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Standards Based Interactive Bilingual Math Centers for the Kindergarten Classroom

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STANDARDS BASED INTERACTIVE BILINGUAL MATH CENTERS FOR THE KINDERGARTEN CLASSROOM

A Project Report
Presented to
The Graduate Faculty
Central Washington University

In Partial Fulfillment
of the Requirements for the Degree
Master of Education
Master Teacher

by
Laura Berge
May 2006
Acknowledgments and Dedications

I want to acknowledge the wonderful support my committee offered me during this process. They made this project manageable, worthwhile and a vital learning process for me.

This work is dedicated to the amazing Dr. Cathrene Connery, my wonderful fiancé Eric Hevland, and my ever smiling children. The support, guidance and encouragement these individuals offered me helped me through what seemed to be an unobtainable goal at times. Thank you to my children who went without their mommy many a night and share my sense of pride in a job well done. Thank you to my fiancé who dealt with my stress while always smiling and offering encouragement, and lastly thank you to Dr. Connery who gave so much of her time and expertise in completing this project. I couldn’t have done it without you!

Laura A. Berge, M.Ed
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CHAPTER ONE:
INTRODUCTION

Statement of the Problem

Recent statistics from public schools estimate that there are two million English Language Learners (ELLs) in Kindergarten through the third grade (Abedi, Hofstetter, & Lord, 2004). Young ELLs face an increased risk of school failure due to a lack of knowledge on the part of early childhood educators regarding linguistic and conceptual development in young children (Coppola, 2005). Research suggests that early deficits in math are strongly associated with long-term math failure (Griffin, Case & Siegler, 1994 in Fuchs, Fuchs, & Karns, 2001) and children from high poverty backgrounds, including many ELLs, are at increased risk for failure.

In Washington, 29.9% of the state’s population is under the age of 18. Out of this number, 8.8% of the K-12 school population is Hispanic. Approximately, 14% of our state population speaks a language other than English in their home (Washington State Census, 2000). In 2000, the U.S. Census Bureau reported 78.5% of Hispanics in this country speak a language other than English in their homes. Of that population, 40.6% of all respondents reported they spoke English “less than very well.”

The Office of the Superintendent of Public Instruction (OSPI) for the state of Washington reports that for the 2005-2006 academic year, 70.1% of third grade, Hispanic students did not meet the state standards for mathematics in comparison with 58.1% of their European-American counterparts. This statistic is staggering. The need to align current research and educational pedagogy regarding effective teaching practices for ELL students must be breached if we are to close the achievement gap and ensure success for all of our students.
In addition, the National Council of Teachers of Mathematics (NCTM) has made recommendations regarding math learning. The NCTM standards include mathematical concepts and learning in the following categories: Number and Operations, Geometry, Algebra, Data Analysis and Probability, Measurement, Problem Solving and Proof and Communication, Connections and Representation. Historically, minority students have continually failed to reach these mathematical benchmarks. It is vital that young students get the solid mathematical foundation they need to meet increasingly high standards.

Purpose & Significance of the Project

The need for this project is evidenced by the above demographic statistics. Statistical data from various research sources indicate a large discrepancy between mathematical achievement levels of Hispanic students. The project is significant in that it integrates current research on early learners, educational pedagogy, ELL teaching strategies, and mathematical learning to ensure success in mathematics for young Hispanic students. Toward this end, the purpose of this project was to develop bilingual math centers using a constructivist approach and the latest research on second language acquisition and teaching for the early childhood classroom. This project is also unique because it supplements current math curriculums used throughout the state while providing the necessary scaffolds ELL students need in order to succeed at mathematics.

Definition of Terms

This project draws on terminology associated with the domains of second language acquisition and pedagogy. The following terms are utilized across the text.
• Comprehensible input = the language a learner can understand that is mediated through the aid of contextual clues such as prior knowledge, gesture, body language, visual references, and other contextual supports.

• English Language Learners (ELLs) = describes students who are acquiring English as a second, third, or fourth language.

• English as a Second Language (ESL) = the field of study that addresses theoretical and pedagogical applications to the teaching and learning of English as second language.

• Second language acquisition (SLA) = involves the unconscious process of acquiring a language including the native language and subsequent languages in a natural, meaningful, and developmental way. The L2 or second language is learned through social interaction with native speakers of the L1 or native language.

Organization of the Project

This project is organized into five chapters. Chapter one includes a statement of the problem and the purpose and significance of the project of itself. Chapter two contains a review of related literature. Chapter three outlines methods the author used to create the supplemental curriculum presented in chapter four. Chapter five concludes the document.
CHAPTER TWO:

Review of the Literature

Young Learners & Early Childhood Education

To fully understand teaching young children, one must have a sound grasp on Early Childhood Education. Young children learn best in a cooperative environment which includes hands-on learning, communicative opportunities, and culturally sensitive and well prepared teachers. To adequately support a developmental task such as learning math, a teacher must draw on his/her knowledge of child development and learning, the strengths, interests and needs of the individual student, and knowledge of the social and cultural context in which the student lives. Weaver (1996) outlines seven principles of constructivist learning (Weaver, 1996). In the first principle, learning involves the construction of concepts as opposed to the mastery of facts. Second, conceptual development is a complex process that incorporates the clarification of critical features from variable and non-distinguishing features. Third, learning is idiosyncratic, non-linear and often appears chaotic because the learner must form hypotheses that they test and adapt. In the fourth principle, learning proceeds best when learners are engaged in personally meaningful processes where they can take risks, experiment and learn without negative consequences. The fifth principle states learning proceeds best in natural vs. contrived contexts. Sixth, some learners will develop the ability to learn from part to whole, while others appropriate the parts within a holistic context. Finally, learning proceeds best when support is scaffold by adults or more advanced peers. This is because much learning occurs as the result of informal observation facilitated by indirect instruction (Weaver, 1996).

Vygotsky (1978) contends that early childhood teachers need to understand the influence of sociocultural contexts on learning, recognize children’s developing competence and accept the
variety of ways children express their developmental achievements. Research reinforces and demonstrates that young children, in Piaget's (1969) pre-operational stage, are concrete thinkers who need hands-on learning to succeed. Piaget states, "The logico-mathematical structures arise from the coordination of the actions of the subject and not from the pressure of the physical objects" (p.156). The National Association of Education for Young Children (NAEYC) states that, "If progress in improving mathematic proficiency in Americans is to continue, much greater attention must be given to early mathematical experiences" (p.2).

Vygotsky (1978) also believed that play leads to development. As a result, young children need opportunities to practice new skills, solve complex problems and develop strategies that will aid them in their mathematical development. Children’s natural interests, and their disposition to use these interests in making sense of their world, must be included in math leaning. Children’s cognitive, linguistic, physical and socio-emotional development must be considered to develop an effective math curriculum. Such a curriculum would be built on cooperative learning, developmentally appropriate practices, hands-on experiences, and student directed engagement. In addition, the curriculum needs to be based on culturally relevant schema as a necessary component for children’s success. Children who interact within small groups operate on the edge of their developing capacities as social relationships are built and contextualized learning occurs. Frede & Barnett (1992) emphasize "A growing body of research indicates that more developmentally appropriate teaching in pre-school and kindergarten predicts greater success in the early grades" (p. 3, as in NAEYC statement).
Young Children & Language

Chomsky (1969) demonstrated that children between five to ten years old are still acquiring the structures of their first language. It is critical that teachers of young children understand that bilingualism has been associated with higher levels of cognitive attainment (Hakuata, 1989) and accordingly plan a classroom environment that respects, accepts, values, encourages and promotes all children. The NAEYC position statement of 1995 recommended that early childhood teachers recognize young children can and will acquire English when their home language is used and esteemed. Programs need to develop and provide alternative and creative strategies for young children’s learning. This includes the use of the native language. NAEYC also recommends educators must recognize all children are cognitively, linguistically and emotionally connected to language and their home culture while acknowledging that children demonstrate meaning and capabilities in many ways.

The NAEYC statement also references Krashen’s theory of comprehensible input. It asserts educators of young children need to understand second language acquisition while acknowledging that learning transfers between languages. The loss of children’s home languages may result in a loss of a family’s ability to communicate, which in turn can damage a child’s esteem making learning even more difficult. As NAEYC statement regarding effective education of linguistic and culturally diverse young children (1995) argue “The nation’s children all deserve early childhood education that is responsive to their families, communities and racial, ethnic and cultural background. For young children to develop and learn optimally the ECE professional must be prepared to meet their students’ diverse developmental, cultural, linguistic and educational needs.” (p.1)
Thomas & Collier (1997) in their *School Effectiveness for Language Minority Students*, developed a conceptual framework known as the Prism Model to demonstrate the complex process of second language acquisition within the school context. This model has four major components which must be addressed to fully meet the needs of ELL students. The first component of this model, and center of the learning process, represents the sociocultural processes an individual student goes through when acquiring a second language. This process includes the student’s past and present social and cultural experience.

Another component of this model is language development. This portion of the model considers the linguistic processes a student progresses through in the process of acquiring a second language. This component considers both the student’s first and second languages noting that cognitive and academic success in the second language is dependent on a students’ first language. Therefore, it is essential the first language must be developed.

The third component of the Prism Model is academic development. This aspect of children’s school experience includes all the school and content knowledge at each grade level. Research in this area has shown that postponing or interrupting academic development is likely to promote academic failure in the long term.

The last component of Thomas & Collier’s work is cognitive development. Cognition refers to the natural, subconscious process that occurs developmentally from birth to the end of schooling and beyond. It is extremely important that cognitive development continues through a child’s first language through the elementary school years at the very minimum. Research demonstrates that transfer of knowledge occurs between both languages and, to ensure a student’s success, the child requires a solid foundation of conceptual knowledge in their native language. This model pulls together all aspects of an ELL student’s learning to ensure success.
As the authors state, “The more children develop L1 academically and cognitively at an age-appropriate level, the more successful they will [be] in academic achievement in L2 by the end of their school years” (p. 49).

Mathematical Learning & The Young Child

Current math research reinforces the fact that children need to have fully developed numeracy skills at the Kindergarten level. Kindergarten children should have two major mathematical schemas: one for verbal counting and another for quantity discrimination (Fuchs & Karns, 2001). Griffin, Case & Siegler (in Fuchs & Karns, 1994) suggest that early deficits in math are strongly associated with long term math failure. They also assert that children from high poverty backgrounds, which include many ELLs, are at increased risk for failure.

Vygotsky (1978) sees mathematical learning as a communication process that occurs within a social context. Students learn math best in a cooperative environment and when their zone of proximal development is taken into account. Research also suggests that a cognitive approach (Piaget, 1969) helps young children explain, justify and question their learning and that of their peers to promote a higher level understanding of mathematical concepts. The National Council of Teachers of Mathematics (NCTM), the Math and Science Education Board (MSEB), and the American Association for the Advancement of Science (AAAS) call for an instructional approach that emphasizes communication. The math learning centers presented in this project are built on this concept.
Research and the Brain

Current brain research has found that neuro-chemical communication between neurons is facilitated and connections are made not only by adjacent neurons, but also between distant neurons. These connections in the brain are bidirectional in that they can be made from simple to complex and from complex to simple. Parallel processing occurs as different areas in the brain are simultaneously activated. There is evidence that both the right and left hemisphere are equally vital structures in early language learning because concepts and language travel between both sides of the brain. Effective teaching, therefore, should include instructional foci moving from part to whole and whole to part while engaging the learner in a sociocultural context. By understanding learning, teachers can better comprehend how to reach English language learners within their classroom. Linking second language acquisition with content will ensure success for students.

Young English Language Learners

Language minority students are the fastest growing population in schools located in the Pacific Northwest. The number of second language learners has more than doubled in Washington over the past decade, with most ELLs represented in the early elementary grades (August & Hakuta). By far, the largest population of ELLs are native Spanish speakers. The 2005 National Assessment of Educational Progress (NEAP) reported that only 19% of Hispanic fourth graders performed at or above proficiency levels in mathematics nationally compared to 47% of the European-American population.

Recent statistics from public schools estimate there are two million ELLs in Kindergarten through third grade (Abedi, Hofstetter and Lord, 2004). In Washington, 29.9% of
the state population is under the age of 18. Out of this number, 8.8% children are Hispanic while 14% of the total state population speaks a language other than English in their home (Washington State Census, 2000). The U.S. Census Bureau reported that 78.5% of Hispanics in the United States speak a language other than English. Of that population, 40.6% of these respondents reported they spoke English “less than very well.” Looking at this same census data, 80.4% of the nation’s population reported they were high school graduates while only 53.4% of the Hispanic population graduated from high school. Clearly the achievement gap of the Hispanic population is evident in this demographic data.

Young ELLs and the Acquisition of the L1 & L2

The National Center for Research on Cultural Diversity and Second Language Learning (1995) outlined eight principles for teaching linguistically diverse students. The first of these principles state that bilingualism is an asset and should be fostered. Second, the center states there is an ebb and flow to bilingualism. Third, there are different cultural patterns for language use. The fourth principle contents code-switching is a normal language phenomena for children. Fifth, children can learn a second language in many different ways. Sixth, language is used to communicate meaning. Seventh, language flourishes best in a language rich environment while the eighth principle states children should be encouraged to experiment with language.

Authors of the Teachers of English to Speakers of Other Languages (TESOL) statement on the education of K-12 language minority students argue for the need to learn by students having access to positive learning environments, appropriate curriculum, a full delivery of services, and equitable assessments. Fathman, Quinn and Kessler (1992) identify strategies such as promoting collaboration between teachers and students, modifying language, relating learning
to everyday life, adapting materials and employing language teaching techniques to represent concepts. ELLs must be given every possible opportunity for success through research based practices delivered by qualified and caring teachers in a positive and safe classroom.

Research shows that young ELLs face an increased risk of school failure due to a lack of knowledge on the part of early childhood educators regarding language development in young children (Coppola, 2005). The Office of the Superintendent of Public Instruction (OSPI) for the state of Washington reported that for the 2005-2006 academic year that 70.1% of third-grade Hispanic students did not meet standards for mathematics. This statistic is staggering when compared to 58.1% of their European-American counterparts.

In addition, Thomas & Collier found that bilingually schooled students outperform their monolingual peers, highlighting that the strongest predictor of L2 achievement is the amount of formal L1 schooling a student has received. Research by Cummins (1981) and Thomas & Collier (1997) confirm ELLs can take 5 to 10 years to reach the academic proficiency of their native speaking peers. There is mounting evidence of the connection between L1 loss and educational difficulties experienced by ELL students (Moran & Hakuta, 1995). A strong L1 foundation acts as a support in learning the L2. Teachers must understand the importance language plays within all areas of their classrooms and particularly math.

Mathematics and language are intricately connected and language facilitates mathematical thinking. It can be especially helpful for young ELL students to build a strong mathematical foundation in their L1 before entering higher grades in which math education and language become much more decontextualized and cognitively demanding. Cocking and Mestri (1988) suggest that in general, language minority students’ performance in math is influenced by both linguistic and non-linguistic factors. These influences include entry characteristics of the
learner, educational opportunity provided to the learner, and the child’s motivation to learn. These factors collectively play a part in a child’s success. In addition, when standards specific to language minority students are applied, ELLs also have a better chance for success. Language minority students need to have access to multicultural math environments that build on the child’s background and interests, make appropriate use of effective SLA methods of teaching, and be given a chance to show their competence in a variety of ways.

ELLs and Mathematical Learning

The NCTM (1994) position statement on language minority students asserts that, “cultural background must not be a barrier to full participation in mathematics programs” (p.2). ELL students are best served by mathematical teaching that includes meaningful activities based on prior experiences. Equity in mathematics learning requires teachers to accommodate differences in order to ensure all students learn math. Within the United States, informal math knowledge has been documented to develop at a slower rate in children from low social economic homes. Educators must be aware that young students will enter school at different developmental stages and with varying experiences regarding math. In math, as in literacy, children who live in poverty, members of linguistically diverse populations, and ethnic minorities demonstrate significantly lower levels of achievement. DeAvila and Duncan (1981) have verified there is a strong relationship between the degree of English proficiency and math achievement.

As a result, teachers must ensure that these students are given every opportunity to learn math in the best and most effective ways possible. It has been amply documented that traditional math instruction does not promote achievement for ELL students. Teachers must select math
tasks that engage students' interests and intellect. ELL students need meaningful math activities that build on real life and prior experiences and provide for challenging problem solving opportunities. Diaz-Ricoa and Weed (1995) state that the difficulties LEP students have with math include language areas such as math vocabulary, syntax, semantics and discourse. Khisty (1995) found that in bilingual elementary classrooms, students do not receive adequate training in the language of math. English Language learners must be provided relevant mathematical learning opportunities and teachers must use multiple assessment approaches. Teachers should not focus on what students don’t know, but instead focus on ways students can show what they do know. Early childhood math assessment is useful if it aims to help young children by identifying their strengths and by helping to guide instructional planning. However, it is not beneficial when assessment aims to place children in rigid, permanent, leveled groups. Careful assessment is especially important for children from ethnically, culturally, and linguistically diverse backgrounds.

In the new field of ethnomathematics, the written and non-written forms of mathematical knowledge by marginalized groups or people who have been ignored by the conventional history of math are recognized and esteemed (Powell and Frankenstein, 1997). With the help of ethnomathematics, traditional math education can be viewed as a means of infusing culture and diversity into an appropriate curriculum which benefits struggling minority students. According to Crump (1992), evidence suggests there is one universal grammar of number much like Chomsky's universal grammar concept. Thomas & Collier also encourage the concept of providing a socioculturally supportive school environment for language minority students that validates their natural language and provides academic and cognitive development to flourish through the native and second language and culture.
Assessment & the ELL Student

In assessing young ELL students, it is critical that evaluators have cultural and linguistic competence, knowledge of the children they are assessing, and use multiple methods which are age appropriate to serve as an on-going means to guide instruction. There are a number of obstacles which can cause assessment to be ineffective or invalid. These hurdles include a scarcity of well prepared, bilingual, and or bicultural teachers, a lack of culturally and linguistically diverse assessment methods, and an on-going climate that does not view assessment as the primary purpose of helping to support learning. Early childhood educators must recognize that children are best understood in the context of family, culture and society and, for optimal development and learning, all educators must accept, respect, value, promote and encourage children from culturally and linguistically diverse backgrounds. Because culture and language are critical components of children’s development, pedagogical practices are not developmentally appropriate unless they are responsive to cultural and linguistic diversity. Teachers must not only understand how young children learn, but in today’s environment, teachers must also understand culturally and linguistically diverse students.

In measuring ELL students’ mathematical learning, our traditional assessment scales have been normed on groups of white, middle class students (Bowman, 1992). As a result of our test-driven system, it is vital teachers to understand the process of SLA and students from diverse backgrounds. Cocking & Chipman (1983) believe that the actual competence of minority students may be under-measured because of the style and format of testing instruments fails to tap ELLs actual skill and concept knowledge. However, our current test taking environment does not allow for many variations in standardized testing. Therefore, teachers should use a variety of assessment methods to provide a complete picture of student progress instead of simply relying
on standardized tests. Students must be allowed to demonstrate what they know in a variety of ways. Assessments should have three primary purposes: (a) planning for individuals and groups and communicating with parents, (b) identifying children who need extra help and (c) evaluating programs and guiding instruction.

Teachers and schools who use uni-lateral or standardized assessments to place students in permanent instructional groups do a huge disservice to all students because children do not have the opportunity to learn collaboratively from one another. If teaching is conceived as the construction of a bridge between subject matter and students, it follows that only learner-centered teachers who design a collaborative, positive, and interactive classroom can facilitate connections between language, subject matter, and student peers.

Best Practices for Math in the Early Childhood Classroom

Research validates the early childhood education concepts and ELL teaching strategies which employ realia, manipulatives, multiple intelligence theories, discovery learning, peer assisted learning strategies (PALS), hands-on learning, and cooperative experiences (Short & Spanos, 1989). Funer, Yahya & Duffy (2005) indicate that both ELL and special education students benefit from instruction organized from concrete to abstract concepts. Further, NAEYC states that young children need concrete experiences in order to gain conceptual understanding.

Research also demonstrates the importance of classrooms that operate under a cooperative umbrella. Cazden (1988) asserts classrooms that emphasize individual performance and are teacher centered which offer little or no student participation are culturally incongruent. Educators can not expect to reach students from diverse backgrounds if they do not first realize that their classroom instruction must reflect their ability to make learning personal and also help
students to make connections between learning and their daily lives. The NCTM contends, in their 2000 position statement, that young children in supportive and encouraging classrooms with opportunities to engage in oral communication learn to communicate mathematically.

Opportunities for self expression in mathematics can be provided at learning centers (Cooke & Buchholz, 2005). The teacher, in facilitating these centers, serves as a guide as young students explore, make connections, and communicate their math knowledge.

Young ELLs are capable of sophisticated levels of thinking when they are offered cognitively guided instruction. Cognitively guided instruction in bilingual classrooms (Secada & DeLaCruz, 1996) gives students the opportunity to develop and figure out concepts for themselves as they articulate reasons for their actions, strategies, and experiences in the L1 and L2. In this manner, the language of math becomes accessible, in either language, as teachers and students continually talk, explain and reflect on their math knowledge.

Along with cognitive guided activities, teachers must make use of extensive modeling with students to provide the comprehensible input ELLs need to make sense of learning experiences. Because scientific and mathematical skills and knowledge acquired through L1 instruction transfer, employing a child’s L1 is an efficient and culturally appropriate way of developing math literacy while learning English. In addition to the L1, progressive formalization helps students develop spontaneous ideas into scientific concepts (Vygotsky, 1978) as teachers bridge children’s home cultures with that of the school. By drawing on students’ background knowledge and using metaphors, teachers can point out how student’s ideas can be transformed and formalized.

This is why it is essential that instruction should take into account students’ need for context-rich, meaningful environments. Without carefully considering the knowledge students
bring to learning situations, it is difficult to predict what they will understand about new information presented to them. Teachers with high expectations provide an active and challenging environment in which students are encouraged to interact regarding their informal and formal understandings using manipulatives and demonstrations. Integrated content and language objectives lead to the acquisition of academic language in a cooperative environment.

The concept of a “Math talk” time allows children to communicate mathematically, make connections between concepts, and share the language of math in a whole class activity. In this manner, the learning children engage in with their peers at centers is then shared with the larger class. The teacher facilitates open-ended discussions for student consideration and response. For example, students may share work samples, problem solving solutions and strategies, or make connections to their daily lives during math talk. To fully utilize this practice, teachers using math talk should receive training based on Classroom discussions: Using math talk to help students learn by Chapin, O'Connor, and Anderson (2003).

Mathematical Learning Centers

In every early childhood setting, children should experience research based curriculum and teaching practices. The implementation of math centers for ELL students and all young children is an effective way for young students to learn math. Research supports math activities that are hands-on, meaningfully relevant to everyday life, while naturally peaking the interest of students (Thornburg & Karp, 1992). By clustering objectives in cooperative math centers, teachers provide multiple opportunities for students to learn mathematical concepts. Small groups allow students to use language and problem solving skills as they develop their math competencies. Math centers allow students opportunities for self expression as well. The NCTM
states that young children in supportive, encouraging classrooms, with opportunities to engage in oral communication, learn to communicate mathematically. Learners benefit from having a variety of ways to understand a given concept while articulating their knowledge with peers in math centers. It is vital for a child’s confidence to build math knowledge through positive experiences while being allowed to foster their natural curiosity.

The play component in math centers allows students to progress from intuitive to explicit knowledge. Math centers are well planned by teachers who understand how to embed significant math leaning into a cooperative, play like experience. Teachers must understand that a math center is more than play and provide opportunities for students to ask questions, reflect, extend their learning, and communicate with math language. During center time, teachers serve as a facilitator to help guide students and allow for reasoning and communication to occur. Centers involve heterogeneous groups of students working together with concrete activities and manipulatives. The design of centers must also take into account students’ ages, developmental levels, interests, and levels of English proficiency. Students of diverse backgrounds have a better chance to succeed when they work with a student partner who can provide information by scaffolding their need for comprehensible input. Math buddies or bilingual pairs allow students the opportunity to feel successful within groups of their peers.

Young students and diverse learners do well with the use of a multimodal model which incorporates individual learning styles, multiple intelligences, tangible learning objects and opportunities to explain their problem solving and metacognition. Thornburg and Karp (1992) have found that in as short as one year’s time, students who learned math concepts in small groups while speaking their own language with peers demonstrated improvements in their math communication abilities. Math centers provide the constructivist philosophy that young children
learn best in. Problem solving and reasoning are at the heart of mathematics. Research and expert practice indicate that certain concepts are challenging and accessible for young students when taught in an appropriate environment.

Researchers have identified number and operations, geometry, and measurement to be particularly important for young children. With such enormous variability in young children's development, it is vital that all students, especially children from linguistically diverse backgrounds and students with learning disabilities receive math education that is interactive, meaningful, and hands-on. Math education should not be narrowly defined as the transmission of a set of skills based on rote learning. Teachers must also orchestrate the classroom in ways that promote investigation and growth of mathematical ideas. Also, teachers need to understand that small group work allows students to use their language. Duran (1991, in Fennema, Carpenter & Lamon) found a relationship between the degree of bilingualism and logical reasoning in students. This research demonstrates the need for bilingual centers in which students are encouraged to communicate in both their languages.

This chapter highlighted research regarding young learners and early childhood education. It presented research on young children and language, while emphasizing the acquisition of first, second, and mathematical language by ELL students. The chapter included a review of the literature specific to brain research, the process of second language acquisition, and the assessment of ELLs. The document concluded with an overview of best practices for mathematics, focusing on L1 and L2 language development as a central aspect of the implementation of math centers. In the chapter that follows, the author describes the methodology used to develop the project outlined in chapter four.
CHAPTER THREE:  
METHODOLOGY

Population

The setting for my project is any primary elementary classroom which serves ELL and Spanish-speaking students. The communities I envisioned for the implementation of my project are located in the Central portion of Washington State. The school districts which will benefit most from my project have a large number of Native Spanish speakers from working-class family traditions. However, this project is appropriate for any classroom in need of scaffolded mathematic instruction based on a constructivist approach. This project is designed to be used throughout the academic year. It allows teachers to use lessons either sequentially or thematically or to pull single lessons to meet the developmental needs of students within their classroom. Several of the student materials are available in both English and Spanish.

NCTM Standards

The content for the math centers was derived from the National Council of Teachers of Mathematics standards for kindergarten aged students. Each week, teachers will select activities from one or more of the six following standards: (a) number and operations, (b) algebra, (c) geometry, (d) measurement, (e) data analysis, (f) problem solving and (g) reasoning/proof. The students’ math talk addresses NCTM’s communication, connections and presentation standards.
Procedure

I began developing my bilingual math centers by first reviewing all relevant literature in the fields of Early Childhood Education, English Language Learners and Mathematical Learning. I also examined literature regarding a constructivist approach to teaching and the theories behind centers in the kindergarten classroom. I based my centers on my research review and upon the prism model for second language acquisition developed by Thomas & Collier (1997). This conceptual model (see Figure 2.0) has four major components. The model views the ELL student as a whole child with needs in academic, cognitive, linguistic, and sociocultural domains. The math centers afford students opportunities for culturally relevant learning and growth in all realms represented by the Prism model.

Figure 2

Language Acquisition for School

An interdependent model that views the students' social and cultural being as the center of student learning.

L1 = native language (Spanish)  
L2 = second language (English)

Language Development = linguistic processes in both languages.

Academic Development = school work.

Cognitive Development = developmental, natural and subconscious process of continued growth.

After reviewing the research literature and Thomas & Collier’s (1997) model, I then reviewed the National Council of Teachers of Mathematics most recent math standards. I then
aligned these standards with Washington's Grade Level Expectations (GLEs) to provide teachers with a quick reference to ensure the centers meet state standards. In addition, I further aligned the center activities to international standards outlined by the Teachers of English to Speakers of Other Languages (TESOL) professional organization.

After intertwining and establishing these standards, I visited local schools which represented the population demographics to which my math centers are geared. These visits allowed me to determine how teachers use math instruction time and identify which strategies they employed to reach ELL students. The school I visited currently implements a dual language program in Kindergarten through fifth grades. I spent two hours in the first grade observing math instruction in both English and Spanish. On Tuesdays and Wednesdays, math instruction is delivered in English. On Thursdays and Fridays, math instruction is conducted in Spanish. The lessons are sequential regardless of language without repetition to develop a cumulative knowledge base.

I also triangulated the data by interviewing experts in the areas of Math and Early Childhood Education to discuss the project and obtain insight, opinions and feedback. I determined from this process that the need for an organized, bilingual, standard driven math center curriculum is necessary to meet the needs of school districts with high Spanish-speaking populations.

Next, I formulated daily schedules and the approximate time needed to complete all math centers for the entire academic year. I was then able to develop each center by selecting lessons based on their ability to meet the criteria integrated in the multiple sets of standards. A variety of resources were used to develop the math center lessons including adaptation of internet lessons, math lessons from various curricula, lessons donated and adapted from local teachers, and lessons I have used within in my own classroom. The final product resulted in the representation
of each standard with a minimum of six center activities. However, I incorporated additional lessons for specific standards. Finally, I listed all the benefits that my math centers offer teachers who chose to use them as supplemental math curriculum as listed in Chapter 4.

Materials

Several materials have been developed for this project. Center activities were proposed using the NCTM standards. A list of consumable materials, black line masters, instructions and other student materials were created for each activity to be used at the centers. An inventory of necessary manipulatives has been included for teacher reference. In addition, tools were designed for teacher assessment. These materials can be found in Chapter Four of this document.

The project is designed for teachers to establish distinct, free-standing math centers housed in large plastic containers. These containers will include all supplies for ready access. Teachers can organize and label each center using the inventory checklists that have been provided by attaching the document to the top of the container. In this manner, all necessary materials are included in each center.

Implementation Design

The first month of school is spent establishing rules and procedures and introducing concept of centers. This time should be used to establish procedures and also give students a chance to explore manipulatives with little teacher direction. Students should all have a bilingual partner who will also serve as their math partner. Ideally, teachers should organize their students into four table groups that rotate through centers as represented in Figure 1.0. Students should practice this rotation often during the first month of school. The remainder of school year should be divided into weeks. The implementation design for this project spans approximately 20
Student groups rotate tables Monday through Thursday so that every student group completes all four centers in one week. On Friday, students may go to any available spot and any available table.

This chapter presented the author's methodological approach to the construction of the project. The chapter highlighted the materials, implementation design, and procedure used to develop the math centers referenced in chapter four. The daily schedule, classroom set up and the integration of NCTM standards were addressed as critical features in the design of the project. This document now turns to present the actual bilingual math centers.
weeks. However, teachers may reintroduce activities according to student needs. As stated above, teachers can use activities from the centers sequentially or pull lessons from a particular center to meet their student's needs.

Daily Center Time

A teacher should plan to allot approximately 60 minutes for math centers and instruction daily. At the beginning of each week, 10-15 minutes of center introduction is needed. This introduction should be followed by 5 minutes of direct instruction daily to reintroduce centers and place students in the appropriate groups. Once students are familiar with teacher expectations and center requirements, approximately 30 minutes should be allotted for the students to enthusiastically engage in the center activity. This center time should be followed by approximately 10 - 15 minutes of “math talk”, as described in Chapter 2, so students have the opportunity to conceptualize, internalize, and express mathematical learning on a daily basis.

Daily Classroom Set-Up

The teacher arranges and sets up four math centers each week so students can rotate and complete each of the individual centers Monday through Thursday. On Friday, students choose their favorite math center with their partner. Teachers will encourage students to share their learning through math talk similar to previous days in the week.
Standards Based Interactive Bilingual Math Centers
For the Kindergarten Classroom

A Supplemental Curriculum for use in the Kindergarten Classroom

Developed By
Laura Berge, M.Ed
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Recent statistics from public schools estimate that there are two million English Language Learners (ELLs) in Kindergarten through the third grade (Abedi, Hofstetter, & Lord, 2004). Young ELLs face an increased risk of school failure due to a lack of knowledge on the part of early childhood educators regarding linguistic and conceptual development in young children (Coppola, 2005). Research suggests that early deficits in math are strongly associated with long-term math failure (Griffin, Case & Siegler, 1994 in Fuchs, Fuchs, & Karns, 2001) and children from high poverty backgrounds, including many ELLs, are at increased risk for failure.

In Washington, 29.9% of the state’s population is under the age of 18. Out of this number, 8.8% of the K-12 school population is Hispanic. Approximately, 14% of our state population speaks a language other than English in their home (Washington State Census, 2000). In 2000, the U.S. Census Bureau reported 78.5% of Hispanics in this country speak a language other than English in their homes. Of that population, 40.6% of all respondents reported they spoke English “less than very well.”

The Office of the Superintendent of Public Instruction (OSPI) for the state of Washington reports that for the 2005-2006 academic year, 70.1% of third grade, Hispanic students did not meet the state standards for mathematics in comparison with 58.1% of their European-American counterparts. This statistic is staggering. The need to align current research and educational pedagogy
regarding effective teaching practices for ELL students must be breached if we are to close the achievement gap and ensure success for all of our students.

In addition, the National Council of Teachers of Mathematics (NCTM) has made recommendations regarding math learning. Historically, minority students have continually failed to reach these benchmarks. It is vital that young students get the solid mathematical foundation they need to meet increasingly high standards.

Mathematics & L1 and L2 Learning

Mathematics and language are intricately connected and language facilitates mathematical thinking. It can be especially helpful for young ELL students to build a strong mathematical foundation in their L1 before entering higher grades in which math education and language become much more decontextualized and cognitively demanding. Cocking and Mestri (1988) suggest that in general, language minority students' performance in math is influenced by both linguistic and non-linguistic factors. These influences include entry characteristics of the learner, educational opportunity provided to the learner, and the child's motivation to learn. These factors collectively play a part in a child's success. In addition, when standards specific to language minority students are applied, ELLs also have a better chance for success. Language minority students need to have access to multicultural math environments that build on the child's
background and interests, make appropriate use of effective SLA methods of
teaching, and be given a chance to show their competence in a variety of ways.

Purpose & Significance of the Project

The need for this project is evidenced by the above demographic statistics.
Statistical data from various research sources indicate a large discrepancy
between mathematical achievement levels of Hispanic students. The project is
significant in that it integrates current research on early learners, educational
pedagogy, ELL teaching strategies, and mathematical learning to ensure success
in mathematics for young students. Toward this end, the purpose of this project
was to develop bilingual math centers using a constructivist approach and the
latest research on second language acquisition and teaching for the early
childhood classroom. This project is also unique because it supplements current
math curriculums used throughout the state while providing the necessary
scaffolds ELL students need in order to succeed at mathematics.

The Importance of Mathematical Learning Centers

In every early childhood setting, children should experience research
based curriculum and teaching practices. The implementation of math centers for
ELL students and all young children is an effective way for young students to
learn math. Research supports math activities that are hands-on, meaningfully
relevant to everyday life, while they naturally peak the interest of students. By
clustering objectives in cooperative math centers, teachers provide multiple
opportunities for students to learn mathematical concepts. Small groups allow students to use language and problem solving skills as they develop their math competencies. Math centers allow students opportunities for self expression as well. The NCTM states that young children in supportive, encouraging classrooms, with opportunities to engage in oral communication, learn to communicate mathematically. Learners benefit from having a variety of ways to understand a given concept while articulating their knowledge with peers in math centers. It is vital for a child’s confidence to build math knowledge through positive experiences while being allowed to foster their natural curiosity.

The play component in math centers allows students to progress from intuitive to explicit knowledge. Math centers are well planned by teachers who understand how to embed significant math leaning into a cooperative, play like experience. Teachers must understand that a math center is more than play and provide opportunities for students to ask questions, reflect, extend their learning, and communicate with math language. During center time, teachers serve as a facilitator to help guide students and allow for reasoning and communication to occur. Centers involve heterogeneous groups of students working together with concrete activities and manipulatives. The design of centers must also take into account students’ ages, developmental levels, interests, and levels of English proficiency. Students of diverse backgrounds have a better chance to succeed when they work with a student partner who can provide information by
scaffolding their need for comprehensible input. Math buddies or bilingual pairs allow students the opportunity to feel successful within groups of their peers.

Young students and diverse learners do well with the use of a multimodal model which incorporates individual learning styles, multiple intelligences, tangible learning objects and opportunities to explain their problem solving and metacognition. Thornburg and Karp (1992) have found that in as short as one year’s time, students who learned math concepts in small groups while speaking their own language with peers demonstrated improvements in their math communication abilities. Math centers provide the constructivist philosophy that young children learn best in. Problem solving and reasoning are at the heart of mathematics. Research and expert practice indicate that certain concepts are challenging and accessible for young students when taught in an appropriate environment.

Target Population

The setting for this project is any primary elementary classroom which serves ELL and Spanish-speaking students. The communities envisioned for the implementation of the project are located in the Central portion of Washington State. The school districts which will benefit most from the project have a large number of Native Spanish speakers from working-class family traditions. However, this project is appropriate for any classroom in need of scaffolded mathematic instruction based on a constructivist approach. This project is
designed to be used throughout the academic year. It allows teachers to use lessons either sequentially or thematically or to pull single lessons to meet the developmental needs of students within their classroom.

Description of the Project

In this project, teachers will find learning centers which can be used as individual or collective extension activities to complement their current math curriculum. The project is organized into four sections. These components include an inventory list, individual standards, literacy connections, and references for standards.

The inventory list includes an outline of consumable and non-consumable materials used to implement the center activities. These materials include items such as pattern blocks, unifix cubes, tanagram pieces, geoboards, and other manipulative objects. Photos of the materials are presented for teachers to reference these necessary objects.

The project also includes individual standards specific to the areas of Number & Operations, Geometry, Algebra, Data Analysis & Probability, Measurement, Communication, Connection & Representation, and Problem solving, Reasoning and Proof. Teachers can implement each of these thematic strands by utilizing the resources provided for each standard. These items include a bulleted list of the NCTM standards, individual lesson activities, student instruction cars, and blackline masters for instruction and assessment.
Each of the lesson activities were designed to integrate the TESOL, NCTM and Washington State GLE standards to allow teachers to choose centers or activities based on their needs. Individual lesson activities also include a list of desired student outcomes, necessary materials, steps required for teacher preparation, the procedures associated with the activity, and finally assessment options. Student instruction cards are available for all center activities. Student instruction cards are designed for children to use at centers written in student-friendly language. These cards may be copied onto heavy tagboard and laminated for added durability. Finally, each lesson activity includes a list of blackline masters for added instructional and evaluative purposes.

A teacher’s total curriculum can also be enhanced by the list of developmentally, linguistically, and culturally appropriate texts found within the literacy connection component to the project. This resource is composed of a series of suggested books specific to mathematical concepts and Mexican culture. This list incorporates picture books, as well as non-fiction and fictional texts. Finally, in the fourth section of the project, a list of standards from the NTCM, TESOL, and Washington State GLEs are provided for teachers and administrators easy reference.

Implementation Plan

The first month of school is spent establishing rules and procedures and introducing concept of centers. This time should be used to establish procedures
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direction. Students should all have a bilingual partner who will also serve as their
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Summary

With such enormous variability in young children’s development, it is vital that all students, especially children from linguistically diverse backgrounds and students with learning disabilities receive math education that is interactive, meaningful, and hands-on. Math education should not be narrowly defined as the transmission of a set of skills based on rote learning. Teachers must also orchestrate the classroom in ways that promote investigation and growth of mathematical ideas. Also, teachers need to understand that small group work allows students to use their language. This project meets the need for bilingual centers in which students are encouraged to communicate in both their languages.
Please note:

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The Project Chapter -
Pages PS 10 (or page 27) through the end of the chapter (166 total pages): Exercises have been redacted due to copyright concerns or restrictions.

Please also note: Chapter V and VI are not available for this pdf.