups were conducted at pre and post points of the study, splitting all participants randomly into two focus groups at each point. During the course of the focus groups, several key ideas about teacher candidates' experience came to light. One of the prevalent comments included that teacher candidates' own k-12 experiences with mathematics, whether positive or negative, had a large impact on their current views of mathematics. This information is important for special education teacher preparation programs as they recruit for and structure their undergraduate preservice programs. Teacher candidates' comments about mathematics attitudes also appeared resistant to change through the study's quantitative attitudinal survey administrations, as well as case

study, final project, and focus group comments. As a result, teacher preparation programs must ask key questions about perspective teacher candidates' views of and experiences with mathematics learning to best select individuals for their teacher preparation programs (Boe, 2006; Boe, Shin, & Cook, 2007; Darling-Hammond, 2000). Additionally, time must then be invested in these programs to further develop positive and constructivist attitudes towards mathematics. It appears that semester long efforts of facilitating mathematics instruction may be too short for this purpose.

In terms of efficacy, the majority of teacher candidates spoke about how they felt they were entering the current study with little to no coursework and practical experiences in teaching mathematics. When ending their participation in the research, many participants commented that they needed more work and study in teaching mathematics after this 10-week study. Many teacher candidates emphasized their understandings and benefits from hands-on learning and application used within the DAL's preparation, but felt they needed more of these training experiences to best understand the DAL framework and mathematics instruction. These comments are important for teacher preparation programs as they set up courses and fieldwork experiences. Teacher candidates evidenced a need for sequential field experiences that require increased understanding and application of concepts as they progress through their programs. Also, it seemed that since teacher candidates' had little prior knowledge and strong fears about teaching mathematics, they would benefit from having mathematics methods courses at the beginning of their professional development, rather than in the last year, as the participants in this study (Boe, 2006). Additionally, it would be helpful to have more than one of these courses and practical experiences, since teacher

candidates evidenced a need and desire to have more direct mathematics teaching experiences on an ongoing basis.

In terms of mathematics instructional knowledge, teacher candidates' comments evidenced that they were able to retain information about the mathematics instructional strategies for at-risk learners in mathematics taught within the scope of the DAL framework. As also shown through their instructional exams, the participants as a whole were able to master the identification of learning characteristics and instructional strategies for their target population. For teacher candidates, this instructional knowledge gain was important, considering that most of the participants entered the program with little or no knowledge of these strategies at the outset of the study. Total understanding, usage, and comfort with these strategies would need more time, further courses, and additional field experiences to develop based on data collected through teacher candidate instructional exam scores, final projects, and focus groups. At the same time, many teacher candidates voiced that they felt what they had learned as instructional strategies were not really pedagogical practices, because they viewed instructional strategies as involving multiple structured steps. Many instructional strategies employed within the DAL were more holistic and/or complex and were not necessarily step-oriented (Allsopp, Kyger, & Lovin, 2006). Further time would also need to be spent on emphasizing the utility of these pedagogical strategies for mathematics learning with diverse populations, as well as on direct application of these skills with students. Additionally, since teacher candidates employed instructional strategies within the DAL framework's contexts of the Algebraic Literacy Library's (ALL) literature, it was thought that instructional strategy application may have seemed more complex to teacher candidates imbedded within such

complicated storylines as those included in the library's Caldecott Award winning literature. From teacher candidate feedback, it appeared that greater clarity might have occurred with instructional strategy application within different or more limited contexts. Another more effective route may have been to spend more time with the strategies in isolation before having teacher candidates use them imbedded within this literature-based context.

Most teacher candidates indicated that they entered the study perceiving that algebraic thinking at the elementary level involved the numbers and symbols of the secondary classroom. Throughout the study, it appeared that many teacher candidates continued to perceive algebraic thinking in this way. Teacher candidates who did internalize the ideas surrounding basic algebraic thinking including patterning, representing mathematical models, setting up and solving basic equations, and monitoring change across different situations viewed these skills as very elementary pieces of algebraic thinking and seemed to doubt the need and usability of them in the total scope of algebra. Mean content knowledge survey scores supported these teacher candidate comments, since these scores were below competency level for the participants as a whole, with most participants expressing difficulty with conceptual understandings of both basic mathematics and algebraic thinking skills. Individual difficulties with content were also observed through the case study participants with all three having individual content knowledge scores below competency levels. These results indicate a strong need for more intensive content knowledge exposure for preservice teacher candidates in special education who will be teaching mathematics (Baker, Gersten, & Lee, 2002). This need could be satisfied through innovative teacher preparation

programs involving content knowledge instruction imbedded within instructional knowledge and application experiences. If future special educators are better able to understand mathematics content, as well as instructional perspectives, they will be better equipped to teach these skills to students who are struggling in mathematics.

Limitations of the Study

Threats to Internal Validity

Instrumentation, maturation, testing effects, observational bias, and student absences were all thought to be possible threats to the internal validity of the study at the outset of the investigation. All of these possible threats were assessed by the researcher before the study was begun and a minimization of these threats through study constructs was attempted. During the course of the study, two more possible threats to validity came to the surface. The first was that many teacher candidates were unexpectedly absent from coursework and practicum. These absences were controlled for by ensuring that teacher candidates had to “make up” missed practicum days, but because of the set up of the practicum experiences and student schedules, teacher candidates were unable to make up individual missed DAL instructional sessions with students. The second threat was different unexpected events at the cooperating public school site, such as lock-downs, picture days, and lack of instructional space, which occurred and could have caused large numbers of students to be unable to participate in instructional sessions on particular days. To overcome this threat, the researcher worked with school administration to secure flexible and viable school space and instructional time, versus just allowing sessions to be missed by students.

Threats to External Validity

The chief threat to external validity during the study was the researcher-determined elements that would be monitored to evaluate change in teacher candidate professional development in teaching algebraic thinking to at-risk learners. These variables were determined to be efficacy about teaching mathematics, attitude towards mathematics and mathematics instruction, content knowledge of mathematics, and instructional knowledge and application with at-risk learners. If an evaluation of teacher candidate change in a preservice application-based teacher preparation was completed again using the DAL framework, these elements may be conceptualized differently by other investigators. Thus, the current elements considered essential to teacher professional development in mathematics instruction are unique to this study.

Threats to Legitimation

While the study incorporated 19 participants and a mixed methods approach at one university and one school site, these results would not be generalizable to other settings because of the limited size of the population. The current study's results are indicative of possibilities for further lines of inquiry at other sites and with more participants. For generalizability, a larger undergraduate teacher candidate population, and more research studies in more locations would need to be completed.

Implications of Research Findings

Developmental-Constructivism

The current study was conducted within a developmental social constructivist frame (Darling-Hammond, 2000). Along these lines, the research provides valuable insight into undergraduate teacher candidate knowledge and skill construction by being

involved in an application-based training experience. Key elements that were brought to light included individual differences in developmental level and progression; length of time needed for the development of teaching abilities for mathematics instruction for at-risk learners in mathematics; and types of instruction and activities needed to facilitate teacher candidate change in abilities to teach mathematics to at-risk learners.

In terms of individual differences in teacher candidate development and progression of teaching skills, the case studies particularly illustrated this idea. Each teacher candidate entered the study at different developmental levels, based on differences among their feelings, abilities, and knowledge about teaching mathematics. Along these same lines, each of the participants, while involved in the same instructional experience through the DAL framework, changed along the five different aspects (attitude, efficacy, content knowledge, and instructional knowledge and application) identified as important to developing instructional abilities in mathematics. The top-achieving participant was able to juggle the task of instructional practice and application with her students, by truly adapting a constructivist approach to her own learning through using instructional sessions as situations to test instructional knowledge and application; seeking feedback and assistance from university staff for problem solving concerns and issues within her individual instructional sessions; and working to establish new mathematics instructional understandings and abilities by making sense of learning in coursework and practicum sessions by incorporating them in her own instructional meetings with students. The mid-achieving participant struggled more with instructional practice and application, being unable to see her own deficiencies in mathematics ability, and lacking comprehension of key instructional principles within the DAL framework.

The low-achieving participant battled with her fear of mathematics, but progressed in her constructivist attitude towards mathematics instruction and her content knowledge for instruction. While this teacher candidate viewed herself as needing much more assistance with teaching mathematics, her skills greatly increased over the course of the study. Keeping these observations in mind, designers of future special education teacher preparation programs can design programs to facilitate a wider array of teacher candidate abilities, and work to individualize the experience of teacher candidates within a larger teacher preparation program, which appears to be necessary for increased teacher candidate progress in teaching abilities. Indeed, many of the same instructional practices we implement as effective differentiated and individualized learning with our k-12 struggling learners, could be effective in meeting the needs of the teacher candidates who will be working with these students (Boe, Shin, & Cook, 2006).

Throughout the different data collection methods employed within the study, a consistent comment by teacher candidates was that the teacher preparation experience for teaching mathematics needed to be longer in both the training and application pieces. These comments are worthwhile in informing the development of future special education programs, where experiences that span an entire semester or longer appear to be needed. Because of the sheer nature of any teacher preparation program being a developmental process over the course of years, not a semester, it would seem conceivable that teaching mathematics be incorporated throughout an entire preparation program involving multiple semesters rather than as an isolated experience. In this way, greater connectivity would be seen between teaching mathematics and teaching in the other content areas like reading and writing. Additionally, teacher candidates would be

able to build on their cumulative experiences for both knowledge attainment and practice in teaching mathematics.

On the last idea of the types of preparation experiences, teacher preparation programs could vary pedagogical practices to better meet the needs of teacher candidates. Throughout the study, participants described multi-sensory and hands-on formats that assisted their learning process or would do so in the future (Darling-Hammond, 2000; Darling-Hammond, 1999). Teacher preparation programs often advocate these exact, student-centered experiences in the classrooms of their future teachers. However, it appears that further time and development needs to be spent on cultivating this same pedagogical practice for the teacher candidates' own learning. In this way, teacher candidates would have a living and breathing model of how this form of instruction can effectively meet learning needs. However, changes such as these in teacher preparation programs would require teacher preparation to rethink the traditional university classroom experience and its dynamic with connected practica.

Theory to Practice Gap

A greater understanding of undergraduate teacher preparation can inform teacher preparation program design and implementation. However, it can only facilitate change in these programs' design when in depth and reflective efforts are made to redesign and rework such programs by university special education administration (Boe, Cook, & Shin, 2007; Darling-Hammond, 2000). Faculty and staff have to have an open-mindedness of approach and flexibility of design with these programs. Instead of viewing teacher preparation programs as static entities, a constantly expanding and exploratory view must be taken by programs in developing future teachers' abilities.

As mentioned earlier in this study's review of the literature, NCATE (2005) requires undergraduate special education teacher preparation programs to incorporate field work components in their teacher preparation programs. However, many of these practica lack the linkages to program coursework, the faculty support to facilitate connections between academic learning in coursework and application in field work, and the efforts of universities and school districts to work towards the common goal of improving teacher preparation through supported and integrated experiences between public school classrooms and university coursework. As evidenced through this study, to teach content area learning such as mathematics, teacher candidates need extended, as well as progressively increasing levels of instructional responsibilities and expectations. These types of experiences can only be structured for future teachers by establishing structured partnerships between public schools and colleges of education built on flexibility, mutual support, and communication.

In the particular university-school partnership in this study, all of the above elements of effective partnership building were valued, but at times were difficult to successfully incorporate. For instance, there were specific difficulties in navigating an effective and productive relationship between the teachers working within the school site and the teacher candidates working with students using the DAL framework. These difficulties could have been stimulated by the teachers at the Title I school site being faced with a large number of academic performance criteria laid out by the school's district because of the school's poor academic performance measured by the state's academic monitoring system. This fact may have caused teachers to see teacher candidates not only as providers of mathematics instruction via the DAL, but also as

assistants in improving student test scores through providing help with student mathematics test-taking. While this task was not a goal of the teacher candidates' courses, practicum, or this research, it was difficult for teacher candidates to successfully communicate their purpose and academic goals for students to teachers within the school, even with supervisor support. Additionally, the problem of shared mathematics goals by teachers and teacher candidates may also have been aggravated by a lack of communication between teachers and teacher candidates. As evidenced by several comments in teacher candidate final projects, because of the "pull-out" nature of the teacher candidate instructional experience with the school's students, several teacher candidates did not realize the importance of collaborating with the classroom teachers until the end of the instructional experience. Through recognizing these difficulties, insight into the challenges facing strong university-school partnerships can be better understood.

Recommendations for Future Research

While this study is a beginning investigation into using the Developing Algebraic Literacy (DAL) framework in a beginning fieldwork experience, further research is advocated based on the current findings. The DAL has currently been explored along the five dimensions identified by the researcher as pertinent to special education teacher preparation in mathematics: efficacy about mathematics instruction, attitude towards mathematics instruction, content knowledge for mathematics instruction, and instructional knowledge and application for teaching at-risk students mathematics. Further research would be necessary in several areas to expand current findings. One of these areas would be to implement findings found in the current study in regards to the

time for preparation and application of the model. At the same time, each of the variables identified by the research as important to special education teacher preparation in mathematics would need to be evaluated in isolation to better identify the impact of that particular element on overall preparation to teach mathematics. Additionally, investigations involving a greater number of participants, in a variety of college and university settings throughout the country, would facilitate a more comprehensive idea of the utility of the DAL within preservice special education teacher preparation programs. Lastly, collecting student outcome data resulting from teacher candidates using the DAL framework would give more evidence of the utility of the actual framework with learners.

In summary, future research endeavors along the lines of the current investigation would expand the ideas surrounding mathematics content area instruction abilities for future special educators. Mathematics continues to be a key problematic for learners at-risk for school failure (Allsopp, Kyger, & Lovin, 2006; Baker, Gersten & Lee, 2002), while at the same time, the number of special educators continues to have difficulty keeping pace with the growth of students needing specialized and targeted instruction in mathematics (USDOE, 2003). Of key concern is the stimulation of not only basic arithmetic skills with these students, but ones such as algebraic thinking that activate higher order thought processes that enable students to not only compute answers, but comprehend, represent, and problem solve. The development of these types of skills must be developed early on in students' learning careers, especially in learners requiring extra learning assistance because of learning disabilities or other environmental and learning factors. Changing the way we approach special education teacher preparation in the content area of mathematics has the potential to change the educational and job

possibilities for a valuable section of the student population which has yet to be fully reached mathematically.

References

- Allsopp, D., Kyger, M., & Lovin, L. (2006). Teaching algebraic thinking. In P. Hudson & S. Miller (Eds.), *Designing and implementing mathematics instruction for students with diverse learning needs* (pp. 432-488). Boston: Pearson.
- Allsopp, D.H., McHatton-Alvarez, P., DeMarie, D., & Doone, E. (2006). Bridging the gap between theory and practice: Connecting course and field experiences. *Teacher Education Quarterly*, 33(1), 19-35.
- Ashton, P., & Crocker, L. (1986). Does teacher certification make a difference? *Florida Journal of Teacher Education*, 3, 73-83.
- Baker, S., Gersten, R., & Lee, D.S. (2002). A synthesis of empirical research on teaching mathematics to low-achieving students. *The Elementary School Journal*, 103(1), 51-73.
- Bandura, A., Barbaranelli, C., Caprara, G., & Pastorelli, C. (1996). Multifaced impact of self-efficacy beliefs on academic functioning. *Child Development*, 67, 1206-1222.
- Betz, N. E., & Hackett, G. (1986). Applications of self-efficacy theory to career development. *Journal of Social and Clinical Psychology*, 4, 279-289.
- Biesta, G. (2007). Why “what works” won’t work: Evidence-based practice and the democratic in educational research. *Educational Theory*, 57(1), 1-22.
- Boe, E. (2006). Long-term trends in the national demand, supply, and shortage of special education teachers. *The Journal of Special Education*, 40(3), 138-150.
- Boe, E., Shin, S., & Cook, L. (2007). Does teacher preparation matter for beginning

- teachers in either special or general education? *The Journal of Special Education*, 41(3), 158-170.
- Bottge, B., Heinrichs, M., Chan, S., & Serlin, R. (2001). Anchoring adolescents' understanding of math concepts in rich problem-solving environments. *Remedial and Special Education*, 22(5), 299-314.
- Bryant, N. D., Fayne, H., Gavish, B., & Gettinger, M. (1980). Narrowing the gap between research and practice. *Technical Report #4*. Washington, DC: Office of Special Education.
- Carnine, D. (1997). Bridging the research-to-practice gap. *Exceptional Children*, 63(4), 513-521.
- Cawley, J. F., Parmar, R. S., Yan, W., & Miller, J. H. (1996). Arithmetic computation abilities of students with learning disabilities: Implications for instruction. *Learning Disabilities Research and Practice*, 11, 230-237.
- Czerniak, C. (1990). *A study of self-efficacy, anxiety, and science knowledge in preservice elementary teachers*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Atlanta, GA.
- Chambers, D. (1994). The right algebra for all. *Educational Leadership*, 51, 85-86.
- Charalambous, C., Phillipou, G., & Kyriakides, L. (2002). *Towards understanding teachers' philosophical beliefs about mathematics*. Presented at the Annual Meeting of the International Group for the Psychology of Mathematics Education, Norwich, England.
- Cronje, J. (2006). Paradigms regained: Toward integrating objectivism and

- constructivism in educational design and the learning sciences. *Educational Technology Research & Development*, 54(4), 387-416.
- Darling-Hammond, L., & Ball, D. (1998). Teaching for high standards: What policymakers need to know and be able to do. *CPRE Joint Report Series*. Philadelphia, PA: Consortium for Policy Research in Education.
- Darling-Hammond, L. (2000). How teacher education matters. *Journal of Teacher Education*, 51(3), 166-173.
- Darling-Hammond, L., Chung, R., & Frelow, F. (2002). Variation in teacher preparation: How well do different pathways prepare teachers to teach? *Journal of Teacher Education*, 53(4): 286-302.
- Duchnowski, A. J., Kutash, K., Sheffield, S., & Vaughn, B. (2006). Increasing the use of evidence-based strategies by special education teachers: A collaborative approach. *The Journal of Teaching and Teacher Education*, 22(7), 838-847.
- Dwyer, E. (1993). *Measuring teacher attitude toward low achievers in mathematics*. Paper presented at the annual meeting of the Mid-South Educational Research Association. New Orleans, LA.
- Edwards, C., Carr, S., & Siegel, W. (2006). Influences of experiences and training on effective teaching practices to meet the needs of diverse learners in schools. *Education*, 126(3), 580-592.
- Enochs, L., Smith, P., & Huinker, D. (2000). Establishing factorial validity of the mathematics teaching efficacy beliefs instrument. *School Science and Mathematics*, 100(4), 104-202.
- Florida Department of Education. (2008). *Next Generation Sunshine State Standards*.

Retrieved June 30, 2008, from

<http://www.floridastandards.org/FLStandardSearch.aspx>

Gagnon, J., & Maccini, P. (2001). Preparing students with disabilities for algebra.

Teaching Exceptional Children, 33(2), 8-15.

Gagnon, J., & Maccini, P. (2001). Preparing students with disabilities for algebra.

Teaching Exceptional Children, 43(1), 8-15.

Golder, G., Norwich, B., and Bayliss, P. (2005). Preparing teachers to teach pupils with

special educational needs in more inclusive schools: Evaluating a PGCE

development. *British Journal of Special Education, 32*(2), 2005.

Hammer, P., Hughes, G., McClure, C., Reeves, C., & Salgado, D. (2005). *Rural*

teacher recruitment and retention practices: A review of the research literature,

national survey of rural superintendents, and case studies of programs in

Virginia. Charleston, West Virginia: Appalachia Educational Laboratory.

Kortering, L., deBettencourt, L., & Braziel, P. (2005). Improving performance in

high school algebra: What students with learning disabilities are saying.

Learning Disability Quarterly, 28, 191-203.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive

theory of career and academic interest, choice, and performance. *Journal of*

Vocational Behavior, 45, 79-122.

Maccini, P., & Gagnon, J. (2006). Mathematics instructional practices and assessment

accommodations by special and general educators. *Exceptional Children, 72*(2),

217-234.

Maccini, P., & Hughes, C. (2000). Effects of problem-solving strategy on the

- introductory algebra performance of secondary students with learning disabilities. *Learning Disabilities Research & Practice*, 15(1), 10-21.
- Maccini, P., McNaughton, D., Ruhl, K. (1999). Algebra instruction for students with learning disabilities: Implications from a research review. *Learning Disability Quarterly*, 22(2), 113-126.
- Marso, R. N., & Pigge, F. L. (1986). *Relationships between student characteristics and changes in attitudes, concerns, anxieties, and confidence about teaching during teacher preparation*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.
- Mizer, R., Howe, R., & Blosser, P. (1990). Mathematics: Promising and exemplary programs and materials in elementary and secondary schools. *Mathematics Education Information Report*. Washington, DC: Office of Educational Research and Improvement.
- McInerney, M., & Hamilton, J. (2007). Elementary and middle schools technical assistance center: An approach to support the effective implementation of scientifically based practices in special education. *Exceptional Children*, 73(2), 242-255.
- National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM
- Nougaret, A., Scruggs, T., & Mastropieri, M. (2005). Does teacher education produce better special education teachers? *Exceptional Children*, 71, 217-229.
- Puchner, L., & Taylor, A. (2004). Lesson study, collaboration and teacher efficacy:

- Stories from two school-based math lesson study groups. *Teaching and Teacher Education*, 22, 922-934.
- Rice, C., & Gossling, D. (2005). Recruiting and retaining male special education teachers. *Remedial and Special Education*, 26(6), 347-356.
- Sands, D., Duffield, J., & Parsons, B. (2007). Evaluating infused content in a merged special education and general education teacher preparation program. *Action in Teacher Action*, 28(4), 92-103.
- Singh, D., & Stollof, D. (2007). *Measuring teacher dispositions*. Paper presented at the National Fifth Annual Symposium on Educator Dispositions, Erlanger, Kentucky.
- Smith, S., Daunic, A., & Taylor, G. (2007). *Treatment fidelity in applied educational research: Expanding the adoption and application of measures to ensure evidence-based practice*. *Education and Treatment of Children*, 30(4), 121-134.
- University of Maryland System. (1993). *Special teachers for elementary and middle school science and mathematics: A proposal submitted to the National Science Foundation Teacher Preparation and Enhancement Program*. Unpublished manuscript.
- U.S. Department of Education. (2006) *26th Annual report to Congress on the implementation of the Individuals with Disabilities Education Act, 2004*. Washington, DC: U.S. Department of Education, Office of Special Education and Rehabilitative Services. *26th Annual Report to Congress, 2004*)
- U.S. Department of Education. (2007). *Improving basic programs operated by local education agencies (Title I, Part A)*. Retrieved December 12, 2007, from <http://www.ed.gov/programs/titleiparta/index.html>

- U.S. Department of Education. (2003). *Meeting the highly qualified teachers challenge: The secretary's second annual report on teacher quality*. Washington, DC: Author.
- U.S. Department of Education, National Center for Education Statistics (U.S. ED/NCES). (2001). *The Nation's Report Card: Mathematics 2000*. By J. Braswell, A. Lutkus, W. Grigg, S. Santapau, B. Tay-Lim, & M. Johnson. NCES 2002-517. Washington, DC.
- U.S. Department of Education. (2007). State and local implementation of the *No Child Left Behind Act. Volume II – Teacher Quality Under NCLB: Interim Report*. Washington, DC.
- Van Laarhoven, T., Munk, D., Lynch, K., Bosma, J., & Rouse, J. (2007). A model for preparing special and general education preservice teachers for inclusive education. *Journal of Teacher Education*, 58(5), 440-455.
- Witzel, B., Mercer, C.D., & Miller, D. (2003). Teaching algebra to students with learning difficulties: An investigation of an explicit instruction model. *Learning Disabilities Research & Practice*, 18, 121–131.
- Witzel, B., Smith, S., & Brownell, M. (2001). How can I help students with learning disabilities in algebra? *Intervention in School and Clinic*, 37(2), 101-104.

Appendix A: Literacy Instructional Practices within the DAL Framework

Strategies	Description	Points for Usage	Example Applications
Engagement	The establishment of student attention and interest in instructional tasks through the usage of stimulating materials that present ideas that have meaningfulness and relevancy for student learning	<ul style="list-style-type: none"> *Utilize applicable and relevant materials *Allow opportunities to manipulate high interest stimuli *Provide time for meaningful student responses to experiences 	<ul style="list-style-type: none"> *Use of Caldecott Award & Honor Winning Books *Student experiences with concrete manipulatives and eye-catching representations *Investment in Student Solution Ideas
Big Picture (Holistic)	Introduction of larger reading concepts such as theme, problem, or thoughts and feelings evoked by the story as a whole, rather than the component parts of reading including phonemic awareness, phonological development, and vocabulary progression	<ul style="list-style-type: none"> *View stories as whole entities to understand and explore *Discuss student thoughts on story theme, plot, and resolution to develop shared understandings *Cultivate competence with elements of setting, character, and plot to stimulate students' thinking on larger story issues 	<ul style="list-style-type: none"> *Implement teacher-guided discussions *Use shared book experiences for multiple genres exposure *Employ games that compare and contrast themes expressed in different literature pieces *Integrate multiple modalities when getting at key concepts (ie. visual, dramatic, and written)
Active Questioning	Involves reading with purpose by focusing on what is currently known on a topic, what information gain is desired, and what information is actually presented in text when it is read and discussed	<ul style="list-style-type: none"> *Tap into previous knowledge before actually reading *Figure out ideas or curiosities for upcoming reading that can guide students' thinking while reading *Follow up after reading with discussions or activities that explore what has been gained during reading 	<ul style="list-style-type: none"> *Question-Answer Relationship (QAR) strategies to explore answer finding in text *Directed Reading Thinking Activities (DR-TAs) to develop students' thought processes *K-W-L to stimulate prior knowledge, questioning, and learning

Making Connections	To further instruction in a given content area, instruction on new concepts is tied to previous learning, as well as having the relevancy explained between new concepts and the total scope of learning	<ul style="list-style-type: none"> *Begin instruction by reviewing previous learning on a related subject *Explain how the new skill is related to previous learning *Preview how the new learning bridges content to future learning 	<ul style="list-style-type: none"> *Utilize students' personal experiences and relate them to what is currently being learned *Establish connections between reading skills learned through explicit instruction and their application in children's literature *Employ connections that can be made within and across the content areas, incorporating both reading and mathematics learning
Structured Language Experiences	Guided oral and written opportunities that focus and develop students' abilities to communicate important learned concepts and their applications	<ul style="list-style-type: none"> *Make specific goals for students' verbal and written communications on a specific topic *Provide guidelines for outlining pertinent points for discussion or writing *Pair or group students in ways that develop individual strengths and abilities through interactions 	<ul style="list-style-type: none"> *Provide prompts for specific written response information on a topic *Allow students to explain their own constructed understandings of concepts by providing them oral or written opportunities to explain a new concept as a "teacher" *Provide compare/contrast opportunities for students to share understanding and construct new group understandings

Appendix B: Algebraic Literacy Library with Sample Book Guide

Caldecott Algebraic Literacy Library	Algebraic Literacy Strand
Chodos-Irvine, Margaret. (2003). <i>Ella Sarah Gets Dressed</i> . San Diego: Harcourt, Inc.	Understand patterns, relations, and functions
Cronin, Doreen & Lewin, Betsy (ill.). (2000). <i>Click, Clack, Moo: Cows that Type</i> . New York: Simon & Schuster.	
Falconer, Ian. (2000). <i>Olivia</i> . New York: Atheneum Books for Young Readers.	
Rappaport, Doreen & Collier, Bryan (ill.). (2001). <i>Martin's Big Word: The Life of Dr. Martin Luther King, Jr.</i> New York: Jump at the Sun: Hyperion Books for Children.	
Weatherford, Carole & Nelson, Kadir (ill.). (2006). <i>Moses: When Harriet Tubman Led Her People to Freedom</i> . New York: Jump at the Sun: Hyperion Books for Children.	
Gerstein, Mordicai. <i>The Man Who Walked Between the Towers</i> . New York: Square Fish.	Represent and analyze mathematical situations and structures using algebraic symbols
McCarty, Peter. (2002). <i>Hondo & Fabian</i> . New York: Henry Holt and Company.	
Rohmann, Eric. (2002). <i>My Friend Rabbit</i> . Brookfield: Roaring Book Press.	
Thayer, Ernest & Polacco, Patricia. (1997). <i>Casey at the Bat</i> . New York: The Putnam and Grosset Group.	
Williems, Mo. (2004). <i>Knuffle Bunny: A Cautionary Tale</i> . New York: Scholastic.	

Kerley, Barbara & Selznick, Brian (ill.). (2001). <i>The Dinosaurs of Waterhouse Hawkins</i> . New York: Scholastic.	<p style="text-align: center;">Use mathematical models to represent and understand quantitative relationships</p>
Muth, Jon. (2005). <i>Zen Shorts</i> . New York: Scholastic.	
Savant, Marc. (2001). <i>The Stray Dog</i> . New York: Scholastic.	
Taback, Simms. (1999). <i>Joseph Had a Little Overcoat</i> . New York: Viking.	
Woodson, Jacqueline & Lewis, E. B. (2004). <i>Coming on Home Soon</i> . New York: G. P. Putnam's Sons.	
Giovani, Nikki, & Collier, Brian (ill.). (2005). <i>Rosa</i> . New York: Henry Holt and Company.	<p style="text-align: center;">Analyze Change in Various Contexts</p>
Henkes, Kevin. (2004). <i>Kitten's First Full Moon</i> . Greenwillow Books.	
Jenkins, Steven, & Page, Robin (ill.). (2003). <i>What do you do with a Tail Like This?</i> Boston: Houghton Mifflin.	
Juster, Norton & Raschka, Chris (ill.). (2005). <i>The Hello, Goodbye Window</i> . New York: Michael Di Capua Books: Hyperion Books for Children.	
Williams, Mo. (2003). <i>Don't Let the Pigeon Drive the Bus!</i> New York: Hyperion Books for Children.	

Source

Chodos-Irvine, M. (2003). *Ella Sarah Gets Dressed*. San Diego: Harcourt, Inc.

Target Area

*Understand patterns, relations, and functions

-Recognize, describe, and extend patterns such as sequences of sounds and shapes or simple numeric patterns and translate from one representation to another (NCTM, 2000)

Target Grade Levels

Early Elementary

Story Synopsis

Written and illustrated by Margaret Chodos-Irvine, the main character Ella Sarah has a mind of her own, especially about what she wants to wear. No one in her family seems to understand her sense of fashion. Throughout the story, her mother, father, and sister attempt to convince her that more practical and less colorful outfits would be more suitable. However, Ella Sarah is unconvinced. Exasperated, she finally decides to dress herself in these colorful clothes, since no one else will help her do it. The outfit ends up being the perfect outfit for her get together with friends, who seem to be the only ones who understand her fashion sense.

Reading Instruction

*Active Questioning Strategy

-Utilize “I Wonder” to stimulate ideas and questions that students have before reading the book, which are answered when reading the book, and discussed as a class after reading the book (Richards & Gipe, 1996).

*Big Ideas

-Develop the story’s theme through dramatic reenactments with class members, and as a group determine the main theme of what has taken place in the book

*Structured Language Experience

-Within Cooperative Learning Groups (listed under Mathematics Instruction), students spend time discussing how their individual patterns are the “same” and “different” and “why”

Mathematics Instruction

*Explicit Instruction

-After reading the story, the teacher will spend time explaining the core concept of “pattern” and describe different ways patterns can be constructed

*Teacher Modeling

-The teacher will have an enlarged model of Ella Sarah from the book, and show how each piece of Ella Sarah’s clothing can have different patterns based on a choice of different sized wrapping paper or wallpaper pieces

*Cooperative Learning Groups

-Students will be given a chance to construct their own patterns by all being given their own eighteen inch model person, and being asked to dress these people with their own patterns of wrapping or wallpaper pieces. When finished decorating their figures, the teacher should set group guidelines for structured oral discussions on the “sameness” and “differences” of the patterns that group members have made (more information listed under Reading Instruction)

*Concrete [in Concrete-Representational-Abstract (CRA)]

-Concrete materials will be utilized throughout this activity for the demonstration of patterns on Ella Sarah’s clothing by the teacher, as well as the students’ pattern construction on their figures

Extension

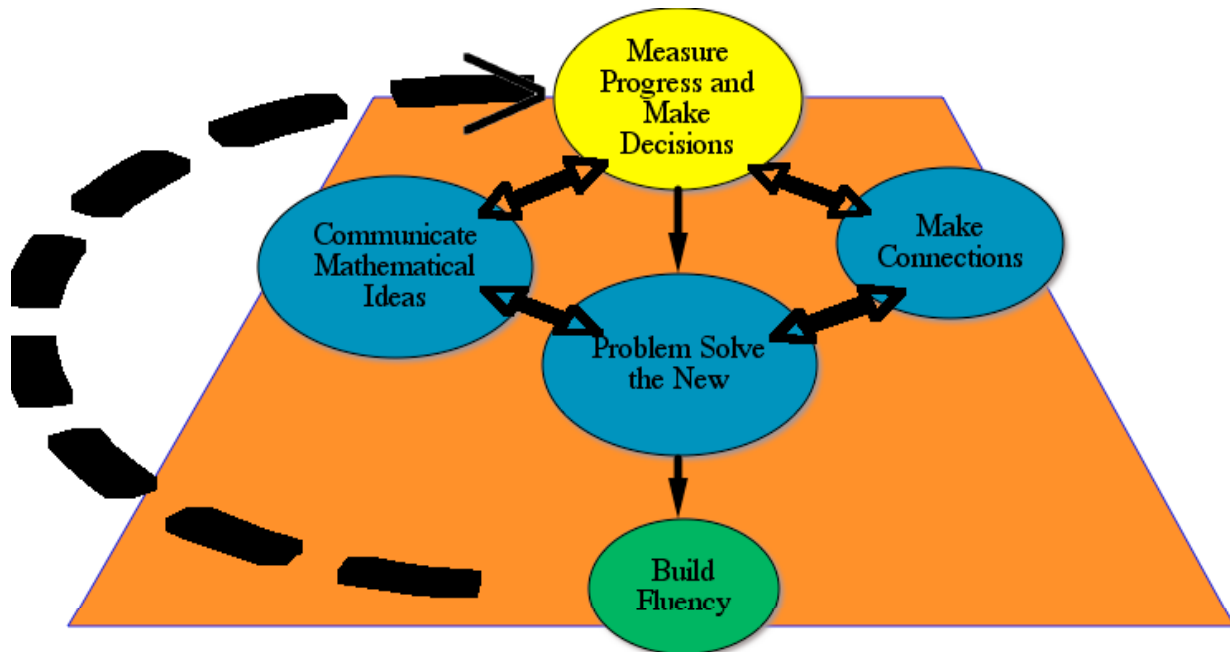
*If students grasp the concepts of recognizing, describing, and extending patterns through the usage of concrete materials, then visual representations can be provided that ask students to identify and describe patterns.

*If students grasp the concepts of recognizing, describing and extending patterns through the usage of representational materials, then abstract symbols (ie. numbers) can be utilized with students to have them recognize, describe, and extend presented patterns.

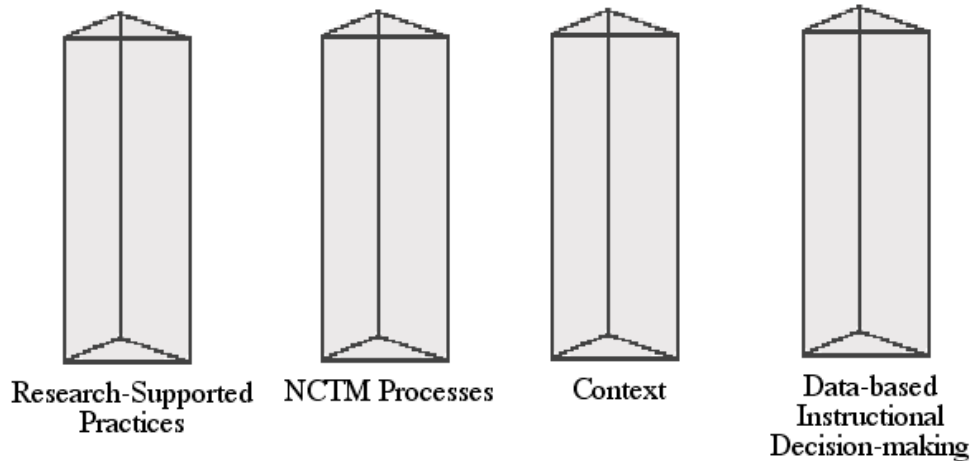
Appendix C: Mathematics Instructional Practices within the DAL Framework

Strategies	Description	Points for Usage	Example Applications
CRA	An instructional style that utilizes a leveled presentation of mathematics concepts that progresses from concrete materials, to pictorial representations, to abstract symbols.	<ul style="list-style-type: none"> *Rate of progression between the levels will be individual for students *Initial presentations of materials should begin with concrete or tactile materials *As concepts are grasped at the concrete level, presentations will progress to visual representations of concepts 	<ul style="list-style-type: none"> *Use concrete materials that involve aspects of story content *Involve materials at the concrete and representational level that are presented in the children's story and/or of high interest to children
Authentic Contexts	Situations in which learning can take place through problems that are meaningful and involve real life situations for application	<ul style="list-style-type: none"> *Establish situations that are meaningful and relevant to children *Provide contexts that extend children's typical presentation of material *Ensure that contexts extend easily to real life application for problem solving 	<ul style="list-style-type: none"> *Children's literature is employed for the context based situations for learning *Stories and situations presented in literature provide rich situations for actual problem-solving
Explicit Instruction with Modeling	Teacher guided explanations of new concepts that specifically expound on the nature of the new material and how it is used. Modeling is often used in conjunction with explicit instruction to provide working examples of the new material in action.	<ul style="list-style-type: none"> *Used when it is unlikely that students will pick up on subtle clues within exploratory learning *Employed with initial instruction on novel concepts *Best implemented in conjunction with other learning strategies 	<ul style="list-style-type: none"> *Teacher demonstrations on white boards at the front of the classroom *Teacher explanations using technology at the front of the classroom *Teacher modeling using high interest materials
Scaffolding	Facilitating student understanding and application of new concepts through graduated steps towards independence rather than through instruction and independent application immediately	<ul style="list-style-type: none"> *Should begin with material with which a student is already familiar *Steps should be incremental, and may differ from student to student in terms of how large each increment is 	<ul style="list-style-type: none"> *Used for more difficult concepts with supports gradually decreasing *Can occur within mathematics and reading content alone, as well as between reading and mathematics content
Metacognitive Strategies	When learners have the ability to think about their thought processes and how they apply these effectively for problem-solving	<ul style="list-style-type: none"> *Students may need to develop awareness of these abilities first, before efforts at using these skills are applied *Many times children need modeling and scaffolding to successfully implement these strategies on their own for problem-solving 	<ul style="list-style-type: none"> *Developing self-monitoring skills for answers that making sense *Checking that answers provide the requested information in questions
Student-Centered Learning	Learning that focuses on students' experiences, grasps, and outcomes with activities and learning experiences, rather than teacher directed instruction that focuses on giving the information to learners	<ul style="list-style-type: none"> *Students should be made to feel involved in and masters of their own learning *Overall learning goals and objectives should be clearly defined 	<ul style="list-style-type: none"> *Cooperative learning groups *Paired learning teams *Student exploration with concrete manipulatives and visual representations to make meaning
Multiple Opportunities for Practice	Providing learners many different ways of practicing and reinforcing skills, which typically should involve a variety of modalities and situations for retention of skills	<ul style="list-style-type: none"> *Varying practice methods should be incorporated *Teachers should closely monitor students progress during these opportunities *Practice opportunities should have gradually decreasing levels of support based on student need 	<ul style="list-style-type: none"> *Activities that facilitate learners' constructing their own understandings *Communication of ideas and problem application *Practice involving manipulatives and instructional games *Written worksheets or journal entries

APPENDIX D: DAL Model Visual Conceptualization



Develop Algebraic Literacy



Appendix E: DAL Initial Session Probe

B.7 DAL Initial Session Probe Guide

DAL Initial Session Probe

Title of Narrative Context _____

Level of Understanding _____

Target Algebra Learning Objective _____

C R A

Evaluation of Student's Problem Solving	
Read	A S N
Represent	A S N
Solve	A S N
Justify	A S N

Based on student's performance,
Student **is is not** at instructional level
Level of Understanding: C R A

Flexible Interview Notes & Misconceptions Observed

Where I will begin for next session at **Build Automaticity** Step:

Target Learning Objective: _____

Level of Understanding: _____

Appendix F: DAL Full Session Notes

B.8 - DAL Session Notes Guide

1. Build Automaticity (10 minutes)

Narrative Name _____

Target Algebra Learning Objective _____

Strategies Used by Student or Reinforced/Concepts & Skills Emphasized

Timing Response Task _____

Level of Understanding
C R A

Correct/Incorrect per minute _____

Goal for Future _____

2. Measure Progress & Make Decisions (10 minutes)

Narrative Name _____

Level of Understanding

Target Algebra Learning Objective _____

C R A

Read A S N
Represent A S N
Solve A S N
Justify A S N

Flexible Interview Notes & Misconceptions Observed

3. Problem Solve the New (15-20 minutes)

Title of Narrative Context _____

Level of Understanding

Target Algebra Learning Objective _____

C R A

Make Connections: Existing mathematical knowledge

Link

Identify

Rationale

Problem Solve

Read A S N
Represent A S N
Solve A S N
Answer A S N

Student Problem Solving Strategies/Processes

Communicate Mathematical Ideas

Target Concept/skill/strategy _____

Language Notebook Representation Brief Description _____

Make Connections: Student Interests

Graphic Organizer Used _____

Student Connections Made:

Appendix G: Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

Items and Reliability Coefficients from Instruments Developed and Modified from the STEBI-A

Source	Instrument	Sample Items (Alpha)	Reliability
Science Teaching Efficacy Beliefs: Elementary Inservice (Riggs & Enochs, 1990)	STEBI-A	SE: Even when I try very hard, I do not teach science as well as I do most subjects.	SE 0.92
		OE: The low science achievement of some students cannot generally be blamed on their teachers.	OE 0.77
Science Teaching Efficacy Beliefs: Elementary Preservice (Enochs & Riggs, 1990)	STEBI-B	SE: Even if I try very hard, I will not teach science as well as I will most subjects.	SE 0.90
		OE: The low science achievement of some students cannot generally be blamed on their teachers.	OE 0.76
Chemistry Teaching Self-Efficacy Beliefs: Middle School Inservice (Rubeck & Enochs, 1991)	STEBI-CHEM	SE: Even when I try very hard, I do not teach chemistry as well as I do most subjects.	SE 0.88
		OE: The low science achievement of some students in the chemistry section of science cannot generally be blamed on their teachers.	OE 0.80

Appendix B
MTEBI (Mathematics Preservice)

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

	SA Strongly Agree	A Agree	UN Uncertain	D Disagree	SD Strongly Disagree
1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.	SA	A	UN	D	SD
2. I will continually find better ways to teach mathematics.	SA	A	UN	D	SD
3. Even if I try very hard, I will not teach mathematics as well as I will most subjects.	SA	A	UN	D	SD
4. When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.	SA	A	UN	D	SD
5. I know how to teach mathematics concepts effectively.	SA	A	UN	D	SD
6. I will not be very effective in monitoring mathematics activities.	SA	A	UN	D	SD
7. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	SA	A	UN	D	SD

8.	I will generally teach mathematics ineffectively.	SA	A	UN	D	SD
9.	The inadequacy of a student's mathematics background can be overcome by good teaching.	SA	A	UN	D	SD
10.	When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.	SA	A	UN	D	SD
11.	I understand mathematics concepts well enough to be effective in teaching elementary mathematics.	SA	A	UN	D	SD
12.	The teacher is generally responsible for the achievement of students in mathematics.	SA	A	UN	D	SD
13.	Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.	SA	A	UN	D	SD
14.	If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.	SA	A	UN	D	SD
15.	I will find it difficult to use manipulatives to explain to students why mathematics works.	SA	A	UN	D	SD
16.	I will typically be able to answer students' questions.	SA	A	UN	D	SD
17.	I wonder if I will have the necessary skills to teach mathematics.	SA	A	UN	D	SD
18.	Given a choice, I will not invite the principal to evaluate my mathematics teaching.	SA	A	UN	D	SD
19.	When a student has difficulty understanding a mathematics concept, I will usually be at a loss as to how to help the student understand it better.	SA	A	UN	D	SD
20.	When teaching mathematics, I will usually welcome student questions.	SA	A	UN	D	SD
21.	I do not know what to do to turn students on to mathematics.	SA	A	UN	D	SD

Appendix H: Preservice Teachers' Mathematical Beliefs Survey

Mathematical Beliefs Questionnaire

Please circle the number which best describes your agreement with each statement.

1-Strongly disagree 2-Moderately disagree 3-Slightly disagree 4-Slightly agree 5-Moderately agree 6-Strongly agree

1. Solving a mathematics problem usually involves finding a rule or formula that applies.
1 2 3 4 5 6
2. The field of math contains many of the finest and most elegant creations of the human mind.
1 2 3 4 5 6
3. The main benefit from studying mathematics is developing the ability to follow directions.
1 2 3 4 5 6
4. The laws and rules of mathematics severely limit the manner in which problems can be solved.
1 2 3 4 5 6
5. Studying mathematics helps to develop the ability to think more creatively.
1 2 3 4 5 6
6. The basic ingredient for success in mathematics is an inquiring nature.
1 2 3 4 5 6
7. There are several different but appropriate ways to organize the basic ideas in mathematics.
1 2 3 4 5 6
8. In mathematics there is usually just one proper way to do something.
1 2 3 4 5 6
9. In mathematics, perhaps more than in other fields, one can find set routines and procedures.
1 2 3 4 5 6
10. Math has so many applications because its models can be interpreted in so many ways.
1 2 3 4 5 6
11. Mathematicians are hired mainly to make precise measurements and calculations for scientists.
1 2 3 4 5 6
12. In mathematics, perhaps more than in other areas, one can display originality and ingenuity.
1 2 3 4 5 6
13. There are several different but logically acceptable ways to define most terms in math.
1 2 3 4 5 6
14. Math is an organized body of knowledge which stresses the use of formulas to solve problems.
1 2 3 4 5 6
15. Trial-and-error and other seemingly haphazard methods are often necessary in mathematics.
1 2 3 4 5 6
16. Mathematics is a rigid discipline which functions strictly according to inescapable laws.
1 2 3 4 5 6
17. Many of the important functions of the mathematician are being taken over by the new computers.
1 2 3 4 5 6

18. Mathematics requires very much independent and original thinking.
1 2 3 4 5 6
19. There are often many different ways to solve a mathematics problem.
1 2 3 4 5 6
20. The language of math is so exact that there is no room for variety of expression.
1 2 3 4 5 6
21. The teacher should always work sample problems for students before making an assignment.
1 2 3 4 5 6
22. Teachers should make assignments on just that which has been thoroughly discussed in class.
1 2 3 4 5 6
23. Children should be encouraged to invent their own mathematical symbolism.
1 2 3 4 5 6
24. Each student should be encouraged to build on his own mathematical ideas, even if his attempts contain much trial and error.
1 2 3 4 5 6
25. Each student should feel free to use any method for solving a problem that suits him or her best.
1 2 3 4 5 6
26. Teachers should provide class time for students to experiment with their own mathematical ideas.
1 2 3 4 5 6
27. Discovery methods of teaching tend to frustrate many students who make too many errors before making any hoped for discovery.
1 2 3 4 5 6
28. Most exercises assigned to students should be applications of a particular rule or formula.
1 2 3 4 5 6
29. Teachers should spend most of each class period explaining how to work specific problems.
1 2 3 4 5 6
30. Teachers should frequently insist that pupils find individual methods for solving problems.
1 2 3 4 5 6
31. Discovery methods of teaching have limited value because students often get answers without knowing where they came from.
1 2 3 4 5 6
32. The teacher should provide models for problem solving and expect students to imitate them.
1 2 3 4 5 6
33. The average mathematics student, with a little guidance, should be able to discover the basic ideas of mathematics for her or himself.
1 2 3 4 5 6
34. The teacher should consistently give assignments which require research and original thinking.
1 2 3 4 5 6
35. Teachers must get students to wonder and explore even beyond usual patterns of operation in math.
1 2 3 4 5 6

36. Teachers must frequently give students assignments which require creative or investigative work.
1 2 3 4 5 6

37. Students should be expected to use only those methods that their text or teacher uses.
1 2 3 4 5 6

38. Discovery-type lessons have very limited value when you consider the time they take up.
1 2 3 4 5 6

39. All students should be required to memorize the procedures that the text uses to solve problems.
1 2 3 4 5 6

40. Students of all abilities should learn better when taught by guided discovery methods.
1 2 3 4 5 6

Note: Items 1 – 20 constitute the Mathematical Beliefs Scale (MBS) with items 2, 5, 6, 7, 10, 12, 13, 15, 18, & 19 scored positively (strong agreement indicates an informal, constructivist view) while items 1, 3, 4, 8, 9, 11, 14, 16, 17, & 20 were scored negatively (strong agreement indicates a formal approach to mathematics). Items 21 – 40 constitute the Teaching Mathematics Beliefs Scale (TMBS) with items 23, 24, 25, 26, 30, 33, 34, 35, 36, & 40 scored positively and items 21, 22, 27, 28, 29, 31, 32, 37, 38, 39 scored negatively.

Appendix I: Mathematical Content Knowledge for Elementary Teachers Survey

Mathematical Content Knowledge for Elementary Teachers

1. In the sentence $18 \div 6 = 3$, 18 represents a number of cookies. Which of the following statements is true?
 - a. Neither 6 nor 3 can represent a number of children.
 - b. If 6 represents a number of cookies, then 3 represents a number of cookies.
 - c. If 6 represents a number of children, then 3 represents a number of cookies.
 - d. 6 must represent a number of cookies.

2. The number $10 \div \frac{1}{2}$ represents the solution to the problem. Which of the following statements can represent the problem?
 - a. How many boys came to the club meeting if half of the ten children present were boys?
 - b. With 10 sticks of gum, how many children can have gum if each gets $\frac{1}{2}$ of a stick?
 - c. Give each of 2 children half of a box of 10 apples. How many apples will each get?
 - d. Divide 10 crayons equally between two boxes. How many crayons will be in each box?

3. To estimate 43×28 by rounding to the nearest 10, think
 - a. 40×20 .
 - b. 40×30 .
 - c. 45×25 .
 - d. 50×30 .

4. 5% of \$170 indicates the amount you would have if you
 - a. divide \$170 into 100 equal parts and take 5 of the parts.
 - b. divide \$170 into 5 equal parts and take 1 of the parts.
 - c. divide \$170 into 10 equal parts and take 2 of the parts.
 - d. take 5 times \$170 and move the decimal point 2 places to the right.

5. A piece of tape 1.6 meters in length is to be cut in equal lengths measuring 20 centimeters each. How many pieces of tape can be produced?
 - a. 8
 - b. 0.8
 - c. 32
 - d. 12.5

6. A strip of paper 3 yards, 5 inches long is taped on a wall for a mural. Another piece 1 yard, 2 feet, 7 inches long is taped end-to-end with the first piece, giving a total length of:
- 5 yards.
 - 4 yards, 3 feet, 2 inches.
 - 5 yards, 2 feet.
 - 5 yards, 2 inches.
7. The average (mean) of 4 whole numbers is 16. Two of the numbers are 32 and 2. The other two numbers are
- both greater than 2.
 - both less than 32.
 - both 16.
 - equal.
8. Which of the following conceptual models would be the least feasible for the concept of integers?
- a number line, i.e. a thermometer
 - the charges of protons and electrons
 - number of letters in the alphabet
 - winning and losing money (i.e. a poker game)

9. Solve:

$$\begin{array}{r} 12\frac{13}{24} \\ - 3\frac{10}{18} \\ \hline \end{array}$$

10. One of your students, Greg, explains that to solve the problem, 294×12 , he thinks $3600 - 72 = 3528$. Greg says that this works because of the distributive law. Where does the 72 come from by Greg's reasoning?
- $300 - 294 = 6$ and $6 \times 12 = 72$.
 - $2 \times 9 \times 4 = 72$.
 - Since the first factor has 3 digits and the second has 2 digits, then $3 \times 2 \times 12 = 72$.
 - Adding the digits in the ones place we get $2 + 4 = 6$. Adding the digits in the other places we get $2 + 9 + 1 = 12$. Now $12 \times 6 = 72$.

11. What number would go in the circle below to make the statement true?

$$\textcircled{\quad} \frac{2}{4} = \frac{\quad}{5}$$

12. Mary has socks in two drawers of her dresser. In the top drawer, one-third of the socks are white. In the bottom drawer, two-fifths of the socks are white. She has the same number of socks in both drawers. What portion (fraction) of Mary's socks are white?
13. Arrange the following from largest to smallest:
 .990 .099 .0991 .9909
14. Check that $4 + 5 + 6 = 3 \times 5$, $7 + 8 + 9 = 3 \times 8$, and $39 + 40 + 41 = 3 \times 40$. Write down a sentence that explains the pattern. Express your sentence using symbolic (algebraic) notation.
15. Claudia has \$11,372 to invest in stocks. She decides to purchase stock in Acme Automobiles, which is selling at the rate of \$36 a share. Claudia did the following to determine the number of shares she could buy.

$$\begin{array}{r} 315 \\ 36 \overline{)11372} \\ \underline{108} \\ 57 \\ \underline{36} \\ 212 \\ \underline{180} \\ 32 \end{array}$$

What does the "57" indicate?

- a. The "57" means that Claudia has 572 shares of stock so far, because you still have to "drop the 2."
 b. The "57" means that so far in the problem, Claudia has 57 dollars left.
 c. The "57" means that so far in the problem, Claudia has bought 57 shares.
 d. The "57" means Claudia would have at least \$570 left if she bought only 300 shares of stock.

16. Calculate $\frac{(-40) \times 5 + (7 - (-3))}{(-10)} =$

Show your steps.

17. Solve: $3\frac{2}{5} \div 2\frac{3}{7} = ?$

18. Which of the following statements about a prime number, x , is false?
- a. The greatest common factor of x and any other number is either x or 1.
 b. The least common multiple of x and any other number, call it y , is either y or their product, xy .
 c. The prime factorization of x is x numbers long.
 d. The only factors (or divisors) of x are 1 and x .

19. Your class has recently been learning the procedure for multiplying 2-digit numbers. One of your students, Gloria, multiplies 43 and 49 as shown below.

At first,
her work
looked
like this

$$\begin{array}{r} ^2 \\ 43 \\ \times 49 \\ \hline 387 \end{array}$$

Followed
by this

$$\begin{array}{r} ^1 \\ 43 \\ \times 49 \\ \hline 387 \\ 172 \\ \hline 559 \end{array}$$

A few of her classmates show Gloria the traditional procedure correctly and offer the following advice, which you overhear. Which response is the most conceptually correct?

- 559 divided by 49 is clearly not 43. What do you get when you divide these numbers?
 - 4 tens times 3 ones is 120 and 4 tens times 4 more tens is 1600 and 1600 plus 120 is 1720.
 - You see that you are on the second line in your answer. You have to shift over one place to the left every time you go down a line in your process.
 - Since the 7 goes beneath the 9, the 2 needs to go beneath the 4 because it is in the same place value.
20. You notice one of your students doing subtraction problems in an unusual way. The following two examples demonstrate the method used.

$$\begin{array}{r} 4296 \\ - 1771 \\ \hline \end{array} \longrightarrow \begin{array}{r} 4^{\overset{12}{2}} 2^{\overset{11}{1}} 96 \\ - ^{\overset{2}{1}} 1771 \\ \hline 2525 \end{array}$$

$$\begin{array}{r} 43591 \\ - 17267 \\ \hline \end{array} \longrightarrow \begin{array}{r} 4^{\overset{13}{3}} 3^{\overset{12}{2}} 5^{\overset{11}{1}} 9^{\overset{10}{7}} 1^{\overset{9}{6}} \\ - ^{\overset{2}{1}} 17267 \\ \hline 26324 \end{array}$$

When asked about the process, the student replies, "My uncle says that if the top number is too little to subtract, then just put a "1" in front of the top number to make it big. But, every time you do that, then you have to go down and to the left and make that number one bigger, because otherwise you'll mess up the answer." Which of the following reasons validates this procedure for subtraction?

- $c(a-b) = ca-cb$
- $(a-b) = (a+c) - (b+c)$
- By the associative property for numbers, one may add ten instead of subtracting ten during computation.
- This is just another way of our usual "borrowing", as in taking away a ten to get more ones, taking away a hundred to get more tens, and so on.

Appendix J: Instructional Knowledge Exam and Scoring Rubric

**EEX 4846 Final Exam – Effective Mathematics Instruction
Spring 2008
150 points**

Multiple Choice (2 pts each; 50 pts. Total)

Directions: Write the letter of the best answer next to each question.

Effective Instructional Practices

1. Which of the following instructional strategies/techniques is NOT emphasized within the effective mathematics instructional practice *explicit teacher modeling*?
 - a. cuing important features of the target mathematics concept/skill
 - b. telling students what to do and when to do it
 - c. using examples and non-examples
 - d. using think alouds

2. Which of the following instructional strategies/techniques is NOT emphasized within the effective mathematics instructional practice *scaffolding instruction*?
 - a. providing specific corrective feedback
 - b. providing specific positive reinforcement
 - c. fading teacher direction from high, the medium, to low
 - d. providing general feedback on student performance

3. Which of the following instructional strategies/techniques is NOT emphasized within the effective mathematics instructional practice *teaching problem solving strategies*?
 - a. teaching general problem solving strategies
 - b. asking students to discover strategies on their own
 - c. teaching specific learning strategies for particular mathematical concepts/skills
 - d. modeling strategies

4. Which of the following instructional strategies/techniques is NOT emphasized within the effective mathematics instructional practice *structured cooperative learning*?
 - a. playing games for fun for the purpose of motivating students
 - b. assigning students roles and ensuring that all students have the opportunity to engage in different group roles/responsibilities
 - c. teaching behavioral expectations
 - d. ensuring that all students have multiple opportunities to respond

5. Which of the following instructional strategies/techniques is NOT emphasized within the effective mathematics instructional practice *monitoring/charting student performance/progress monitoring*?

- a. assigning students grades of A, B, C, D, or F every day for their work
- b. frequently assessing students' performance
- c. providing a visual display of students' performance
- d. engaging students in goal setting

6. Which of the following instructional strategies/techniques is most reflective of the effective mathematics instructional practice *C-R-A sequence of instruction*?

- a. teaching students at the abstract level first and then moving down to representational or concrete levels if necessary
- b. using only commercial manipulatives at the concrete level
- c. discouraging students from drawing pictures because they will not be allowed to do this on state assessments
- d. grounding abstract mathematical concepts and skills in concrete experiences, first using discrete materials and then teaching drawing strategies.

7. Which of the following instructional strategies/techniques is most reflective of the effective mathematics instructional practice *instructional games*?

- a. they should be motivational, provide multiple opportunities to respond, and include a tangible way to monitor students' performance
- b. they should primarily be fun for students
- c. they should only include commercial games (store bought) since this lets students know that they are important
- d. they should provide multiple opportunities to respond regardless of whether they are motivational to students or not

8. Which of the following instructional strategies/techniques is most reflective of the effective mathematics instructional practice *building meaningful student connections*?

- a. linking what students know to what they are going to learn
- b. identifying what students will learn and linking what students know to what they are going to learn
- c. linking what students know to what they are going to learn and providing a rationale for why what students will learn is important in their lives
- d. linking what students know to what they are going to learn, identifying what students will learn, providing a rationale for why what students will learn is important in their lives

9. Which of the following instructional strategies/techniques is most reflective of the effective mathematics instructional practice *structured language experiences*?

- a. telling students what they should know through “teacher talk”
- b. encouraging students to use different ways to communicate what they understand about the mathematics they are learning
- c. using a foreign language as a novel mechanism for reaching students who are having difficulty with mathematical concepts
- d. making students write down in words what they did to solve a problem in step-wise fashion

10. Which of the following instructional strategies/techniques is most reflective of the effective mathematics instructional practice *explicit teacher modeling*?

- a. telling students what they need to know and what they need to do
- b. using multiple techniques to make mathematical concepts/skills accessible including techniques such as multi-sensory methods, examples and non-examples, cueing, and think alouds
- c. allowing students to discover the meaning of mathematical concepts without teacher direction
- d. providing students with multiple opportunities to respond in order to build proficiency

11. The primary purpose of the effective mathematics instructional practice *C-R-A sequence of instruction* is

- a. to help students build conceptual understandings of abstract mathematical concepts
- b. to make mathematics fun for students
- c. to build students’ sensory motor abilities through handling objects and refining fine motor abilities through drawing pictures
- d. to “dumb-down” mathematics for struggling students

12. The primary purpose of the effective mathematics instructional practice *explicit teacher modeling* is

- a. to make teaching efficient so that teachers can cover as much material as possible in the mathematics curriculum
- b. to provide students with a “bridge” that allows them to access the meaning of mathematical concepts
- c. to make sure that students do it the “right way”
- d. to ensure that the classroom operates in an orderly fashion without behavioral disruptions

13. The primary purpose of the effective mathematics instructional practice *scaffolding instruction* is

- a. to incorporate cooperative learning into your instructional plan
- b. to incorporate peer tutoring into your instructional plan
- c. to provide students with appropriate levels of teacher support for the purpose of helping students demonstrate increasing levels of understanding of a target mathematics concept/skill
- d. to provide a way to manage student behavior during mathematics instruction

14. The primary purpose of the effective mathematics instructional practice *monitoring/charting student performance/progress monitoring* is

- a. to continuously measure student performance in order to make efficient instructional decisions based on data
- b. to test students for the purpose of assigning grades
- c. to teach students how to make graphs and charts
- d. to place students into differentiated learning groups

15. The primary purpose of the effective mathematics instructional practices such as *instructional games, structured cooperative learning, and self-correcting materials* is

- a. to provide students with fun activities to do so that they do not get bored with mathematics
- b. to develop social skills in students
- c. to provide students with multiple opportunities to respond to a mathematics learning task in order to develop proficiency and maintenance
- d. to have several different activities planned for “Fun Fridays”

Learning Characteristic Barriers

16. The learning characteristic *metacognitive deficits* is a barrier to learning mathematics for struggling learners because

- a. it inhibits students from thinking about what they are learning mathematically, making connections, employing strategies, and monitoring their own learning
- b. it makes students think about too many things at one time thereby confusing them
- c. it inhibits short term memory
- d. it inhibits long term memory

17. The learning characteristic *learned helplessness* is a barrier to learning mathematics for struggling learners because
- it results in students refusing to help others thereby lessening their chances of learning through working with others
 - it makes teachers tired of always having to answer students' questions resulting in teachers telling students answers rather than them figuring them out on their own
 - it causes attention deficits
 - it results in students failing to take risks in problem solving due to past experiences of failure
18. When students have difficulty being aware of their own learning, difficulty employing strategies, and difficulty monitoring their own learning in mathematics they are exhibiting which of the following learning characteristic barriers?
- memory deficits
 - learning helplessness
 - cognitive processing deficits
 - metacognitive deficits
19. When students who do not have sensory impairments have difficulty accurately perceiving mathematics accurately when it is presented exhibit which of the following learning characteristic barriers?
- memory deficits
 - learning helplessness
 - cognitive processing deficits
 - metacognitive deficits
20. In class, you were briefly presented a picture and then were asked to write an appropriate title for a story based on the picture. Many students wrote titles that did not accurately represent the picture. This experience was an illustration of which learning characteristic barrier?
- visual processing deficit
 - auditory processing deficit
 - attention deficit/distractibility
 - memory deficit
21. Which of the following statements best portrays true attention deficits?
- students are unable to attend

- b. students also have hyperactivity/impulsivity
- c. students “hyper-attend” meaning they actually attend to so many things that they have difficulty attending to what is most important
- d. students engage in behaviors that are distractible to others

Foundations

22. Four instructional anchors for ensuring mathematics learning success of struggling learners include all of the following except

- a. teaching the big ideas in mathematics and the big ideas in doing mathematics
- b. understanding learning characteristics and barriers for students with learning problems
- c. using standardized high stakes testing to grade schools on their effectiveness in teaching mathematics
- d. making mathematics accessible through the use of responsive teaching practices

23. Which instructional anchor for mathematics learning success of struggling learners has as its purpose to use data for the purpose of instructional decision-making?

- a. teaching the big ideas in mathematics and the big ideas in doing mathematics
- b. understanding learning characteristics and barriers for students with learning problems
- c. using standardized high stakes testing to grade schools on their effectiveness in teaching mathematics
- d. using continuous assessment/progress monitoring

24. In class, you were asked, “what is: $4+3+4+5+5+3+5+3+4$?”, with the answer being “even par for nine holes of golf.” This was an example of the importance that _____ has/have for meaning related to mathematics.

- a. context
- b. disability
- c. conceptual understanding
- d. numbers and mathematical symbols

25. When students are taught only the procedures/algorithms of mathematics (e.g., $2 \times 4 = 8$; $\frac{1}{2} \times \frac{1}{4} = \frac{1}{8}$), they often never acquire

- a. procedural understanding
- b. conceptual understanding
- c. contextual understanding
- d. the ability to do math facts efficiently

Short Answer/Essay (100 points total)

Directions: Respond in writing to each question. Make sure that you address all parts of each question. You can use the back of the page if you need more room - be sure you clearly mark the question number that each response addresses.

Effective Instructional Practices

26. (20 pts) Select one of the effective mathematics instructional practices for struggling learners listed below (CIRCLE THE INSTRUCTIONAL PRACTICE YOU CHOOSE TO WRITE ABOUT). For the instructional practice you select, describe the following points: 1) its overall purpose; 2) a general summary of how it can be implemented; 3) the important elements/components of the practice; 4) at least two learning characteristic barriers for struggling learners and how the practice addresses each characteristic.

C-R-A Sequence of Instruction

Structured Language Experiences

Monitoring and Charting Student Performance/Progress Monitoring

Explicit Teacher Modeling

27. (30 pts) Describe how each of the following effective mathematics instructional practices for struggling learners is applied within the Developing Algebraic Literacy (DAL) instructional process. Be specific in terms of where in the DAL process each practice can be implemented and how it is implemented.

Building Meaningful Student Connections

Language Experiences

C-R-A Sequence of Instruction

28. (10 pts) A strategy that is implemented during the third step of the DAL process involves the use of graphic organizers. Describe what effective mathematics instruction practice for struggling learners this strategy exemplifies and its primary purpose in terms of student learning.

29. (10 pts) A strategy that is implemented during the third step of the DAL process involves the use of the LIP strategy. Describe what effective mathematics instruction practice for struggling learners this strategy exemplifies and its primary purpose in terms of student learning.

30. (10 pts) A strategy that is implemented during the third step of the DAL process involves encouraging students to communicate about the algebraic thinking concept they are learning. Describe what effective mathematics instruction practice for struggling learners this strategy exemplifies and its primary purpose in terms of student learning.

31. (10 pts) A strategy that is implemented during the second step of the DAL process is to evaluate their abilities to read, represent, solve, and justify given a narrative context that depicts an algebraic thinking concept. Describe what effective mathematics instruction practice for struggling learners this strategy exemplifies and its primary purpose in terms of student learning.

32. (10 pts) A strategy that is implemented during each step of the DAL process is to situate target mathematics concepts/skills within a narrative text. Describe what effective mathematics instruction practice for struggling learners this strategy exemplifies and its primary purpose in terms of student learning.

BONUS (up to 5 points)

What is the primary purpose of the first step of the DAL process? What stage of learning are students developing during this step?

Instructional Exam Scoring Rubric

Student Name: _____

26. (20 pts) Select one of the effective mathematics instructional practices for struggling learners listed below (CIRCLE THE INSTRUCTIONAL PRACTICE YOU CHOOSE TO WRITE ABOUT). For the instructional practice you select, describe the following points: 1) its overall purpose; 2) a general summary of how it can be implemented; 3) the important elements/components of the practice; 4) at least two learning characteristic barriers for struggling learners and how the practice addresses each characteristic.

C-R-A Sequence of Instruction

Structured Language Experiences

Monitoring and Charting Student Performance/Progress Monitoring

Explicit Teacher Modeling

Rubric

- 1.) Its Overall Purpose
 - a. 5 points – Thorough and complete explanation
 - b. 4 points – Main point covered, but minor details may be missing
 - c. 3 points – Some of the main point covered, one or two larger details may be left out
 - d. 2 points – A small piece of the main point is covered, but a majority of the explanation is missing
 - e. 1 points – Vague idea of the overall point, but little evidence of specific understandings
 - f. 0 points – Answer is not relevant to the question asked
- 2.) A General Summary of How it can be Implemented
 - a. 5 points – Thorough and complete explanation
 - b. 4 points – Main points covered, but minor details may be missing
 - c. 3 points – Some main points covered, one or two main points may be left out
 - d. 2 points – One or two main points covered, but many are left out
 - e. 1 points – Vague idea of the overall concept, but little evidence of specific understandings
 - f. 0 points – Answer is not relevant to the question asked
- 3.) The Important Elements/Components of the Practice
 - a. 5 points – Thorough and complete description of all elements/components
 - b. 4 points – All elements/components covered, but descriptions may be lacking depth
 - c. 3 points – Most elements/components covered, and descriptions may be lacking depth and one or two descriptions may be missing

- d. 2 points – Some elements/components covered, and descriptions may be lacking depth and some descriptions may be missing
 - e. 1 points – One or two elements/components covered, and descriptions may be lacking depth or missing for all elements/components
 - f. 0 points – Answer is not relevant to the question asked
- 4.) At Least Two Learning Characteristic Barriers for Struggling Learners and How the Practice Addresses each Characteristic
- a. 5 points – Thorough and complete explanation of learning characteristic barriers, and comprehensive explanation of how the practice addresses each characteristic
 - b. 4 points – Mostly complete explanation of learning characteristic barriers with a general explanation, that lacks some key specifics, of how the practice addresses each characteristic
 - c. 3 points – Learning characteristic barriers are given but explanation of them may be lacking, with a general explanation, that lacks some key specifics, of how the practice addresses each characteristic
 - d. 2 points – One of the learning characteristic barriers and its explanation may be left out, with an explanation of how the practice addresses just that one characteristics
 - e. 1 points – Some indication of learning characteristic barriers and explanation of how the practice addresses one or both, but identification and explanation may be vague and unclear
 - f. 0 points – Answer is not relevant to the question asked

27. (30 pts) Describe how each of the following effective mathematics instructional practices for struggling learners is applied within the Developing Algebraic Literacy (DAL) instructional process. Be specific in terms of where in the DAL process each practice can be implemented and how it is implemented.

Building Meaningful Student Connections
Language Experiences
C-R-A Sequence of Instruction

Rubric

1. Where in the DAL Process Each Practice can be Implemented

- a. 10 points – Thorough and complete explanation of where the practice should be implemented
- b. 8 points – Main points covered for where the practice should be implemented, but minor details may be missing
- c. 6 points – Some main points covered for where the practice should be implemented, one or two major details may be left out
- d. 4 points – A general idea of where the practice should be implemented is given, but more specific information is left out
- e. 2 points – Vague idea of where the practice should be implemented, but little evidence of specific understandings of the location
- f. 0 points – Answer is not relevant to the question asked

how it is implemented

- a. 20 points – Thorough and complete explanation of implementation
- b. 16 points – Main points covered, but minor details may be missing from implementation explanation
- c. 12 points – Some main points covered, one or two main points may be left out from implementation explanation
- d. 8 points – One or two main points covered, but many points are left out from implementation explanation
- e. 4 points – Vague idea of the overall implementation, but little evidence of specific understandings
- f. 0 points – Answer is not relevant to the question asked

28. (10 pts) A strategy that is implemented during the third step of the DAL process involves the use of graphic organizers. Describe what effective mathematics instruction practice for struggling learners this strategy exemplifies and its primary purpose in terms of student learning.

Rubric

1. Description of the Effective Mathematics Instruction Practice that the Strategy Exemplifies
 - a. 5 points – Thorough and complete description of the practice that the specific strategy exemplifies
 - b. 4 points – A description that includes most key points about the practice that the specific strategy exemplifies, but minor details may be missing
 - c. 3 points – A description that includes some main points about the practice that the specific strategy exemplifies, one or two main points may be left out
 - d. 2 points – A description that includes one or two main points about the practice that the specific strategy exemplifies, but many points are left out
 - e. 1 points – Vague description of the practice that the specific strategy exemplifies, but little evidence of specific understandings
 - f. 0 points – Answer is not relevant to the question asked

2. Primary Purpose of the Strategy in terms of Student Learning
 - a. 5 points – Thorough and complete explanation
 - b. 4 points – Main point covered, but minor details may be missing
 - c. 3 points – Some of the main point covered, one or two larger details may be left out
 - d. 2 points – A small piece of the main point is covered, but a majority of the explanation is missing
 - e. 1 points – Vague idea of the overall point, but little evidence of specific understandings

29. (10 pts) A strategy that is implemented during the third step of the DAL process involves the use of the LIP strategy. Describe what effective mathematics instruction practice for struggling learners this strategy exemplifies and its primary purpose in terms of student learning.

Rubric

1. Description of the Effective Mathematics Instruction Practice that the Strategy Exemplifies
 - a. 5 points – Thorough and complete description of the practice that the specific strategy exemplifies
 - b. 4 points – A description that includes most key points about the practice that the specific strategy exemplifies, but minor details may be missing
 - c. 3 points – A description that includes some main points about the practice that the specific strategy exemplifies, one or two main points may be left out
 - d. 2 points – A description that includes one or two main points about the practice that the specific strategy exemplifies, but many points are left out
 - e. 1 points – Vague description of the practice that the specific strategy exemplifies, but little evidence of specific understandings
 - f. 0 points – Answer is not relevant to the question asked

2. Primary Purpose of the Strategy in terms of Student Learning
 - a. 5 points – Thorough and complete explanation
 - b. 4 points – Main point covered, but minor details may be missing
 - c. 3 points – Some of the main point covered, one or two larger details may be left out
 - d. 2 points – A small piece of the main point is covered, but a majority of the explanation is missing
 - e. 1 points – Vague idea of the overall point, but little evidence of specific understandings
 - f. 0 points – Answer is not relevant to the question asked

30. (10 pts) A strategy that is implemented during the third step of the DAL process involves encouraging students to communicate about the algebraic thinking concept they are learning. Describe what effective mathematics instruction practice for struggling learners this strategy exemplifies and its primary purpose in terms of student learning.

Rubric

1. Description of the Effective Mathematics Instruction Practice that the Strategy Exemplifies
 - a. 5 points – Thorough and complete description of the practice that the specific strategy exemplifies
 - b. 4 points – A description that includes most key points about the practice that the specific strategy exemplifies, but minor details may be missing
 - c. 3 points – A description that includes some main points about the practice that the specific strategy exemplifies, one or two main points may be left out
 - d. 2 points – A description that includes one or two main points about the practice that the specific strategy exemplifies, but many points are left out
 - e. 1 points – Vague description of the practice that the specific strategy exemplifies, but little evidence of specific understandings
 - f. 0 points – Answer is not relevant to the question asked

2. Primary Purpose of the Strategy in terms of Student Learning
 - a. 5 points – Thorough and complete explanation
 - b. 4 points – Main point covered, but minor details may be missing
 - c. 3 points – Some of the main point covered, one or two larger details may be left out
 - d. 2 points – A small piece of the main point is covered, but a majority of the explanation is missing
 - e. 1 points – Vague idea of the overall point, but little evidence of specific understandings
 - f. 0 points – Answer is not relevant to the question asked

31. (10 pts) A strategy that is implemented during the second step of the DAL process is to evaluate their abilities to read, represent, solve, and justify given a narrative context that depicts an algebraic thinking concept. Describe what effective mathematics instruction practice for struggling learners this strategy exemplifies and its primary purpose in terms of student learning.

Rubric

1. Description of the Effective Mathematics Instruction Practice that the Strategy Exemplifies

- a. 5 points – Thorough and complete description of the practice that the specific strategy exemplifies
- b. 4 points – A description that includes most key points about the practice that the specific strategy exemplifies, but minor details may be missing
- c. 3 points – A description that includes some main points about the practice that the specific strategy exemplifies, one or two main points may be left out
- d. 2 points – A description that includes one or two main points about the practice that the specific strategy exemplifies, but many points are left out
- e. 1 points – Vague description of the practice that the specific strategy exemplifies, but little evidence of specific understandings
- f. 0 points – Answer is not relevant to the question asked

2. Primary Purpose of the Strategy in terms of Student Learning

- a. 5 points – Thorough and complete explanation
- b. 4 points – Main point covered, but minor details may be missing
- c. 3 points – Some of the main point covered, one or two larger details may be left out
- d. 2 points – A small piece of the main point is covered, but a majority of the explanation is missing
- e. 1 points – Vague idea of the overall point, but little evidence of specific understandings
- f. 0 points – Answer is not relevant to the question asked

32. (10 pts) A strategy that is implemented during each step of the DAL process is to situate target mathematics concepts/skills within a narrative text. Describe what effective mathematics instruction practice for struggling learners this strategy exemplifies and its primary purpose in terms of student learning.

Rubric

1. Description of the Effective Mathematics Instruction Practice that the Strategy Exemplifies

- a. 5 points – Thorough and complete description of the practice that the specific strategy exemplifies
- b. 4 points – A description that includes most key points about the practice that the specific strategy exemplifies, but minor details may be missing
- c. 3 points – A description that includes some main points about the practice that the specific strategy exemplifies, one or two main points may be left out
- d. 2 points – A description that includes one or two main points about the practice that the specific strategy exemplifies, but many points are left out
- e. 1 points – Vague description of the practice that the specific strategy exemplifies, but little evidence of specific understandings
- f. 0 points – Answer is not relevant to the question asked

2. Primary Purpose of the Strategy in terms of Student Learning

- a. 5 points – Thorough and complete explanation
- b. 4 points – Main point covered, but minor details may be missing
- c. 3 points – Some of the main point covered, one or two larger details may be left out
- d. 2 points – A small piece of the main point is covered, but a majority of the explanation is missing
- e. 1 points – Vague idea of the overall point, but little evidence of specific understandings
- f. 0 points – Answer is not relevant to the question asked

BONUS (up to 5 points)

What is the primary purpose of the first step of the DAL process? What stage of learning are students developing during this step?

Rubric

- a. 5 points – Thorough and complete explanation of the purpose and correct identification of stage of learning
- b. 4 points – Main points covered on the purpose, but minor details may be missing, and correct identification of stage of learning
- c. 3 points – Some main points covered on the purpose, one or two main points may be left out, and correct identification of stage of learning
- d. 2 points – One or two main points covered on the purpose, and identification of stage of learning may be off-target
- e. 1 points – Vague idea of the overall purpose, and identification of stage of learning may be off-target or left out
- f. 0 points – Answer is not relevant to the question asked

Appendix K: Fidelity Checklist for DAL Initial Session Probe

Initial Session Probe	Yes	No	NA
Teacher notes students' skill level in each of the four problem-solving areas.			
*Teacher candidate gives student a chance to read the context and problem for problem solving.			
*Teacher candidate gives student a chance to represent the problem for solving.			
*Teacher candidate gives student a chance to solve the problem.			
*Teacher candidate has student justify his or her problem-solving.			
*Teacher candidate provides concrete, representational, or abstract materials for student's problem solving.			
*Teacher candidate provides student assistance in problem-solving when needed.			
Teacher determines direction (skill and level), based on data gathered from probe, for first full session.			

Appendix L: Fidelity Checklist for Full DAL Session

Observation # _____

**DAL
Fidelity Checklist**

Tutor: _____

Date: _____

Observer: _____

School: _____

Step 1: Building Automaticity	Yes	No	NA
Students practice problem-solving with familiar target learning objectives and narratives.			
*Teacher candidate points out strategies student uses for problem-solving.			
*Teacher candidate recommends strategies to use.			
*Teacher candidate reinforces student's successes.			
*Teacher candidate provides concrete, representational, or abstract materials for student's problem solving.			
Students respond to a timed probe consisting of specific response tasks on this same learning objective.			
*Teacher candidate provides all probe tasks at the same response level.			
Teacher and students record data from the timed probe for goal-setting and decision-making purposes.			
*Teacher candidate and student discuss student performance.			
*Teacher candidate and student make goals for future sessions for timed probe.			
*Teacher candidate and student record student performance on data tracking sheet.			

Step 2: Measuring Progress & Making Decisions	Yes	No	NA
Teacher notes students' skill level in each of the four			

problem-solving areas.			
*Teacher candidate gives student a chance to read the context and problem for problem solving.			
*Teacher candidate gives student a chance to represent the problem for solving.			
*Teacher candidate gives student a chance to solve the problem.			
*Teacher candidate has student justify his or her problem-solving.			
*Teacher candidate provides concrete, representational, or abstract materials for student's problem solving.			
*Teacher candidate provides student assistance in problem-solving when needed.			
Teacher determines Step 3, Problem Solving the New's target learning objective and appropriate level for student instruction.			

Step 3: Problem Solving the New	Yes	No	NA
Making Connections to Existing Mathematical Knowledge is where the teacher first provides an advance organizer that addresses three important items.			
*Teacher candidate gives student a graphic organizer for making connections.			
*Teacher candidate <i>links</i> new target learning objective to previous mathematics instruction.			
*Teacher candidate <i>identifies</i> the new target learning objective.			
*Teacher candidate provides a <i>rationale</i> for the new target learning objective.			
Problem Solving is where the new problem narrative is introduced; it is at this point that the student reads the story aloud, represents the problem situation, solves the problem, and provides justification for their response and approach.			
*Teacher candidate gives student a chance to read the context and problem for problem solving.			
*Teacher candidate gives student a chance to represent the problem for solving.			
*Teacher candidate gives student a chance to solve the problem.			
*Teacher candidate has student justify his or her			

problem-solving.			
*Teacher candidate provides concrete, representational, or abstract materials for student's problem solving.			
*Teacher candidate points out strategies student uses for problem-solving.			
*Teacher candidate recommends strategies to use.			
*Teacher candidate provides student assistance in problem-solving when needed.			
Communicate Mathematical Ideas is where the teacher elicits, from the students, something she found interesting about the problem and spends a few minutes of focused time engaging students in using language to describe the mathematical idea.			
*Teacher candidate discusses an interesting mathematical idea from the lesson with the student.			
*Teacher candidate has student draw a picture representation of the mathematical idea.			
*Teacher candidate has student label the picture representation of the mathematical idea.			
*Teacher candidate has student write a brief description of the mathematical idea.			
Make Connections to Students' Interests is where graphic organizers are utilized.			
*Teacher candidate gives student a graphic organizer for making connections from the new mathematical idea to student interests.			
*Teacher candidate discusses how the mathematical idea relates to student interests.			
*Teacher candidate and student use the graphic organizer to show connections between the mathematical idea and student interests.			

Appendix M: Focus Group Questions

Focus Group Questions

Attitude

1. How important do you think algebraic thinking is in a child's mathematic curriculum? Mathematics in the total scope of the academic curriculum?
2. How would you describe the nature of algebraic thinking in general? Rule-governed? Haphazard? Etc.? What about mathematics in general?
3. How do you feel about teaching algebraic thinking to students at-risk for mathematics failure? What makes you feel this way? What about teaching mathematics in general to students at-risk for mathematics failure?

Self-Efficacy

4. How prepared do you feel to teach algebra to elementary students at-risk for mathematics failure? What makes you feel this way? How prepared do you feel to teach mathematics in general to students at-risk for mathematics failure?
5. How much impact do you think you as a professionally trained teacher can/will have on students with low-algebra achievement? What about low mathematics achievement in general?
6. How much impact do you think your planning and reflection on your mathematics instruction will impact how your students progress through algebraic thinking material? What about how they progress through mathematics material in general?

Instructional Knowledge Information

7. How well do you feel you understand the instructional strategies presented for teaching algebra? Teaching mathematics in general?
8. What do you think some sound pedagogical strategies are for teaching algebra? Mathematics in general?
9. What strategies, if any, do you think would not work for teaching algebra to at-risk learners? Mathematics in general?

Instructional Knowledge Application

10. Describe your comfort level in utilizing mathematics strategies for teaching algebra. For mathematics in general?
11. Describe how ready you feel to use mathematics strategies for teaching algebra. For mathematics in general?
12. Describe how likely it would be for you to review instructional strategies for teaching algebra that we have discussed and then apply them once you feel prepared. For mathematics in general?

Content Knowledge

13. How would you describe your level of understanding of elementary algebra content? How would you describe your level of understanding of general mathematics at the elementary level?

14. What do you think your greatest strength in terms of content knowledge is for algebra? For mathematics in general?
15. What do you think your greatest weakness in terms of content knowledge is for algebra? For mathematics in general?
16. Are there any strategies you will use to make yourself more comfortable with the content knowledge of algebra? Of mathematics in general?

About the Author

Sharon Nichole Estock Ray earned a Bachelor's of Science degree in Psychology with a Minor in Communication Sciences and Disorders, and a Master's of Education in Special Education with a Concentration in Learning Disabilities from James Madison University. She has also earned a Doctorate degree in Special Education with a Cognate in Literacy from the University of South Florida. Sharon has made several presentations on the national and local levels involving mathematics and reading instructional practices for learners with special needs.

Sharon has her own remediation service for learners with special needs. She also works part-time teaching university level education courses. Her interests include teacher preparation, content area learning, at-risk learners, and transition services.