ME, ME, JUST LET ME DO IT!

THE IMPORTANCE OF ADDING SCIENCE PROCESS SKILLS AND HANDS-ON SCIENCE EXPERIENCES IN THE PRE-K CLASSROOM

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RESEARCH QUESTION

How will integrating science process skills and developmentally appropriate "hands-on" science activities in a Pre-K classroom improve student readiness skills for kindergarten?

What I really wanted to know was

- How would on task behavior increase?
- How would language comprehension and language skills increase?
- How would cognitive counting and cognitive matching skills increase?
- How would phonological skills increase?
- What would the impact of this intervention have on my English Speakers of Other Languages in my class?

RATIONALE

This action research study examined the impact of the integration of science process skills and developmentally appropriate hands-on science experiences on student readiness skills for kindergarten within the pre-kindergarten High/Scope Daily Routine. The researcher's hope was that the intervention would increase the students' levels of readiness skills for kindergarten.

From the minute a child is born, he has an innate drive to make sense of his world by tasting, touching, smelling, tasting, and hearing. These science process skills are developed in everyday life. Science becomes less of a struggle to students when science skills are introduced and developed at an early age. The early introduction of science process skills assist students in creating a lifelong interest in science that can translate into future studies and careers.

The rationale for this action research study was based on the critical needs of my students concerning their level of engagement in daily routines, lack of readiness skills evidenced in the pre-tests given at the beginning of the school year for phonological awareness, cognitive matching, cognitive counting, language comprehension, and language naming; and the number of English Speakers of Other Language (ESOL) students in my classroom lacking a viable "pre-school vocabulary." After collecting initial data about the level of my students' readiness skills and examining my reflective journal, I realized that I had three problems presenting challenges. The first problem was the age of the students in my classroom as the majority of students starting the 2006 school year would not turn five until after March of 2007. Secondly, the level of student engagement in our daily routines was low because of their maturity level. Most of the students did not like to participate in language activities. The last serious challenge was that their readiness skills were significantly lower than any of the past year's classes. As I looked back on my reflective journal I noted the students were most involved and enthusiastic on "Wacky Wednesday". Every "Wacky Wednesday" since the beginning of school during Discovery Time the students would participate in a developmentally appropriate "hands-on" science activity. More sharing would occur during small and large group discussion relating to these activities. The science vocabulary introduced during this time was being used during work time by the students in the block and writing areas. The answer to my problem seemed to be in creating a science oriented classroom. Matching pre-k students' natural curiosity with science process skills and planned science-based developmentally appropriate activities on a daily basis that included interactive story reading, child-interest driven activities, music, movement, oral language activities, and hands-on exploration activities, would increase the student level of on task behavior that would result in increasing the developmental pace of readiness skills. Science process skills are skills used across the curriculum such as attentive observation, object manipulation, classification, making predictions and the use of verbal, musical, and kinesthetic languages to describe the properties of manipulated objects. The objective of such activities would be increased student on task behavior in classroom daily routines. The readiness skills, concepts, and vocabulary developed in these activities especially by ESOL students would be a building block for future school success in developing good habits of mind.

Scientific awareness can begin in pre-kindergarten when children's curiosity and desire to learn are at a high point, and will be enriched in the following years. In my pre-kindergarten classroom it is common to hear "ME, ME, JUST LET ME DO IT!"

LITERATURE REVIEW

Pre-kindergarten students are natural scientists every day in observing people, animals, and objects in their environment. They informally conduct experiments, report and record their discoveries to their peers and significant adults in their lives. Oxford (1997) agrees "Piaget portrayed the child as a lone scientist, creating his or her own sense of the world. The individual will interpret and act accordingly to conceptual categories or schemas that are developed in interaction with the environment. The knowledge of relationships among ideas, objects, and events is constructed by the active processes of internal assimilation, accommodation, and equilibration" (p.39). The constructivist approach sees young children as active constructors of knowledge where learning emphasizes the process and not the product. Learning is a process of constructing meaningful representations, of making sense of one's experiential world. Science is sometimes thought of as the precise field of memorized facts that makes many teachers and students uncomfortable and is associated with activities that are often non-constructivist and developmentally non-appropriate in relation to young children. Science should be viewed as an ongoing part of the total curriculum woven into daily activities and routines. It is important to pair scientific concepts and science process skills with developmentally appropriate hands-on activities as a starting point for early childhood science education. Wasserman (1988) makes the distinction between what is important in teaching and learning science in a science environment. Learning science in a science environment is being in constant motion involving inquiry, exploration, and examination. These activities all require an action involving active experimentation, creativity, and problem solving in combination of children's interests. Teaching science is not just teaching the facts of science and expecting the students to memorize them. Haury (2002) who supports this view says "Observation in science is more than 'seeing'; it refers to skills associated with collecting data using all the senses, as well as instruments that extend beyond the reach of our senses, and it is influenced by assumptions and theoretical knowledge of the observer" (p.2-3). Chaille (1991) states "Scientists seeking to understand an unknown world by way of experiment, are continually doing the same things that we see children doing: having insights, asking questions, solving problems, tying new ideas. Scientists, like children do not simply apply systematic methods to answer predetermined questions. Scientists – filled with wonder and curiosity - are constantly puzzling, testing, and probing ideas just like children" (p.5). She also notes that there are characteristics of young children and scientists that are shared from a constructivist perspective of process of knowledge construction that are important for educators to consider: Young children are social beings and theory builders needing to build a foundation of physical knowledge. As their ideas mature, they become more independent, intellectual, and morally autonomous. The teacher's role is to be the question asker, encourager, environmental organizer, public relations manager, documenter of children's learning and theory builder. Schweinhart (1997) suggests that preschool programs that focused on child-initiated learning, activities contributed to students' short and long term academic and social development compared to programs based on teacher-directed lessons provided only a short-term advantage in academic development sacrificing a long-term contribution to their social and emotional development. On this basis, research supports a preschool curriculum approach based on child-initiated learning activities rather than on teacher-directed lessons. The role of teacher is not to dispense knowledge but to provide students with opportunities and incentives to scaffold learning. Teachers should be seen as "guides" and learners as "sense makers." Piaget's theory asserts that cognitive structures change through the processes of adaptation by assimilation and accommodation (Huitt & Hummel, 2003). Accommodation is the changing of the cognitive structure to make sense of the environment. Assimilation involves the interpretation of events in terms of existing cognitive structure. According to Piaget's theory, cognitive development consists of a constant effort to adapt to the environment in terms of assimilation and accommodation. Learning activities should involve problems of classification, ordering, location, and conservation using concrete objects. The principles of his theory include how children will provide different explanations of reality at different stages of cognitive development.

Cognitive development is facilitated by providing activities or situations that engage learners and require adaptation (assimilation and accommodation). Learning materials and activities should involve the appropriate level of motor or mental operations for a child of a given age and avoidance of asking students to perform tasks that are beyond their current cognitive capabilities. At the preschool level, as part of learning new concepts, new vocabulary, and building on previous experiences, "hands-on" experiments are an important strategy along with developmentally appropriate activities. "The most effective learners are actively engaged in learning through observing, reading, and experimenting" according to Minnick-Santa and Alvermann (1991, p7). Teachers should use teaching methods that actively engage students' curiosity and present challenges, providing students a wide variety of concrete experiences to help the child learn (use of manipulatives, working in groups to get experience in seeing from another's perspective, field trips). Tobin & Fraser (1990) supports that learning science implies direct experience with objects as the process of knowledge construction is elaborated and continuously changed as the experience is negotiated with peers and teachers.

Viewing early learners as active scientists has evolved with the establishment of Project 2061 in 1985, the AAAS initiative for science reform in grades K-12 and with the definition of the concept of science literacy in 1989. *The Benchmarks for Science Literacy* (1993) outlined what all children should be able to do in science by the end of grades 2, 5, 8, and 12. The document *National Science Education Standards* (1996) defined standards for children at each grade, kindergarten through high school. In 1998, the National Research Council and the American Association for the Advancement of Science jointly published *Dialogue on Early Childhood Science, Mathematics, and*

Technology Education that reinforces the idea that children learn science best when science is presented through “hands-on” meaningful and relevant activities. The National Research Council suggests students in the earliest grades should be expected to use simple tools-magnifiers, thermometers, and rulers-to gather data and learn what constitutes evidence. Conezio and French (2003) point out that science for young children should focus on the world in which children live. Science should be an integrated part of the curriculum rather than an isolated subject and they make a case that science should be used as a foundation to teach language and literacy skills.

According to the NAEYC, social and culturally appropriate preschool programs are defined as developmentally appropriate programs (DAP) that contribute to children’s development by influencing the development of children’s knowledge in physical, social, emotional, and intellectual areas. Bredekamp and Copple (1997) reinforce the idea that children can best learn science when it is presented through “hand-on” meaningful, and relevant activities. The teacher’s role is to prepare the environment and provide guidance and support. Developmentally appropriate practices are both age and individually appropriate in reference to the child (Aldridge, 1992; Bredekamp 1987; Bredekamp & Rosengrant, 1992; Charlesworth, Harat, Burts, & DeWolfe, 1992; Galen, 1994; Gestwicki, 1995). Child-centered learning is the most essential element of DAP classrooms. Classrooms characterized by child-initiated activities appear to facilitate children’s creative development. The Hyson research team found that children in child-initiated classrooms scored higher on measures of creativity (divergent thinking) than children in academically oriented classrooms (Hirsh-Pasek Hyson, & Rescoria, 1990.; Hyson, Hirsh-Pasek, & Rescoria, 1990). Higher levels of cognitive functioning are also associated with DAP classrooms as evidenced in research revealing better verbal skills (Marcon, 1992), better receptive language (Dunn, Beach, & Kontos, 1994), overall higher reading and mathematics scores (Sherman and Mueller ,1996), and more confidence in the students own cognitive skills (Mantzicopoulos, Neuharth-Pritchett, and Morelock, 1994).

Furthermore, when science process skills are emphasized in the classroom, student proficiency on individual skills increases, some skills are transferred to new situations, and the skills are retained over time (Padilla, 1990). Padilla suggests that basic science process skills provide a foundation for more complex science process skills. These basic science skills are observing, inferring, measuring, communicating, classifying, and predicting. More complex science process skills are identifying variables, defining operations, formulating hypotheses, interpreting data, experimenting, and formulating models. Padilla affirms that as teachers we cannot expect students to develop the more complex skills if students are not provided the opportunity to practice the basic skills. According to Mancinelli, Gentili, Priori, and Valuitutti (2004), the key to effective thinking is evocation, through evocation the student uses his own mental resources slowly and repetitively building meaning of what he sees, hears, smells, and touches. Evocation involves responding, questioning, drawing out facts to make conclusions about information. The student can then voluntarily and mentally reconstruct all perceptions coming through the senses using oral and written language, especially in group discussions and writing through concept maps. These effective mental habits can be used by the student every day. Examples of meaningful learning in which children's intellect as well as growing academic skills flourish can be seen in the schools found in

Reggio Emilia, Italy (Reggio Children, 1997). Here young children can express their previous knowledge in the pursuit of serious topics and apply their emerging academic skills to generate high-quality products simultaneously.

One of the benefits of learning science and science process skills in a developmentally appropriate classroom and in implementing the constructivist pedagogies is in the area of social growth. Students, along with their teachers, co-construct knowledge as they solve problems. Brain research is confirming what many teachers already know: when learning is linked to real-life experiences, students retain and apply information in meaningful ways. Good habits of mind are developed when students sense and experience meaningful science activities and are provided opportunities to theorize about causes and effects, to hypothesize explanations to account for observations and to analyze and synthesize whatever information is available (Katz,1999). Social and emotional growth is seen as children are engaged in investigations of things around them in the course of which they persist in seeking answers to their questions, and solutions to the problems they encounter. Vygotsky's Cultural-Historical Theory is "the idea that child development is the result of the interactions between children and their social environment. Children are active partners in these interactions, constructing knowledge, skills, and attitudes and not just mirroring the world around them" (Leong & Bodrova, 2001, p.1). The interactions include those with teachers, classmates, peers, and family members along with any significant objects and culturally specific practices of the children. In theory of the Zone of Proximal Development (ZPD) learning could lead a child's development if it occurred in the child's ZPD. The ZPD contains the edge of emergence skills and concepts if given appropriate support by those around him. ZPD on a pre-kindergarten level may take place in the form of dramatic play whereas on an older child's level formal instruction. The range of skill and concept development depends on the teacher as a guide and ample experience with peers. According to ZPD theory, social interaction individually and collectively plays a role in the development of cognition.

The High/Scope Approach used for this research project was consistent with the constructivist and developmentally appropriate pedagogies. The High/Scope Approach advocates a child centered curriculum. The consistent daily routine establishes consistent times for children to plan, carry-out, reflect upon, and share activities; engage in large and small group activities, share meals and snacks, clean-up the classroom and play outdoors. Children have opportunities to make choices and work with materials in their own ways interacting spontaneously with adults and peers. Teachers and paraprofessionals are trained to write daily, objective notes (key notes) on what children say and do. The High/Scope's Key Experiences provide the framework the teacher uses to plan activities and observe students as they encounter and understand their world. Ten major categories represent the Key Note Experiences: creative representation, language and literacy, initiative and social relations, movement, music, classification, seriation, number, space and time." High/Scope emphasizes children's thinking and reasoning with a problem solving approach to develop analytic and reasoning skills while at the is an example of the correlation of science process skills to the High/Scope Key Experiences. (Appendix A)

BACKGROUND/CONTEXT

Biscayne Gardens Elementary School is located in a diverse, urban community, classified as a Title I school where 87% of the students are on free/reduced lunch fees. In our school learning community, Creole is the predominant home language. The sample in this project is a Miami-Dade County Public Schools Voluntary Pre- Kindergarten (VPK), classified Title I, and using High/Scope Curriculum. The class profile of the 18 pre-kindergarten students in this research project is 39% Creole, 33% Black-Non-Hispanic, 22% Hispanic, and 6% Multi-racial (Anglo-Hispanic); 61% are ESOL; 12% are special education students and 22% are in the Speech Program.

THE INTERVENTION

After collecting my initial data about the level of my students' readiness skills and examining my reflective journal, I decided to create a science-oriented environment. By capitalizing on the children's interests and questions, science process skills were integrated into daily routines, the literacy program, and "Wacky Wednesday" activities. The High/Scope Curriculum set the stage for developmentally appropriate and child-initiated projects.

The basic science process skills were emphasized throughout activities that the students were involved as a part of the daily routines. The teacher, paraprofessional, and volunteer used a list to assist them in integrating the process skills throughout the day (Appendix B). The more the teacher became familiar with the skills the easier it was to integrate science process skills into the curriculum. For example, observing using the senses to gather information about objects or events was integrated at work time and during recall time. Inferring, making an educated guess about an event or object and predicting outcomes, was integrated into story time. Communicating using words and/or graphics was used during all the daily routines. The pre-k children learned to develop and use concept maps with symbols and words to describe their observations. Classifying, grouping ordering objects and events into categories based on properties and attributes was integrated during clean-up time. Integrated higher level science skills were developed during "Wacky Wednesday" activities.

"Wacky Wednesday" occurred every Wednesday afternoon as developmentally appropriate "hands-on" science experiences were implemented (Appendix C). Science vocabulary derived from the activity was introduced and integrated into the daily routines (Appendix D). Small group discussion occurred after each session allowing children in their own language an opportunity to express what they observed. Literacy and Language activities in large and small groups were correlated to the "Wacky Wednesday" activity. Concept maps were introduced and used by the teacher and student as a way of communicating the development of science concepts. Music and movement activities were correlated with the science concept being taught. Supporting science music and movement activities were used on a daily basis. Opportunities to observe and explore nature objects were made available for the students. Simple tools (pulleys, hands lens) and equipment were introduced and provided for use. Everyday events (weather, insects) were used to help children learn about nature and students were encouraged to make comparisons as these statements represented how young children made conclusions from their observations. Books about nature and science were placed in the book corner, centers and on the science table. Selected types of media (online resources and movies) were used to introduce and develop science concepts.

Creating a science environment by integrating science into the pre-kindergarten classroom daily provided the opportunity for my students to individually develop their readiness skills for kindergarten.

DATA TOOLS

Base line data tools used for this research project were the Phonological Early Learning Inventory pre and post tests (PELI) and the Learning Accomplishment Profile Diagnostic (LAP-D) pre and post subtests: Cognitive Counting, Cognitive Matching, Language Naming, and Language Comprehension.

The PELI was administered in October and in May. ESOL I and II students were not tested on the PELI pre-test in October. The PELI is a pre and post inventory administered individually by the teacher to each preschool student in Miami-Dade County Public Schools Voluntary Pre-Kindergarten Program (VPK) to evaluate the student's language and literacy progress and to assist in program planning.

The LAP-D Subtests were administered in November and May. The LAP-D Standardized Assessment, a norm-referenced and criterion-referenced instrument, was used because it provides a developmental assessment of two major developmental areas: cognitive and language relating to the research question. The purpose of the assessment is to assist in program planning and to design intervention strategies. The assessment is appropriate for children 30-72 months and the items range from six months to 72 months. The LAP-D test measures children's development in terms of Age Equivalent Growth (AEG). Age Equivalent Growth (AGE) is the result of the LAP-D test showing developmental age in months that the child is performing in cognitive and language skills.

Qualitative Data was collected from teacher lesson plans, the teacher’s reflective journal, student’s work, and daily key notes (anecdotes) used in the High/ Scope Program. Key notes were taken by the teacher, paraprofessional, student teacher, and volunteer.

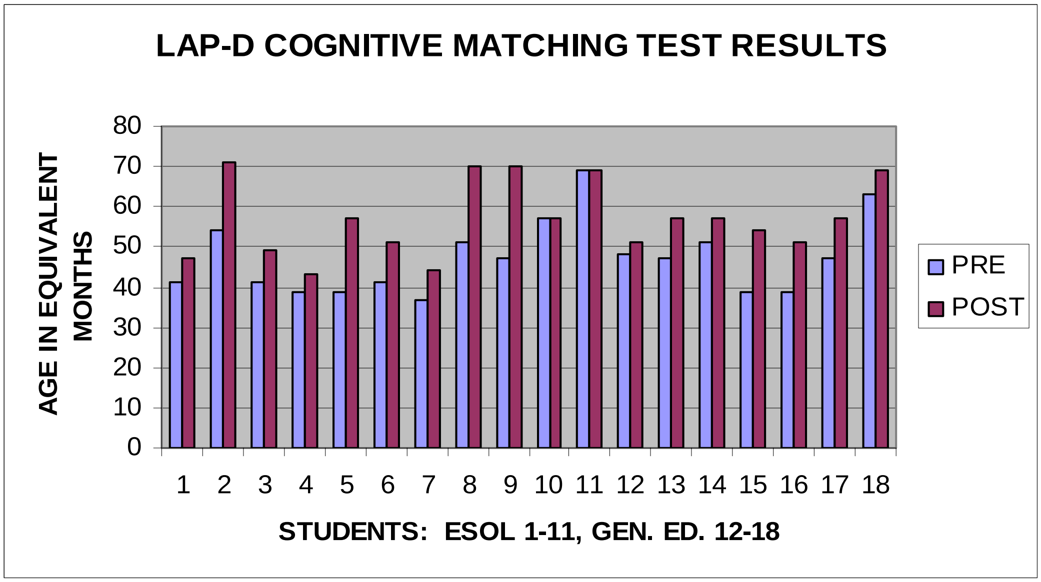
QUANITATIVE DATA RESULTS

CLASS LAP-D RESULTS INCLUDING ESOL STUDENTS

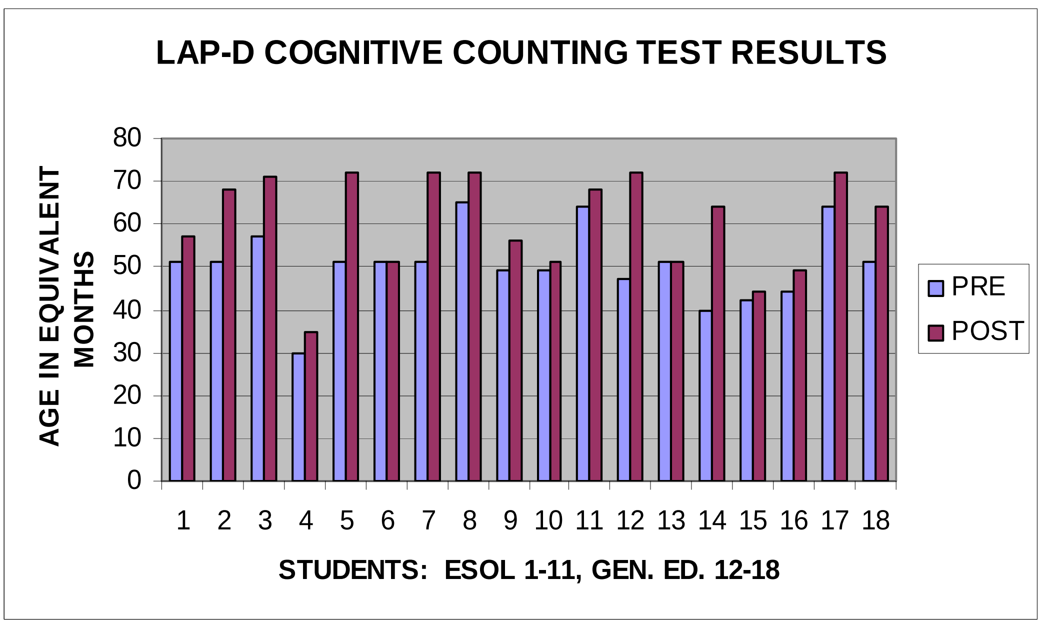
Overall, the Post LAP-D subtests showed interesting results over a period of six months:

- All the students in the class increased 6 months or more in Age Equivalent Growth (AEG) even though some remained behind their own age level
- Some ESOL and ESE students showed an increase of 16 months or in AEG
- Four speech students as a subgroup showed significant AEG gains in language comprehension and language naming
- Twelve students were at their own AEG or higher.

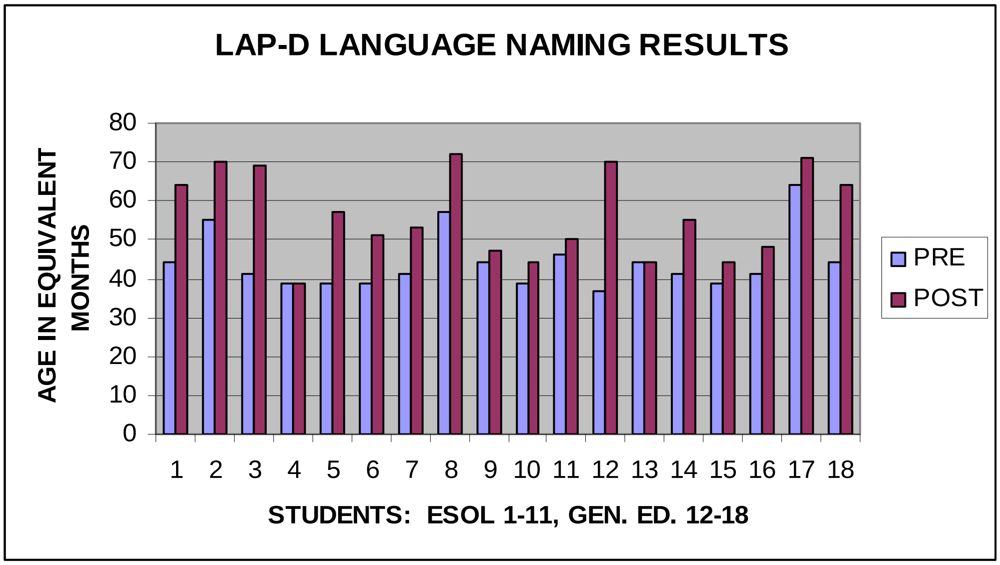
The Cognitive Matching Post-Test revealed that 11 students scored an increase of 6 months or more of age equivalent growth (AEG) with a range of 6 to 25 months and a mean score of 9 months AEG.



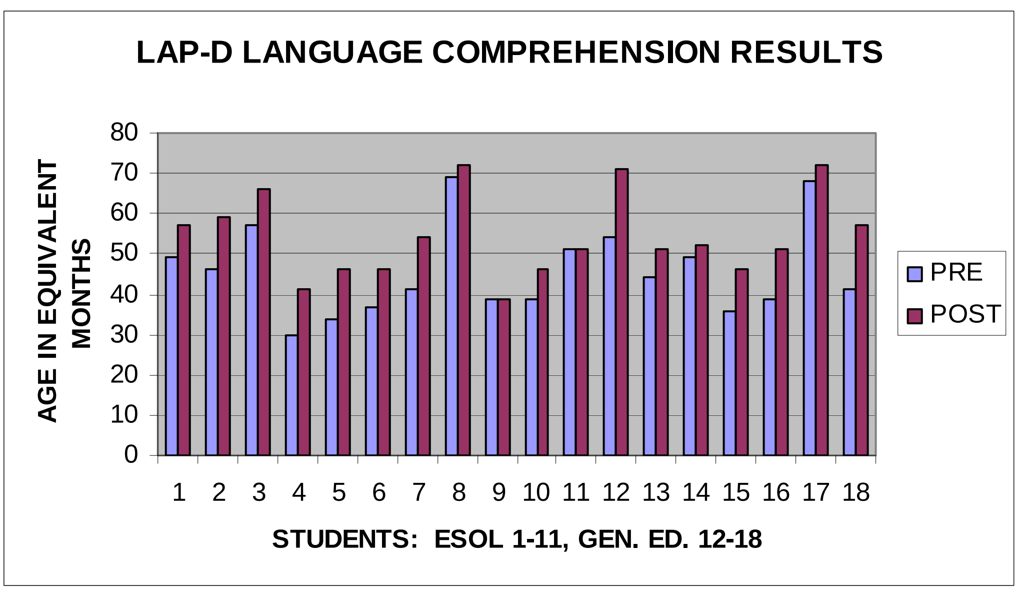
The Cognitive Counting Post-Test revealed that 12 students scored an increase of 6 months in AEG with a range of 6 -25 months and a mean score of 9 months AEG.



The Language Naming Post-Test revealed that 12 students scored an increase of 6 months in AEG with a range of 6 to 31 months and a mean score of 13 months AEG.



The Language Comprehension Post Test revealed that 14 students scored an increase of 6 months in AEG growth with a range of 6 to 16 months and a mean score of 8 months AEG.



ESOL LAP-D RESULTS

Before this research began, nine ESOL students tested below their AEG and two tested at their AEG. After the sixth month intervention, four ESOL II and III students made six months of progress but still remained below their age level. The seven remaining ESOL students stayed on or above their age level. Of the four students who tested below their age level on the pre and post test, the gap between where they were and actual age level has narrowed. The significant gains in AEG of over 16 months were in ESOL III and IV students.

The AEG increase in post-mean scores for Cognitive Matching in ESOL students was ten months. Five ESOL students had a post-mean score of fourteen months difference below their actual age level. Four ESOL students scored above their age level and two students scored on age level.

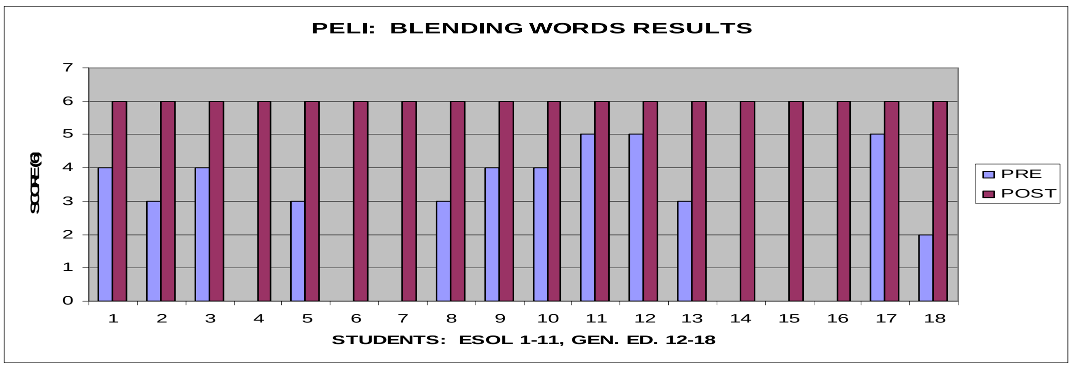
The AEG increase post-mean scores for Cognitive Counting in ESOL students was eight months. Four ESOL students had a post mean score of five months difference below their actual age level. Six ESOL students scored above their age level and one student score on age level.

The AEG increase post-mean scores for Language Naming in ESOL students was twelve months. Six ESOL students had a post-mean score of 13 months difference below their actual age level. Four ESOL students scored above age level and one scored on age level. The AEG increase post-mean scores for Language Comprehension in ESOL students was seven months. Eight ESOL students had a post mean average of nine months below their actual age level. Three ESOL students scored above grade level.

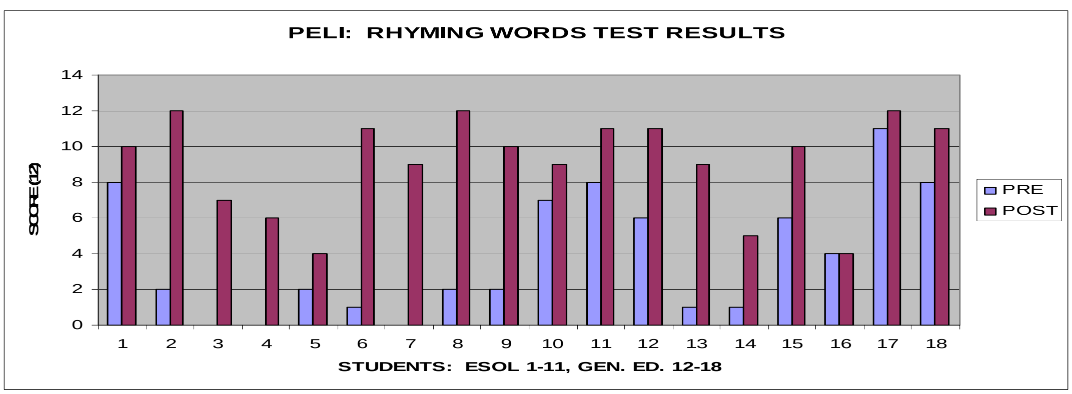
PELI CLASS RESULTS INCLUDING ESOL STUDENTS

Over six months the pre-post PELI scores revealed a 44% class average increase in upper and lower case letter identification. There was over 50% class average increase in these test components: Word Awareness, Rhyming Words, Concept of Print, Segmenting, and Alliteration. Students 4 and 7 were not given the pre-test because they were ESOL Levels I and II.

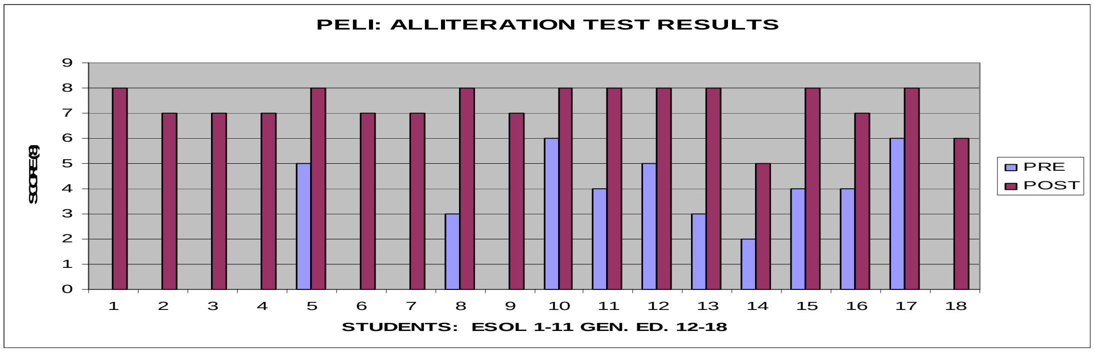
- The post-mean score for Blending was six on a scale of six for both the ESOL group and the entire class from the pre-test mean score of two and four respectively.



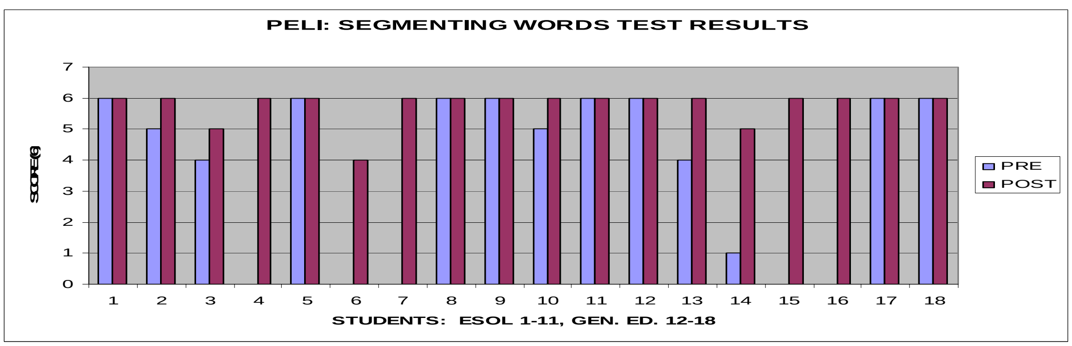
- The post-mean score for Rhyming Words was nine on a scale of twelve for both the ESOL group and the entire class increased from the pre-test mean score of two and four respectively.



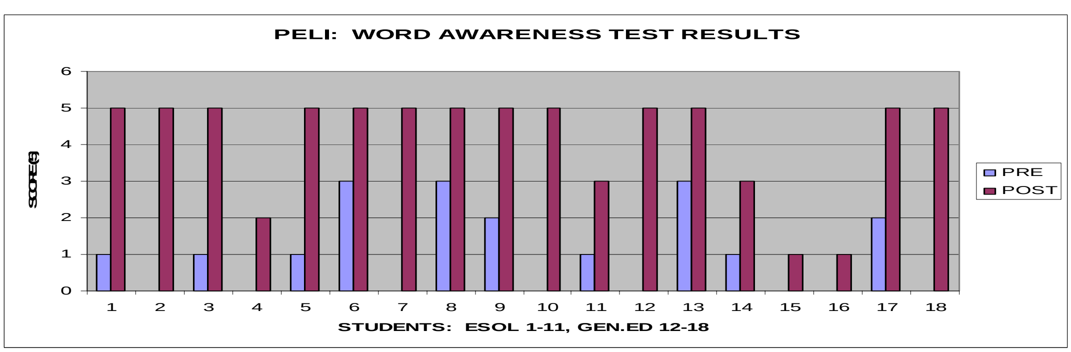
- The post-mean score for Alliteration was seven on a scale of eight for both the ESOL group and the entire class increased from the pre-test mean score of two for both groups.



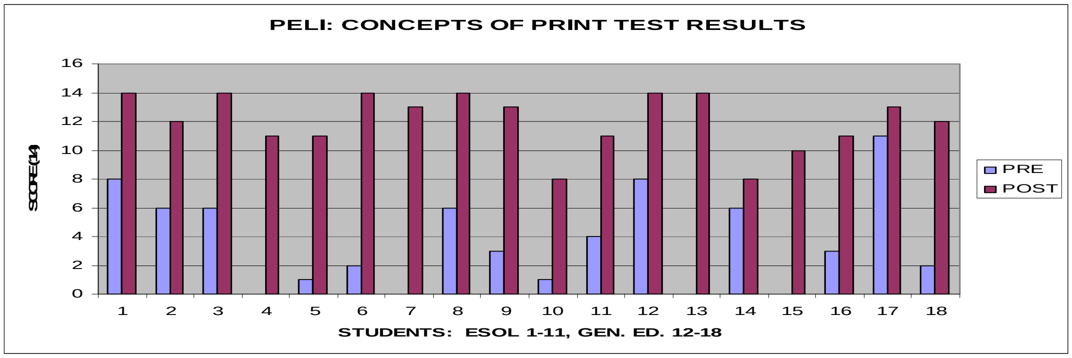
- The post-mean score for Segmenting was six out of six for both the ESOL group and the entire class increased from the pre-test mean score of four and five respectively.



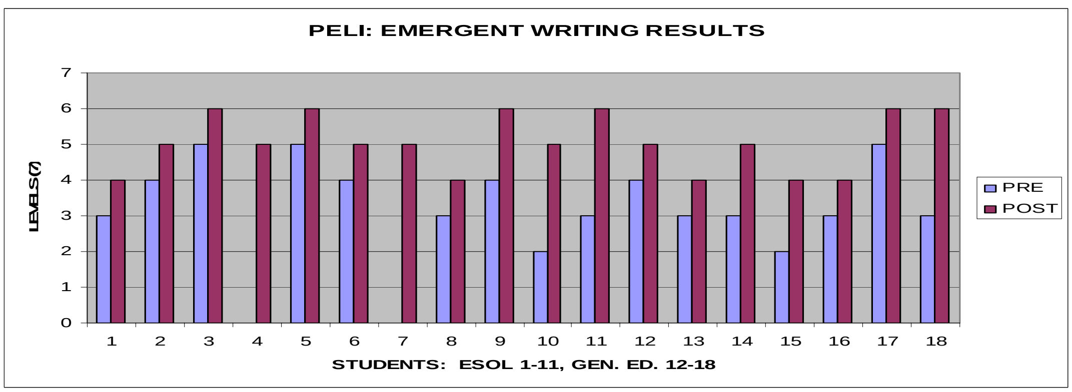
- The post-mean score for Word Awareness was four out of five for both the ESOL and the entire class from the pre-test mean score of one for both groups.



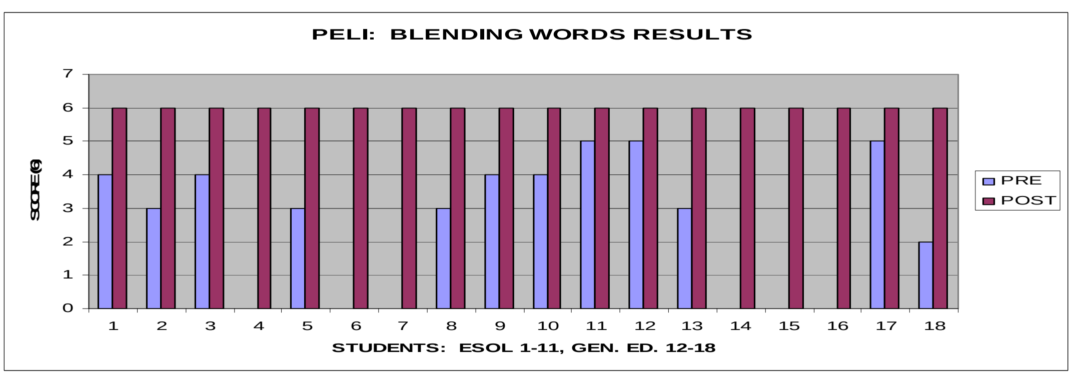
- The post-mean Concept of Print results rose to 12 from three points. The post-test ESOL scores for Concept of Print were higher than the general education population.



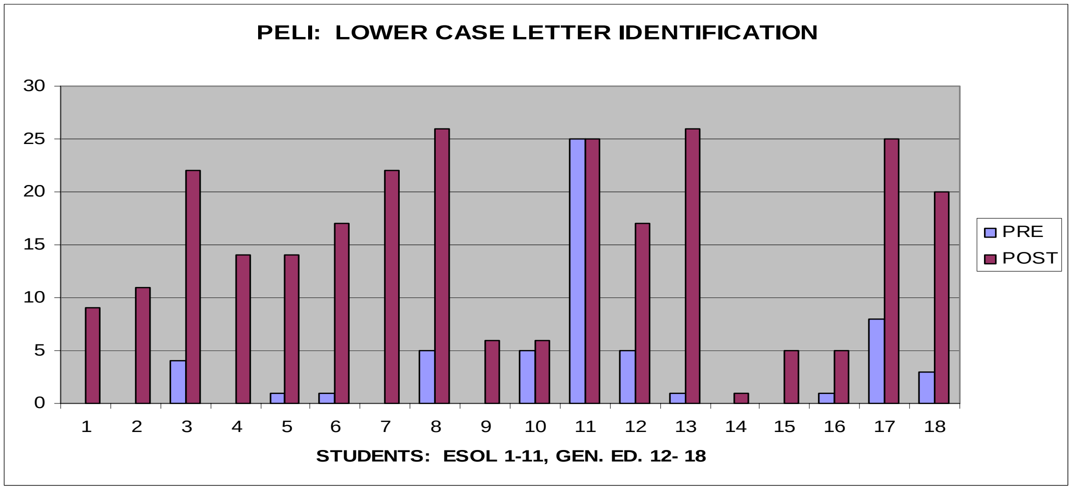
- The post-mean Emergent Writing levels rose to level five from level three.

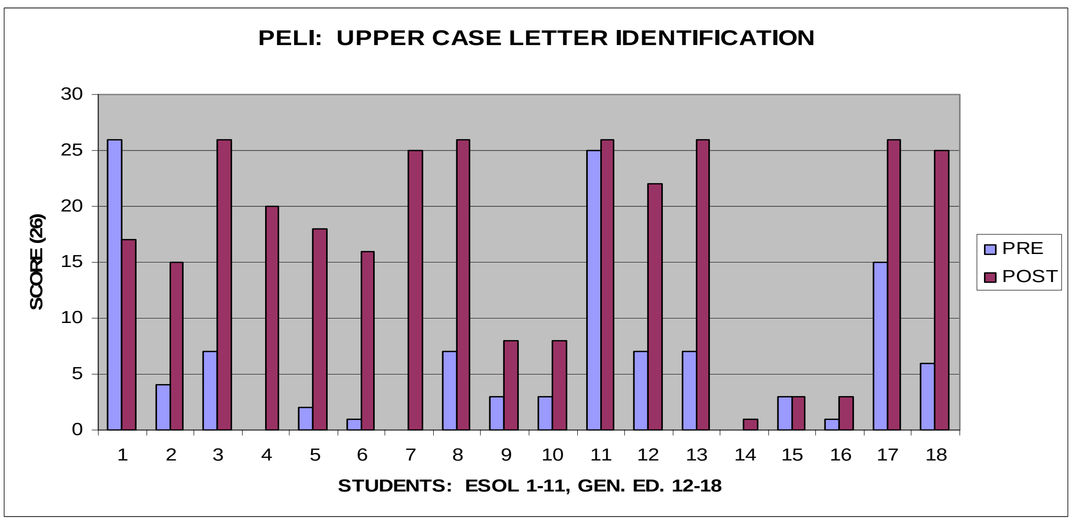


- The entire class scored 100% on the post test Blending.



- Lower and upper case letter identification results showed the ESOL students out performed the general education population.





No child fell further behind from the pre-post PELI tests. In fact, all children previously performing below their age level narrowed their individual gap and many children performing at or above age level increased their individual performance above age level.

ESOL PELI RESULTS

ESOL I and II students (ESOL Student ID number 4 and 7) were not given the Pre-PELI test at the beginning of the intervention because of Miami-Dade County School Board VPK policy. The ESOL pre-post PELI outcomes for the other nine students (mean, mode, median) were higher than the general education population in Alliteration, Blending, Segmenting, Word Awareness, Rhyming and Emergent Writing components.

QUALITATIVE DATA RESULTS

More on task behavior was noted by the adults observing in the classroom during hands-on science activities and during large/small discussions.

The adults noted that there was a transfer of vocabulary into other daily routine activities. During work time in the block area, as Leslie tied yarn to the front of his truck he was heard saying “I will pull my truck to Canada. It won’t take a bunch of force to pull it instead of push it.” At outdoor play Kaia said “Oh look! Water is a force! It pushes the dirt out of the way when I pour it out of my bucket on the sidewalk. It mixes and makes mud. It is wet now.” Observing an insect outdoors with a hand lens, Jeremy was heard telling a classmate “I know it’s an insect. Look it has six legs, wings, and antennas! Spiders have eight legs and this don’t have eight legs.”

LAP-D AND PELI ANALYSIS

The strengths in the gains of age equivalent growth in the LAP-D post-test suggested that developmentally appropriate “hands on” science activities and the inclusion of science process skills throughout the pre-kindergarten daily routines positively impacted student readiness skills for kindergarten. With six months of intervention, many students showed AEG for six months or more on the subtests.

The PELI post-test outcomes suggested that the regular education and ESOL population are performing at a similar level. Both groups benefited from the intervention and brought the ESOL students level up to the regular education level when the group began at a deficit. The lower ESOL Concept of Print scores may have been the result of the lack of books and reading experiences at home.

Developmentally appropriate activities engaged children at their interest level resulting in more student attending behavior. Providing students with appropriate science vocabulary and opportunities to reflect in concept mapping, cooperative activities, and participation in discussions allowed students to build understanding of scientific concepts. Every student’s social and emotional growth was positively impacted by the process.

The developmentally appropriate science activities included content, scientific processes, and scientific processes of mind. At first it was difficult identifying where I could build a greater focus on these components. With practice it became much easier to use these activities to support specific language, literacy and mathematic key experiences during the daily routines to create a science environment.

Many parents made unsolicited positive comments on the interest the students were showing at home in observing and classifying objects as the child would explore materials in the home environment. In the future, I will publish parent newsletters with the science vocabulary, science process skills, and hands on science experiences on a monthly basis. Parents will be invited to our "WACKY WEDNESDAY" experiences. Connecting the school with home learning experiences is expected to enhance the intervention.

Pre-kindergarten is a perfect time to begin introducing students to scientific ethics. It is never too early to focus on how important it is to make accurate observations, along with teaching that it is all right to make mistakes - trial and error is an opportunity for learning, and opportunity to investigate things for ourselves. If we are willing to correct our mistakes and reinvestigate, a new discovery can be made. Integrating science process skills and developmentally appropriate "hands-on" science activities in a pre-k classroom does not only improve student readiness skills for kindergarten but improves emotional and social skills as well.

CONCLUSION

Daily integrating science process skills and developmentally appropriate “hands-on” science experiences into a constructivist preschool classroom had an impact on students’ readiness skills for kindergarten, especially with ESOL students. The intervention appeared to reach through and transcend all cultural and language barriers by taking hold of and focusing on a child’s innate nature to make sense of his world as he is developmentally capable. This conclusion suggests future research is needed in developing science oriented pre-kindergarten classrooms. This intervention would be useful in developing individual pupil progression plans for foreign born students.

At the same time with the same intervention, students who are on age level are provided opportunities to excel in the age equivalent growth. It is an acceleration strategy enabling all students to maximize their age equivalent growth impacting the development of readiness skills.

It is important that teachers have the resources and training to implement this intervention. A resource book which provides the methods and procedures for creating developmentally appropriate “hands-on” science experiences for the pre-kindergarten classroom would be invaluable.

POLICY RECOMMENDATIONS AND IMPLICATIONS

Hands-on science activities and the integration of science process skills had a positive impact on student's readiness skills by increased student attending behavior, observed science process skill transfer into other subject areas, an accelerated increase in age equivalent growth in cognitive and language development along with an accelerated increase in phonological awareness skills. Children should engage in meaningful hands-on developmentally appropriate activities and use science process skills. Children should be doing what best serves their development and learning in the long term.

The Miami Dade Public School System through the State's Voluntary Pre-K Program (VPK) has added a new component to the High/Scope Daily Routine called Discovery Time. This new component is an excellent opportunity to utilize children's natural curiosity and interests in planning meaningful developmentally appropriate science experiences. Science process skills and meaningful science activities can be integrated into the routines of the High/Scope Daily Routines to build readiness skills in reading and math. Examples of meaningful long-term projects in which children's intellects and growing academic skills flourish can be seen in Reggie Emilia, Italy (Reggio Children, 1997). Young children can express their intellectual nature in the pursuit of serious topics and apply their emerging and academic skills generating high quality products simultaneously.

Furthermore, it is important for teachers to take the time to reflect upon their own science teaching. We should ask questions of ourselves: Are the new materials presented for student memorization or assessment purposes rather than providing students an opportunity to make sense of it? Has there been an opportunity for the student to use prior knowledge and their senses to make new connections with the new concepts introduced? How can our teaching practices be changed so students can reflect and synthesize their experiences? What kind of open-ended questions should we be asking? Yager (1991) says science classrooms have ten characteristics where the constructivist model works best:

- Use student identification of problems with local interests and impact as organizers for the course
- Use local resources as original sources of information that can be used in problem resolution
- Involve students in seeking information that can be applied in solving real-life problems
- Extend learning beyond the class period, the classroom, and the school
- Focus on the impact of science on each individual student
- Refrain from viewing science content as something that merely exists for students to master on tests
- De-emphasize process skills as the "special" skills that should be mastered because they are used by practicing scientists
- Emphasize career awareness-especially careers related to science and technology
- Provide opportunities for students to perform in citizenship roles as they attempt to resolve issues they have identified
- Demonstrate that science and technology are major factors that will affect the future.

Let us not forget that support should be given to train and prepare pre-kindergarten teachers in planning developmentally appropriate hands-on science activities and integrating science process skills with the daily routine. Many pre-kindergarten teachers are not familiar with utilizing process skills throughout the daily routine. Teachers need a basic understanding of science inquiry and their own reflective processes with a familiarity of science concepts before they can develop a science learning environment. A science learning environment is one where the teacher is a question asker, encourager, environment organizer, public relations manager, documenter of children's learning, and theory builder. A teacher has to successfully experience the excitement of exploration and observation before she can take it to the classroom. When the constructivist perspective permeates the classroom, conceptual changes in thinking, learning, and teaching can take place.

There has been little action research on the impact of utilizing science process skills and developmentally appropriate science activities in pre-kindergarten. Research is needed in the area of assessing the impact of accelerating the increase in age equivalent growth, improvement in readiness skills for kindergarten and increasing on task behavior in the classroom.

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APPENDICES

Appendix A

State of Florida Sunshine State Standards
Correlation of High/Scope Key Experiences to Sunshine State Standards Grade: PreK-2 (excerpt)

Sunshine State Standards Grade PreK-2 The Nature of Science	**High/Scope Key Experiences for Preschool Children Relationship of High/Scope Key Experiences to the Sunshine State Standards The Nature of Science**
Standard 1: (SC.H.1.1) **The student uses the scientific processes and habits of mind to solve problems.** 1. Knows that in order to learn, it is important to observe the same things often and compare them. 2. Knows that when tests are repeated under the same conditions, similar results are usually obtained. 3. Knows that, in doing science, it is often helpful to work with a team and to share findings with others. 4. Knows that people use scientific processes including hypotheses, making inferences, and recording and communicating data when exploring the natural world. 5. Uses the senses, tools and instruments to obtain information from his or her surroundings.	• Exploring and describing similarities, differences and the attributes of things • Recognizing objects by sight, sound touch, taste, and smell • Imitating actions and sounds • Relating models, pictures, and photographs to real places and things • Creating and experiencing collaborative play • Talking with others about personally meaningful experiences • Describing objects, events, and relations • Experiencing and comparing time intervals • Anticipating, remembering, and describing sequences in events
Standard 2: (SC.H.2.1) **The student understands that most natural events occur in comprehensive, consistent patterns.** 1. Knows that most natural events occur in patterns.	• Exploring and describing similarities, differences and the attributes of things • Describing objects, events, and relations
Standard 3: (SC.H.3.1) **The student understands that science, technology, and society are interwoven and interdependent.** 1. Knows that scientists and technologists use a variety of tools (e.g., thermometers, magnifiers, rulers, and scales) to obtain information in more detail and to make work easier.	• Describing objects, events, and relations • Recognizing objects by sight, sound touch, taste, and smell

Appendix B

The Science Process Skills by Padilla (1990)

BASIC SCIENCE PROCESS SKILLS	DEFINITION/EXAMPLE
OBSERVING:	Using the senses to gather information about an object or event. Example: describe yellow.
INFERRING:	Making an "educated guess" about an object or event based on previously gathered information. Example: She makes lots of mistakes because her eraser is used up.
MEASURING:	Using either standard and nonstandard measures or estimates to describe the object or event. Example: using a ruler to measure the height of a plant.
COMMMUNICATING:	Using words or graphic symbols to describe an action, object or event. Example: drawing a concept map.
CLASSIFYING:	Grouping or ordering objects or events into categories based on properties or criterion. Example: Placing all the cubes that are the same color together.
PREDICTING:	Stating the outcome of a future event based on a pattern of evidence.
INTEGRATED SCIENCE PROCESS SKILLS	
DEFINING OPERATIONALLY:	Stating how to measure a variable. Example: the plant growth will be measured in inches.
FORMULATING HYPOTHESES:	Stating the expected outcome of the experiment.
INTERPRETING DATA:	Organize data and draw conclusions from it. Example: read and analyze a graph
EXPERIMENTING:	Being able to conduct an experiment and the parts of an experiment.
FORMULATING MODELS:	Create a mental or physical model of a process or event.
CONTROLLING VARIABLES:	Identify that variables can affect an experimental outcome.

Appendix C
Integrating Science in Curriculum Areas

TOPIC EXAMPLES	ACTIVITY EXAMPLES	SUNSHINE STATE STANDARDS
How do you make mud?	"Mrs. Wishy Washy" Sand Table Water Play Concept maps	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1; ALL THE LANGUAGE ARTS
Exploring Pattern Blocks	Introduce patterns Exploring pattern blocks "Mr. Noisy's Patterns" Patterns on clothing Patterns in nature Sorting by color Sorting by shape People patterns	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1; ALL THE LANGUAGE ARTS
Exploring Cuisenaire Rods	Exploring rods Sort by color Arrange by size What ways can you make an orange block? Make pattern trains	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS
Exploring Insects: Butterflies Ladybugs	Observation Drawing in journals Attributes of Insects Raising caterpillars to become butterflies Life cycle Collection in the bug jar Compare and contrast to other critters "The Grouchy Ladybug" "The Very Hungry Caterpillar"	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS
Exploring Spiders	"The Very Busy Spider" Ananzi Stories Attributes of Spiders Observation of spiders Making spiders Compare and contrast to insects Different kinds of spiders	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS
Exploring Trees: Apple Orange Mango Avocado Pine	Foss Kit on trees Tree books Parts of a tree Sort leaves Attributes of trees	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS
Exploring Birds	Attributes of birds Observation Colors "Are You My Mother?" 'A Mother for Choco" Compare and contrast to other animals we know Sort by size and color Field trip to Parrot Jungle	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS
Exploring Amphibians: Frogs Toads	Attributes of amphibians Over in the Meadow Raising tadpoles	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1; ALL THE LANGUAGE ARTS
How do you make Bubbles?	Bubble experiment	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS

How do you make Butter?	Butter experiment	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1; ALL THE LANGUAGE ARTS
Exploring Colors	Jello Experiment Rainbows Art area Prisms Color paddles Mixing colors "The Monster Party" M&M count	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS
Exploring seeds: Beans Pumpkins Watermelon	Soaking and examining seeds with hand lens. Sorting seeds by size, type, and color Growing seeds "Pumpkin,Pumpkin" "Jack and the Beanstalk"	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS
Exploring our 5 senses: Touch Taste Smell Sound Sight	Aliki's "The 5 senses" Taste Party Mystery touch Box Sort and Classify Loud and quiet noises "Arthur's Glasses" 5 senses experiments	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS
Exploring magnets	Magnet Races What can a magnet attract Cereal experiment Magnet Experiments Observation	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS
Exploring fruit and vegetables: Green beans Watermelon Oranges Apples Pineapples Peas	Fruit and Vegetable. Party Sort and Classify? How do we grow? Attributes of fruits and vegetables. Healthy diet	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS
Exploring Actions and Reactions	Bottle Rockets Force-fast and slow Push and Pull body	SC.A.1.1.1,2,3;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1; ALL THE LANGUAGE ARTS
Hot and cold	How does fat keep us warm? Experiment How do you make ice cream? Jello experiment Candy melt Ice melt	SC.A.1.1.1,2,3; SC.B.1.1.4,5;SC.H.1.1; SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1
Exploring force: Push and pull Water Air	Magnets Balloons Experiments Kites Wind Water play Push and Pull Body	SC.A.1.1.1,2,3; SC.C.1.1.1,2;SC.C.2.1.1,2; SC.H.1.1;SC.H.2.1;SC.H.3.1;PE.A.2.1;PE.B.2.1; PE.A.1.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS
Weather and Weather words	Calendar activities	;SC.H.1.1;SC.H.2.1;SC.H.3.1; MU.A.1.1;MU.E.1.1;VA.E.1.1;HE.B.3.1; MA.E.2.1;MA.E.1.1;MA.E.3.1;MA.B.1.1;MA.B.2.1; MA.B.3.1;MAB.4.1 ALL THE LANGUAGE ARTS

Appendix C
Integrating Science in Curriculum Areas

Appendix D

PRE-K SCIENCE VOCABULARY WORD

(FROM MDCPS PRE-K TO 2NG GRADE CBC)

INTRODUCTION TO SCIENCE AND SCIENCE PROCESS SKILLS

Particle	Whole	Part	Pieces	Invisible	Energy	Measure	Nutrition
Diet	Heat Energy	Light Energy	Melt	Hot	Warm	Cold	Cool
Shade	Food Groups	Shadow	Sunlight	Position	Rotate	Moon	Stars
Clouds	Sunny	Cloudy	Rainy	Overcast	Patterns	Windy	Chilly
Sun	Planets	Sunlight	Air	Food	Water	Shelter	Space
Die	Basic Needs	Living	Non-living	Grow	Changes	Human	Puppy
Baby	Adult	Kitten	Cat	Bird	Animal	Frog	Eyes
Vision	Sight	Bright	Shiny	Dull	Colors	Shapes	Observe
Properties	Attributes	Tongue	Sour	Sweet	Salty	Taste	Flavor
Odor	Scent	Aroma	Sound	Loud	Whisper	Quiet	Yell
Scream	Roll	Slide	Fly	Float	Sink	Push	Pull
Butterfly	Insect	Life cycle	Stages	Larvae	Mammal	Spider	Egg
Chrysalis	Moth	Amphibian	Back	Up	Down	Fast	Slow
Backward	Forward	Environment	Straight	Motion	Speed	Motion	Seed
Plants	Stem	Roots	Fruit	Product	Sprouts	Explain	Materials
Findings	Hypothesis	Report	Graph	Trials	Data	Tools	report
Procedure	Size Words	Findings	Record	Result	Scientist	Habitat	Test
Scale	Hand Lens	Magnify	Predict	Classify	Sort	Properties	Textures
Shapes	Problem Statement						

Appendix E

PICTURES

How do you make mud?
Solid to Liquid

How do you make butter?
Liquid to Solid

How do you make Bubbles?
Air takes up space

Why do I get a tummy ache when I eat too
much candy and drink soda?
Making Predictions
The Memento – Diet Coke Explosion
Chemical Reactions