Using the Theory of Multiple Intelligences to Increase Fourth-Grade Students' Academic Achievement in Science

by
Linda Davis

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Approval Page

This applied dissertation was submitted by Linda Davis under the direction of the persons listed below. It was submitted to the Fischler School of Education and Human Services and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Nova Southeastern University.

David Weintraub, EdD
Committee Chair

Date

Maryellen Maher, PhD
Dean of Technology and Research

Date

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Abstract

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This applied dissertation was designed to increase the academic achievement of 4th-grade students in science. The problem to be solved was that 4th-grade students in a rural elementary school exhibited low academic achievement in science.

The researcher utilized the multiple intelligences (MI) theory and brain-based learning to develop the IMPACT strategy. This acronym was based on the essential components in the treatment program: introduce the focus lesson, make it relevant, practice the new concept in MI learning centers, allow time to set goals and reflect on learning, choose an independent learning project, and take time to celebrate. The independent variable consisted of the MI learning centers, and student achievement was the dependent variable. In the one-group/pretest-posttest research design model, the participants were given a pretest, exposed to an intervention program (i.e., the IMPACT strategy), and given a posttest to determine the effectiveness of the intervention.

As a result of the intervention, 3 of the 6 expected outcomes were achieved: Twenty students completed and turned in science class work assignments daily, displayed appropriate behavior for learning during science, and displayed a positive attitude about learning in science. Analysis of the results indicated that there was a significant improvement in students' achievement, behavior, and self-esteem.

Recommendations based on the results of this applied dissertation are as follows: (a) Students should be given more input regarding learning activities, (b) monthly parental involvement should be encouraged, (c) the school should seeks business alliances and apply for more grants, and (d) a longitudinal study be conducted to investigate the long-term implications of the IMPACT strategy in an interdisciplinary approach. Teachers can use this strategy as a way to increase student academic achievement and to enhance their own professional development.

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Chapter 1: Introduction

Description of Community

This applied dissertation took place in a small, rural community in the southeastern region of the United States. The community had approximately 30,900 residents. The population was 65.0% African American, 34.0% Caucasian, 0.5% Hispanic, and 0.5% Asian. The community has a variety service industries, agricultural, and retail career opportunities; however, there has been a decline in job opportunities for residents interested in employment with manufacturing plants because many plants are relocating overseas. The majority of the jobs pay minimum wages. The median per capita income for a family of four is $24,888. The median personal income is 88% lower than the national average income of $43,057 (Barge, 2003).

The county ranks 38th out of the 45 counties in the state for the number of African Americans and 35th for the percentage of Caucasians that are living below the poverty level. Approximately 32.1% of African Americans and 11.2% of Caucasians lived below the poverty level in 1999, and 28.2% of children from birth to age 17 were impoverished (“SC School Budget,” 2001). Moreover, the county ranks 22nd in the state for an escalating unemployment rate; 8.9% of the county residents are unemployed (“SC Jobless Rate,” 2003).

Writer’s Work Setting

There are six schools in the district: an early childhood center, a primary school, a Title I elementary school, a junior high school, an alternative school, and a high school. This applied dissertation took place in the Title I elementary public school. The school’s mission statement was revised by the school board in the 2003-2004 academic year. The school’s goal is to make everyone successful to promote a unified effort for learning. The

Southeastern Association of Colleges and Schools reaccredited this school in 2001. This elementary school's facility is a two-level building that was erected in 1954 as a middle school and remodeled in the 2000-2001 school year to house fourth-, fifth-, and sixth-grade students. At the time of this applied dissertation, the school's population consisted of 814 students: 232 fourth graders, 290 fifth graders, and 292 sixth graders. The student population was 68.9% African American and 29.0% Caucasians; 2.1% of the students had other ethnic origins.

The school's annual report card for 2003 (South Carolina State Department of Education, 2003) indicated that over 13% of the students were characterized as having disabilities other than speech. There were three resource classrooms that served students with exceptional learning disabilities. In addition, 75 students were enrolled in the gifted and talented pullout program. The percentage of students eligible for free or reduced-price breakfast or lunch had increased over the past 2 years. Free breakfast or lunch was provided for 73.5% of the students, and reduced-price breakfast or lunch was provided for 6.9% of the students, which surpassed the mean for this southeastern state. The average daily attendance rate was 95.5%. The average pupil to teacher ratio was 27:1. The state department of education's per student budget was $6,631, which was slightly lower than the national mean of $7,376 per student ("SC School Budget," 2003).

The calendar school year was from August 11, 2003 to May 21, 2004. The school hours were from 7:20 a.m. to 2:25 p.m. This learning setting is unique because sixth-grade students are not typically housed with elementary students in the state.

The school facility consists of 50 classrooms, a media center, a gymnasium, and 11 restrooms. A security system equipped with video and alarm components were installed was part of the school's renovation process to ensure student and staff safety.

The staff of the school in the 2003-2004 academic year consisted of 34 teachers, 3 instructional assistants, 1 guidance counselor, 1 media specialist, 1 police officer, 3 educational leaders, 3 custodians, and 8 food service workers. The teachers had an average of 14 years of teaching experience, 26 teachers held master's degrees, and 2 teachers had received National Board Certification. Teachers spend 21.3 days in professional growth and development (South Carolina State Department of Education, 2003). The average teacher salary was $38,912.

Writer's Role

At the time of this applied dissertation, the writer was a full-time fourth-grade teacher in the school. She held a master's degree in elementary education and had taught in a regular, self-contained fourth-grade classroom for 10 years. The main role of the writer in the classroom was to serve as a facilitator of learning as well as a disseminator of information. Fulfilling her professional obligations as a NatureShift ambassador, the writer encourages other educators to visit the Natureshift Web site and to allow their students to use interactive lessons and games to learn more about scientific skills taught in class. During this applied dissertation, the writer provided pertinent information about the study to parents through a newsletter that contained descriptions of various learning activities the parents can do at home with their children.

Chapter 2: Study of the Problem

Problem Statement

The problem to be solved was that fourth-grade students in a small, rural elementary school exhibited low academic achievement in science.

Problem Description

Fourth-grade students were taught science directly from textbooks that were adopted by the district in 2002. Teachers relied on traditional instruction methods and utilized the worksheets that accompanied the textbooks to test students' knowledge. The students' desks were arranged in straight rows, a seating arrangement that does not facilitate cooperative learning, and there were few opportunities for students to exchange meaningful dialogue with their classmates to reflect on their learning. The teachers controlled the learning process. Students were required to raise their hands and respond by answering questions that came directly from the textbook. Students were not conducting experiments or choosing activities that met their intellectual abilities daily. Instead, they complete worksheets and answered questions from the textbook.

When given a performance task, some students talked to their classmates instead of completing their work. This inattentive behavior reflected students' frustration; students often complained that the work was hard. This negative attitude affected their performance and resulted in work that was incomplete and inappropriate student behavior, such as talking out loud, passing notes, and sleeping in class. These situations illustrate the problem is described in the contextual setting. Descriptions of the problem provided by the writer documented the problem that existed in the classrooms.

Problem Documentation

Students in the writer's work setting were experiencing low academic achievement in science. Of the 24 fourth-grade students, 15 had shown a 20% decrease in academic achievement in science on their report cards and 11 had been labeled as underachievers based on their performance on unit tests and daily tasks performed in class. During science activities, teachers observed that 15 of the 24 students were not actively engaged, were inattentive, and displayed poor behavior. On average, 12 of the 24 students did not complete and turn in their science class assignments. Six teachers indicated from observations that 9 of the 24 students exhibited disruptive classroom behavior and negative attitudes about learning.

Causative Analysis

The writer identified four probable causes of the students’ low academic achievement in science: (a) students’ disengagement, (b) teachers’ misconceptions about students’ learning abilities, (c) teachers’ reliance on traditional teaching methodologies, and (d) parents’ lack of interest in change in the science curriculum.

The first probable cause was disengaged students. Students did not engage in the learning process because they were preoccupied. They exchanged notes in class and chatted with their peers during instructional time. This voluntary engagement in disruptive behavior inevitably interfered with the students’ ability to complete the tasks that were assigned to them.

The second probable cause of the low academic achievement was teachers’ misconceptions about students’ intelligence and academic ability. In this school, children were considered “smart” if they had a high IQ based on the Stanford Binet Intelligence Test, which measures cognitive development. Teachers overlooked the intellectual capabilities of children who were not classified by that measurement. A high number of students were recommended for special education services because teachers mislabeled the students based on their inability to retain and recall information.

The third probable cause of low academic achievement was the teachers' reliance on traditional teaching methods. Some teachers had taught for over 10 years at this school. These teachers had become static and comfortable in their style of teaching, and they were not afforded the opportunity to network with other educators in their grade level to gain insight into research-based strategies that promote academic achievement. The teachers relied on the results of student worksheets to assess the students' mastery of a given task.

The fourth probable cause was that parents did not recognize the need for change in the science instruction. Parental involvement at the school was low. Few parents attended Parent-Teacher Association (PTA) meetings, volunteered in the classroom, or attended teacher-parent conferences. In combination, these factors contributed to the problem of students' low academic performance in science at the school.

Relationship of the Problem to the Literature

Numerous topic areas were researched in the literature regarding the causes of students' low academic achievement in science, including student disengagement. Lovett (2001) reported that individuals employ 5% of their brain to learn. Roberts (2002) found that students have a tendency to become bored when they are not engaged in the learning process. Low interest in learning and student temperament have been suggested as underlying causes of students' disengagement and low academic performance (Schaefer & McDermott, 1999). According to the annual school report card for 2003 from the South Carolina State Department of Education (2003), 56.1% of the fourth-grade students in the writer's work setting scored below basic on the science section of the Palmetto Achievement Challenge Test (PACT).

Another probable cause was teachers' misconceptions about students' intelligence. Students' academic achievement is impacted by teachers who tend to categorize students into two groups: easy to teach or hard to teach. This type of grouping can result in inaccurate labeling of students and negatively influence the students' panoramic view of learning (David & Capraro, 2003). Teachers who use this ineffective technique to classify students' learning often focus more on the students' failures than on their successes (Nuzzi, 1997), and the teachers' negative expectations become a self-fulfilling prophecy in the learning and behavior of the students (Rubado, 2002).

This way of thinking leads teachers to group students homogenously and to give them all the same instruction. Research conducted on this issue revealed that students' intellectual capabilities go unnoticed due to the misconceptions teachers have when they label students. Callahan (2001) said that when students who vary in rate and performance level are grouped in this matter, they are not given the appropriate learning opportunities to excel academically.

Another cause of low academic achievement is the teachers' reliance on traditional teaching methods. According to Tomlinson and Kalbfleisch (1998), in classrooms where teachers use traditional instructional methods, some students do not excel in the classroom. Lovett (2001) explained that educational methods have changed little since the industrial period of learning; educators have yet to broaden their knowledge to embrace the information era. Amaral and Garrison (2001) added, "The science curriculum has traditionally been textbook and worksheet driven with limited opportunity available for teachers to conduct experiments that would take student through experiences worthy of time it takes to carry them out" (p. 4).

Fountain and Fillmer (1987) noted that educators focus more on left brain functions and less on right brain functions. When students are not as successful as their peers, they are less likely to become engaged in learning activities. Foster and Heiting (1994) indicated that traditional teaching methods focus on students giving the correct answer. Teachers rely heavily on dominating activities in the classroom and giving instructions to maintain constant control of the events that may ensue as well as the outcome of the assigned task.

McBeath (1994) found that students who are taught with such an approach have limited opportunities to interact and perform higher order thinking skills. Moreover, when teachers lecture and require the students to memorize information, the learner becomes passive. McBeath referred to this type of learning as *one-way communication*. Lovett (2001) concluded that there are internal forces within society that continue to perpetrate these traditional practices within the learning setting. One such embedded force is the impact parents' play in their child's education.

Another plausible cause is that parents do not see the relevancy for change in science instruction. Kober (1993) found that the attitudes parents have about science have a significant effect on their children's academic performance. Lovett (2001) noted,

> Many parents do not see the need for change and take the position, 'If it is was good enough for me' . . . . However, students today are living in a world that is very different from that in which their parents grew up. (p. 43)

In addition, Kober (1993) indicated that it is the different beliefs children adopt from their parents about learning that impact the outcome of their achievement in science.

At the writer's school, only 12.5% of the parents participate in education-related events such as PTA meetings, volunteering in the classroom, and attending teacher-parent conferences. Parents have a strong influence on the behavior and learning of their children based on their viewpoint of school (David & Capraro, 2003). Moreover, the negative attitudes of parents have a tremendous impact on academic achievement (D. H. Gardner, 1996; Jones, 2001). Research has indicated that parents who see the relevance of science will be more likely to improve their attitude about science and help their children engage in more activities in school and at home (D. H. Gardner, 1996).

Chapter 3: Anticipated Outcomes and Evaluation Instruments

Goal

The goal for this applied dissertation was that fourth-grade students in a small, rural elementary school would exhibit increased academic achievement in science.

Expected Outcomes

The following outcomes were projected for this applied dissertation:

1. Twenty-four of 24 students will show a 20% increase in academic achievement on their report card in science.

2. Twenty-four of 24 students will show a 10% increase based on the unit test results and daily task performed in class.

3. Twenty-four of 24 students will show a 20% increase in their ability to engage in independent learning projects.

4. Twenty of 24 students will complete and turn in science class assignments daily.

5. Twenty of 24 students will display appropriate behavior for learning.

6. Twenty of 24 students will display a positive attitude about learning.

Measurement of Outcomes

The six expected outcomes were measured using the following methods and instruments. The first outcome was measured using raw data from the fourth-quarter report cards. For the second outcome, unit test scores and daily task performance reports were used to assess the students' learning capability in science. The third outcome was evaluated using portfolio assessment to measure the students' ability to participant in independent learning projects. The fourth outcome was measured using a checklist to record the completed and turned in tasks performed daily. To measure attainment of the fifth outcome, the writer created the Learning Instrument (see Appendix A) that was used to assess students' feelings about learning in science. This assessment instrument consisted of three sections. In Section 1, the students were asked to describe their current academic performance in science. In Section 2, the students were asked to reflect on their feelings about learning in science. Section 3 contained two open-ended short-answer questions that allowed the students to describe their feelings pertaining to what the like best about science and what they like the least about science.

The writer-created Interview Instrument (see Appendix B) was used in the case study to get a better perspective of the relationship between the problem and student academic achievement. This evaluation tool was administered at the conclusion of the research study. Four students from the purposive sampling were asked the following two questions: "Did you learn science better using the different intelligences that you have?" "Did the different activities help you enjoy science more? Why or why not?"

The sixth objective was measured using pretest-posttest data from the writer-created Climate Instrument (see Appendix C) that indicated students' attitude about learning and the classroom climate. This measurement tool consisted of seven items, rated on a 3-point Likert scale: *agree*, *not sure*, and *disagree*. The feedback from this measurement tool allowed the writer to make instant improvements in the learning climate when feasible. Moreover, the feedback identified variables that hindered or fostered the learning process.

The writer-created Multiple Intelligences Instrument for Learning in Science (see Appendix D) helped students identify the preferred intelligence used to acquire knowledge in science. This instrument consisted of statements that described the seven multiple intelligences that students were asked to rate on a Likert scale from 0 to 4. Each section included two sentences that described characteristics related to the seven intelligences identified by H. Gardner (1987): (a) verbal/linguistic, (b) musical, (c) logical mathematics, (d) interpersonal, (e) spatial, (f) intrapersonal, and (g) bodily kinesthetic.

The writer created and used the Multiple Intelligences Journal Writing Instrument (see Appendix E), to assess, refine, and clarify the students' learning capability. In addition, this instrument provided a format to which the students involved in the case study could refer when reflecting on a particular intelligence they used to learn about a skill or topic in the different learning centers. The instrument had two sections. Section 1 of the journal-writing instrument provided the students with the phrase, "I learn more information in science when I use _______ intelligence. I am good at this intelligence because _______. " Section 2 prompted the students to articulate when a particular intelligence they were exposed to was not compatible with their learning needs. "I do not like to use_________ intelligence. I am not good at this intelligence because ________."
These open-ended statements provided the students with a consistent format to reflect on the intelligences they preferred to use the most to retain information in science and which intelligences they preferred not to use when learning science.

Content validity was established for all of the measurement tools using a panel of experts, four teachers who had 10 or more years of experience teaching science, to analyze and evaluate the items on each instrument. Gay and Airasian (2000) reported that content validity is essential to assessing and to justifying the dimensions of the intended course of action.

Mechanism for Recording Unexpected Events

The writer kept a weekly journal to record observations and incidents that were beyond the writer’s control. Adjustments to the study were made as needed.

Chapter 4: Solution Strategies

Discussion and Evaluation of Solutions

The problem to be solved was that fourth-grade students in a small, rural elementary school exhibited low academic achievement in science. Related literature was revised to evaluate three possible solution strategies: (a) multiple intelligences (MI), (b) brain-based learning, (c) an enriched climate, and (d) metacognitive skills.

The first probable solution strategy dealt with H. Gardner’s (1987) MI theory, which was formulated in 1983. According to this theory, children have seven intelligences that are based on their particular level of cognitive development: (a) verbal-linguistic, (b) logical-mathematical, (c) bodily-kinesthetic, (d) intrapersonal, (e) interpersonal, (f) musical, and (g) spatial. Naturalist intelligence was later added, increasing the number of MI to eight. The writer’s perception of the term *intelligence*, based on H. Gardner’s (1987) definition, is the capability to understand problems as they occur in a learning environment.

This solution strategy provides teachers with an innovative style of teaching science, a novel way to stimulate learning, and a plan that is unique to the ability level of each learner. This personalized instruction gives teachers a medium to teach state-mandated standards (Bellanca, 1998; Chapman, 1993; H. Gardner, 1993). In fact, Blythe and Gardner (1990) stated that this approach focuses on a variety of children’s abilities. This strategy promotes learning activities that are conducive for promoting hand-on instructional methods. The assessment of students learning is what Blythe and Gardner refer to as *intelligence-fair*. The students are taught from the perspective of how they can use their unique intelligence to ensure retention of the concept. B. Campbell (1992) used MI in a curriculum based on the interest of the students. This design includes the following: (a) a lesson, (b) MI centers, (c) reviewing and reflecting on the concept learned, and (d) independent learning projects.

Educators use the MI theory to provide daily learning experiences geared toward the unique learning ability of the child (Hatch, 1997). Equally important, children interact in meaningful dialogue with their peers to negotiate, resolve problems, and communicate understanding of a concept as they become productive learners (McBeath, 1994). Vialle (1994) suggested educators use an observational checklist to identify a child's intellectual strengths and weaknesses to enhance their understanding. Hoerr (1994) noted the use of a MI profile in the classroom is vital when exposing children to a variety of intelligences.

Blythe and Gardner (1990) recommended that teachers immerse students in a reality-based approach to learning that includes field trips to such things as a local museum, a park, or a theater performance. These directed learning excursions are based on projects and planned units of study. Community members serve as volunteers to share their knowledge about particular occupations in which children may have an interest. In short, educators who use MI strategies in the classroom will tailor learning for every child.

H. Gardner (1995) described the MI strategies that provide many opportunities for children to achieve success in school. Educators can use MI strategies to enrich the curriculum to assist all students to become successful learners (Greenhawk, 1997). Using MI strategies enables the teacher to develop a plan that is unique for the ability level of the learner (Bellanca, 1998). Armstrong (1994) said,

> The theory of multiple intelligences makes things simpler. By chunking the broad range of human abilities into basic intelligences, a map [is provided] for making sense out of the many ways in which children learn and a blueprint for ensuring their success in school and life. (p. 28)

B. Campbell (1992) indicated that it is critical for educators to implement the MI theory into the classroom to help students experience learning success. Balanos (1996) noted that the impact of MI-based curriculum can improve a child's self-concept. Teele (1996) indicated that intellectual empowerment increases students' motivation to learn using their diverse talents and skills. According to Smerechansky-Metzger (1995),

> The implementation of MI in activities and program is intended to motivate students while giving them the self-confidence to achieve. If implemented in educational settings, [MI strategies] will allow for cooperative learning, self-directed learning, leadership roles, and greater academic achievement and retention due to enjoyment of the activities. (p. 14)

Use of the MI theory in the science classroom allows students (a) to obtain a better understanding of scientific inquiry, (b) to develop skills related to processing information, and (c) to enhance their academic achievement (Thompson & MacDougall, 2002). Mettetal, Jordan, and Harper (1997) said,

> Multiple intelligences provide children with different range of learning experiences to meet their diverse intellectual capabilities. Teaching children about their multiple intelligences may enhance developmental process, giving children more opportunities to feel confident about their abilities. (p. 115)

Ellison (1992) noted that the MI theory can be used to set educational learning goals to help students reflect on better ways of learning in the classroom.

Armstrong (1994) recommended that learning organizations focus on bodily kinesthetic intelligence so children can be guided to understand how they can use their own body to retain information through clapping, jumping, and role-playing in the classroom. Paik (2003) recommended that children use their bodily-kinesthetic and interpersonal intelligences to engage in teamwork activities to foster learning and broaden their social skills.

Interpersonal intelligence is another intelligence that is critical for learning.

Educators and counselors need to allow students to interact and respond appropriately to their moods and the behavior of others to gain knowledge about a particular lesson (H. Gardner, 1983). Thompson and MacDougall (2002) noted that engaging students in lab experiments fosters interpersonal intelligence as well.

Intrapersonal intelligence is vital for helping children seek their inner feelings and thoughts to gain a broader understanding in a learning setting (H. Gardner, 1997). The MI approach should focus on the skills that are needed to help learners focus on the main lesson from a different aspect to add rigor to the curriculum (Tomlinson & Kalbfleisch, 1998). These intelligences should be nurtured and reinforced to allow students to become successful lifelong learners. Most importantly, educators need to concentrate on making children active learners by drawing on direct physical and social experiences as well as cultural experiences to stimulate learning (Fisher, 2003). Using the think-pair-share strategy provides teachers with an integrated approach to help students develop their intrapersonal and interpersonal capabilities (Kagan, 1994; Thompson & MacDougall, 2002).

H. Gardner (1993) stated that the project approach allows students to work in small group, but the students create original projects to explain what they have learned at the conclusion of the thematic unit. Teachers can use this theory to scaffold learning. The scaffold method involves helping children conceptualize their learning as it relates to their own academic success in school (Smerechansky-Metzger, 1995).

Brain-based learning is the second possible solution strategy. Brain-based learning research has provided educators with many strategies to foster student achievement and empower students to become successful learners. For example, Bucko (1997) reported that the human brain is structured to react to the environment and experience so it is important for educators to involve the child in every aspect of his or her learning development. Although brain research does not mandate how educators must engage the learner, it does provide a practical way to maximize learning in the classroom (Wolfe & Brandt, 1998).

Naturally, an integrated approach to teaching is required to help students use the right and left hemisphere of their brains. Engagement in right brain activities develops spatial, visual, kinetics, and tactile tasks; left brain activities allow students to use their verbal linguistic acuity that is essential for learning skills and concepts in the classroom (Fountain & Fillmer, 1987). In other words, brain-based research strategies need to involve the whole child. For this reason, teachers need to design performance tasks that allow students to engage their bodies as well as their brains to solve problems (Hardiman, 2001).

The use thematic units when teaching a concept is compatible with stimulating high academic achievement in students. When a lesson is taught around a theme, children can see the relevancy of learning that information and store it for their future application. In a classroom setting, students use concept maps to help them analyze and synthesize information to understand the relationship of the concept or skill better (Hardiman, 2001; Jensen, 1998). A learning setting should provide the human brain with a variety of learning experiences that is challenging and rigorous because the brain learns best when stimulated (Wolfe & Brandt, 1998). Higher order thinking skills are critical in the employment of a rigorous culture of learning (Sousa, 1998). The daily regimen for optimal learning practices is to allow the proper amount of time for students to internalize and reflect on their learning (Callison, 2001). These activities can heighten learning experiences that stimulate many parts of the student’s brain for learning (Kolb, 2000).

It is recommended that educators assign active, hands-on activities to allow children to explore, analyze, and solve problems using real-world application (Wolfe & Brandt, 1998). As a matter of fact, take-home or independent projects, experiments, and dramatizations are prudent ways of incorporating brain-based learning in the classroom. In addition, educators can ask the students create pictures and give oral presentations to integrate the brain functions holistically (Prigge, 2002).

Also, activities that use sensory perceptions to engage the learner are feasible for educators who want to facilitate long-term memory learning (Sousa, 1998). Prigge wrote,

> Students need drill and practice to retain information. Brain-friendly drill and practice involves “creative repetition” so that students are not drilling and practicing in the same way every day. Using games, computer, music, rap songs, cooperative learning and other activity-based drills and practices can all help students remember knowledge and skills. (p. 240)

To summarize, brain-based learning provides educators with a practical way to incorporate activities to stimulate the right hemisphere and the left hemisphere of the brain for optimal learning. Research findings indicated that brain-based learning is highly correlated to the MI theory (Smerechansky-Metzger, 1995). The developing brain is altered as an individual undergoes engagement in a variety of learning experiences (Caulfield, Kidd, & Kocher, 2000).

A positive academic climate is another possible solution strategy that plays a critical role in cognitive maturation (Prigge, 2002). Student achievement increases when there are positive student-teacher interactions in the classroom (Sousa, 1998). A positive academic atmosphere promotes constructive learning (Callison, 2001). Bucko (1997) noted,

> Climate is a term often used to describe the character and culture of a school. A pleasant academic orientation enhances the mind’s readiness to accept and retain information. Friendly classmates, pleasant surroundings, gentle colors,

> cleanliness, and abundant classical music are possible ingredients of a healthy learning climate. (p. 24)

Fogarty (1998) suggested that educators can establish a safe and caring learning environment by having class meetings to discuss problems or major concerns students may have in the classroom. Also, it was noted that this environment allows students to explore and investigate free of threats (Caine & Caine, 1990). For example, when the brain is in the receptive mode, it promotes normal and healthy body functions, allowing individuals to feel more relaxed. Rushton and Larkin (2002) said, “An enriched culture of learning supports risks taking and views failure as a natural part of the learning process” (p. 28). The ambiance for learning can significantly impact one’s aptitude as well as change one’s attitude about learning (Harty, Beall, & Scharmann, 1985). Educators need to allow time in the classroom so children can interact with their peers at the beginning of the school day and at the end of the school day to stimulate the learning process (Callison, 2001). This method develops students who are able to maintain a commitment to achievement (Baldwin, 2000).

Teachers need to examine age, gender, race, and socioeconomic background in order to address students’ learning behavior. Schaefer and McDermott (1999) noted that students who are taught in a nurturing climate will have a better probability of excelling beyond those students who are not exposed to this type of environment. The learning climate and the quality of assigned work stimulate and nourish learning development. When performed simultaneously, these entities foster student achievement (Tomlinson, 2002).

L. Campbell (1997), Carlton (2000), Diefenbacher (1999), Hetland (2000), and Hodges (2000) pointed out that listening to music could impact the learning atmosphere as well. Background music is a vital part in a learning setting to lessen the stress and the anxiety associated with performance (Giles, 1991). D. Campbell (1995) indicated that listening to classical music increases one's spatial-temporal reasoning skills to establish an enriched tranquil atmosphere for learning.

Another possible solution strategy is to address metacognitive skill in the learning environment. Rushton and Larkin (2002) added that metacognitive skills present a trajectory that educators can use to build on prior learning experiences to help children understand concepts better. Teachers need to use metacognitive skills so children can learn in different ways to reflect on their own learning. By using the experience-awareness-theory model, children can strengthen the metacognitive skills needed for achievement. In a lesson, teachers can use a process referred to as layers. In the first layer, students share outcomes of what they have learned. In the second layer, students analyze and locate similar topics that relate to what they have learned. In the third layer, the students integrate their learning experiences using real-world illustrations. In the fourth layer, students are empowered to apply what they learned in different learning situations. Inevitably, the students become aware of what they have learned (i.e., the theory stage). This is when students inquire and explore new dimensions of their knowledge without aid from the teacher (Horton & Findley, 2001).

Metacognitive skills permit individuals to solve problems and reflect on their learning (Caine & Caine, 1990). Group discussions within a cooperative learning setting provide an avenue to manifest metacognitive process skills into the learning environment (Hardiman, 2001). These metacognitve skills are necessary in the information era to nurture convergent and divergent thinking, which empowers students to engage in learning experiences to acquire self-actualization (McBeath, 1994).

When children feel good about how they learn, they are more likely to excel in all academia and embrace their intellectual differences. Individuals who engage in social interactions in the classrooms are likely to become motivated to complete assigned tasks and are more willing to share what they have learned (Matthews & Keating, 1999). Teachers can sharpen students' emotions appropriately as a part of teaching and learning process by making use of storytelling activities, celebrations, discussions, classroom routine activities, and self-reflections to help students gauge their emotions toward learning. It is beneficial to the teachers to enrich the learning process with visual representations as a follow-up to students' progress in the class by using a daily chart to provide another way for children to reflect on their learning (Prigge, 2002).

Description of Selected Solutions

Two solution strategies were selected to solve the problem of low academic achievement in science: MI theory and brain-based learning. MI theory integrated with brain-based learning were utilized by the writer to provide an innovative matrix of activities to engage students to accommodate their unique learning capabilities (Hoerr, 1994; Smerechansky-Metzger, 1995).

The strategy designed by the writer to teach scientific concept skills to the target group of fourth-grade students by integrating MI theory and brain-based learning to increase student achievement in science was called IMPACT, an acronym derived from the following components of the treatment program: (a) Introduce the focus lesson, (b) make it relevant, (c) practice new concept in MI learning centers, (d) allow time to set goals and reflect on learning, (e) choose an independent learning project, and (f) take time to celebrate. The writer designed this solution strategy using a format similar to the strategies found in L. Campbell's (1997) four-step model and H. Gardner's (1993) project approach.

The project model consisted of focus lesson that used a thematic approach to teach scientific concept skills. Five intelligences were emphasized; each learning center allowed the students to use a different intelligence. In the Team Work Center, students worked together in cooperative groups to solve problems. In the Get to Know Me Center, the students reflected on their feelings about a particular concept to develop or enhance their intrapersonal intelligence. In the Make It Center, the students created visual representations to explain what they have learned. In the Reading Center, the students read nonfiction literature to learn more about a particular science concept to develop or enhance their verbal linguistic intelligence. In the Keep It Moving Center, the students were engaged in interactive learning experiences such as interviews, role-playing, and creative movement activities to develop or enhance their bodily-kinesthetic intelligence.

The students were actively engaged in the MI centers for 30 minutes each day. Allocation of this amount of time gave students the opportunity to choose a particular center to develop or enhance their intellectual development in science, and the writer facilitated them during the learning process. Ten minutes was allocated for students to share and review their learning experiences and set goals. This afforded the students an opportunity to reflect on and appreciate the unique ways they acquire information. The writer had the students create and design one independent learning project that focused on the various intelligences used to summarize what was learned. Classical music was played softly in the background as the children participated in the numerous activities. This particular technique was designed to provide a climate conducive for learning. The writer’s goal was to reduce the students’ levels of anxiety and frustration about learning in science because an enriched climate for learning is linked to brain-based learning and to MI theory.

The writer used portfolios as an informal assessment. This enabled students to internalize the growth and development of their learning in science. Students set goals and refined them weekly. Guest speakers were used to provide reality-based learning experiences. Finally, the students designed a personalize T-shirt that described their unique talent to celebrate their learning diversity.

Report of Actions Taken

Month 1. In the 1st month of implementing the IMPACT strategy, the writer established the philosophy of the intervention program. The writer discussed the importance of learning science by incorporating the different intelligences an individual can possess (i.e., verbal-linguistic, interpersonal, intrapersonal, bodily-kinesthetic, logical-mathematical, spatial, and musical). The projected plans were discussed with the target group of 24 students and child assent and parent consent forms were hand delivered to the students. The students were selected for this research study based on their PACT scores and placement in the writer’s fourth-grade class.

Twenty 20 child assent forms were returned with 20 parent consent forms. After receiving the forms, the writer administered following the evaluation tools: the Learning Instrument (see Appendix A), the Climate Instrument (see Appendix C) and the Multiple Intelligences Instrument for Learning in Science (see Appendix E). The Learning Instrument (see Appendix A) was used to measure students’ intellectual disposition about learning in science. The Climate Instrument was used to measure the appropriate climate for learning concepts and standards in science. The Multiple Intelligences Instrument for Learning in Science was used to assess the current repertoire of intelligence used to acquire information in science. These tests took about 15 minutes to complete. The writer then discussed the projected plans again with the target group of students as well the importance of learning science by cultivating the many intellectual capabilities they possess.

The writer introduced a thematic unit called Organisms and Their Environment. The students were given a pretest to assess their knowledge on this unit of study. Bodily-kinesthetic intelligence was the focus of the lesson, and verbal-linguistic intelligence was the supporting intelligence in this lesson. The main component of the bodily-kinesthetic intelligence approach is to use the body to perform tactile experiences and engage in hands-on learning activities. The verbal-linguistic intelligence approach engages the learner in an enriched learning experience of reading and writing.

The writer remained motionless, pretending to be a rock, and role-played what a rock would say about being a nonliving part of the ecosystem and the function it performs. Also, the writer pretended to be a flower in a garden and described what a flower would say about being a living part of the ecosystem. Nonfiction trade books were used to expand the concept of living and nonliving things further. The students chose a MI learning center activity to learn more about the ecosystem. The students were apprehensive when they were first introduced to the learning centers format of learning. They were more receptive to teacher-directed forms of learning.

In the Make It Center, the students had an opportunity to plant a flower (a living thing) into soil (a nonliving thing) and chart its growth throughout the research study. The students were more excited when they found out they would take their plant home at the end of the 3-month study. In the Reading Center, students read book pertaining to nonliving and living things in the environment. In the Team Work Center, the students worked in cooperative groups to discuss why nonliving and living things are necessary to support an ecosystem's growth and development. In the Get to Know Me Center, the students expressed their feelings about why growth and development is important in their life. In the Keep It Moving Center, the students engaged in role-playing activities. The students pretended to be such things as the sun, a flower, a butterfly, a lion, the wind, and water to understand the unique role each of these elements play in the environment. After the lesson, the students were given 10 minutes to share their experience in the learning centers. Some students had a difficult time articulating their ideas and did not want to participate in the shared discussion. On the other hand, some students expressed admiration for retaining information because they could work alone or with a group.

During the 2nd week, spatial intelligence was the target intelligence used in the focus lesson. Spatial intelligence is the ability to learn from visual images (H. Gardner, 1997). The focus lesson discussed how animals and organisms survive in a particular biome (tundra, rainforest, grasslands, desert, wetlands, or woodlands), and the characteristic of each environment was described. The writer held a picture of a penguin in the desert and asked students to draw a biome that will allow the penguin to survive. Then, the students were placed in groups to discuss their drawings. The students were given 30 minutes to engage in a MI learning center activity. In the Make It Center, the students selected a particular animal. Then, they constructed a biome that was suitable to help that particular animal survive. This center allowed the children to develop their bodily-kinesthetic intelligence by solving the problem using their bodies. In the Reading Center, the students read stories from an array of literature pertaining to habitats from animals, thereby strengthening their linguistic intelligence. The activities used in the Team Work Center focused on strengthening or developing the students' interpersonal intelligence. The students were given a set of five pictures that had an animal in a particular environment that was not suitable for its needs. The students had to discuss the most appropriate biome that would meet the needs of that animal. In the Get to Know Me Center, intrapersonal intelligence was used to help the participants understand how their emotions gauge their learning of a particular skill. The students were asked to describe how they would survive if they were stranded in a desert for 2 days. The students were able to problem solve and integrate this experience into their everyday lives. They discussed what they would do if they were stranded on the highway with a flat tire. The students enjoyed this center because it allowed them to relate the learning experience to their own life. In the Keep It Moving Center, bodily-kinesthetic intelligence was applied to help the participants use their body to learn about how a polar bear would respond and how it would survive in the rainforest, the tundra, the grassland, and the woodlands. The students role-played the behavior of a polar bear using its bodily movement and gestures.

As the students become more involved in the student-directed approach to learning, they candidly and overtly expressed their enjoyment for learning science in many different ways. The students listened to classical music as they engaged in their MI learning center activities to promote a climate conducive for learning. The students used their metacognition skills to reflect on their learning experiences in science for 10 minutes. Students who did not normally interact in the traditional classroom instruction responded to the MI learning centers with ease. The students responded in the sharing session that the different learning activities helped them take ownership of their learning by choosing activities that intellectually challenged them to understand the assigned task better.

The focus lesson about endangered animals was introduced using intrapersonal intelligence activities that were supported by interpersonal intelligence activities.

Individuals who possess intrapersonal intelligence understand how feelings and emotions guide their learning. Educators, counselors, and health care providers usually have strong interpersonal intelligence, which enables them too interact and respond appropriately to the moods and behavior of others (H. Gardner, 1987). The students wrote a letter to their local state representative and senator requesting that they strengthen the Endangered Species Act to protect the endangered animals in their community. This was a collaborative effort to improve the natural wildlife in their community as well as their state.

Month 2. The students continued working in the different MI learning centers. The Climate Instrument was given a second time to the target group. The focus lesson consisted of the intrapersonal intelligence activities, supported by spatial intelligence activities. Spatial intelligence is the ability to learn from visual images (H. Gardner, 1987). The students took a stuffed animal home for a week and shared the different things they did at home to learn more about that endangered animal with their family. The students queried members of their family to explain to them how environmental issues have evolved and changed over the last decade.

The main lesson was on how animals behave and interact within their environments. In the Make It Center, the students created a bat or an animal of their choice and described how that animal behaves and interacts in its environment. In the Reading Center, the students engaged in choral reading activity to learn more about how animals interact and behave in their environment. In the Team Work Center, the students worked in cooperative groups, using the think-and-share technique to discuss how certain behaviors of animals are beneficial and harmful to humans. In the Get to Know Me Center, the students were asked to think about an animal that best describes how they act and behave within their environment and explain the reason they chose that particular animals to describe them. In the Keep It Moving Center, the students read information about how animals interact and behave within their group and performed a skit to describe that interaction and behavior. As the students were exposed to the different activities, they listened to classical background music. The classical background music was used to provide an inviting climate for learning to help the students to feel more relaxed.

The students used their learning activity time to work on their Parade of Animal Production Show. The students shared one activity they completed in a learning center activity. In the Parade of Animals Production Show, students participated in role-playing activities, skits, and drawings germane to how a particular animal interacts in its environment.

Month 3. The writer initiated the culminating activities. Students were administered the following: the Learning Instrument, the Interview Instrument, the Climate Instrument, and the Multiple Intelligences Instrument for Learning in Science. In the 10th week of the study, four students who were involved in the case study were interviewed by the writer using the Interview Instrument. Each interview took place in the writer's classroom and lasted about 5 minutes. Throughout the week, the students planned and made sketches to finalize the design of their T-shirts. The students used fabric markers and fabric paint to illustrate the unique intelligences they possess. Also, students submitted their independent learning project for a portfolio assessment. The students were given a posttest pertaining to the information taught in the unit. Parents were invited to participate in a Portfolio Night. The last week of the research study was designated for celebratory festivities. The students wore their personalized T-shirts during the celebration to promote self-esteem and appreciation of their intellectual diversity. The students displayed their independent learning projects and presented what they have learned through songs, skits, posters, computer-generated information, role-playing, and problem-solving activities during the Celebration of Learning Diversity Day. The parents who participated in the research study were invited to share this special day. All students received certificates of participation and certificates that identified the dominant intelligence they used to achieve success in science.

The dominant intelligence was determined based on the raw data obtained from the Multiple Intelligences Instrument for Learning in Science. The 20 students responded to the statements that best described how they acquire knowledge in science. In addition, the identification of the dominant intelligence was based on the writer's observation during the 30-minute interactions in the MI centers. Students' interactions, learning interest, and reactions were essential factors used to determine the dominant intelligence. The writer informed the 20 students that the dominant intelligence was the intelligence that they used most often and the one they felt most comfortable using to learn in the different learning centers.

Chapter 5: Results

Introduction

This chapter summarizes the results of the qualitative and quantitative data of the research study obtained via the one-group/pretest-posttest research design method. The students from the target group were used in this case study to obtain data on their performance in their learning environments. Gay and Airasian (2000) stated that a case study is a detailed account of the participants in their natural learning setting that is made to obtain qualitative data. In this study, information was collected via observations, interviews, and a reflective journal. The writer made use of related field notes pertinent to the independent variable outcome. Gay and Airasian stated, "Field notes are the observer's record of what he or she has seen, heard, experienced, and thought during an observation session. They may contain a descriptive and reflective aspect" (p. 213). A MI profile was formulated as a result of the data collected from the Multiple Intelligences Instrument for Learning in Science. Each profile consisted of the intelligence used most often to achieve academic success in science. In addition to that, the writer used data from the Climate Instrument to make immediate improvements in the learning environment to meet the educational needs of the students. Descriptive statistics were obtained from the one-group/pretest-posttest research design model. The writer used the alpha level of 0.05 to measure the significant level used for rejecting the null probability.

Procedures

The data were analyzed to substantiate the effectiveness of the treatment program on the dependent variable, academic achievement. The writer protected the privacy of the subjects by ensuring the anonymity of responses on each evaluation tool. In addition, the writer focused on major themes developed as a result of the qualitative data obtained from the four students who were interviewed. A *t* test was used to assess the pre- and posttest mean difference. To accomplish this, the writer typed the raw data into the Statistical Package for the Social Science (SPSS), a computer software program used to analyze data (Gay & Airasian, 2000).

Descriptive statistics generated from the one-group/pretest-posttest research design method yielded the mean, standard deviation, and the Pearson *r*. The data collected from descriptive statistics yielded the Pearson *r*; the writer used the variables that were interval with the assumption that there would be a linear relationship between the two variables. Also, the writer obtained the standard deviation to gain a better understanding of how the scores were dispersed around the mean.

Triangulation was used to obtain a comprehensive analysis of the four students who were interviewed in the case study to add validity to the qualitative data. Using aggregated data from the SPSS program, the writer formulated scattergrams and tables to explain the results of the treatment program. Gay and Airasian (2000) defined this process as “the use of multiple methods, data collection strategies, and/or data sources, in order to get a more complete picture and to cross-check information” (p. 630).

These procedures were utilized in the research study to help the writer understand the correlation between the pretest and the posttest results to determine the degree of their academic success. Indeed, the qualitative and quantitative data provided tangible evidence to prove or declaim the anticipated outcomes established in the study. The anticipated outcomes were as follows:

1. Twenty-four of 24 students will show a 20% increase in academic achievement on their report card in science. This outcome was not met.

2. Twenty-four of 24 students will show a 10% increase based on the unit test

results and daily task performed in class. This outcome was not met.

3. Twenty-four of 24 students will show a 20% increase in their ability to engage in independent learning projects. This outcome was not met.

4. Twenty of 24 students will complete and turn in science class assignments daily. This outcome was met.

5. Twenty of 24 students will display appropriate behavior for learning. This outcome was met.

6. Twenty of 24 students will display a positive attitude about learning. This outcome was met.

The first expected outcome was that there would be a 20% increase in the students' academic achievement based on their report card grades. Table 1 shows a comparison of the third- and fourth-quarter grades.

Table 1

Frequency of Third-Quarter and Fourth-Quarter Grades

Grade	Third quarter	Fourth quarter
A	6	6
B	9	13
C	3	1
D	2	0
F	0	0

Note. A = 100-93; B = 92-85; C= 84-77; D = 76-70; F = below 70.

The grades did not show a 20% increase as projected. In the third quarter, there were 6 As, 9 Bs, 3 Cs, and 2 Ds. Surprisingly, in the fourth quarter, there were 6 As, 13

Bs, and 1 C. A Pearson *r* of 0.38 was calculated using the SPSS to show the relationship between the third-quarter grades and the fourth-quarter grades. This calculation showed a linear relationship.

The second expected outcome indicated that 24 of 24 students would show a 10% increase on the unit test results and daily tasks performed in class. The correlation coefficient for the unit test was 0.19. The Pearson *r* of 0.19 compared the relationship between the two variables, the unit pretest and the unit posttest. This correlation indicated a linear relationship between the unit pretest and the unit posttest. There was a 9% inclination in the unit test results from pretest to posttest. In summary, the arrangement of the scores formed a linear regression. The interval of the scores indicated that the scores generally increased on the unit posttest.

The differences between the unit pretest and unit posttest as well as the semester pretest and semester posttest were tested for significance using a paired samples *t* test (see Table 2). These data depict the correlation coefficient between the pretest and the posttest scores for the unit test and the semester grades.

Table 2

Analysis of Correlation Between Pretest and Posttest Scores

Variable	Correlation coefficient	Significance
Unit test	0.05	0.00
Semester grade	0.89	0.00

Note. $N = 20$, $P < 05$.

Correlation coefficients of 0.05 and 0.89 were presented for the two variables, respectively. Using the alpha level of 0.05, there was a significant difference between the two variables of 0.00. Ergo, the null hypothesis was rejected; Variable A was not equal to Variable B. A two-tailed test of significance was performed to reject the Type II error.

The third expected outcome was that 24 of 24 students would show a 20% increase in their ability to engage in independent learning projects. The results showed that the students who were involved in the study engaged in 100% of the independent learning projects. Prior to the research study, 80% of the students expressed a desire to work on independent projects beyond the contextual setting of the classroom. At the conclusion of the study, 83% of the students participated in the independent learning projects, a gain of 3 percentage points.

The fourth expected outcome was that 20 of 24 students would complete and turn in science class assignments daily. During the 1st week of the research study, 20 students completed their assignment for the week, and this continued throughout the remaining weeks of the study. It was confirmed that 100% of the students who participated in the intervention program completed all of the assignments that were presented to them throughout the duration of the investigation.

A two-tailed paired samples *t* test was used to analyze the differences between the unit and semester pretests and posttests (see Table 3). Over the course of the 3-month research study, there were significant gains in academic achievement. As illustrated in Table 3, the pretest mean for the unit test was 66.25 and the posttest mean was 82.25, a mean difference of 16.00. The semester pretest mean was 85.90 and the posttest mean was 89.35, a mean difference of 3.45. Therefore, the significant value of 0.00 for the variables were less than .05, indicating an improvement in the unit as well as the semester grades the students received at the conclusion of the research study. The standard error column provides an index of the variability one can anticipate in the repeated random sample of 20 fourth graders similar to the ones in this study. In brief, as discussed previously, the 20 students demonstrated improvement on the unit tests, which obviously had a great impact on their overall semester grades.

Table 3

Analysis of t Test Scores for the Pretest and Posttest

Variable	Pretest *M*	Posttest *M*	*M* difference	*T* value	*P value*	Standard error *M*
Unit	66.25	82.25	16.00	7.29	.00	2.194
Semester	85.90	89.35	3.45	5.33	.00	.647

Note. P = <05.

The fifth expected outcome was that 20 out of 24 students would display appropriate behavior for learning. Table 4 presents the results of the Learning Instrument that was administered prior to the integration of MI and brain-based learning strategies into the science curriculum and again at the conclusion of the 3-month study. As can be seen in Table 4, the range of the pretest scores fluctuated from 5% to 70%. On the posttest, the percentage ranged from 10% to 100%. When asked to respond to Statement 1 on the pretest, only 25% of the students indicated that they wanted their classmates to help them in the learning process in science. Whereas, at the conclusion of the study, 55% of the students indicated that they wanted their classmates to assist them while they were engaged in a learning experience in science. Statement 2 yielded the greatest increase from pretest to posttest; by the end of the study, 100% of the students expressed enthusiasm for learning in science as a result of participating in the research investigation. Generally, an overview of the qualitative findings showed significant improvement of the students' learning behavior in regard to learning science.

Table 4

Percentage of Responses for Learning in Science

	Preproject			Postproject		
Statement	Agree	Not sure	Disagree	Agree	Not sure	Disagree
1. I learn when my classmates help me in science.	25	30	45	55	0	45
2. I enjoy learning in science.	25	5	70	100	0	0
3. I have a good attitude about learning in science.	30	5	65	100	0	0
4. I listen to my teacher during science instruction.	50	0	50	100	0	0
5. I want to perform better in science.	60	0	40	90	0	10

Note. Numbers in the table represent percentages.

In response to Statement 4 on the pretest, responses on the 3-point Likert scale indicated that 50% of the students agreed and disagreed that they listened to the teacher during science instructional time. After the treatment program, 100% of the students said they were more attentive to the teacher during science instructional time.

In regard to the sixth expected outcome, the 20 students were asked to respond to the statement, "I am a student who has a positive attitude, sometimes likes, or dislikes science." Before the IMPACT strategy was implemented, 8 out of the 20 students indicated they had a positive attitude about learning in science, 4 students said that they liked science sometimes, and 8 students indicated that they did not like the subject. Following the implementation, 100% of the students indicated that they had a positive attitude toward learning in science. These data support the data in Table 4, which show that prior to the treatment program, 60% of the 20 students expressed a desire to perform better in science and 40% did not feel they needed to perform better in science. By the end of the implementation, 100% of the students acknowledged the fact that they wanted to perform better in science and they had a positive attitude toward learning in science.

Student behavioral infractions that occurred in the classroom included such things as name calling, blurting out answers, passing notes, and sleeping. Infractions that occurred on the playground were instigating fights and bullying. Before the research study, an average of 20 infractions occurred in classrooms and 30 occurred in the playground each week. After implementation of the IMPACT strategy, a mean of 2 infractions in the classroom and a mean of 5 infractions were observed in the playground weekly by the writer. Before the intervention program, 60% of the infractions occurred in the classroom. At the conclusion of the study, 29% of the infractions occurred in the classroom.

Table 5 displays the range of intelligences students used to engage in different learning experiences while participating in the research study. With the data from the Multiple Intelligences Instrument for Learning in Science, the writer was able to generate a MI analysis using the raw data from the assessment tool. The MI analysis provides a clear representation of the different ways the 20 fourth graders acquired knowledge from the various skills assigned in the MI learning centers.

Table 5

Multiple Intelligences Analysis

	Students' responses to how the intelligence describes them				
Type of intelligence	Describes me	Strongly	Somewhat	Hardly	Does not
Musical	48	19	10	0	23
Verbal-linguistic	63	33	5	0	0
Logical-mathematical	53	27	10	0	10
Interpersonal	63	16	5	5	16
Spatial	71	19	10	0	0
Intrapersonal	23	27	27	0	23
Bodily-kinesthetic	60	11	9	0	20

Note. Responses are reported in percentages.

Results From the Case Study

In an effort to add validity to the qualitative data, the writer used triangulation. Through interviews, it was found that 4 of the students involved in the case study were able to process and comprehend information better by using their different intellectual capabilities. Moreover, the students stated that they were excited about learning science differently using the MI Journal Writing Instrument to reflect on their MI learning experiences. For example, one student expressed, "I love science now because I get to work in fun learning centers painting and building fun things."

A review of the students' reflective journals indicated that the four students were good at a particular intelligence because it allow them to understand a concept better in the different learning centers. On March 10, 2004, a 10-year-old student wrote the following journal entry.

> I learn more information in science when I use my bodily-kinesthetic intelligence. I am good at this intelligence because I get to move around in class. I am more relaxed when I can move around and work on different activities. Seating [*sic*] in a desk all day makes me very sleepy, and I sometimes forget what the teacher is saying. I have more energy and I do not feel sleepy. Also, I like it when I pretend to be an animal.

The reflective MI journals further indicated that the four students who were interviewed were good at a particular intelligence because it afforded them the opportunity to internalize the concept from many avenues. As an illustration, here is a journal entry another student (age 9) wrote on April 7, 2004.

> I learn more information in science when I use my interpersonal intelligence. I am good at this intelligence because I get a chance to talk about different ways to solve a problem in science. My classmates listen to me and I listen to my classmates. I can share my thoughts without anyone laughing at me because I am wrong.

In brief, these findings garnered from the case study support the quantitative data presented in this research study.

Discussion

The epicenter of this research study resides in the results ascertained from the quantitative and qualitative data. In pursuit of a solution strategy to the problem of students' low academic achievement in science, the theory of MI and brain-based learning proved to be beneficial in resolving the problem that existed in this rural elementary school setting. These results offer an unfettered amount of evidence to substantiate the hypothesis that integration of the MI theory and brain-based learning research will increase the academic performance of fourth-grade students in science. The students who participated in the research investigation using the IMPACT strategy provided the writer with crucial data that corroborated the findings indicated by practitioners and authorities in the field of MI and brain-based learning.

MI learning centers provided each child with a personalized hands-on approach to learning. The students became aware of their learning strengths and weaknesses. Moreover, they became more appreciative of their learning diversity, more attentive in class, and more willing to engage in science activities. The students were able to process information by actively participating in the different MI learning activities. The thematic unit helped the students make meaningful connections as they were immersed in the learning process. As Caine and Caine (1990) noted, educators can implement numerous ways for children to synthesize information.

The results of this study validate that children need to cultivate the different intelligences they possess to increase their critical-thinking skills and to comprehend the subject matter better. The writer's observations revealed that students were more enthusiastic and projected a positive attitude about science in general. Also, the data gathered via the Learning Instrument indicated a strong relationship between the academic improvement of the 20 students and their disposition toward science. The number of classroom infractions decreased, which had a significant influence on the academic performance of the 20 students in the study. The parents of the 20 students who were involved in the study reported an improvement in the students' behavior at home as well.

Implications of Findings

There are many implications of this fruitful undertaking. In this study, students' behavior and attitudinal preferences toward learning were significant predictors of student achievement. An enriched climate for learning made it possible for the students to excel. Sousa (1998) said, “How a person feels about a learning situation determines the amount of attention devoted to it” (p. 23).

As indicated by responses to the Behavior Instrument, following the intervention, students were more motivated to engage in hands-on activities in science that challenged and engaged them intellectually. Moreover, students’ attitude about learning played an important role in how they processed information in the different MI learning centers. Therefore, it is essential for educators to consider how students feel about learning so they can embrace how they learn and choose learning activities that accentuate their intellectual abilities.

The data demonstrated how a change in behavior is generally associated with a change in learning. The students showed a willingness to resolve problems with their classmates without teacher intervention. The writer observed there were fewer infractions in the classroom as well as on the playground. The transformation in students’ disposition resulted in improved behavior during science instruction.

In addition, the target group of 20 students set learning goals and that helped them to establish a sound understanding of their strengths and weaknesses. This process had a profound impact how they learned and how they perceived themselves based on their learning trajectory.

Another implication of this study is that an enriched learning atmosphere is necessary to help students make many interconnections with the learning environment to retain information. Fountain and Fillmer (1987) found that fourth-grade students received better scores in science in a curriculum that was integrated with the MI theory.

Administration of the Climate Instrument every month was beneficial to the writer as well as to the students. Both could monitor the learning environment and make changes whenever needed for optimal learning to occur. Sousa (1998) suggested that educational leaders need to embrace how the human brain learns and make the necessary changes in the learning/teaching environment. Moreover, it is highly probable that once educators at a contextual setting grasp the educational ramifications of the findings, there will be a profound effect on academic achievement (Baldwin, 2000; Bucko, 1997; Callison, 2001).

Some of the expected outcomes were not achieved, and the writer can offer some plausible insights to explain why this occurred. Over the last decade, the MI theory has impacted the educational system and has enhanced the learning process and promoted self-esteem (L. Campbell & Campbell, 1999). With this undertaking, the writer asserted qualities of a transforming leader to help integrate the IMPACT strategy into the instruction.

Using the IMPACT strategy, the 20 students improved academically in science, which allowed the writer to engage in professionally growth as well. Professional growth was gained through reflective teaching and interacting with the students to provide them with research-based teaching practices. As a result of this endowment, the writer was able to provide students with essential skills to help them learn and process information to become critical thinkers and problem solvers. A teacher can expect to improve student achievement as well as broaden his or her professional development. With this knowledge, educators can guide students toward a career objective that is compatible to their intellectual capacity.

How did the MI approach help increase science scores and why was it the variable? The integration of MI strategies helped increase science scores because each learning experience helped foster students' convergent and divergent thinking. The MI activities differentiated the learning process, allowing the 20 students to become self-motivated. The 20 students were accustomed to the traditional approach to learning, which is more teacher-directed and less student directed. The MI approach helped the students experience intellectual, social, and emotional growth as they actively participated in the MI learning center activities each day for 30 minutes.

The writer believes that MI was the variable for student achievement because of the differentiated approach to acquiring knowledge in science. The 20 students were engaged in different learning experiences, which provided them with diverse ways of processing that information to understand the objective of the lesson better. In so doing, the 20 students were able to work together in small learning groups with their peers or independently to solve problems. The crucial component of this strategy is the many learning choices students were given. The 20 students were able to explore the objectives by taking ownership of their learning. Furthermore, the MI approach encouraged students to learn at their own pace, challenged them to become creative, and helped them become aware of their academic potential.

In conclusion, the research findings summarized from the quantitative and qualitative data indicate that the IMPACT strategy is an effective tool to improve the academic achievement of fourth-grade students. Even though there were some limitations present in this study, the intervention was, overall, beneficial to the students.

Limitations

There were two apparent limitations in this research investigation. One unanticipated event was that although the writer proposed that 24 students would participate in the research study, only 20 students returned the child assent forms and parent consent forms that were required for participation in the research study. As a result, half of the expected outcomes were not achieved. The writer can only postulate that the students and parents might not have fully understood the parameters of the study or they simply were not interested in engaging in a research study. To make this point clear, one parent in a telephone conference with the writer commented that the study was very comprehensive and wanted to know if the research study would interfere with the other subject areas.

In addition, there were many interruptions during the scheduled 30-minute MI learning center activities. For instance, three students were pulled out to rehearse for the school pageant. In many cases, students were dismissed from school early for appointments and other circumstances beyond their control.

In summary, these factors had a direct bearing on the outcomes that were unattainable based on the situations that were presented during the treatment of the independent and the dependent variables. The limitations presented in this study served as a precursor to provide the writer with recommendations to broaden the study for future research.

Recommendations

Based on her analysis of the descriptive and inferential data collected from this research study, the writer makes four noteworthy recommendations:

1. The students should be allowed more input in the learning centers activities.

2. More family activities should be orchestrated to improve the home-school learning environment.

3. The IMPACT strategy should be incorporated into other discipline areas.

4. Applications should be made for more grant money to fund field trips.

The rationale for the first recommendation is for students to have a more active role in their learning. This future action plan is vital to help students embrace their own diverse learning needs and to stimulate their motivational level. Perhaps all of the students would participate in the subsequent research study.

The reason for the second recommendation is to create additional activities to encourage parental involvement. It is important for parents to interact in the learning setting in different monthly activities. Monthly parental involvement will allow parents to become valuable assets to the school learning environment as well as in the home.

The third recommendation is to incorporate the IMPACT strategy into other discipline areas. The writer also recommends that a longitudinal study be undertaken at the school to examine the long-term results of using MI and brain-based learning strategies in an interdisciplinary approach. The research question for this study was, "How would an interdisciplinary curriculum impact academic achievement of fourth-grade students?" This recommendation would help students make a conscious effort to use their different intellectual capabilities to clarify their knowledge in a given subject area.

The last and most important recommendation is for the school to seek business alliances and apply for grants to fund the expansion of the IMPACT strategy in an interdisciplinary approach. Funds are needed to purchase massive amounts of resources to correlate with each thematic unit. The supplementary materials would help students embrace and employ the unique intelligences that they possess.

Using the synergy of the IMPACT strategy, the writer will continue to practice, review, and acquire new avenues to integrate MI theory and brain-based learning strategies into the other classrooms within the school setting. The writer will expound upon the research findings to initiate more research on the use of the MI strategies throughout the school district. The writer's main focus in this study was to integrate spatial, kinesthetic, interpersonal, intrapersonal, and verbal-linguistic intelligences in the science curriculum. Musical, logical-mathematical, and naturalist intelligences will be researched in a subsequent study.

In summary, these recommendations would provide the writer and others with additional research to study the integration of MI and brain-based learning strategies into other subject areas. The writer hopes that the recommendations that resulted from this research will serve as a catalyst for educational reform in the writer's learning organization and possibly extend to schools beyond the writer's school district. Clearly, these recommended future interventions would enhance the learning climate to increase student achievement and broaden community awareness of the need to support the diversity of learning for every child.

Dissemination

The writer disseminated the results of the applied dissertation to parents and teachers. A portfolio of activities was used during a workshop presentation to allow other educators to see a snapshot of the different activities that the students participated in during the research study.

Results of the data gathered were made available to the parents in a newsletter that explains the results of the IMPACT strategy used to increase academic achievement in the science curriculum. The results of the intervention were outlined in a summary of the data collected.

Conclusion

In brief, the 3-month research study integrated MI and brain-based learning strategies to enhance the academic performance of fourth-grade students. The writer used the IMPACT strategy to foster an appreciation for learning science using five learning centers: the Get to Know Me Center, the Make It Center, the Reading Center, the Team Work Center, and the Keep It Moving Center. As indicated by the qualitative and quantitative data presented in this research, a MI curriculum can significantly improve student achievement.

The research study helped students acknowledge their strengths and weaknesses to become reflective learners. Furthermore, it decreased the daily occurrences of inattentive students as well as significantly improving students' classroom behavior and attitudes about science. Clearly, the IMPACT strategy can provide educators with another way to foster student achievement and to enhance their own professional development.

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Appendix A

Learning Instrument

Purpose: This survey will be used find out how you feel about learning in science.

Your name is not needed on any part of this survey. All the information received from this survey will remain a secret. Your answers will be used to help improve your learning in science.

Section 1
Directions: Use a pencil to darken the bubble that best describes you.

I am a student who
O has a positive attitude about learning.
O sometimes likes science.
O dislikes science.

Section 2
Directions: Circle the number that describes how you feel about learning in science.

	Agree	Not Sure	Disagree
1. I learn when my classmates help me in science.	1	2	3
2. I enjoy learning in science.	1	2	3
3. I have good attitude about learning in science.	1	2	3
4. I listen to my teacher during science instruction.	1	2	3
5. I want to perform better in science.	1	2	3

Section 3
Direction: Write a short answer for each question.

6. What learning activity do you like the best in science?

____

____

____

7. What learning activity do you like the least in science?

____

____

____

Appendix B

Interview Instrument

Title of Project: Integration of Multiple Intelligences in Science for Student Achievement

Time of Interview:______________

Date:___________________

Place:______________________________________

Description of the project: The purpose of this interview will be to get feedback on how students feel about the science after taking part in the study.

1. Did you learn science better using the different intelligences that you have?

2. Did the different activities help you enjoy science? Why or why not?

Appendix C

Climate Instrument

Purpose: The purpose of this instrument is to find out how the classroom climate effect how you learn in science. Your name is not needed on any part of this instrument. All the information received will remain a secret. Your answers will be used to improve the learning climate in the classroom.

Section 1

Directions: Darken the bubble that best describes you.

I am a student who often makes:
O outstanding grades
O good grades
O not very good grades

Section 2

Directions: Read each sentence and circle the number that best describes how you feel about your learning environment in science.

	Agree	Not sure	Disagree
1. My learning environment is friendly and inviting.	1	2	3
2. My teacher makes me feel comfortable.	1	2	3
3. My teacher makes me feel smart.	1	2	3
4. I learn best when I take part in the activity.	1	2	3
5. I learn best in a quiet classroom.	1	2	3
6. I feel safe in my learning environment.	1	2	3
7. My teacher respects me and my ideas.	1	2	3

Appendix D

Multiple Intelligences Instrument for Learning in Science

Purpose: The reason for this instrument is to find the different ways you learn in science. Your name is not needed on any part of this instrument. All the information received will remain a secret.

Directions: Read the statements and circle the number that best describes how you learn in science.

4 This describes me completely.
3 This strongly describes me.
2 This somewhat describes me.
1 This hardly describes me.
0 This does not describe me.

I like to sing songs to help me learn in science.	4 3 2 1 0
I like to listen to background music.	4 3 2 1 0
I like to make tapping sounds while learning or studying.	4 3 2 1 0
I like to read books to learn in science.	4 3 2 1 0
I like to write about the things I learned in science.	4 3 2 1 0
I like to learn by thinking a problem out.	4 3 2 1 0
I like to group things to understand them better.	4 3 2 1 0
I like to use many ways to solve a problem in science.	4 3 2 1 0
I like to work with classmates.	4 3 2 1 0
I like to talk with my classmates to learn.	4 3 2 1 0
I like to draw pictures to explain things in science.	4 3 2 1 0
I like to learn using posters, charts, and graphs.	4 3 2 1 0
I like to write about how learning makes me feel.	4 3 2 1 0
I like to work alone in science.	4 3 2 1 0

I like to learn by doing experiments in science.	4 3 2 1 0
I like to perform a skit or play.	4 3 2 1 0
I learn when I can move around in class.	4 3 2 1 0

Appendix E

Multiple Intelligences Journal Writing Instrument

Directions:

Follow this guide when you write about how you use the different intelligences to learn in science.

Section 1

I learn more information in science when I use______________________intelligence.

I am good at this intelligence because

____
____
____
____
____
____
____
____

Section 2

I do not like to use ____ intelligence.

I am not good at this intelligence because

____
____
____
____
____
____
____
____
____