

# The Development Of A Fuzzy Model To Quantify Training Andeducational Factors And The Resulting Impact On Student Successand Lear

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THE DEVELOPMENT OF A FUZZY MODEL TO QUANTIFY TRAINING AND  
EDUCATIONAL FACTORS AND THE RESULTING IMPACT ON STUDENT SUCCESS  
AND LEARNING

by

CHANDRE BUTLER  
B.S. University of Central Florida, 2000

A thesis submitted in partial fulfillment of the requirements  
For the degree of Master of Science  
in the Department of Industrial Engineering and Management Systems  
in the College of Engineering and Computer Science  
at the University of Central Florida  
Orlando, Florida

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2005

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## **ABSTRACT**

The utilization of fuzzy mathematical modeling for quantification of the quality of training and educational delivery is an innovative application that can result in measurable and repeatable results. This research was designed to apply proven quantification techniques and Industrial Engineering methodologies to a nontraditional environment. The outcomes of this research provide the foundation, initial steps and preliminary validation for the development of a systematic fuzzy theoretical model to be applied for the quantification of various areas within training and education delivery. The test bed for this methodology is Orange County Public School system, the twelfth largest school district in the nation. The organizational and operational factors of a large school district are highly compatible with Systems Engineering concepts. The debate over education reform has drawn from referenced areas within the Industrial Engineering community including quality, continuous improvement, benchmarking and metrics development, data analysis, and scientific/systemic justification requirements. In spite of these applications, the literature does not reflect a consistent and broad application of these techniques in addressing the evaluation and quantification of educational delivery systems. This research draws on the previously listed areas within Industrial Engineering to apply these techniques to enhance the understanding and promote quantification of the multiple factors acting on the educational delivery system. The importance of addressing these issues is a national concern given the significant changes in the United States educational delivery system. For example, over the past 40 years there has been a more than three-hundred percent increase in per-pupil appropriations yet the academic performance gains have been limited and the quantification and measurement of those gains is even more limited. This body of work will

identify the systems, sub-systems, system factors, and factor degrees of existence necessary to quantify and measure these performance changes. Finally, the research will quantify the inputs and produce a model that provides a numeric value that represents the condition of the system and various subsystems of an educational system.

This work is dedicated to those whom I love; my family, my people and to the future of a people entrenched in faith, in search of understanding, and in hope of social equity.

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## LIST OF ACRONYMS/ABBREVIATIONS

AHP	Analytic Hierarchy Process
AI	Artificial Intelligence
AYP	Annual Yearly Progress
BRP	Blue Ribbon Panel
DCF	Department of Children and Families
DOR	Degree of Realization
ESEA	Elementary and Secondary Education Act
ESOL	English for Speakers of Other Languages
FCAT	Florida Comprehensive Assessment Test
FLDOE	Florida Department of Education
FST	Fuzzy Set Theory
GPA	Grade Point Average
NAEP	National Assessment of Educational Progress
NCLB	No Child Left Behind
NIST	National Institute of Standards and Technology
OCPS	Orange County Public School System
PTA	Parent Teacher Association
SME	Subject Matter Expert
SSE	Sum Squared Error
SSS	Sunshine State Standards
US	United States of America

## CHAPTER ONE: INTRODUCTION

### Background

Why the Need for Public Service Accountability? A major component of the political platform of the United States of America's 43<sup>rd</sup> president, George W. Bush, the need for educational reform consisting of increased accountability, increased academic standards, and decentralized control in order to facilitate a more effective and globally competitive public educational delivery system spurred the creation and adoption of the *No Child Left Behind Act* and other corresponding educational legislation fronted by the US Department of Education. A major key to understanding this educational reform and to ensure proposed positive change, is to view the current public educational institution in terms of a collective network of interconnected and interdependent processes that function as a collaborative unified educational delivery system. The approach must also be of sound scientific research and systematic implementation. This mention of processes, system, and scientific research correlate directly with the foundational concepts of Industrial Engineering. System efficiency and effectiveness is the common goal for both; the stipulated educational reform legislation of *No Child Left Behind* and the underlying mission of Industrial Engineering as a science. This potential partnership is poised to provide a means for successful educational reform and mission fulfillment. With the recent reelection of the current US President, George W. Bush, a major social issue of his political tenure is that of increased academic achievement in the public Elementary and Secondary Educational institutions (grades preK-12). President Bush's *No Child Left Behind (NCLB) Act 2001* educational reform legislation is in most part a reauthorization of the Elementary and Secondary Education Act of 1965 (ESEA). This

legislation is comprised of Titles I-IX and corresponds to the following Title definitions table:

**Table 1 Elementary and Secondary Education Act of 1965 (ESEA)**

TITLE I	Improving the Academic Achievement of the Disadvantaged
TITLE II	Preparing, Training, and Recruiting High Quality Teachers and Principals
TITLE III	Language Instruction of Limited English Proficient and Immigrant Students
TITLE IV	21 <sup>st</sup> Century Schools
TITLE V	Promoting Informed Parental Choice and Innovative Programs
TITLE VI	Flexibility and Accountability
TITLE VII	Indian, Native Hawaiian, and Alaska Native Education
TITLE VIII	Impact Aid Program
TITLE IX	General Provisions

There are four main common themes of the NCLB legislation:

1. Accountability for Results
2. An Emphasis on doing What Works based on Scientific Research
3. Expanded Parental Options
4. Expanded Local Control and Flexibility

These four items are the bedrock foundational concepts supporting modern educational reform legislation and are derived from the ESEA 1965 TITLES I-IX.

Along with the renewed ESEA legislation, NCLB assesses the degree of compliance and academic progress based on the standard scaled results of each state's educational competencies assessment test in the major academic areas of Reading/Language Arts and Mathematics. The levels of assessment stated by NCLB are Basic, Proficient, and Advanced. For a student to be performing at grade-level means that they would have a proficient level of mastery of curricula specified for that particular grade.



Further, alignment of National directives stipulates the obligations of State educational accountability under the educational reform legislation. It is up to the State Government to decide and deploy the methods in order to comply with the NCLB legislation. The State of Florida has mandated a set of academic standards referred to as the Sunshine State Standards (SSS) and a comprehensive education plan “The A+ Plan for Education” to ensure that academic curricula are aligned with State and National educational reform. The FCAT (Florida Comprehensive Assessment Test) assessment tool used to determine the degree of compliance of student academic performance with that of the SSS. This FCAT tool measures the Reading and Mathematics proficiency of each student assessed. The implementation of the SSS is the responsibility of the District. The educational District of interest within this body of work will be the Orange County Public School System (OCPS Orange County Florida) led by Superintendent Ronald Blocker. The District level of the public educational delivery system has expressed its concern on the integration/implementation of National, State, and Community stipulated public educational directives.

The forming of the OCPS Blue Ribbon Panel on Education is the result of this expressed educational concern initiated by the OCPS District in order to facilitate higher student achievement and continuous improvement from a student performance perspective as well as from a Management/Operations standpoint. The following is a list of the objectives of the Blue Ribbon Panel:

1. To identify factors that significantly impact student performance

2. To compare current Public Educational Practices across National/International Public Educational delivery systems, with those of the OCPS
3. To produce implemental recommendations based on panel findings

How was The Blue Ribbon Panel Committee formed was formed through the joint efforts of Orange County Government, The City of Orlando, Orange County School Board, Orange County Mayor (Richard T Crotty), Mayor of Orlando (Buddy Dyer), and the OCPS Board Chairman (Tim Shea). Experts and Specialists in Education, Public Administration, Corporate Management, and Law, were nominated to serve on the panel. These panel member's biographies can be viewed in Appendix A. Based on numerous existing research on factors that impact student performance and operations success, and through expert guidance, the following areas of focus were determined as being significant in addition, these factors were later validated to be significant as determined by how they were derived utilizing modern Systems Methodology that will be addressed in detail within Chapter Two of this body of work.

The following factors were deemed significant influencers of system and student performance:

- I. Early Childhood Education Factor
- II. Student Performance Factor
- III. Teacher Performance, Retention, and Pay Factor
- IV. Parental and Community Support Factor
- V. Education Management Factor

The following descriptions of the highlighted factors of interests will provide more detail as to what the factors are and to what extent they will be investigated (OCPS Blue Ribbon Schools, 2004).

**I. Early Childhood Education Factor** – The Early Childhood Factor will examine the methods and processes that the OCPS District utilizes when preparing and identifying children prior to their entrance into the public educational delivery system. Identified areas of interest are:

1. Pre-Kindergarten Programs
2. Early Intervention Programs
3. Early Academic Performance Assessment Programs

These are mainly issues that impact future participants in the public education system. The age range for students is from 0-4 years of age.

**II. Student Performance Factor** - The Student Performance factor will examine current student performance and the quality of existing programs and curriculum. In particular students who are not proficient in the established SSS for grade-level expectations, i.e. FCAT scores of level 1 or 2, will be examined. Are remedial efforts even worth the effort after a certain grade level? Other methods of remediation such as retention and remedial intensive educational programs will be reviewed, also. In addition to traditional remedial programs that may happen during regular school hours, special programs during off-hours, summer, and weekends will be explored as well.

**III. Teacher Performance, Retention and Pay Factor** – What conditions impact teacher performance quality? How do you retain quality instructors? These issues will be aggregated into the Teacher Performance, Retention, and Pay factor. Also other concerns such as, “Does certification actually make a significant difference in instruction quality and improved student achievement?” will also be examined?

**IV. Education Management Factor** – As being a public governmental agency steeped in tradition, the public education system exhibits administrative policies and processes that may have become inadequate and antiquated over time. The public educational delivery system is indeed dynamic and has more recently become an issue of international review being that the world has become smaller with the advent of information technologies and the increased ease of global commerce. What organizational, management, and administrative actions impact student performance and achievement? The Education Management factor will examine these and other related administrative issues of interest.

**V. Parental and Community Support Factor** – The Parent and Community Support factor will be an aggregate of activities in which Parent/Caregiver engages in that have been scientifically proven to impact student performance and achievement. An example of programs that have traditionally entailed parental support and involvement such as the Parent Teacher Association (PTA) and overall school accessibility activities with parents/caregivers, will also be assessed and studied to determine how they impact student performance and achievement. Also the community involvement of businesses

and faith-based organizations will be examined. Both economically and socially significant issues will be of interest when defining the Parental and Community Support factor. As a side note, to further address the notion of a more all encompassing title, it was recommended that the word “Family” be defined synonymously with “Parent” thus these words are interchangeable within the scope of this work. This factor will be the factor of interest throughout this body of work. The qualitative and subjective nature of the Parental and Community Support Factor issues contribute to the complexity of understanding their impact on public educational delivery system performance. This factor will be the focus of research.

**VI. The Media/Social Perception and Portrayal of System Factor** - In addition to the previous five factors, a sixth factor, “The Media/Social Perception and Portrayal of System” will be discussed. The reason for this additional factor came as a result of a couple of findings. Firstly within the modern systems methodology, discussed in more detail in Chapter Two, the Feedback Loop, which facilitates the flow of system information and communications, has been identified as a major culprit of poor system quality in many systems (Evans and Lindsay, 2001); therefore as a major sub-component of any system the Feedback Loop is extremely important in conducting the transfer of information.

Secondly a public programs monitoring and evaluation expert’s research noted the lack of studies which addressed the stated concerns of the power of perception, i.e. political power, and the media’s portrayal of the public education delivery system as well as other public programs. Most notably these concerns of media perception are rooted in the

science of Psychology but have not been widely recognized within the field of Education as being a significant impacting factor of system performance. Yet according to a recent OCPS BRP survey, ninety-one percent of the responses support that politically-driven mandates are believed to significantly impact the public educational delivery system (OCPS Blue Ribbon Schools Survey of Teachers and Administration, 2005). The media is arguably the most recognized and organized source of information in society.

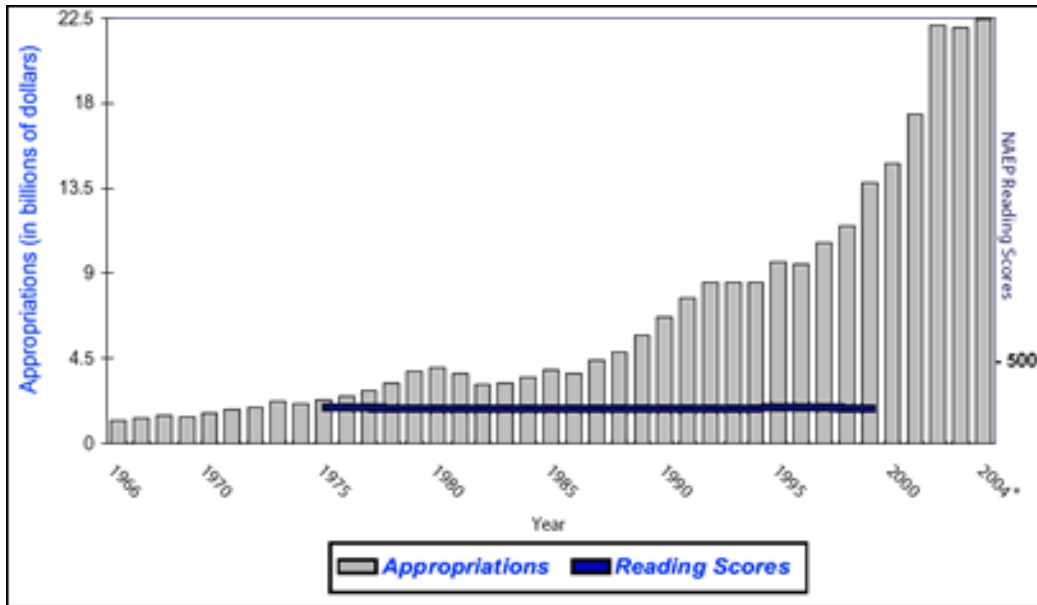
These six aforementioned factors will comprise the center of investigation within this body of work. Not only will the impact of student performance and achievement be defined, but the degree of factor influence on educational performance outcomes is a point focus.

### **Significance of Research**

Successful measurement, modeling and evaluation of public education systems in large metropolitan areas has been consistently difficult due to the dynamic environments, multiplicity of factors and difficult to quantify factors.

### **Objective**

So what is the objective of this body of work? The following Figure 1 is an example of the approach government has taken in order to increase student academic achievement.



**Figure 1: (U.S. Department of Education, Office of the Secretary, Office of Public Affairs No Child Left Behind: A Parents Guide, Washington, D.C., 2003)**

*Note: Appropriations for ESEA do not include funding for special education. Reading scores are the average scores for 9-year-olds, according to the National Assessment of Educational Progress (NAEP). A score of 200 implies an ability to understand, combine ideas and make inferences based on short, uncomplicated passages about specific or sequentially related information.*

Since the inception of the ESEA of 1965 through year 2003, the federal government has spent over \$242 billion on TITLE I disadvantaged children’s education, yet the achievement gap between minorities, non-minorities, and the economically destitute, remains, with only recent nominal gains being realized. “According to the most recent National Assessment of Educational Progress (NAEP) on reading in 2000, only 32 percent of fourth-graders can read at a proficient level and thereby demonstrate solid academic achievement; and while scores for the highest-performing students have improved over time, those of America’s lowest-performing students have declined”

(National Assessment of Educational Progress, 2001). So, what is being said? “National K-12 education spending has increased 101 percent since 1990-91, 48 percent since 1996-97, and 22 percent since the 1999- 2000 school year. When this is calculated on a per-pupil basis and is adjusted for inflation, funding has increased: 7 percent in the last 3 years for which data is available, 15 percent over 5 years, and 21 percent over 10 years.” (10 Facts About K-12 Education Funding, 2005). Many countries, internationally, have produced consistently higher student achievement yet accomplish this with far less resources than the United States. When adjusted for inflation the per-pupil appropriations in 1965-66 was \$2,853 in comparisons to an increase of \$7,086 in 1999-2000 (Archived Information The Facts About, 2002). Under the current governmental management structure, the source of federal appropriations allocation and the point of resource request are somewhat remotely distant from each other thus creating probable process discontinuity. This discontinuity has created an increased chance of appropriations allocation inefficiencies. For every dollar allocated for closing the achievement gap and increasing student performance, there has been little to no substantial positive gains as of yet. Why? Possibly there is lack of understanding as to which factors or combination of factors exist, that significantly impact student achievement and the educational/training system success. The objective of this work is to first illuminate, and to determine to what degree, the factors that significantly impact student achievement and the efficiency/effectiveness of the educational/training system utilizing a Fuzzy Set Theory approach. Finally, to create a Fuzzy Mathematical Model, from a systems perspective, that will quantify discovered qualitative factors in order to provide a sound, scientific,



and systematic methodology to facilitate a deeper understanding of identified factors and their behavior within the public educational delivery training system.

### **The Industrial Engineering Link to Educational Reform**

So how is Industrial Engineering defined within this body of work? “Industrial Engineers figure out how to do things better. They engineer processes and systems that improve quality and productivity. They work to eliminate waste of time, money, materials, energy, and other commodities.... Industrial engineer is synonymous with systems integrator - a big-picture thinker, in other words” (Institute of Industrial Engineers, 2005). The ideals of performance improvement and increased quality, which are reverberated in TITLES I & II of ESEA 1965 and NCLB 2001; along with the expressed major theme of desired proven scientific research coupled with systematic analysis stipulated within NCLB legislation, make for a seamless partnership between education reform and the field of Industrial Engineering. From the perspective of the industrial engineer, NCLB educational reform legislation calls for Public Education Systems integration that will lead to increased student performance, higher operational efficiency, proven systematic and scientific benchmarked methods of metrics development through accountability, and a resultant product that meets or exceeds stakeholder expectations. Yes, the public educational delivery system is designed to produce students who can successfully meet the expectations of society. Principles of industrial engineering are applicable for educational delivery systems.

The following topics are specific areas of focus in which Industrial Engineering can help government and legislators realize their stated mission for modern education reform and will be the underlying basis of this body of work:

**I. Quality and Continuous Improvement Principles** – W. Edwards Deming, Joseph M. Juran, and Philip Crosby, arguably the most notable modern Quality gurus, approached the issue of Quality as a science and art. Quality will be defined as simply “Meeting or Exceeding Stakeholder Expectations” within this body of work. NCLB legislation defines viable stakeholders of the public education system as Parents, Teachers, Administrators and Community.

As evidence of a commitment to quality and its importance, the United States government has instituted programs that promote quality initiatives in production & manufacturing, healthcare, services, and educational systems administration. For instance, in an effort to ensure US corporate economic global competitiveness and increased productivity, the Malcolm Baldrige National Quality Improvement Act (Public Law 100-107) was created in 1987 as a means to spur quality awareness within the United States. The Malcolm Baldrige National Quality Award, a result of this legislation, has come to acknowledge organizations who have made considerable strides to make Quality their prime initiative. This award includes recognition of five different types of organizations including both educational organizations as well as governmental agencies. At the State level, The Florida Sterling Council’s “Sterling Award” is patterned after the National Baldrige Award and uses the same evaluation criteria. In retrospect, the most

notable contributions of the three aforementioned quality gurus will be discussed and examined in the context as to how they are related to modern education reform and how possible implementation can occur.

Also, a tool that can be utilized within the public educational delivery system in order to ensure continuous improvement and increased quality is the Deming Cycle: “PDCA or PDSA” (Plan Do Check Act or Plan Do Study Act). It is an iterative revolving process that emphasizes structured planning, acting according to plan, checking/studying these actions, and making recommendations to improve on the planned actions based on the results. The Deming Cycle is the basis of many process improvement models including the Waterfall Process Model, which will be discussed later.

Though modern quality philosophy may have originated in manufacturing and production environments, the concept of quality exists in many other fields of interest including public educational delivery systems. Continuous improvement is the goal of any system administrator.

**II. Systems Modeling** – Systems modeling will be utilized in this research through the application of a General Systems Model methodology (Input, Throughput, Output, Feedback Loop, Enablers, and Stakeholders) that will be discussed in detail later on within this work. Once the educational delivery system has been successfully defined at the OCPS District Level, a model that will quantify the current state of educational delivery system can be created. The model outcomes can then be used to drive program

intervention implementations that will facilitate administrators in their quest for meeting stated system performance goals. A benefit of such a model is anticipated educational delivery system information that could result in faster responses to trends, crisis, or better yet, prevention of such critical states of the educational delivery system. A more modern approach to understanding qualitative measurement and decision-making activities in which the industrial engineer employs a fuzzy logic methodology, has proven to be quite beneficial. There are five types of systems where fuzziness is necessary or beneficial (McNeill & Thro, 1994):

1. Complex Systems that are either difficult or impossible to model
2. Systems controlled by human experts
3. Systems with complex and continuous input/outputs
4. Systems that use human observations for input data
5. Systems that are naturally vague

The public educational delivery system conforms to many, if not all, of the aforementioned ideal conditions justifying the use of a Fuzzy methodology.

### **III. Variation Identification and Control (Common-Cause and Special-Cause) -**

Variation is any deviation from the expected or desired condition. This variation, in any environment, can reduce the quality of the output of the system. There are two commonly accepted and recognized sources of variation, Common-Cause and Special-Cause. The public education system, as with any other system, contains inherent Common-Cause

variation that is a result of its design. Special-Cause variation can be explained as the result of an event that can be contributed to a known deviant event that could be identified. A method that can be used to detect such variation is to establish some form of accountability that prompts those who are in positions of authority, to execute required actions such as monitoring processes within the system. This approach can be used to empower individuals and teams to take action to modify and change undesirable process states. Control and mitigation of such variation can result in highly favorable outcomes that further support the directives of modern education reform.

**IV. Metrics Development and Data Analysis** – Metrics and benchmarks are the basis of improvement. Metrics are deemed significant measures of a system that indicate whether or not a system is meeting an intended performance state. Federal and State educational policy have determined the significant metrics of interest that will be investigated within this research. The metrics that are included in this work are: FCAT Reading scores and FCAT Math scores of Achievement Level 3 or higher, and the meeting of Federal AYP (Annual Yearly Progress). These metrics will be discussed in further detail in the following sections. Accountability is a driving force to metrics development. Structured Data Analysis is also important to consistent accurate interpretation and increased quality. Data is meaningless without valid interpretation. It is this interpreted data that yields information, which is used to initiate actions that support education reform.

**V. Systematic and Scientific Methods** – Valid and consistent procedures should be a common occurrence in a systems environment. Well-documented procedures are

repeatable and also reduce common cause system variation. The public educational environment represents a complex collection of systems. Successful education reform under specific conditions should be able to be applied in various with repeated applications when needed.

The principles of Industrial Engineering provide ideal tools for supporting education reform at the National, State, District, and Campus level. Increased appropriations have not consistently resulted in expected favorable returns; Industrial Engineering can help answer some of the questions about successful education reform and public educational system improvement.

Education reform has been deemed an extremely pertinent issue of the current US presidential administration. There are known factors, as determined by research that impact the performance of the public educational system and student learning. Yet this research shows that there are apparent inefficiencies in the number of appropriations per student and the lack of significant improvement in student performance. Historically speaking, the industrial engineer is well equipped to solve complex problems such as being able to determine inefficiently operating systems. The industrial engineer will then provide recommendations of the required actions that would facilitate improved system performance.

## **CHAPTER TWO: APPLICATION ENVIRONMENT**

### **The Public Educational and Training Delivery System**

Systems Engineering is defined as: “Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs” (International Council on Systems Engineering INCOSE, 2005).

Thus the purpose of a system is to alter material, energy, or information in an effort to accomplish a desired objective. They are composed of various sub-components:

1. Structural sub-components (Static Parts)
2. Operating sub-components (Perform a process)
3. Flow sub-components (Material, Energy, Information)

Also there are relationships that exist between the components of the system. They can be identified as:

1. First-order (Functionally necessary to each other)
2. Second-order (Complementary and add to system performance)
3. Redundant (Duplicate or back-up, utilized for increased system reliability)

Every system should have defined boundaries, limits, and scope. Without these defined areas it is quite difficult to manage and understand the system and how it performs.

Outside of these defined boundaries is the environment. The environment continually imposes itself upon the system, and is many times the source of uncontrollable variation.

A system can be broken-down into smaller functional groupings called sub-systems.

These sub-systems exhibit the characteristics of the overall system and contribute to the performance of the system.

The following are classifications of systems:

1. Natural and Human-Made Systems
  - a. Natural – Exists without human aide
  - b. Human-Made – Exists due to Human activity
2. Physical and Conceptual Systems
  - a. Physical – Tangible, Actual
  - b. Conceptual – Intangible, Symbolic
3. Static and Dynamic Systems
  - a. Static - A system is a structure without activity
  - b. Dynamic - A system that combines structure with activity



#### 4. Closed and Open System

- a. Closed – Interaction with the environment is virtually non-existent and system boundaries are highly restrictive
- b. Open – System boundaries are less restrictive and allows matter, energy, and information to cross system boundaries

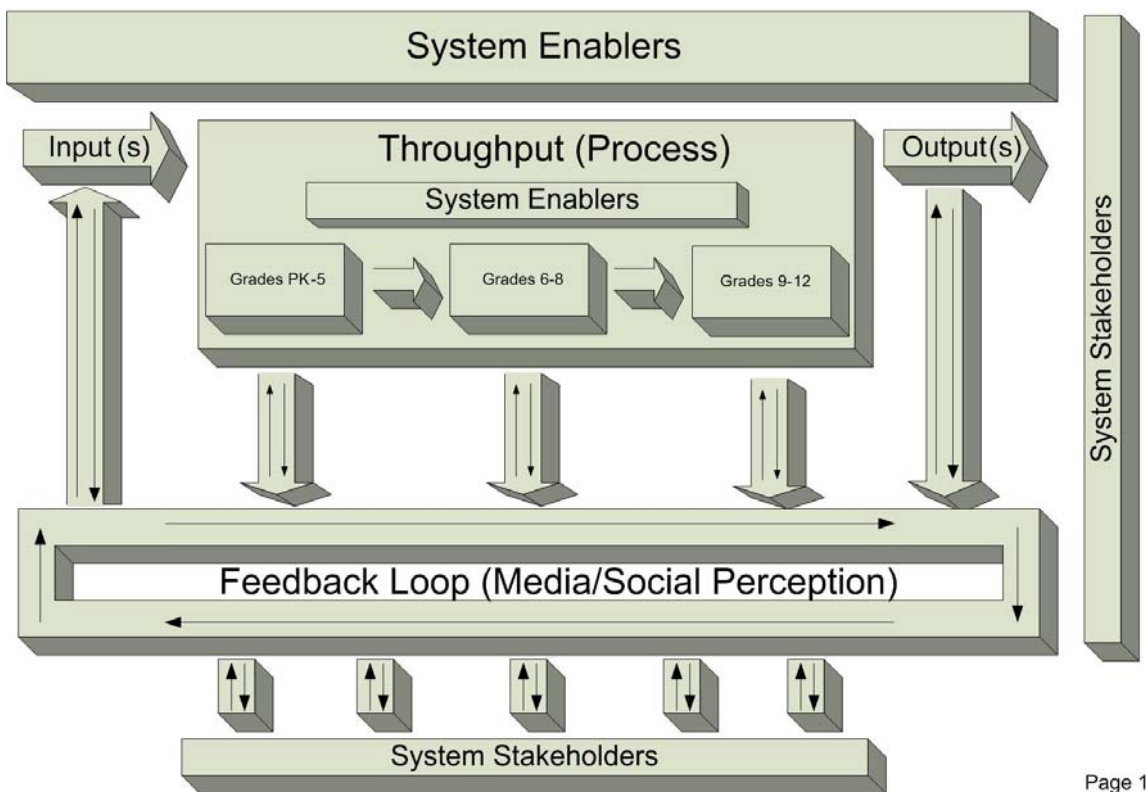
Based on the previous definitions, the public educational delivery system can be defined as a human-made, conceptual, dynamic, and open system. The inherent complexity of this system is demonstrated by the classification of this system in three categories.

The environment of the public educational delivery system, from a systems perspective, accounts for many significant factors that impact the system as a whole, should be structured by a methodology that integrates the needs of stakeholders in the most efficient operational manner, and delivers a quality-driven outcome. The methodology to be used is the General Systems Model Theory most notably created by Ludwig Von Bertalanffy, was originally derived from the biological sciences, and now widely accepted within engineering and organizational management theory (Bertalanffy, 1968). The systems' methodological basis involves primarily six distinct aspects that constitute the system:

1. Input(s)
2. Throughput (Process)
3. Output(s)
4. Feedback Loop(s)
5. System Enablers
6. System Stakeholders

The following figure further delineates this systems methodology in a manner that details the relationship between the six aforementioned system aspects.

### Public Education Delivery Systems Model (General Level)



Page 1

**Figure 2: The Public Education Delivery Systems Model**

Within the OCPS educational delivery system the delineated factors that most significantly impact the quality of the educational delivery system can be seen as to how they apply to this Systems Methodology within the following paragraphs.

## **Input(s)**

The Inputs topic is the first area of interest within the General Systems Methodology. An input is defined as an object(s), specifically in this case of the educational delivery system, young children ages 0-5 years, which is/are to be transformed in accordance to the system's designed expectations. Quality Management Theory's perspective on the management of system Inputs, in which the provider of these Inputs are referred to as "Suppliers", is one of extreme importance towards the prevention of downstream and future system quality issues (Evans and Lindsay, 2001). Educational delivery system programs and interventions that stress the importance of Inputs management and highly prioritize such actions are better suited to enable students to attain the intended level of learning proficiency. It is through long-term alliances with parents and their communities that can make the difference in system quality. According to a recent OCPS BRP survey of Teachers and Administrators when asked to rate issues that impacted public schools in their community topics that referenced system Inputs such as "Lack of Discipline" and "Lack of Family Support" garnered ninety-two percent and ninety-five percent responses, respectively, as being issues of significant to slight importance (OCPS BRP Survey Results, 2005). These results coincide with Quality Management Theory in that if there were a more vested interest in the area of the educational delivery system Inputs, there would be an increased likelihood of preventing system quality issues and an increased potential for quality system operations.

It is logical to see that the following factors, from Chapter 1, should be addressed within the discussion of system Inputs:

1. Parental and Community Support Factor

## 2. Early Childhood Education Factor

### **Throughput (Process)**

Traditionally the Throughput (Process) is the commonly referenced area of direct concern for systems administration and other educational delivery system stakeholders. Hence this belief of limited focus and control, that does not place enough emphasis on interactions with predecessor events such as with the Inputs, and various environmental factors, has in some ways perpetuated the diminished quality of the Outputs of the system. Operational efficiency is an identified measure of system performance requested by System Stakeholders and embraced by system administrators as well as System Enablers. Specifically speaking, in the OCPS educational delivery system over seventy percent of the annual budget is appropriated to areas within the Throughput section of the systems methodology (OCPS Final Budget 2004-2005). The most common measure of efficiency is a ratio of the perceived benefit, or result, of an action, intervention, or program per dollar of appropriated expenditures. This efficiency ratio is in common use in business and organizational management theory.

The following factors are most commonly reviewed within the context of the Throughput (Process) discussion as pertaining to identified factors:

1. Student Performance Factor
2. Teacher Performance, Retention, and Pay Factor
3. Education Management Factor

### **Output(s)**

The output(s) of the system are the end results of the processing of input(s). In the educational delivery system the intended outputs are students; preferably students who have attained proficient levels of mastery of the minimum educational delivery system standards. Florida SSS indicate that students, who have scored a level 3 or higher on educational areas of interest, Reading and Mathematics, on the FCAT, have demonstrated compliance to the SSS level of learning proficiency. Traditionally in the educational delivery system the inspection of overall system quality was concentrated at the output of the system. Being that the public educational delivery system is a serial system, meaning that antecedent events are contingent on predecessor event results; outcomes at the system outputs are contingent on quality conformances or non-conformances of predecessor events. To be a quality product, the outcome should meet or exceed mandated legislation as well as stakeholder expectations. In the essence of continuous improvement the system output is an initial step for future improvement intervention plans. Key areas to consider in the outputs discussion are transitory interventions, from exit of the educational delivery system to the next phase of life, for acceptable and unacceptable levels of quality output, more specifically, interventions for graduates and student drop-outs. Also final quality assessments, i.e. accurate analysis of student competency, should be instituted prior to system exit.

The following factors that accent student performance and operational efficiency which are exhibited at the system output are:

1. Student Performance Factor
2. Education Management Factor

The output of the educational delivery system is educated and uneducated students. The performance of the system is directly correlated to the performance of exiting students. Though separating the performance of students from the operational status of the public educational delivery system is seemingly a prominent belief within the education profession, from a systems perspective is highly improbable.

### **Feedback Loop(s)**

Feedback Loops are the channels of communication that traverse the entire system, and are used to transport information pertaining to the status of the system or subsystem components. These channels of communication connect the outputs of the system to persons in positions of authority who may alter or modify the system in order to produce quality outputs and also connects the system outputs to system stakeholders. Data analysis and metrics development are major components within the feedback loop and hence is the major area of interest within this body of work. Systems modeling provides pertinent information that may facilitate more reliable and scientific based decision-making. In the past within the educational delivery system, ineffective intra-system feedback loop(s) have attributed to the reduction in overall system quality. Within the current OCPS educational delivery system framework, the following areas would

potentially be categorized in the feedback loop under the General Systems Methodology; Information Technology, Accountability Research & Assessment, and Community Relations. The specific impacting factors identified earlier in Chapter 1, which can be found within the feedback loop discussion are:

1. Media/Social Perception and Portrayal of System Factor
2. Education Management Factor
3. Student Performance Factor
4. Teacher Performance, Retention and Pay Factor
5. Parental and Community Support Factor

This feedback loop is responsible for providing legislators, education administrators, and stakeholders, information that is in turn used to make decisions or shape perspectives about the educational delivery system. How the system is perceived is a direct result of the system's feedback loop.

### **System Enablers**

System Enablers are responsible for enabling the system to accomplish its intended function. Inefficiencies found within the services/functions provided by System Enablers will directly impact educational system quality. System Enablers could be either internal or external to the educational delivery system. Within the current OCPS educational delivery system Throughput section of the systems methodology, services provided by Internal System Enablers, are the organizational responsibility of the Chief Operations

Officer (COO); Executive Support Services, Food & Nutrition Services, Planning, Contracts Administration, Procurement Services, Safety & Security, and Transportation & Support Services. In addition, other areas that may not be the COO's responsibility such as Fiscal Services, Human Resources & Labor Relations, and Instruction & Curriculum Services are also Internal System Enablers under the General Systems methodology.

External System Enablers, who are outside of the span of control of OCPS, yet within the OCPS educational delivery system, are; Parents/Caregivers, Tax-Payers, Lottery Participants, Businesses, Foundations/Philanthropists, Faith-Based Organizations, and Government (Local, State and Federal). Many of these External System Enablers are also major System Stakeholders, as will be discussed in the next section. These System Enablers are engaged in parallel support activities that facilitate educational delivery system function. External System Enablers contributions are the major sources of appropriations for educational system delivery system function. Factors that impact performance in the context of Systems Enablers would include:

1. Parental and Community Support Factor
2. Teacher Performance, Retention, and Pay Factor
3. Education Management Factor
4. The Media/Social Perception and Portrayal of System Factor

System enablers are often overlooked and ignored until they fail to perform as expected. They potentially provide more stakeholder dissatisfaction than satisfaction. Traditionally,



internal system enablers were considered the educational delivery system thus excluding pertinent system influencers. The expanded perspective of the systems methodology defines system enablers as a single component of the overall educational delivery system.

### **System Stakeholders**

System Stakeholders are defined as persons, entities, or groups of entities that share a vested interest in the system. As with the previous section on System Enablers, System Stakeholders may be either internal or external. Normally, stakeholders are discussed from an external viewpoint; also this stance will be taken in this body of work, since it is logical to assume that every internal entity of the system has a vested interest in the success of the system. In terms of the OCPS public education delivery system, the following have a vested interest in the success or failure of the educational delivery system: Taxpayers, Businesses, Post-Secondary Education, The Military, Government (Judicial, Executive, and Legislative), Political Groups/Lobbyists, The General Public, Parents, and Faith-Based Organizations. The Outputs of the system will impact each stakeholder. In the quality-driven system it is stakeholder expectation that defines whether or not the educational delivery system is producing a quality Output. If students graduate from the public educational delivery system and performed at an acceptable level on educational issues not valued by major stakeholders, then how can these graduates of the system be considered quality products (Achieve 2004)?

Logically, all identified factors would be considered within the context of the Systems Stakeholder discussion since stakeholders have a stake in total system performance:

1. Early Childhood Education Factor

2. Student Performance Factor
3. Teacher Performance, Retention, and Pay Factor
4. Parental and Community Support Factor
5. Education Management Factor
6. The Media/Social Perception and Portrayal of System Factor

Stakeholders are major influencers of educational reform policy. Utilizing a systems approach should promote an increase in systems quality by incorporating stakeholder expectations earlier in the educational delivery system design.

### **Training System Methodology**

Considering the public educational delivery system as a training system is a logical idea. In fact the Output of the educational system should be a well-educated trained individual who has met the expected performance requirements instituted by legislature. Training Systems Theory as an organized systems approach is relatively new. This discussed framework has been derived from various sources and backgrounds in Psychology, the Cognitive Sciences, and Systems Simulation & Modeling. This Training methodology can be implemented at both the administrative level as well as the teacher/instructor level. The Training Systems Theory Methodology allows an administrator to analyze the value of a specific identified task, or groups of tasks, as they relate to the end goal of a defined successful training system. The following paragraphs will include definitions of the components within the Training Systems Methodology and an example of how the current OCPS educational delivery system relates to this methodology.

## **I. Educational Delivery System Functional Objectives – The Training System**

Functional Objectives address the concerns of System Stakeholders, namely Legislature in terms of the OCPS educational delivery system, and define as to how the Training system will assess quality system performance. For instance the OCPS District has adopted the following Academic Policies that can be identified as Training System functional objectives (OCPS Ends Policies, Academic Achievement 2004):

“ Students will achieve academically at levels commensurate with challenging and yearly individual learning goals.

### 2.1 Students will demonstrate the ability to think independently

Accordingly, students will:

2.1.1 Demonstrate and apply critical thinking using research, creativity, analysis, synthesis and evaluation of information

2.1.2 Apply their learning to real life situations appropriate to age levels

### 2.2 Students will master academic skills in core areas

Students will:

2.2.1 Be literate

2.2.1.1 Read at or above grade level by age nine

2.2.1.2 Read a variety of texts with fluency and comprehension appropriate to the materials

2.2.1.3 Demonstrate an aesthetic appreciation of literature

2.2.2 Communicate effectively and fluently, both orally and in writing

2.2.3 Use mathematical and scientific concepts to solve problems

2.2.4 Have knowledge of current events in the context of American and world history

2.2.5 Use the humanities and the fine arts for exploration, communication and self-expression:

- Music
- Theater Arts
- Visual Arts
- Philosophy”

The above objectives are the foundation for the following sections within the Training System Methodology.

**II. Conditions of Task Performance** - There are three stated conditions of task performance, the psychological, the physiological, and environmental. Examples of Psychological task performance conditions that exist within the OCPS Training System area:

1. Task Time Constraints
2. Impromptu Response

Such conditions involve mental capacity and ability to operate under various Psychological task performance conditions of stress and expression.

Physiological conditions are limited when referring to the educational delivery system.

Examples of such conditions are:

1. Remain Attentive and Alert
2. Seated erect in a Chair/Desk

These Physiological conditions refer to the physical expectations of students in the OCPS system.

Environmental task performance conditions define the surroundings under which training will take place. Traditionally the OCPS educational delivery system has followed the most commonly accepted educational delivery method, the classroom setting. However recently the following examples have also been implemented to take advantage of different learning environments:

1. Online Instruction
2. Career and Technical Education (Real-World Work Environment)
3. Home-Schooling

Identifying the conditions under which training will commence, will aide system administrators in the creation and selection of appropriate educational curricula.

**III. Tasks and Behaviors** – Identifying the boundaries of the Training System, is the first step to identifying required training task. In the General Systems Methodology the start is the Inputs and the end is the Output. Also Training subsystems occur within the educational delivery systems that have defined boundaries:

1. Task Identified: The first task is identified.
  - a. Example: *“A student solves a math word problem”*.
  
2. Skills Requirement: Defines the skills required to accomplish the task.
  - a. Example: *“The student requires skills to perceive the word problem, visually or aurally and then to communicate ideas verbally or through writing.”*
  
3. Knowledge Requirement: For example if a student were to solve a mathematical word problem.
  - a. Example: *“The student must know how to read and comprehend proficiently.”*
  
4. Ability Requirement: The student must be empowered and capable of accomplishing the Task
  - a. Example: *“The student must be allowed time to solve the word problem. Materials required to solve the word problem should be provided, i.e. writing utensils, paper, calculator, etc.”*
  
5. Difficulty: In comparisons to other systems tasks, how likely will the task be successfully completed under the given conditions.

- a. Example: *“Word problems require greater analytical skill than regular math problems therefore the level of difficulty is Higher.”*
6. Criticality: Refers to the tasks’ ranking when prioritized according to the level of contribution or importance to the training system.
  - a. Example: *“Solving word problems is a highly critical task in the Real World; mastery shows proficiency in multiple core educational areas.”*
7. Consequences of Not Accomplishing the Task: What will happen in the case of task failure within the training system?
  - a. Example: *“Failure to solve word problems would negatively impact the student’s academic record.”*
8. The Frequency of Occurrence of the Task: How often does the task occur?

Fundamental tasks that emphasize core educational requirements should be treated differently than non-essential tasks.

  - a. Example: *“In relation to the entire academic curriculum, solving word problems is a frequent task encountered at multiple levels of math and grade levels.”*
9. The Measures of Performance for the Task: How is task success defined and to what degree?
  - a. Example: *“Passing an examination of math word problems would define student mastery of the subject. Yet there are various levels of mastery, for*

*instance the FCAT defines levels of 3-5 that define skill mastery at different levels of proficiency.”*

10. The Standard to Which the Task Must Be Performed

- a. Example: *“SSS specify that by a specific grade level math world problems are included as a topic area requiring student mastery.”*

11. Behaviors: Are the exhibited higher level groupings of function achieved via task success.

- a. Example: *“Mastering word problems exhibits accomplished student performance and training system effectiveness.”*

In summary, the Training System Methodology is a structured approach to defining the educational delivery system and a tool to facilitate continuous improvement. The framework can be used at multiple levels of administration and instruction within the system.

### **OCPS Statistics and Demographics Summary**

The following OCPS statistics were obtained from (The OCPS Pocket Facts 2004-1005):

1. The Orange County public school system is the 12th largest district out of more than 16,000 in the nation and is the fifth largest in Florida.
2. Number of Schools: 155
3. Total Students: 174,060



4. White 38.12%
5. Black 27.99%
6. Hispanic 27.86%
7. Asian/Pacific Islander 3.90%
8. Multi-Cultural 1.72%
9. American Indian/Alaska Native .41%
10. General Operational Fund (Budget) \$1,155,839,244

Overall the application environment has been defined as the OCPS Public Educational Delivery System. Both, a General Systems Methodology as well as a Training Systems Methodology was employed to identify the test bed's infrastructure that will be referred to throughout the rest of this body of work.

## **CHAPTER THREE: METHODOLOGY**

### **Qualitative Data (Factor Surveys)**

#### Primary Data Collection

Qualitative data is the primary source of collected data, input, that will be used to generate the fuzzy model and will be further discussed in detail in Chapter Five. The finished survey, which can be viewed in Appendix B, consists of two sections. Section 1 of the survey is based on the expertise of personnel employed within the public education delivery system, researchers, and educational consultants. The questions asked were designed to have the survey participant rank the relationship of pair-wise comparisons of the six factors, introduced in Chapter One, based on a process referred to as Analytic Hierarchy Process (AHP) further detailed in Chapter Five of this body of work. This data was then used to determine the coefficient weights of the Fuzzy Model discussed in Chapter Five, more specifically the weight of the coefficient for the Parental and Community Support Factor.

Section 2 of the survey explains the Fuzzy linguistic level assignment, which is a translation of the linguistic terms of significance, and transforms them into quantitative information. The Fuzzy linguistic level assignments were made by the researcher and determined that 4 linguistic levels of significance would suffice to model the levels; Very Significant, Significant, Moderately Significant, and Not Significant. Usually 3-5 defined linguistic levels are used because as the number of levels increases, the complexity

increases and the potential for related sampling and data collection error increases as well. In this research 4 linguistic levels were used, Very Significant, Significant Moderately Significant, and Not Significant. The use of the Fuzzy approach in scoring classification helps to accurately and consistently rank linguistic values. Humans tend to rank and describe events, items, and their perception based on a continuum, a range, rather than as a discrete exact statement. Linguistically comparisons words and phrases such as; “like”, “somewhat”, “could be”, and other adverbs, underline the existence of uncertainty and the lack of absolute certainty, which humans encounter on a continual basis. The fuzzy level assignment will be more aptly referred to as “The Degree of Realization” (DOR). This assessment will be determined by trained evaluation personnel SME who will utilize the information in Section 2 of the survey in Appendix B. The Degree of Realization can be described as; “if there is evidence or potential evidence that an object of interest exists and to what degree the object may potentially exist based on human observation, human expertise, or human intuition”. The Degree of Realization is the foundational component of the analysis portion of the formulated Fuzzy Model.

Since the survey is not assumed to be perfect, because human participant responses are not absolutely repeatable and accurate 100% of the time, sampling error exists. Ideally the survey should be given to the same participants multiple times to mitigate various types of sampling error. Consensus on the allowable level of model variability, error, is the responsibility of system experts and has a bearing on the confidence level of the formulated Fuzzy Model.

### Preliminary Data Collection (Application Environment)

In conjunction with the aforementioned data collection method, an OCPS Blue Ribbon Survey that was a joint effort between the OCPS BRP and the University Of Central FL. College Of Education was used to derive insight into the significance of the factors that (Positively and Negatively) impact student performance and educational delivery system performance.

This OCPS BRP survey addressed the following:

1. Was administered using a robust online survey software tool called Zoomerang®
2. OCPS District Superintendent notified the instructional personnel of the targeted population (12,742 administrators and teachers) to participate in the survey.
3. Roughly 41% (5,171 administrators and teachers) of the targeted population responded to the survey.
4. Anonymity was ensured as the University of Central Florida was the 3<sup>rd</sup> party administrator of the survey.
5. Teacher Respondent Composition: Elementary 54%, Middle 21%, High 23%
6. 106 questions were asked that covered the following categories within the survey:
  - a. Achievement Gap
  - b. Amounts of Time for teaching and paperwork
  - c. Demographics

- d. Exceptional Students
- e. Failing Schools
- f. Level of Support
- g. Local Issues
- h. NBCT/Advanced Degrees (National Board Certified Teachers)
- i. No Child Left Behind
- j. OCPS and Teacher Leadership
- k. Pay For Teachers
- l. Personal Effectiveness
- m. School District Rating
- n. Special Educational Programs
- o. Testing
- p. Uniforms

These OCPS BRP survey responses, Learning Impediments, were then coded, normalized based on the most significant factor, and ranked, so that the responses would fit the developed “FUZZY MATHEMATICAL MODELING OF THE PUBLIC EDUCATIONAL DELIVERY SYSTEM SURVEY section 1” of Appendix B. By using a Fuzzy level assignment process, later explained in more detail, the following data tables are the result:

**Table 2 OCPS BRP Survey Results Coding**

<b>Learning Impediments (Negative)</b>	<b>% Impact</b>	<b>Factor Interpretation</b>	<b>Linguistic Term</b>
Lack of Family/Parent Support .31	0.31	* Parental and Community Support	Very Significant
Student Behaviors .23	0.23	Student Performance	Very Significant
Overcrowded Schools .10	0.1	Education Management	Moderately Significant
Administrative Issues .08	0.08	Education Management	Moderately Significant
Inequity .08	0.08	Education Management	Moderately Significant
Excessive Testing .07	0.07	Education Management	Moderately Significant
Quality of Teachers .04	0.04	Teacher Performance	Not Significant
Burn Out .03	0.03	Teacher Performance	Not Significant
	0	Early Childhood Education	Not Significant
	0	Media/Social Perception	Not Significant

**Table 3 OCPS BRP Survey Results Coding**

<b>Learning Impediments (Negative)</b>	<b>Normalized % Impact</b>	<b>Rank</b>	<b>AHP Rating</b>	<b>Questions</b>
Lack of Family/Parent Support .31	1.000	1	*	1,89
Student Behaviors .23	0.742	2	1	7-10
Overcrowded Schools .10	0.323	3	5	1
Administrative Issues .08	0.258	4	5	11,12
Inequity .08	0.258	5	5	13,14
Excessive Testing .07	0.226	6	5	7,8,9,105
Quality of Teachers .04	0.129	7	7	10,15-27,95
Burn Out .03	0.097	8	7	
	0.000	9	9	
	0.000	10	9	3,31,59,60,104,106

The significant Learning Impediment was determined by the number of responses of the survey. The top ranked (highest response frequency) impediment established the base for comparisons of the factors, in this case the Lack of Family/Parent Support where 31% of the surveyed respondents agreed was the leading very significant Learning Impediment.

An Analytic Hierarchy Process rating was then assigned. Each corresponding survey question category can also be determined as presented within the OCPS BRP survey.

In addition to the OCPS BRP responses, individual teachers and educational system consultants answered the survey questions that determined the level of significance for factors outlined in this research, that (Positively and Negatively) impact educational system and student performance. The end result of the combined survey responses was two Fuzzy mathematical models that included each factor's weight or perceived (Positive or Negative) impact on public educational delivery system performance and student learning. This methodology will be explained in greater detail in the following chapters.

After the OCPS BRP Survey responses were coded the fuzzy mathematical model was created using the developed fuzzy model survey of Appendix B. This survey contains two sections: Section 1 is "Factor Weighting Calculations" and Section 2 is "Fuzzy Linguistic Level Assignment". Respectively, there are 22 and 27 questions. Each question in section 1 ask a survey respondent to delineate the (Positive and Negative) impact of a factor within a pair-wise comparisons of the six educational factors described in Chapter 1 of this research. Section 2 was not utilized in this research but is a very important aide to use when determining the degree of existence of a factor of interest.

### **Quantitative Data (Responses)**

As the Output portion of the Fuzzy Model the following responses were identified as prominent measures of student and Public Educational Delivery System performance within OCPS and the Florida Department of Education (FLDOE) the following responses have been identified:

1. Florida A+ Plan School Rating (Theoretical Score: 0 - 600)
  - a. This is a calculated school rating based on student performance as further described in FL Dept. of Education publications.
2. NCLB AYP (Adequate Yearly Progress) (Theoretical Score: 0 - 1)
  - a. This is a percent measure of compliance to NCLB AYP mandates (30 criteria).

The Florida A+ Plan School Rating system metric is mainly an aggregate measure of individual student performance. The NCLB AYP is more of an administrative based system metric instituted in part by the US Federal government. More individually based student performance metrics at the Florida State level are:

1. FCAT Achievement Level Reading Score (Theoretical Score: 100 - 500)  
(Levels 1-5)
2. FCAT Achievement Level Math Score (Theoretical Score: 100 - 500)  
(Levels 1-5)

These two scores are by far, the most pertinent student performance metrics within the OCPS District and have been the focus of recent political educational debate. FCAT Achievement Level scores are the major component of Florida A+ Plan School Rating. Though it has been noted in past research that the GPA (Grade Point Average) has been used as the major indicator of individual student achievement, however due to the existent variation in the methods used to derive the GPA calculation between campuses,



districts, and states, it was decided that it would not be discussed within the context of this research.

The four identified responses will provide meaning to the output of the Fuzzy Model. The quantitative output will then be used to determine the status of the public educational delivery system or can even be used as a predictor of FCAT level of proficiency of individual students and possibly Florida A+ School Ratings. The calculated median of all sampled individual student related data for each Factor will comprise the data used to determine the educational system level of performance. Once there is a quantitative output from the Fuzzy Model, SME's will then define the output range for each of the four Responses and will classify this quantitative result. This process will be covered in more detail in Chapter 6.

### **Summary of FCAT Grades Scoring Calculations**

Due to the complexity of scoring calculations a detailed FCAT Grades Scoring Calculations explanation can be seen in FL Dept. of Education publications. In General the theoretical range of achievement level of the FCAT is 100-500. FCAT Achievement levels are defined as:

**Table 4 FCAT Achievement Level Explanation**

<b>FCAT Achievement Level</b>	<b>Explanation</b>
<b>LEVEL 1</b>	This student has little success with the challenging content of the <i>Sunshine State Standards</i> .
<b>LEVEL 2</b>	This student has limited success with the challenging content of the <i>Sunshine State Standards</i> .
<b>LEVEL 3</b>	This student has partial success with the challenging content of the <i>Sunshine State Standards</i> , performance is inconsistent. A student scoring in Level 3 answers many of the test questions correctly but is generally less successful with questions that are the most challenging
<b>LEVEL 4</b>	This student has success with the challenging content of the <i>Sunshine State Standards</i> . A student scoring in Level 4 answers most of the test questions correctly, but may have only some success with questions that reflect the most challenging content.
<b>LEVEL 5</b>	This student has success with the most challenging content of the <i>Sunshine State Standards</i> . A student scoring in Level 5 answers most of the test questions correctly, including the most challenging questions

## **Summary of Florida A+ Plan School Performance Grading Criteria**

The FCAT is the primary measure of students' achievement of the Sunshine State Standards. School performance grades are determined by the accumulation of percentage points for six measures of achievement in addition to two other conditions. Section *6A-1.09981(6)(a)-(f)* of the State Board Rule describes the six performance measures included in the overall performance grade for a school. Points are calculated as follows:

1. One point for each percent of students who score at or above FCAT Achievement Level 3 in reading.
2. One point for each percent of students who score at or above FCAT Achievement Level 3 in mathematics.
3. One point for each percent of students who score 3 or higher averaged with the percent who scored 3.5 or higher on the FCAT writing assessment. In the event that there are not at least 30 eligible students tested in writing, the district average in writing is substituted.
4. One point for each percent of students making learning gains in reading.
5. One point for each percent of students making learning gains in mathematics.
6. One point for each percent of the lowest performing students making learning gains in reading.

These points are added together and converted into a school performance grading scale, shown in the next table.

**Table 5 FCAT School Performance Grading Scale**

<b>School Performance Grading Scale</b>	
Grade	Total points
A	410 and above
B	380-409
C	320-379
D	280-319
F	Less than 280

In addition to the accumulation of percentage points for each of the six performance measures, schools are also evaluated on the basis of two other conditions:

1. Percent Tested: Schools earning enough total points to receive a grade of A must also test at least 95% of their eligible students. All other letter grade designations are based on a minimum of 90% tested. If any school tests fewer than 90% of their students, the school will initially receive an “I” (incomplete). After investigation, if the percent tested remains less than 90%, the final grade will be one letter grade lower than indicated by the total points accumulated.
2. Adequate Progress of the Lowest Students: Schools earning enough points to receive a C or above must demonstrate that at least half of the lowest students make annual learning gains. For a school to be designated a performance grade of A, adequate progress of the lowest students must be met in the current year. For a school to be designated a performance grade of B or C, adequate progress of the

lowest students must be met in the current or previous year. The final grade will be reduced one letter grade for schools failing to meet this criterion. For purposes of this calculation, the lowest students are the lowest quartile (or 25%) of students scoring in levels 1-3 of the FCAT reading in each grade. The lowest 30 students are substituted when there are not 30 in the lowest quartile. In the event that there are not 30 eligible students scoring in FCAT Achievement Level 3 or below, the percent of students making annual learning gains in reading for all students is substituted for this performance measure.

### **Summary of No Child Left Behind Annual Yearly Progress Computations**

NCLB requires that every public school and every school district (Local Education Agency) make adequate yearly progress towards state proficiency goals. All public schools must be held to the same criteria (30 criteria) and all students must be included in the determination of AYP. In addition to the school in total, the determination of AYP is based upon the results of 8 subgroups: White, Black, Hispanic, Asian, American Indian, Economically Disadvantaged, Limited English Proficient (LEP), and Students With Disabilities (SWD). The criteria for determining AYP apply to each subgroup only when the number of students is greater than or equal to 30. Schools will be evaluated for AYP if total enrollment is greater than 10. Proficiency results include only students present in the same school or district for a full academic year.

For example A Florida public school or district makes AYP if following criteria are met like:

1. Participation: At least 95% of all students enrolled in a public school participate in the state assessment program. Students must be tested using the FCAT or an appropriate alternate assessment for limited English proficient students (LEP) and students with disabilities (SWD). This requirement applies to all students and each subgroup.
2. Reading Proficiency: The state has set annual objectives for reading proficiency based on the ultimate goal to have 100% of all students proficient in reading by 2013-14. For 2003-04, the state objective is to have at least 31% of all students and each subgroup reading at or above grade level. For purposes of AYP determination, students scoring 3 and above are considered proficient.
3. Math Proficiency: The state has also set annual objectives for math proficiency based on the ultimate goal to have 100% of all students proficient in math by 2013-14. For 2003-04, the state objective is to have at least 38% of all students and each subgroup scoring at or above grade level in math. For purposes of AYP determination, students scoring 3 and above are considered proficient.
4. Other Criteria: NCLB requires the state definition of AYP to include graduation rate and at least one additional academic indicator as determined by the state. In Florida, the writing assessment will be used as the additional indicator and school

grades will be used as an additional condition. Thus, in addition to the three criteria listed above, schools must meet two other criteria:

- a. Improve performance in Writing by 1%: All schools must demonstrate a 1% improvement in the percentage of students meeting state standards in writing. For purposes of AYP determination, students scoring 3 and above are meeting state standards. The writing target is also met if the school has a writing performance rate of 90% or better.
  - b. Improve the graduation rate by 1%: High schools must demonstrate a 1% improvement in its graduation rate. The target is also met if a school attains a rate of 85% or better in the current year. The school is not a D or F: The A+ School Grades are calculated prior to AYP. If a school receives a D or an F, that school does not make AYP.
5. Safe Harbor: A school that has met the requirements for participation as well as the State's other indicators (writing, graduation rate, and school grade), but has not met the reading and/or mathematics proficiency targets can still make AYP through a provision in NCLB called Safe Harbor. Safe harbor applies only to those subgroups that did not meet the reading or mathematics targets. In Safe Harbor, the percentage of non-proficient students must be decreased by at least 10% from the prior year in the subject being evaluated. In addition, the subgroup must make progress in writing proficiency and graduation rate.

## **Sampling Plans**

Sampling Plans describe the method in which information is obtained from a large population. The sample should be a reliable representation of the population of interest.

The level of sampling is dependent on which level of analysis is desired within the OCPS System:

1. District
2. Learning Community
3. Campus

At the District level the population is known and the data is an aggregate of all Learning Community and Campus level data, therefore sampling is limited. The system assessment data is quite similar at both the District and Learning Community Level.

At the Campus level a sampling plan may be employed when periodic quick assessments may be desired to aide in administrative decision-making activities. For instance, the Fuzzy Model can be used as a prediction heuristic that could estimate the potential impact of a new intervention or other change. For an administrator could estimate the school rating based on sampling students within each of the six levels of assessment dictated by the Florida A+ Plan. The final sampling decision will be the responsibility of the systems expert. The sampling plan decision will result in some type of Sampling Error.

The following formula can be used to determine a statistically significant sample size that mitigates the potential impact of sampling error and can estimate the amount of sampling error according to (O'Brien & Charlton, 1996):



$$SE = Z [(p(1-p)/n)]^{.5} [(N-n)/(N-1)]^{.5}$$

**EQ. 3.1**

Where:

SE = Sampling Error

Z = Z score of the desired level of confidence

p = % of sample in one category (Use of 0.5 is acceptable if unknown)

n = Sample Size

N = Population Size

As a result, the calculated Sampling Error (SE) for this research is .0088, less than 1% based on the values of n = 5,171; N = 12,742; p = 0.5; Z = 1.645 (at  $\alpha = .05$ ).

By rearranging the terms and solving for “n” we can determine the appropriate statistically significant sample size as indicated by the following equation:

$$n = N / [ [ \{ SE^2 (N-1) \} / \{ Z^2 p(1-p) \} ] + 1 ]$$

**EQ. 3.2**

A random seed generator that can be found in most business and scientific software packages such as Microsoft Excel® can be used as an aide in determining the random order of sample selections. The provided sampling explanation is for informational purposes, since this research utilized a process that did not require a derived sample size

based on EQ 3.2. However, it is rather apparent that the sample size of 5,171 respondents is statistically adequate.

To reiterate what was said before, to identify the best sampling plan for a specific situation is best handled by an informed and trained person.

### **Data Collection Organization**

Subjective qualitative data is the primary type of collected data within this body of work. As a trained administrator of the research, the researcher will administer Section 1 (Relative Coefficient Weight Estimation) of the survey through direct interview sessions, preferably, or the survey respondent may complete the survey on his/her own time in the absence of the researcher. This data is then checked for consistency (reliability) and the Model Coefficient Weights are established. Next, a trained evaluator SME (Subject Matter Expert) will administer Section 2 of the survey on a case-by-case basis. Once the data is collected, Fuzzy Sets are created and the model output can be calculated. More detail specific explanations will be discussed later within the following chapters of this body of work. Model validation is the next step in the process that validates the resultant Fuzzy Model findings. Within the validation phase a controlled test environment will be utilized to minimize unwarranted system impact. Once evaluated and deemed ready, the findings may be utilized and implemented. Feedback is generated from the findings and improvement in design is initiated as detailed in the next section.

## Findings Implementation

In order to facilitate the implementation of the findings of this research it is recommended that an iterative process called the “Waterfall Process Model” be utilized.

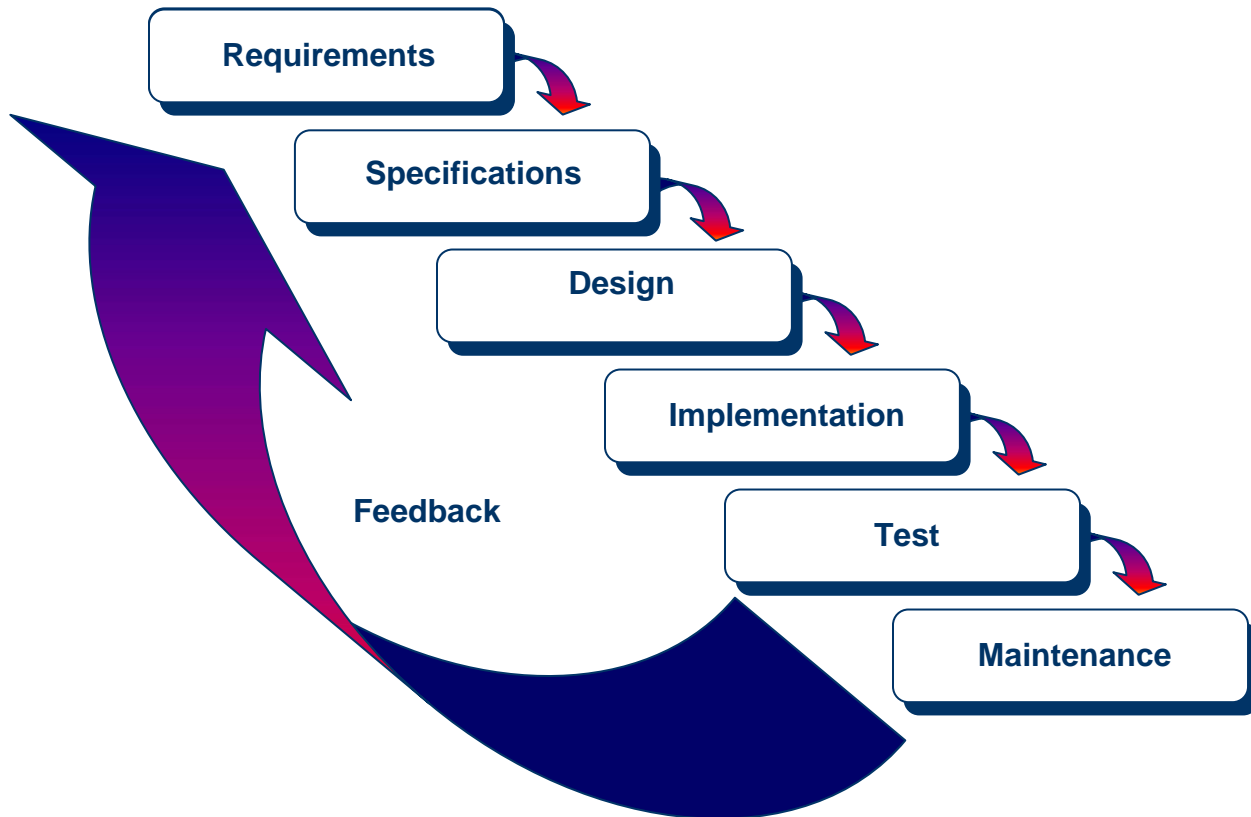


Figure 3 The Waterfall Process

The iterative Waterfall Process Model is a systematic approach that ensures continuous improvement from the defined requirements to the maintenance and steady state operational phase of a system, thus defining the system’s lifecycle. The *Requirements* are the results of the identified needs or goals to be attained. *Specifications* are the solidification or realization of the requirements and are design specific. Once the specifications are defined the *Design* integrates the specifications with other factors and defines the boundaries and operations governance. The *Implementation* of the design

under *Test* conditions ensures proper implementation. Once sufficiently tested and proven the implemented design is operating at steady state and *Maintenance* activities are required to maintain the desired level of operations. Finally an overall assessment is made and the resultant *Feedback* generates new requirements and is used to improve the process.

Now that the research methodology has been described, the next section will describe the basis of Fuzzy Set Theory and how the Fuzzy model is derived.

## CHAPTER FOUR: MODEL DEVELOPMENT

### **Fuzzy Set Theory (FST) Introduction**

The recent focus on public systems accountability is not a new concept within the public services sector. As an attempt to meet greater demand for public administrative accountability certain management interventions were researched, one such Organizational Management Theory, the Decentralized Management Theory, was accepted and implemented. This Decentralized Management Theory was touted as a contemporary approach to reducing operational expenditures and promoting innovation flexibility during the 1980's - 1990's. Less direct operational involvement at higher levels of administration and more accountability and empowerment at lower levels, mainly the District and Campus levels within the public educational delivery system, are the basis of this management theory as it applies to public educational delivery system. As a result of the widespread acceptance of the Decentralized Management Model, local Districts and Campuses have been allowed to evolve unique programs, methods, and procedures that are intended to ensure quality educational delivery. In the OCPS educational delivery system, the Florida SSS and various OCPS District Performance initiatives are the organizational mandates that direct local Campus operations and administration. With the unprecedented growth of educational districts, such as that of the OCPS District, the increased systems complexity and diversity have caused management inefficiencies, most notably, in the area of systems Accountability. FST was created to address such concerns of system complexity by transforming complexity into a manageable discrete concept. The following section will discuss the base methodology of FST and how it can be applied to the public educational delivery system.

Fuzzy Set Theory, also referred to as Soft Computing or Fuzzy Mathematics, is a mathematical and philosophical methodology created by Dr. Lotfi A. Zadeh, and made notable by his early published work of the 1960's, "Fuzzy Sets", in which he attempted to create a context for understanding uncertainty, complexity, and subjectivity, also referred to as vagueness. Such common "Real-World" issues of imprecision under non-ideal conditions exist in all systems that involve human interaction. In contrast to FST, Classical Discrete Set Theory, founded in classic Greek philosophy, discusses logic or set theory in a definitive absolute context. When comparing these two theories FST is a relatively modern concept. Classical Discrete approaches are the most commonly accepted approach to systems modeling in the United States, yet internationally, widely accepted in Japan, FST has begun to rival such classical approaches in successful technological and organizational application.

The following is a theoretical approach to understanding both Classical and FST. Their underlying assumptions, application strengths, and inherent differences will be discussed.

### **Classical Discrete Set Theory & Fuzzy Sets (Membership Inclusion)**

A. Classical Discrete Set Theory can be defined as:

S: Is the Universal Set

U: Is a subset of S

x: Is the element of interest

U:  $S \rightarrow \{0,1\}$

For each element of S there is an ordered pair; x and  $\{0,1\}$  in which the first of the ordered pair is the element of interest, and the second being either  $\{0 = \text{Not a member of the set S}\}$  or  $\{1 = \text{An absolute member of the set S}\}$ .

### Classical Discrete Set Theory (Intersection of A and B)

$$P(A \cap B) = P(A) * P(B)$$

An event is a collection of simple events specifying the occurrence of an outcome of element  $x$  in an experiment. The probability of occurrence for the Intersection of event A and B in a Classical set is expressed as the product of event A and event B. Event A and B are assumed to be independent events (probabilities of occurrence) of some element  $x$  according to the Multiplicative Rule for Independent Events (Mendenhall & Sincich, 2004).

For Example if:

$$P(A) = .80$$

$$P(B) = .80$$

$$P(A \cap B) = .64$$

### Classical Discrete Set Theory (Union of A or B)

$$P(A \cup B) = P(A) + P(B) - [P(A \cap B)]$$

The probability of occurrence for the Union of event A and B in a Classical set is expressed as the sum of event A and event B minus the probability of intersection of event A and B. Event A and B are assumed to be independent events of some element  $x$ , according to the Additive Rule of Probability (Mendenhall, & Sincich, 2004).

For Example if:

$$P(A) = .80$$

$$P(B) = .80$$

$$P(A \cup B) = .80 + .80 - (.64) = .96$$

In the next discussion we will see how FST differs from the Classical Discrete approach and the impacts of these differences.

B. Fuzzy Set Theory can be defined as:

S: Is the Universal Set (Universe of Discourse)

F: Is a Fuzzy subset of S

x: Is the element of interest

F:  $m_S(x) = [0,1]$

For each element of S there is an ordered pair; x and [0,1] in which the first of the ordered pair is the element of interest, and the second being a value contained within the interval from 0 to 1.

This interval determines the degree of inclusion of x as a member of set of S. Another explanation of this FST concept is that the Fuzzy Relation/Membership Function  $m_S(x) = [0,1]$ , states that Universe of Discourse (S) exists and the element x is determined to exist within this Universe expressed as a value on the interval from 0 to 1.



### Fuzzy Set (Intersection of A and B)

$$P(A \cap B) = \text{Min. of } m_A(x) \text{ or } m_B(x)$$

The probability of occurrence of two independent events A and B in a Fuzzy Set is expressed as the minimum value of either the probability of event A or event B.

For Example if:

$$P(A) = .80$$

$$P(B) = .80$$

$$P(A \cap B) = .80$$

### Fuzzy Set (Union of A or B)

$$P(A \cup B) = \text{Max. Of } m_A(x) \text{ or } m_B(x)$$

The probability of occurrence of two independent events A and B in a Fuzzy Set is expressed as the maximum value of either the probability of event A or event B.

$$P(A) = .80$$

$$P(B) = .80$$

$$P(A \cup B) = .80$$

In comparing the results of the previous examples in the Classical and Fuzzy Set cases we see the following results:

**Table 6 Classical vs. Fuzzy Set Probabilities**

$P(A) = .80$ $P(B) = .80$	<b>Classical</b>	<b>Fuzzy</b>
$P(A \cap B)$	.64	.80
$P(A \cup B)$	.96	.80

In reference to set membership, if we were to stratify the above results using a quartile approach setting the linguistic levels of qualitative grouping intervals where:

**Table 7 Fuzzy Linguistic Levels Assignment**

<b>Very Significant (4)</b>	<b>Significant (3)</b>	<b>Moderately Significant (2)</b>	<b>Not Significant (1)</b>
1 - .75	.74 - .50	.49 - .25	.24 - 0

It becomes apparent that the result of  $P(A \cap B)$ , the Intersection of two (Very Significant) events is only considered Significant in the Classical case but in the Fuzzy case,  $P(A \cap B)$  is still considered Very Significant. Also as the number of events increases, no matter how high the values of each individual event, the probability of the Intersection of all events approaches zero. The following example will examine the aforementioned theory in a Real-World scenario.

For example if:

x = Parental & Community Support Factor

A = Administration Survey Results of How a Factor (x) positively Impacts System  
Performance dependent on the degree of evidence of Factor presence  
= .80 (Very Significant)

B = Instructor/Teacher Survey Results of How a Factor (x) positively Impacts System  
Performance dependent on the degree of evidence of Factor presence  
= .90 (Very Significant)

Classical Discrete Set Theory Interpretation of Example:

The interpretation of the Intersection  $P(A \cap B)$  is .72 (Significant), One would conclude: If the Parental & Community Support Factor is considered a (Very Significant) Factor by Administration **AND** Instructors/Teachers, then The Parental & Community Factor is a (Significant) positively impacting Factor. In contrast see the following FST outcome.

Fuzzy Set Theory Interpretation of Example:

The interpretation of the Intersection  $P(A \cap B)$  is .80 (Very Significant), One would conclude: If the Parental & Community Support Factor is considered a (Very Significant) Factor by Administration **AND** Instructors/Teachers, then The Parental & Community Factor is a (Very

Significant) positively impacting Factor. The degree of factor significance differs from the Classical approach.

Now in terms of  $P(A \cup B)$ , the Union of two (Very Significant) events is still Very Significant in the Classical case. However if  $P(A) = .45$  and  $P(B) = .45$  then  $P(A \cup B) = .6975$ , two (Moderately Significant) (.45) events have produced a (Significant) (.6975) result. In theory in the Classical Case, no matter how small the value of each individual event, the probability of the Union approaches 1 as the number of events increases. The following example will examine the probability of the Union in a Real-World scenario.

**Example:**

x = Parental & Community Support Factor

A = Administration Survey Results of How a Factor (x) positively Impacts System  
Performance dependent on the degree of evidence of Factor presence =  
.45 (Moderately Significant)

B = Instructor/Teacher Survey Results of How a Factor (x) positively Impacts System  
Performance dependent on the degree of evidence of Factor presence  
= .45 (Moderately Significant)

Classical Discrete Set Theory Interpretation of Example:

The interpretation of the Union  $P(A \cup B)$  is .6975 (Significant), One would conclude: If the Parental & Community Support Factor is considered a (Moderately Significant) Factor by either

Administration **OR** Instructors/Teachers, then The Parental & Community Factor is a (Significant) positively impacting Factor.

Fuzzy Set Theory Interpretation of Example:

The interpretation of the Union  $P(A \cup B)$  is .45 (Moderately Significant), One would conclude: If the Parental & Community Support Factor is considered a (Moderately Significant) Factor by either Administration **OR** Instructors/Teachers, then The Parental & Community Factor is a (Moderately Significant) positively impacting Factor. The degree of factor significance differs from the Classical approach.

Further more FST shows that Fuzzy is an expansion of the Classical Theory, yet quite frequently FST is viewed as a competitor and has not been readily accepted in application. The application and development of Fuzzy Theory is growing and there are numerous applications where FST has proven successful. The following areas are examples of fields of successful Fuzzy implementation. Many of these topics are defining the next generation of cutting-edge technology. Some of these technologies include:

1. AI (Artificial Intelligence)
2. Biomechanics and Ergonomics
3. Occupational Risk and Injury Assessment/Prediction
4. Expert and Knowledge Systems
5. Smart Devices
6. Fuzzy Logic Controllers (Continuous Feedback)
7. Organizational Decision Analysis

Modeling human behavior and performance is an immensely complex task. Fuzzy Set Theory is an alternative theory that deserves closer examination. Applying classical probability approaches to human learning systems has been readily accepted in the recent past, but is it the most efficient and effective approach? Even though comparable in theory and proven through application, FST is considered part of an emerging scientific field of study.

### **Validation Rules for Fuzzy Set Theory Usage**

The validation rules and conditions for FST usage are rather robust. FST is designed to operate in high variability systems that utilize extensive human involvement. The key is to have strategically chosen and trained system experts. The level of training varies per role; systems administrators, evaluators, and experts. Since the FST approach is not a precision quantitative method it is well suited for environments of less direct human control and continuous operations, i.e. the process is in perpetual motion with no start or stop. Such rules that depend on the state of the process like Statistical Process Control and Steady State Operation are of less importance in FST than in quantitatively derived model approaches. Fuzzy Theory aims to channel process vagueness and variability so as to make it more predictable and manageable.

### **Fuzzy Model General Form**

The following equation is the general linear fuzzy model form that will be utilized within this body of research.

$$Y = W_1F_1 + W_2F_2 + \dots + W_nF_n$$

**EQ. 4.1**

Where:

1.  $F_n$  = Factors
2.  $W_n$  = Relative Significant Weight

The relative significant weights will be calculated using Analytic Hierarchy Process. The factor data is derived from SME observation and the resultant Fuzzy Sets.

### **A More Commonly Used Method of Data Analysis “Regression Analysis”**

The use of Regression Analysis is widely accepted, as the premier data analysis method of choice amongst researchers and educational system administrators. Regression Analysis is based on a Classical Discrete Statistical methodology. Multiple Regression Analysis is an expansion of the Simple Linear Regression Analysis Method, and extends simple linear regression theory to include multiple independent factors (x) in a common model that will impact or determine a dependent response (y). The following discussion will include the general forms for both Simple Linear Regression and Multiple Regression methodologies, since Multiple Regression analysis is predicated on the Simple Linear approach. Note, that in using Regression Analysis, the system to be modeled should be in Statistical Control (Low Variability & Steady-State Operations) and that the resultant statistical distribution of the observed data should be identified. Hence the following Regression Analysis methodology assumes that an identified linear relationship between factors and responses exists.

I. Theory & General Equation Forms for Linear-Relationships (Mendenhall & Sincich, 2004):

## Simple Linear Regression Model

$$E(y) = \beta_0 + \beta_1 x_1 + \varepsilon$$

EQ. 4.2

Where:

1.  $(y)$  = Dependent variable or response
2.  $(x)$  = Independent Variable
3.  $E(y)$  = the mean response dependent variable
4.  $\beta_0$  = y-intercept of the graphed line
5.  $\beta_1$  = Slope of the graphed line, the amount of change of  $(y)$  for every one-unit change of  $(x)$
6.  $\varepsilon$  = Random error component

The reason to use Simple Linear Regression is to create a model that represents an observed Real-World scenario. A single graphical line, referred to as the regression line, will be fit to the observed data points, usually which have been displayed using a scatter diagram. The most common method used for determining this single line that has the minimum error is referred to as the Least Squares Method. In summary, the Least Squares Method examines a series of data points in relation to the suggested regression line that results in the least squared amount of deviation between each point and the line, called Sum Squared Error (SSE). The general form of the SSE equation is as follows:



SSE (Sum Squared Error)

$$SSE = \sum [y_i - (\beta_0 + \beta_1 x_i)]^2$$

**EQ. 4.3**

Where:

1. The  $\beta$  terms are estimates of the general form prediction model
2.  $y_i$  = true observed  $y$   $i$ th term

The following are derived formulas that take the partial derivatives of this SSE with respect to the  $\beta$  coefficient estimates ( $\beta_0$  and  $\beta_1$ ) and setting each equation equal to zero.

Formulas for the Least Squares Estimates are:

Note: The derivation of the following formulas will be omitted within this body of work for the sake of expedience, but can be researched within the cited sources. The following formulas are the components of the resultant Simple Linear Regression Model.

$$\text{Slope: } \beta_1 = SS_{xy}/SS_{xx}$$

**EQ. 4.4**

y-intercept:

$$\beta_0 = y_{(\text{mean})} - \beta_1 x_{(\text{mean})}$$

**EQ. 4.5**

Where:

1. The  $\beta$  terms are least square estimates of the general form model
2.  $SS_{xy} = \sum [x_i y_i - (\sum x_i)(\sum y_i) / n]$   $n = \text{Sample Size}$
3.  $SS_{xx} = \sum [x_i^2 - (\sum x_i)^2 / n]$   $n = \text{Sample Size}$
4.  $y_{(\text{mean})} = \text{the average observed } y\text{-value response}$
5.  $x_{(\text{mean})} = \text{the average observed } x\text{-value}$

With this theoretical basis in place for Simple Linear Regression, we can see that as the number of x terms increases the complexity of formula derivation increases substantially. The next section on Multiple Regression Analysis builds on this foundation and warrants the use of the computer to solve the data matrices for each model component.

### Multiple Regression First-Order Model

Within Multiple Regression Analysis, as Simple Linear Regression uses the Least Squares method to fit a regression line to the observed data, Multiple Regression utilizes data matrices to develop the model. The following equation is the general model form of a Multiple Regression equation in standard notation and matrix form:

Standard:

$$E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k + \varepsilon$$

EQ. 4.6

Matrix:

$$\mathbf{Y} = \mathbf{X} \boldsymbol{\beta} + \boldsymbol{\varepsilon}$$

EQ. 4.7

Where (Standard):

1. (y) = Dependent variable or response
2. (x<sub>k</sub>) = Independent Variable
3. E(y) = the mean response dependent variable
4. β<sub>0</sub> = the y-intercept of the graphed line
5. β<sub>k</sub> = the slope of the graphed line, the amount of change of (y) for every one-unit change of (x)
6. ε = Random error component, sum of error is 0

Where (Matrix):

$$\mathbf{Y} = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} \qquad \mathbf{X} = \begin{bmatrix} 1 & x_{11} & x_{12} & \dots & x_{1k} \\ 1 & x_{21} & x_{22} & \dots & x_{2k} \\ \vdots & \vdots & \vdots & \dots & \vdots \\ 1 & x_{n1} & x_{n2} & \dots & x_{nk} \end{bmatrix}$$

$$\boldsymbol{\varepsilon} = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix} \qquad \boldsymbol{\beta} = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{bmatrix}$$

**Figure 4 Regression Matrix**

So, in utilizing the Least Squares Method and Matrix Algebra in the Multiple Regression Analysis, the estimated  $\beta$  coefficients and SSE can be found as follows.

The Formula for the Least Squares Estimates (Multiple Regression Matrix) is:

$$\boldsymbol{\beta} = (\mathbf{X}'\mathbf{X})^{-1} \mathbf{X}'\mathbf{Y}$$

**EQ. 4.8**

$$\text{SSE} = \mathbf{Y}'\mathbf{Y} - \boldsymbol{\beta}' \mathbf{X}'\mathbf{Y}$$

**EQ. 4.9**

Another Multiple Regression model is the quadratic or second-order model that addresses curvature in response surfaces. Though there will be no further discussion on the quadratic

model, however below is the general standard notation. The first-order model is the most frequently used form in educational delivery system data analysis.

#### Multiple Regression Second-Order Model (Quadratic)

$$E(y) = \beta_0 + \beta_1x_1 + \beta_2x_1^2 + \dots + \beta_kx_k + \beta_kx_k^i + \varepsilon$$

**EQ. 4.10**

1.  $(y)$  = Dependent variable or response
2.  $(x_k)$  = Independent Variable
3.  $E(y)$  = the mean response dependent variable
4.  $\beta_0$  = the y-intercept of the graphed line
5.  $\beta_k$  = the slope of the graphed line, the amount of change of  $(y)$  for every one-unit change of  $(x)$
6.  $\varepsilon$  = Random error component, sum of error is 0

#### **Validation Rules and Conditions of Regression Analysis**

As with any scientific method and its theoretical application, there are valid conditions that should be met in order to ensure an unbiased and accurate solution can be attained. “The theory of statistics, like the theories of physics, engineering, economics, etc., is only a model for reality. It exactly explains reality only when the assumptions of the methodology are exactly satisfied” (Mendenhall & Sincich, 2004). The following assumptions are conditions of use for Regression Analysis:

### Assumptions

1. The mean of the probability distribution of  $\varepsilon$  is zero
2. The variance of the probability distribution of  $\varepsilon$  is constant for all levels of  $x$
3. The probability distribution of  $\varepsilon$  is normal
4. The errors between any two observations are independent
5. Inferences about responses are valid only within the interval of observed data ( $x$ )'s
6. At least six significant figures should be maintained when calculating Sum of Squares to avoid substantial errors in calculations
7. The sampling distribution of  $\beta_{1+k}$  coefficients will be normally distributed

As a precision model the output of the Regression Analysis may be compromised if the validation conditions are not satisfied.

### **Model Adequacy**

How well a model fits the observed data is extremely important. The measure of model adequacy most commonly used is Coefficient of Determination ( $r^2$ ), Multiple Coefficient of Determination ( $R^2$ ) in Multiple Regression. In summary  $R^2$  represents the fraction of  $SS_{yy}$  (sample variation) that is caused by the model. When  $R^2 = 0$  there is an implied complete lack of fit between the model and the data, so when  $R^2 = 1$  there is an implied perfect fit of the model to data. The following equation defines  $R^2$  and adjusted  $R^2_a$ , which adjusts for sample size ( $n$ ) and number of  $\beta$  coefficients.

Multiple Coefficient of Determination  $R^2$

$$R^2 = 1 - (SSE/SS_{yy})$$

EQ. 4.11

$$R_a^2 = 1 - [\{(n-1)/n - (k+1)\}(1 - R^2)]$$

EQ. 4.12

Where ( $R^2$ ):

1.  $SSE = \sum (y_i - y_{i \text{ predicted}})^2$ 
  - i. The observed response ( $y_i$ ) minus the predicted ( $y_{i \text{ predicted}}$ ) quantity squared
2.  $SS_{yy} = \sum (y_i - y_{\text{mean}})^2$ 
  - i. The observed response ( $y_i$ ) minus the average observed ( $y_{\text{mean}}$ ) quantity squared

Where ( $R_a^2$ ):

1.  $n$  = data sample size
2.  $k$  = number of  $\beta$  coefficients

The reason for the  $R^2$  adjustment compensates for the potential resultant inaccuracies in the  $R^2$  calculations, i.e. the more  $\beta$  coefficients in the model the higher the  $R^2$  value.

Cronbach's Alpha Coefficient of Reliability is a comparable measure of model adequacy in Fuzzy models as is the  $R^2$  value is in Regression analysis. The most common and widely accepted measure of internal consistency is considered to be the use of coefficient alpha (Cronbach, 1951). We will define the Cronbach's Alpha Coefficient of Reliability as follows:

$$\alpha = (N * r_{avg}) / [1 + (N-1) * r_{avg}]$$

**EQ. 4.13**

Where:

1.  $N$  = The number of items, in this case the number of survey question responses
2.  $r_{avg}$  = The average inter-item correlation, in this case the average correlation between similar and exact question responses of the survey.

When using Cronbach's  $\alpha$ , 0.70 and above is considered an acceptable level for the coefficient (Nunnally, 1978). Hence this is the reason to expect a high positive correlation between similarly grouped survey question responses. G.D. Sideridis conducted a study to determine the limitations and the biasing principles of the Cronbach Coefficient. What he found was that no matter what statistical distributions the data belonged to, Cronbach's Coefficient proved to be a robust and unbiased estimator of reliability in response consistency (Sideridis, 1999).



## **Correlation and Causality**

Using previous definitions of model adequacy will lead into the next discussion in the difference between Correlation and Causality. Traditionally there has been a tendency for regression practitioners and regression analysis interpreters to conclude a causal relationship between independent factors (x) and the response (y), prompted by a high correlation measure. The following warning is a direct quote on the dangers of this correlation and causality assumption. “High correlation does not imply causality... It is incorrect to conclude that a change in x causes a change in y. The only valid conclusion is that a linear trend may exist between x and y.” (Mendenhall & Sincich, 2004).

Causality implies that a response has occurred due solely to the manipulation of a variable within a logical relationship between the response and the variable. Establishing a causal relationship requires further analysis beyond observed data and Regression Analysis. Theoretically, if everything is held constant, an observed change in a variable (x) will always prompt a change in the response (y) in a true causal relationship.

There are valid conditions to look for that can cause the improper interpretation of Regression Analysis responses. The following is a prominent example of a potential problem in regression application.

## **Multicollinearity**

When applying Multiple Regression theory to real-world scenarios there are potential areas of concern that can lead to misinterpretation and misinformation. Traditionally, studies undertaken to identify factors that significantly impact student performance and educational delivery system efficiency, have not widely discussed these conditions and potential pitfalls of Regression Analysis application. For instance, the issue of Multicollinearity, if present at significant levels can skew coefficient and standard error estimates that could lead to misinformation.

Multicollinearity occurs when independent factors are highly correlated with each other.

Remember an underlying assumption within Regression Analysis theory is that the independent factors are truly independent, i.e. the factors are poorly correlated with each other. More specifically in the case of the educational delivery system, the common factors of many scientific studies include Race/Ethnicity, Socioeconomic Status, and Crime/Safety. If these factors are evaluated separately the potential for Multicollinearity is lessened, but if all are included within the same Regression Analysis model as independent factors, there is a high potential for serious Multicollinearity to occur. Why? Statistically speaking, research has identified that there is a significant direct correlation between minority ethnicities, poverty, and crime. So from a systems perspective, the contribution of each of these factors of interest within the educational delivery system impacts the quality and performance of the system differently than if they were evaluated individually utilizing Regression Analysis. Due to Multicollinearity, the degree of impact of each factor may overlap that of other significantly correlated factors, thus obstructing the true degree of impact of each factor as it relates to the total educational delivery system model.

Therefore, not only do system administrators need to know “which factors significantly impact system performance” but also as to “what degree of impact each factor exhibits” is of paramount

importance. Constrained resources and increased mandates of Accountability have driven system administrators to monitor systems at even higher levels of detail versus the traditional approach when aggregated system performance measures were deemed adequate in depicting educational delivery system status.

### **Regression vs. Fuzzy**

There is an increased probability that the source of the data that is used in the Regression analysis is defined, collected, and interpreted by someone not exceptionally proficient in understanding data analysis and its underlying theory. More than less this is due to the fact that the modern public educational delivery system endorses the use of the Decentralized Management Model; in summary, the model fosters more local flexibility, less central management control, which results in potential inherent uncontrolled system variation. In order for Regression analysis to function as theorized, an adherence to the validation conditions should be maintained.

The FST approach, which utilizes the sampling of expert knowledge to determine key model relative weights and refined data, can be an effective method in mitigating prediction model error (variation) caused by non-proficient data analysis practitioners. Remember, as stated before, the Regression Analysis method relies solely on the integrity of the observed data to determine prediction model coefficient weights. Conversely, the FST approach integrates valid expert-derived information within the model and does not rely solely on the interpretation of the response to provide pertinent information.

The following summary table delineates a side- by-side comparison of Regression Analysis and Fuzzy Modeling Theory.

**Table 8 Regression vs. Fuzzy Comparisons**

<b>Category</b>	<b>Regression Analysis</b>	<b>Fuzzy Modeling</b>
Model Creation	1. Choice of Appropriate Model Form is Imperative. 2. Sample data should come from In-Control Process (Low Variability).	1. Model form is more general. 2. Model is not derived from observed process data but by system experts.
Model Adequacy (Reliability)	1. Coefficient of Determination ( $r^2$ )	1. Cronbach's Alpha Coefficient of Reliability ( $\alpha$ )
Sampling Error/Standard Error	1. SE calculated	1. SE calculated
Model Maintenance	1. Must collect more observed data to update changes in the model.	1. Must Sequester SME's to agree on updates.
Response Interpretation (Output)	1. Quantitative requires interpretation by deemed persons.	1. Quantitative more intuitive in nature due to Fuzzy Level Assignments by SME's.
Type of Collected Data (Input)	Quantitative	Qualitative/Hybrid

### **Logical Fallacy (“Post Hoc” and “Regression to the Norm”)**

In the public arena there appears to be more ulterior and politically driven motive at the expense of the public. Where such motive exists there is possibly an increased potential in discovering the exploitation of known logical fallacies such as “Post Hoc” and “Regression to the Norm”. The Post Hoc fallacy, in the case of public education system implemented interventions, can in part be explained due to variation. Variation, or the deviation from an expected outcome, is a major

influential factor of the “Real-World” application of theory. The form of the variation of interest, Common-Cause variation and its natural fluctuation within a system can potentially be misconstrued as being a valid determinant of the effectiveness of an implemented educational intervention. Hence this misunderstanding can be used as a tool for leveraging public opinion. A lack of understanding of such concepts as it relates to many implemented interventions within the public educational delivery system, new and old, possibly tends to perpetuate public acceptance of interventions that provide insufficient scientific proof of effectiveness. The exploitation of positive Common-Cause variation, i.e. highlighting observed positive fluctuations in increased performance outcome that follows an implemented intervention, is a common form of Post Hoc fallacy.

Another common logical fallacy that exploits Special-Cause variation is referred to as Regression to the Norm. Statistically speaking, as an extreme outcome is observed, it is highly probable that the next observed event would be closer to normal or the mean of the outcomes (Gilovich, 1991). This is the definition of Regression to the Norm. Therefore true assessment of intervention effectiveness is obscured. When an educational intervention is introduced after some extreme exceptional outcome, it is fallacious to believe that it was undoubtedly the intervention that caused changes in the subsequent outcomes, since these outcomes will tend to naturally regress towards the mean even without the implemented intervention. Drawing conclusions and formulizing predictive models based on single exceptional events are ill-advised in Quality Management and Control philosophy, yet in public education performance assessment, it is seemingly widely accepted (Evans & Lindsay, 2001). A more appropriate approach that would mitigate the impact of variation in determining effective intervention implementation is to

institute scientific sampling or trial outcomes based on consistent criterion, i.e. using the mean performance outcome of a group of identical events vs. the performance outcome of a single event.

### **Failure is Not Widely Accepted**

An unforgiving culture exists that punishes poor (infrequent) performances and rewards exceptional (infrequent) performances. Thus the opportunity to learn from failure is not truly granted acceptance as a credible benchmark for continuous improvement. An organization with such a culture that does not foster openness, constructive criticism, through action, not just policy, may create a warped sense of introspection that hinders true continuous performance improvement. As a result teachers and administrators express divergent opinions and responses on identical major educational topics (OCPS BRP Survey, 2005). Also, the media has shaped the public educational delivery system. Exceptional outcomes are the basis of the daily media. Media perception is a substantial impacting factor of public perception. Hence continued biased reporting, that does not delineate the conditions or basis of information, of exceptional outcomes, both negative and positive, can potentially fuel logical fallacies. Incomplete or poorly founded information can be more detrimental than if no information were presented.

## **CHAPTER FIVE: OVERVIEW OF THE MODEL**

### **Actual Model Development**

Fuzzy model development, within this research, was derived in conjunction with the findings from the OCPS Blue Ribbon Panel Final Report and structured research by the National Parent and Teachers Association of America. The National PTA has created standards that have succinctly identified the most significant parental factors that impact student learning and has adopted them as significant areas of research interest. The evaluation criterion in this research was derived from educational system consultants and researchers.

The following theoretical Fuzzy Model will utilize previously discussed aspects of this research. Parental and Community Support will be of interest for purpose of example. This research will produce three levels of Fuzzy Model equations:

1. Factor Level (Final Overall Model)
2. Sub-model 1 Level
3. Sub-model 2 Level

The reason for these multiple levels of equations is to allow consideration for the multi-level factors of the Parental and Community Support Factor. Each subsequent sub-model level lends information to the predecessor level and the Final model. Note that a more in-depth factor detail analysis of all Factors is not within the scope of this body of work; however should be explored in future research.

### Theoretical Factor Level Fuzzy Model Equation:

The following discussion is the derivation of the Fuzzy Mathematical model that will be used to indicate the performance of public educational delivery system, more specifically the OCPS system that is the theoretical application test environment.

Public Educational Delivery System Performance (PEDSP) will be defined as follows:

$$\text{PEDSP} = W_1 F_1 \otimes W_2 F_2 \otimes W_3 F_3 \otimes W_4 F_4 \otimes W_5 F_5 \otimes W_6 F_6$$

EQ. 5.1

Where:  $F_i$  = Factors  $W_i$  = Relative Significant Weight  $i = 1-6$

$\otimes$  = Unknown Operant i.e.  $W_1 F_1 \otimes W_2 F_2$

$W_1$  = Relative Significant Weight of Early Childhood Education

$F_1$  = Early Childhood Education: All valid inputs that define the qualitative classification of the factor and degree of existence in equation form

$W_2$  = Relative Significant Weight of Student Performance

$F_2$  = Student Performance: All valid inputs that define the qualitative classification of the factor and degree of existence in equation form

$W_3$  = Relative Significant Weight of Teacher Performance, Retention and Pay

$F_3$  = Teacher Performance, Retention and Pay: All valid inputs that define the qualitative classification of the factor and degree of existence in equation form



**$W_4$  = Relative Significant Weight of Parental and Community Support**

**$F_4$  = Parental and Community Support: All valid inputs that define the qualitative classification of the factor and degree of existence in equation form**

$W_5$  = Relative Significant Weight of Education Management

$F_5$  = Education Management: All valid inputs that define the qualitative classification of the factor and degree of existence in equation form

$W_6$  = Relative Significant Weight of Media/Social Perception of System

$F_6$  = The Media/Social Perception and Portrayal of System: All valid inputs that define the qualitative classification of the factor and degree of existence in equation form

The (+) addition mathematical operant will be used in this model since the goal of the research is to obtain an aggregate degree of influence the Factors exert on the Response.

Therefore the Factor Level Fuzzy Model becomes:

1. Factor Level:

$$PEDSP = W_1 F_1 + W_2 F_2 + W_3 F_3 + \mathbf{W_4 F_4} + W_5 F_5 + W_6 F_6$$

Where:  $F_i$  = Factors

$W_i$  = Relative Significant Weight

$i = 1 - 6$

The six identified Factors ( $F_i$ ) are:

1. Early Childhood Education Factor
2. Student Performance Factor
3. Teacher Performance, Retention, and Pay Factor
- 4. Parental and Community Support Factor**
5. Education Management Factor
6. The Media/Social Perception and Portrayal of System Factor

Next, a further level of analysis of the ( $F_4$ ) Parental and Community Support Factor from the previous discussion yields that there are multiple component sub-model level equations that contribute information to the Parental Support and Community Support portions of the ( $F_4$ ) Factor. In addition it was determined by the researcher that the relative significant weighted contribution of the Parental Support component would be determined through AHP as well as the Community Support component. So, the sub-model 1 level equation for the Parental Support and Community Support components are as follows:

## 2. Sub-model 1 Level:

Parental and Community Support Factor ( $F_4$ ) =  $x_1g_1 + x_2g_2$

Where:  $g_i$  = Sub-model 1 factor

$x_i$  = Relative Significant Weight

$i = 1 - 2$

The two identified Sub-model factors ( $g_i$ ) are:

1. Parental Support
2. Community Support

To continue to the next level of discussion, the final sub-model 2 level of analysis within this body of research consists of the factor components that constitute the sub-model 2 level as follows:

### 3. Sub-model 2 Level:

$$\text{Parental Support} = y_1h_1 + y_2h_2 + y_3h_3 + y_4h_4 + y_5h_5$$

Where:  $h_i$  = Sub-model 2 factor  
 $y_i$  = Relative Significant Weight  
 $i = 1 - 5$

The five identified Sub-model factors ( $h_i$ ) are:

1. Communicating
2. Decision-Making
3. Learning at Home
4. Parenting
5. Volunteering

$$\text{Community Support} = z_1j_1 + z_2j_2 + z_3j_3 + z_4j_4$$

Where:  $j_i$  = Sub-model 2 factor

$z_i$  = Relative Significant Weight

$i = 1 - 4$

The four identified Sub-model level factors ( $j_i$ ) are:

1. Availability of Resources
2. Existing Community Collaborations
3. Mentoring Opportunities between Community and Administration
4. Mentoring Opportunities between Community and Student

Preliminary study has determined that the Parental Support component is believed to be more relatively significant than the Community Support component. The Parental Support component is the major influencer in the Parental and Community Support Factor. According to preliminary qualitative data, the Community Support portion of the factor was not viewed as a necessary component but supplemental when considering its impact on the PEDSP, therefore justifying the lower relative significant weighting as can be seen in the AHP section table 5.3.

#### **(F<sub>4</sub>) Parental and Community Support Factor Sub-model Level**

The following is a list of the sub-model level factors and the criterion a SME would evaluate and determine the DOR for each evaluation criterion. It is recommended that there be at least three evaluation criteria per sub-model level factor in order to ensure that there is an equal likelihood of observed significance between each Fuzzy linguistic level assignment, i.e. there is an equal

chance to observe data at all possible linguistic levels (Not Significant, Moderately Significant, Significant, and Very Significant). The existence of the evaluation criterion is determined to be a Positive influencer of PEDSP and student learning, while the lack of, or absence of the criteria is viewed as a Negative influencer. An SME determines what the Positive and Negative impact on PEDSP based on the sub-model level evaluation criterion observations. The detailed description of the factors are as follows:

#### A. Parental

- Communicating: Communicate with families about school programs and student progress through effective school-to-home and home-to-school communications.
  - a) Criteria:
    - a) Does the Parent/Caregiver Review Student's Progress Reports?
    - b) Have the Parent/Caregiver and Teacher had at least 1 face-face meeting about student related issues, i.e. Open House, Parent Teacher Conference?
    - c) Does the Parent/Caregiver provide periodic feedback of Teacher's performance to the Teacher?
  
- Decision-Making: Include families as participants in school decisions, governance, and advocacy through PTA/PTO, school councils, committees, and other parent organizations.
  - a) Criteria:
    - a) Is the Parent/Caregiver involved in the designated PTA/PTO at the evaluated student's school on a regular basis?

- b) Does the Parent/Caregiver attend or observe OCPS School-board meetings via, television or through actual attendance?
  - c) Does the Parent/Caregiver provide periodic feedback to OCPS via annual survey or other identified feedback methods?
  
- Learning At Home: Involve families with their children in learning activities at home, including homework and other curriculum-linked activities and decisions.
  - a) Criteria:
    - a) Does the Parent/Caregiver provide outside school learning aides such as tutoring and academic related activities for evaluated student?
    - b) Does the Parent/Caregiver aid in or facilitate learning at home activities such as homework?
    - c) Does the Parent/Caregiver ensure that the student's homework is completed and prepared in an acceptable manner to be turned in to the Teacher of the evaluated student?
  
- Parenting: Assist families with parenting and child-rearing skills, understanding child and adolescent development, and setting home conditions that support children as students at each age and grade level. Assist schools in understanding families.
  - a) Criteria:
    - a) Does the Parent/Caregiver provide structured and consistent discipline when appropriate?

- b) Does the Parent/Caregiver provide a living environment that is minimally conducive as determined by the State of Florida Dept. of Children and Family (DCF) services criteria?
  - c) Is the Parent/Caregiver aware of how to improve their parenting skills and the resources that will enable improvement of their parenting shortcomings?
- Volunteering: Improve recruitment, training, work, and schedules to involve families as volunteers and audiences at the school or in other locations to support students and school programs.
  - a) Criteria:
    - a) Does the Parent/Caregiver participate in volunteering activities such as OCPS ADDitions or school sponsored volunteering?
    - b) Is the Parent/Caregiver aware of school volunteering activities?
    - c) Does the Parent/Caregiver feel comfortable, or empowered and encouraged to participate in school volunteering activities?

## B. Community

- Availability of Appropriated Physical and Financial Resources: The availability of appropriated physical and financial resources is key to the successful implementation of planned community support and involvement activities. Do schools get the needed resources they are entitled to?
  - a) Criteria:

- a) Are there known community support resources that have been allocated to the evaluated student's school via Partnerships and Collaborations?
  - b) Do the appropriated community support resources reach their intended destination, the evaluated student's school?
  - c) Are the received community support resources disbursed to the teachers at the evaluated student's school?
  
- Existing Community Collaborations with Schools: Community partnerships with organizations with area businesses and foundations have been proven to be appreciated sources of needed income that supplement appropriated funds. Not only is the school a benefactor, community organizations have a chance to fulfill their community service commitments. Advertisement and recognition to the public are benefits that the sponsors enjoy as a result of the partnership.
  - a) Criteria:
    - a) Are the existing community Partnerships and Collaborations maintained and supported by school administration?
    - b) Are the Partnerships and Collaborations advertised and made known to the Parent/Caregiver of the evaluated student?
    - c) Have community organizations benefited from existing Partnerships and Collaborations with the evaluated student's school?
  
- Mentoring Opportunities between Community Organizations and Administration/Teachers: School administrators and teachers have a need for professional development



and can benefit from a mentoring relationship with administrators of other non-educational based organizations.

a) Criteria:

- a) Do mentoring opportunities exist between Community Organizations and the Administration/Teachers of the evaluated student's school?
- b) Are these mentoring opportunities advertised or made public?
- c) Are these mentoring opportunities funded by the evaluated student's school or other sources?

- Mentoring Opportunities between Community Organizations and Students: Student life enrichment that may lead to educational achievement can be experienced through community mentoring programs.

a) Criteria:

- a) Do mentoring opportunities exist between Community Organizations and the evaluated student?
- b) Are these mentoring opportunities advertised or made public?
- c) Are these mentoring opportunities funded by the evaluated student's school or other sources?

### **The Analytic Hierarchy Process (AHP)**

The method to be used to assign the Relative Significant Weights ( $W_i$ ) is in part a two-fold procedure. Firstly the Relative Significant Weights were derived by the survey of topic experts based on the Analytic Hierarchy Process AHP. AHP was designed to mimic the actual decision-making process of human beings. The associated complex logical and decision making process of people, in its simplest form, can be model as a string of simple pair-wise comparisons of two items (in our case the Relative Significant Weights) of interest, according the base theory of AHP as developed by Dr. Thomas Saaty in the 1970's (Saaty, 1980). The examinee/surveyed assigns relative weights of importance to the pair-wise comparison of one factor compared to the other. Dr. Saaty created a scale of relative importance based on integers between 1 and 9 that describe the degree of importance between the pair-wise comparisons (Saaty, 1980).

**Table 9 Degree of Relative Significance Definitions**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance Over the Other
8	Intermediate Between 7 and 9
9	Absolute Significance

The next pair-wise comparison of items is conducted and the procedure is repeated as with the prior set of comparisons. Such a process of decision-making is best applied to processes that have:

1. Lacking or Incomplete Historical Data
2. Limitations on Measurement Accuracy
3. Environments with a relative high degree of Uncontrollable Variation
4. Complex Systems that may exceed the expertise of Administrators

Priority Discrimination, basically referred to as priority ranking of alternatives or criteria, will be utilized in calculating the Fuzzy Model weighted coefficients. By definition, AHP is a fairly logical choice in applying its theory to educational delivery system related issues. Though there are negatives to using the AHP approach, i.e. the level of complexity increases, as the number of alternatives increases, in this specific case ranking six Factors is quite manageable. The Expert Choice® software is one of the most highly respected decision-making theory based software packages available that can execute AHP.

The following tables delineate the pair-wise comparisons combinations of the Factor Level, and Sub-model Levels previously mentioned, of this research and will be utilized in the AHP analysis.

**Table 10 Factor Level Pair-wise Comparisons Combinations**

<b>Factor</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
<b>1</b>		X	X	X	X	X
<b>2</b>			X	X	X	X
<b>3</b>				X	X	X
<b>4</b>					X	X
<b>5</b>						X
<b>6</b>						

The boldfaced indicators (X) in the table 5.2 reiterate that this research focused on factor 4, The Parental and Community Support factor, as the example of interest.

**Table 11 Sub-model 1 Level Pair-wise Comparisons Combinations**

<b>Factor</b>	<b>Parental</b>	<b>Community</b>
<b>Parental</b>		X
<b>Community</b>		

**Table 12 Sub-model 2 Level (Parental Support) Pair-wise Comparisons Combinations**

<b>Factor</b>	<b>Communicating</b>	<b>Decision-Making</b>	<b>Learning at Home</b>	<b>Parenting</b>	<b>Volunteering</b>
<b>Communicating</b>		X	X	X	X
<b>Decision-Making</b>			X	X	X
<b>Learning at Home</b>				X	X
<b>Parenting</b>					X
<b>Volunteering</b>					

**Table 13 Sub-model 2 Level (Parental Support) Pair-wise Comparisons Combinations**

<b>Factor</b>	<b>Availability of Resources</b>	<b>Existing Community Collaborations</b>	<b>Mentoring Opportunities (Admin.)</b>	<b>Mentoring Opportunities (Students)</b>
<b>Availability of Resources</b>		X	X	X
<b>Existing Community Collaborations</b>			X	X
<b>Mentoring Opportunities (Admin.)</b>				X
<b>Mentoring Opportunities (Students)</b>				

In table 5.3, table 5.4, and table 5.5, each comparison combination was analyzed using AHP. For example, a survey participant was asked to assign the degree of relative significance between Communicating and Decision-Making in table 5.4.

The following table 5.6 includes the actual results of the corresponding AHP analysis:

**Table 14 Pilot AHP Factor Level Results**

Factor/Sub Factor	Positive	Negative	Weighted AHP		Pos. Cons.	Neg. Cons.	Level
			Positive	Negative			
<b>(F4) Parental and Community Support Factor</b>	0.044	0.39	*	*	*	*	Factor
<b>Sub: Parental</b>	0.889	0.889	0.039	0.347	*	*	Sub 1
1. Communicating	0.111	0.136	0.099	0.121	0.87	0.71	Sub 2
2. Decision-Making	0.054	0.054	0.048	0.048	0.87	0.71	Sub 2
3. Learning at Home	0.393	0.398	0.349	0.354	0.87	0.71	Sub 2
4. Parenting	0.413	0.389	0.367	0.346	0.87	0.71	Sub 2
5. Volunteering	0.029	0.023	0.026	0.020	0.87	0.71	Sub 2
<b>Sub: Community</b>	0.111	0.111	0.005	0.043	*	*	Sub 1
1. Availability of Resources	0.69	0.735	0.077	0.082	0.78	0.91	Sub 2
2. Existing Community Collaborations	0.19	0.082	0.021	0.009	0.78	0.91	Sub 2
3. Mentoring Opportunities Community and Admin.	0.079	0.124	0.009	0.014	0.78	0.91	Sub 2
4. Mentoring Opportunities Community and Student	0.04	0.06	0.004	0.007	0.78	0.91	Sub 2

In addition, table 5.6 identifies the AHP rankings for both the positive and negative impact on public educational delivery system by the sub-model level factors of interest. Also the consistency ratio is noted. Typically consistency ratios of .80 or higher are deemed acceptable. In this experimental environment it was decided by the researcher that consistency ratios of .70 or higher were deemed acceptable.

**Applied Fuzzy Set Creation (Qualitative Output)**

The Fuzzy set is derived after the Degrees of Realization (DOR) has been determined by the evaluator for each sub-model level within the Parental and Community Support Factor.

Generally speaking the Fuzzy Sets that exists are:

1. Fuzzy Set A (Positive Factor Influence)
2. Fuzzy Set B (Negative Factor Influence)

Where (For both Fuzzy Set A and B):

S: Is the Universal Set (Universe of Discourse)

F(A): Is a Fuzzy subset of S

F(B): Is a Fuzzy subset of S

x: Is the element of interest (Parental and Community Support Factor)

F(A):  $m_S(x) = [0,1]$  The Degree of Realization of x (Positive)

F(B):  $m_S(x) = [0,1]$  The Degree of Realization of x (Negative)

In direct reference to the research of interest we will focus on both Fuzzy Set (A) and Fuzzy Set (B) that delineates the positive and negative influence of the Factor on the Response.

In a hypothetical example, if an SME evaluator was to:

1. Evaluate 10 cases
2. Use the Fuzzy Linguistic Level Assignment Scale in (TABLE 4.2): Very Significant (4), Significant (3), Moderately Significant (2), Not Significant (1)
3. Observe 3 out of 10 Very Significant Instances
4. Observe 5 out of 10 Significant Instances
5. Observe 2 out of 10 Moderately Significant Instances
6. Observe 0 out of 10 Not Significant Instances

The Fuzzy Set Membership values become:

$$\{.300/4, .500/3, .200/2\}$$

**Figure 5 Fuzzy Set Membership**

*Note: The denominators in FIGURE 5.1 are the linguistic ratings in the fuzzy set and have no numerical value.*

Once the Fuzzy Set is established the consistency (reliability) of the qualitative survey scoring is assessed using Cronbach's alpha EQ. 4.2. If there are inconsistencies in the survey scoring, as indicated by Cronbach's alpha, then further investigation of areas such as SME evaluator error, unclear survey questions, etc. will be administered in order to facilitate consistent outcomes.

Also outlier events can be investigated to determine if there are special causes.

In another example, to determine the Input data for each Factor the Degree of Realization (DOR) is observed for each linguistic level within all individual Factor sub-model levels:

1. Factor A impacts the Response
2. An SME conducts 5 case evaluations (n = 5)
3. There are 2 Factor A Sub-model levels (Sub 1 & 2) for Factor A
  - a. Equally weighted (.500)
4. The following observations were made:
  - a. Sub 1: 3 (Very), 2 (Significant), 0 (Moderate)
  - b. Sub 2: 2 (Very), 1 (Significant), 2 (Moderate)

The following table lists the numerical values for the example:



**Table 15 Observations Fuzzy Set Table**

<b>Factor A (1.00)</b>	<b>Weight</b>	<b>Very Significant /4</b>	<b>Significant /3</b>	<b>Moderately Significant /2</b>
Sub 1	0.500	0.600	0.400	0
Sub 2	0.500	0.400	0.200	0.400

The observation sub-model level Fuzzy Sets are multiplied by their pre-assigned weights to become:

**Table 16 Weighted Fuzzy Sets Table**

<b>Factor A (1.00)</b>	<b>Weight</b>	<b>Very Significant /4</b>	<b>Significant /3</b>	<b>Moderately Significant /2</b>
Sub 1	0.500	0.300	0.200	0
Sub 2	0.500	0.200	0.100	0.200

The Overall Weighted Fuzzy Set Membership function then becomes:

$$\{.500/4, .300/3, .200/2\}$$

**Figure 6 Overall Weighted Fuzzy Set**

The Overall Weighted Fuzzy Set can be calculated by summing the DOR's for each linguistic level. In turn the Overall Weighted Fuzzy Set determines the values of the linguistic levels, which then can be used to make inferences about the Factor A and its component sub-models' likelihood statements, i.e. probabilities.

### Fuzzy Set Creation (Quantitative Output)

An extension of the previous example will be used to determine the quantitative output of the Fuzzy Model. After the SME evaluator has evaluated 5 cases and assigns the numerical DOR that corresponds to each sub-model linguistic level in the following table contains the given example data:

**Table 17 Observations Fuzzy Numerical Table**

<b>Factor A (1.00)</b>	<b>Weight</b>	<b>Very Significant /4</b>	<b>Significant /3</b>	<b>Moderately Significant /2</b>
Sub 1	0.500	0.600	0.400	0
Sub 2	0.500	0.400	0.200	0.400

Taking into account the sub-model weights yields the following:

**Table 18 Observations Weighted Fuzzy Numerical Table**

<b>Factor A (1.00)</b>	<b>Weight</b>	<b>Very Significant /4</b>	<b>Significant /3</b>	<b>Moderately Significant /2</b>
Sub 1	0.500	0.300	0.200	0
Sub 2	0.500	0.200	0.100	0.200

The Overall Weighted Fuzzy Set Membership function becomes:

$$\{.500/4, .300/3, .200/2\}$$

**Figure 7 Overall Weighted Fuzzy Set**

The sum of each linguistic level DOR's for each sub-model is calculated and then the maximum "significant", which includes Very and Moderately, DOR is derived across Fuzzy linguistic levels to yield a single sub-model level numerical value of 0.500 which will be input into the following factor level model to produce a quantitative output:

$$\mathbf{Output = W_A F_A = 1.00 (0.500) = 0.500}$$

EQ. 5.2

Why is the maximum significant DOR used to approximate Factor existence? For one, what is determined, significant, is of interest and is more important than what is "not significant" when attempting to determine how a factor impacts the response output. Utilizing the maximum DOR is based on the fundamental theory of Fuzzy Set Theory in regards to the probability of the Union of events (McNeill, 1994). What is the probability that the Factor A, in the example, would either be determined a Very Significant, Significant, or Moderately Significant impactor of response based on the level of set membership (existence), otherwise explained as:

What is P(AUBUC)?

Where:

A = Very Significant Set Membership  $\{.500/4\}$

B = Significant Set Membership  $\{.300/3\}$

C = Moderately Significant Set Membership  $\{.200/2\}$

Hence the maximum DOR is .500 and validates why this value is used in the Factor Level Fuzzy Model. This is valid because there is more evidence that a Very Significant event exists, at .500, versus the other set membership values of .300 and .200.

From another perspective says, if the probability distribution is unknown for an observed population, it has been a regular practice, in traditional statistical data analysis, to assume that the sampled data is from a known normal distribution, be it that the sample size is sufficiently large. Though normal distributions are common, an assumed Normal distribution may not best represent the existent public educational delivery system within this research. Also the sampled data within this research is drawn from the distribution of individuals and is not from the distribution of averages, i.e. individual sampled data observations are used rather than observed sampled data averages. If the distribution of averages were employed then it would be expected that the sampled data's distribution would be approximately Normal according to the Central Limit Theorem, as long as the population has a finite mean and variance. However the population mean and variance are highly unlikely to be known and calculated in public educational delivery system research; therefore, the maximum DOR value is best suited for this research application.

The check for sub-model level data consistency is also valid in the quantitative case as well as the qualitative. Also as stated before, the system experts will determine the meaning of the output. Subsequent Fuzzy Model outputs would then be compared to the established standard as pre-determined by system administrators.

To summarize Chapter Five, after the Fuzzy Model has been constructed and the Factor Coefficient weights have been determined using AHP the next phase of collection of sub-model level data can take place. Next, case-by-case observations can then be made by a trained SME according to the agreed sampling plan instituted by the expert system administrators.

The results of the SME evaluations comprise the Overall Weighted Fuzzy Sets that utilize maximum DOR's. Finally, the quantitative Fuzzy Model output can be calculated. We can determine when and if the model accurately depicts the performance of the public educational delivery system through model validation techniques that will be covered in the next chapter, Chapter Six Model Validation.

## CHAPTER SIX: MODEL VALIDATION

### Model Bias and Error

Model validation is essential in model development. An invalid model will produce invalid results. This validation extends beyond the within experiments reliability to that of how well the model represents the actual system. Types of methods and model validation techniques include:

1. The use of model consistency measures (Cronbach's  $\alpha$ ) to validate model adequacy
2. The use of system expert knowledge to validate model outputs
3. The use of comparisons analysis between established expected systems objectives and the resultant model outputs
4. The use of quantitative analysis of variance techniques (ANOVA)

Some methods that were used to ensure model consistency were:

1. Surveyed SME's were allowed to review their factor relative significance weightings assignments prior to final submittal.
2. Surveyed SME's could see their responses to multiple comparisons questions simultaneously.
3. Technical Support was provided when the surveyed SME needed clarification of definitions and any other questions, via phone or email.

4. Surveyed SME's were trained in identifying and classifying significant factors that would impact student academic performance based on their level of employment within the public educational delivery system
  - a. Specialized Training/Workshops (Provided by Employer)
  - b. Educational Background (B.S Degree Graduates)

The trained SME is vital to the mitigating of model bias and error as well as other previously mentioned techniques.

### **Sampling and Disaggregated Metrics**

One way to mitigate the impacts of sampling error and disparity, which is utilized within NCLB legislation, is to institute disaggregated metrics. Disaggregated metrics are derived by monitoring sub-segments of a population of interest. The result is more detailed information about this population which empowers administrators to make better informed decisions. By identifying distinct sub-groups of a population ensures adequate population representation within samples. The following list represents classifications of population segmentation by ethnicity, socioeconomic status, language proficiency, and disabilities:

1. White
2. Black
3. Hispanic
4. Asian
5. American Indian

6. Economically Disadvantaged
7. Limited English Proficient
8. Students With Disabilities

A more accurate representative sample of the population can be taken as the result of this disaggregated sub-group approach. Also areas of deficiency become more apparent with disaggregated metrics, though it does require increased attention to detail which may be a resultant negative trade-off that may result in an increased need for additional resources such as time and funds.

### **Fuzzy Model Maintenance**

It is recommended that periodic Fuzzy model reviews be implemented in order to ensure the most accurate information for PEDSP can be assessed. Biannual model reviews should suffice. Also, special Fuzzy Model reviews can be conducted so that the Fuzzy Model may be readjusted to reflect recent system changes in cases of:

1. Newly implemented educational policy and legislation
2. Known shifting educational system trends based on research
3. Known model factor changes
4. The perception of system experts has changed

Overall, the Fuzzy Model maintenance is the responsibility of the systems administrators and is dependent on the desired level of system maintenance.



## **Comprehensive On-Site Fuzzy Model Validation**

Ideally the Fuzzy Model Validation process should take place in the OCPS District at the Campus level for Elementary, Middle, and High Schools. But within this research the focus of model validation will be centered at the elementary campus level. The reason is that the identified responses, FCAT Achievement Level and other FCAT related measures of student and system performance, have been in place only since 1998, approximately six years officially. So, in order to minimize the effects of public educational delivery system variation caused by policy inconsistencies, such as factors that may have impacted student performance prior to the official implementation of the Florida SSS legislation, it is logical to consider the results of elementary school performance as the basis of the fuzzy model validation. A large majority of the currently enrolled students attending an OCPS elementary school have pursued his/her tenure under the jurisdiction of the Florida SSS legislation, since grade 5 is the highest elementary grade. Hence a more consistent basis for Fuzzy Model validation analysis exists. Also, another reason to validate the Fuzzy Model and its application at the elementary academic level is that this body of research focused on the Parental and Community Support Factor as the primary factor of interest, the elementary student is more directly dependent on the actions of the Parent/Caregiver. Research has shown that in the earliest stages of human psychological development, the child is most sensitive to environmental factors and internalizes such experiences; and does not have the capability to decide or exercise alternatives that would mitigate the impacts of these environmental factors. Until higher levels of psychological maturity have been achieved, such as the realization of the individual self, the actions of the Parent/Caregiver are significant impactors of elementary student behavior and performance.

Based on research findings, the OCPS systems personnel, to be surveyed, should come from the following elementary schools (or schools with similar performance):

1. Eccleston Elementary (Central Learning Community; Grade A)
2. Richmond Heights Elementary (Central Learning Community; Grade D)
3. Aloma Elementary (East Learning Community Grade; B)
4. Waterford Lakes Elementary (East Learning Community; Grade A)

At each of these schools, three types of school personnel should be surveyed:

1. Administrator (Principal or Asst. Principal)
2. Instructor/Teacher
3. (PIE) Partners In Education Coordinator or ADDitions Coordinator

The method used to determine which schools that were chosen to validate the model was based on the highest and lowest scoring elementary schools in select Learning Communities, according to the Florida 2004 A+ Plan school grade.

### **Fuzzy Model Output Uses**

This section will discuss the potential and recommended uses of the Fuzzy Model output. Once the validated Fuzzy Model has transformed qualitative factors into quantitative data, Fuzzy Model Output profiles can be created in order to harness the predictive power of the Fuzzy Model. Hence the following simplified example:

1. The following four factor Fuzzy Model was created and validated:
  - a.  $Y = W_1F_1 + W_2F_2 + W_3F_3 + W_4F_4$
  - b. Note the four factor model will not produce a quantitative output greater than 1.
2. An SME evaluated  $n = 10$  cases
  - a. Observed 3 out of 10 Very Significant Instances for each Factor
  - b. Observed 5 out of 10 Significant Instances for each Factor
  - c. Observed 2 out of 10 Moderately Significant Instances for each Factor
  - d. Observed 0 out of 10 Not Significant Instances for each Factor
3. AHP Relative Significant Weighting was determined to be equal for each factor:
  - a.  $.25 = W_1 = W_2 = W_3 = W_4$

The Overall Weighted Fuzzy Set Membership function becomes  $\{.300/4, .500/3, .200/2,\}$  for each factor. The Fuzzy Model then becomes  $Y = .250F_1 + .250F_2 + .250F_3 + .250F_4$ . Substituting the maximum DOR's ( $F_1 = F_2 = F_3 = F_4 = .500$ ) for each factor, produces  $Y = .500$ . Now qualitative data responses can be linked to the calculated model output. For instance, it was determined that for the  $n = 10$  observed evaluated cases:

1. In 5 cases, there was an observed FCAT Achievement Level 3 (scale score: 350) for Math and Reading
2. In the remaining 5 cases, there was an observed FCAT Achievement Level 2 (scale score: 275) for Math and Reading
3. Florida A+ Plan School Rating: B (400 points for all observed cases)
4. School NCLB AYP: 100% (for all observed cases)
5. Fuzzy Model Output: .500

To explain what the Fuzzy Model Output (FMO) is, it is the quantified amount of impact on the response as determined by sampling the existing system through the use of qualitative analysis. The FMO represents the entire system state during any observed period of time. So, a systems administrator could then use this FMO to logically predict the FCAT Achievement Level of students, NCLB AYP, and Florida A+ Plan School Rating. As in the example a systems administrator would expect that when the Fuzzy Model output is .500, expect a student performance level FCAT Achievement Level 3 (scale score: 313) for Math and Reading, barring some level of acceptable prediction error. Note: The mean FCAT scores in the example observed evaluated cases were calculated and rounded to the nearest whole number. As more cases are evaluated more data is available for compilation and can be used to build Fuzzy Model Output profiles. As with any modeling method error exists. The associated model Prediction Error may be described as the difference between the Compiled Fuzzy Model Output profile data and the actual evaluated case data for each output response.

The validated Fuzzy Model can be used as a tool by public education administrators. The ability to know the state of the public educational delivery system as well as the performance potential of the student body is now possible.

## **CHAPTER SEVEN: LITERATURE REVIEW**

The literature review proves quite interesting and somewhat of a challenge because of the relative newness of Fuzzy Set Theory and its application. Much of the existing research had to be extrapolated to apply FST to a public educational delivery system. It was determined that there are few known direct applications of FST in the public educational delivery systems area of interest. Hopefully this completed body of work will reduce the literature gap and contribute useable knowledge of practical application to the Fuzzy Set Theory Body of Knowledge. Also, in Appendix D, a literature review matrix that delineates the source information, chapters of this research supported by the source, and the ideas supported by the source, can be viewed. In summary FST and its application is rather new science. As more practitioners and further development of the science progresses, there will be more examples of successful FST implementation that may benefit humanity.

## **CHAPTER EIGHT: CONCLUSION**

### **Overview and Summary**

Increased systems accountability can propel America's public educational delivery system to higher levels of performance but it will take the right personnel, tools, and leadership.

Contemporary and novel approaches such as Fuzzy mathematical modeling will support this mission of national public education reform. An approach to developing the fuzzy model should include at least the following steps:

1. Define the major impacting factors
2. Define the application environment of interest
3. Determine the approach and methodology
4. Develop the Fuzzy model
5. Validate the Fuzzy model
6. Implement model usage

Applying the use of the Fuzzy model that defines student success, and in turn public educational delivery system quality, will enable the required continuous improvement in educational delivery that is needed in order to remain globally competitive.

## **Recommendations**

The following recommendations were created as a result of the findings of this research.

1. Increased Integrated Systems and Collaboration
2. Employ Variation Reduction Techniques
3. Identify Dedicated Procedures Monitoring and Execution Personnel
4. Pursue Bureaucracy and Culture Change

Increased Integrated Systems and Collaboration will facilitate organizational alignment with Campus, District, State, and National directives. Greater public education reform mission alignment ensures greater system quality by meeting and exceeding system stakeholder expectations. Actions that reduce optional directives and increase legislative mandates increases accountability, however administrators and legislators should enable subordinate policy compliance by providing the needed resources to subordinates in order to ensure policy compliance. The complete integrated system perspective is key to increased system quality.

Throughout this research it has been stated that the Public Educational Delivery System contains inherent system variation. However there are techniques that may be implemented to minimize various types of variation. For instance, standardized tests have become the primary indicator of student academic performance. One way to mitigate testing variation of standardized test is to derive an average test result from a series of similar tests taken by the student versus the result of a single testing session. The use of the standardize test as an indicator of student performance

and is projected to remain so, well into the near future. So, we must improve the methods of its usage.

Procedures monitoring and execution have become extremely important in the shadows of increased accountability. Dedicated personnel should be assigned to monitor system compliance with legislation and other administrative policies. Why? For instance, appropriated funds are available for the socioeconomic disadvantaged Title I designated schools however the administrative Free & Reduced Lunch Application is the indicator for appropriations eligibility. If the applications are not completely and correctly filled-out and filed, needed schools may not receive appropriated funding. Personnel who are adept and aware of policy and procedures are invaluable commodities in times of limited resources.

Another recommendation is to develop and explore methods to update public education system culture. Bureaucracy and Culture change is probably the most difficult of the aforementioned recommendations to implement. The Public Educational Delivery System is founded on Politics and governmental bureaucracy. Mitigating the influence of Politics in public education is quite feasible and is seen as mandatory by corporate and governmental leaders if America is to remain globally competitive educationally and economically.

### **Research Points of Interest**

There were a few interesting points encountered through this research. For instance, surveyed Teachers and Administrators, according to the results of the OCPS BRP Survey Questions: 10 (Teacher Performance) & 11 (Principal Performance), believe that their level of performance



should not be dependant on their student's standardized test performance. What's more interesting is that an overwhelming majority of the respondents felt that student performance should not be a considered a major indicator of teacher and administrator performance by a response rate of 79% for teachers and 77% for administrators. From an educational delivery system perspective the output of the system is indeed a reflection of the quality of the system and its intrinsic sub-components. Hence student achievement and performance should have some direct link to the assessed performance of administrators and teachers.

Another area of enlightenment as a result of this research is the emphasis on the data to information transformation. Decisions and actions based on information not data, is extremely prevalent. Data is meaning-less yet when interpreted by humans and given meaning then and only then is information created. Fuzzy Theory facilitates the data to information transformation earlier during the analysis phase. The result is a more preventive vs. reactive perspective of system performance. The more persons who can understand the methods used to derive system information the better. Increased functional model usability will facilitate consistent and eventually more accurate system assessments.

**APPENDIX A: THE OCPS BLUE RIBBON PANEL ON EDUCATION  
PANEL MEMBER BIOGRAPHIES**

## **THE OCPS BLUE RIBBON PANEL ON EDUCATION PANEL MEMBER BIOGRAPHIES**

BILL SUBLETTE (CHAIR) Bill Sublette is an attorney with his own law practice in Orlando. He earned his law and bachelor's degrees from the University of Florida. In 1992, he won a seat in the Florida House of Representatives, where he served for eight years. While in the Legislature, he served in many leadership positions, including chairman of the Education Appropriations Committee.

Bill and his wife Suzie have three children, Alex (6), Aubrey (2) and Jack (1). Alex is a first grader who attends Blankner School near downtown Orlando. Bill is an active parent at the school and has served on the Blankner School Foundation.

Bill teaches Sunday School at his church and coaches YMCA soccer. He chaired the Mayor's Education Action Council in 2003-04 and participates on the boards of the Howard Phillips Center for Children and Families and the local Boy Scouts of America council. During his tenure as a legislator, Bill was honored by many businesses, civic groups and educational organizations for his effective public service.

DICK BATCHELOR Dick Batchelor is founder and president of Dick Batchelor Management Group, Inc. He is a long time Orlando resident who received degrees from the University of Central Florida and Valencia Community College. As a member of the Florida House of Representatives from 1974 until 1982, Batchelor chaired committees on auditing, energy and health and rehabilitative services.

He currently does political analysis for several local TV and radio stations. Since 1981, he has served as honorary chairman of the "Dick Batchelor Run for the Children," an annual 5-K run that raises funds to treat abused children. In 2002, Batchelor chaired the "Change 4 Kids" campaign that garnered support of a half-cent sales tax increase in Orange County to provide funding for school construction and renovation. Voters approved the tax referendum in September 2002.

Dick and his wife, former TV news anchor Andrea Coudriet, have three sons.

ARISTIDES "KICO" DIAZ Aristides "Kico" Diaz incorporated the Small Business Legal Center, P.A., in 2002 to provide legal services to small businesses at an affordable cost. He graduated from California State University (Sacramento) in 1987 with a degree in Finance. After joining the U.S. Navy, Kico graduated from Legal Officer Training Class at the Naval Justice School. He then received his law degree from the Florida State College of Law in 1997.

Kico serves as president of the Hispanic Bar Association of Central Florida and legal advisor to the Hispanic Chamber of Commerce. He also is a member of the Lynx Citizen Advisory Committee and participates as co-chairman of the Diversity Committee for the Orange County Bar Association.

He has co-founded "Proximate Cause," a motivational and educational program about the law from a minority perspective. The program is designed for high school and middle school students.

DR. JOHN EDWARDS Dr. John Edwards is the associate superintendent of Curriculum and Student Services for Orange County Public Schools. He oversees the implementation of the district's Comprehensive Academic Achievement Plan, which ensures a consistent curriculum from school to school. His department also researches and recommends best practices in instruction.

John led Apopka High School as principal for 11 years before coming to the district office. Prior to that, he was an assistant principal at both Winter Park and Jones high schools. He started his educational career at Edgewater High School, where he taught for 11 years.

He was active in the Apopka Rotary Club and the Apopka Chamber of Commerce for many years, and chaired the Apopka Relay for Life fund-raiser for three years.

COLEMAN FIELDER Coleman Fielder is an adjunct professor at Rollins College, where he teaches social studies and serves as a faculty coordinator for student teachers. He earned his bachelor's degree in business and master's degree in elementary education from Stetson University. He taught in Orange County Public Schools for 37 years, retiring from Brookshire Elementary in Winter Park.

As a member of the U.S. Army Reserve, Coleman served in Operation Desert Storm. He retired from the reserve program with 24 years of service. When he was with OCPS, he served for many years as a member of the Superintendent's Advisory Council. He was selected as a Teacher of the Year from his school and participated in the Local School Advisory Council. At Rollins, he is a member of the college's Education Program Advisory Council.

Coleman is married and he and his wife have two adult children who have their own businesses. For his retirement present, his wife allowed him to purchase a 1950 Chevy, which he is currently restoring. He keeps active by training with his wife for the half-marathon to be held at Disney in January 2005.

DARYL FLYNN Daryl Flynn is a board member of the Orange County Council of PTAs/PTSAs and previously served as its president from 2001 until 2003. She earned degrees from Manatee Junior College and Florida Southern College, and graduated with a master's degree in Public Administration from Florida Atlantic University. She currently works as marketing director of Business Archives, Inc., a document storage and retrieval company, in Orlando.

As her son was going through Orange County Public Schools, Daryl served as president of the Waterford Elementary PTA and later, chaired the School Advisory Council at Discovery Middle. In 2001, she served on the district's Reapportionment Committee and the Superintendent's Accountability Committee.

Daryl is married to James T. Flynn III, founder and CEO of Business Archives, Inc. They have one son, James (20).

WINSTON W. "BUD" GARDNER As President and Chief Operating Officer at TLC Engineering for Architecture, Winston W. "Bud" Gardner, P.E., is responsible for operational management of TLC's 12 operating divisions. Prior to TLC's acquisition of Gardner Griffith & Associates, Inc. in 1994, Gardner was president of the firm and led the business development effort, as well as project management, civil engineering and inspection services. He holds a bachelor's degree in Civil Engineering from Auburn University.

After serving 27 years in the Marine Corps Reserve, Gardner retired with the rank of colonel. He spent 14 years with Pan Am World Services and was responsible for major aerospace projects at Kennedy Space Center and Cape Canaveral Air Force Station. He is a former member of the Florida Senate and the Florida House of Representatives.

Gardner is a member of Florida's Constitutional Accountability Commission, which is charged with determining accurate definitions of terms outlined in Article IX, Section 1 ("Public education") of the Florida Constitution in regard to the education of children. He is also chairman of the Florida Space Research Institute. Previously, he served on Florida's SMART Schools Clearinghouse and the Brevard Community College Foundation Board of Trustees.

J. CHARLES GRAY J. Charles Gray serves as chairman of the board and founding director of the Gray Robinson law firm, which has offices in Orlando, Tallahassee, Tampa, Lakeland, Melbourne, and Clermont. He earned his law and bachelor's degrees from the University of Florida. Charles has been the city solicitor for the City of Orlando and served as chairman of the Florida State Turnpike Authority, the Economic Development Commission of Mid-Florida and the University of Central Florida Foundation.

He has received the J. Thomas Gurney Award for Lifetime of Service to the Community and has been inducted into the Junior Achievement Business Hall of Fame. Charles also has served as vice chairman and director of the Orange County Compact, which pairs mentors with at-risk students.

Charles and his wife Sandra previously were in the cattle business for more than 25 years. They discontinued their business in order to sail around the world. Charles still practices law full-time at GrayRobinson.

DR. FREDERICK HUMPHRIES Dr. Frederick Humphries has served as president of the National Association for Equal Opportunity, Florida A&M University and Tennessee State University. He earned a bachelor's degree in Chemistry from Florida A&M University and a Ph.D. in Physical Chemistry from the University of Pittsburgh.

During his nearly 17-year tenure at Florida A&M University, he more than doubled enrollment while raising academic standards at the same time. He has served as chairman of the Board of Directors of the National Association of State Universities and Land Grant Colleges; member of the Board of Trustees for the University of Pittsburgh; and member of President Bill Clinton's White House Advisory Committee on Historically Black Colleges and Universities.

Frederick also has been invited by several companies to serve on their Board of Directors, including Wal-Mart stores, Inc., Brinker International, Bank of America, Florida, and the National Merit Corporation.

MIILLIE IRIZARRY Millie Irizarry is director of the Women's Residential and Counseling Center/Victims Services Program, which is a transitional housing program for victims of domestic violence and at-risk homeless women and children. She previously was housing director for the Coalition for the Homeless of Central Florida, Inc. She earned her bachelor's degree in advertising/public relations from the University of Central Florida. She currently chairs the Hispanic Chamber of Commerce of Metro Orlando. Millie is a member of the Hispanic Professional and Business Women Association, the Orlando Regional Chamber of Commerce Board of Governors and the Orange County Community Assessment Team for the Independent Living Program.

RANDY LYON As president for the Central Florida region of The Ginn Company, Randy Lyon oversees the development and management of Ginn properties in the area. He holds a B.A. in mathematics and an M.B.A. from Rollins College and has completed post-graduate work at Georgia State University.

Previously, Randy served as president and CEO of Lake Nona Property Holdings, which owns and operates Lake Nona, a master planned development in Orlando. He led the partnership that resulted in the NorthLake Park Community School, which opened in 1999. He serves on the Board of Directors for many organizations, including the Orlando Regional Healthcare Foundation and the Central Florida YMCA.

Randy served as chairman of the board of the St. Stephens School in Bradenton, Florida. In addition, he was tapped to be an advisor to Maui Community College of the University of Hawaii and elected a trustee of Rollins College. He and his wife Andrea and their children live in Orlando.

PERCY R. LUNEY, JR. Percy R. Luney, Jr is dean and professor of law at Florida A&M University College of Law in Orlando. He is a past president of the National Judicial College (Reno, Nevada), the oldest judicial education and training institution in the United States, and has taught at Duke University School of Law and North Carolina Central University School of Law where he also served as dean. Prior to entering legal education, he practiced law in Washington, DC and Nashville, Tennessee.

He earned his bachelor's degree from Hamilton College in Clinton, New York, and his law degree from Harvard Law School. He is a former Fulbright Research Scholar, Lecturer and Specialist, which has provided him with opportunities to teach in Cambodia and Japan. As a Thomas J. Watson Fellow, he traveled extensively and conducted research throughout Africa and Europe. He has authored many articles and books dealing with legal issues.

He serves on several boards, including those for the Citrus Club and Orlando Chamber of Commerce. Percy is a product of public school education and has two daughters who attended public schools.

RICHARD MALADECKI Richard Maladecki is president of the Central Florida Hotel and Lodging Association (CFHLA), a position he has held since 1997. He oversees governmental affairs, a Political Action Committee, membership services community partnerships and board development. He graduated from Wayne State University in Detroit, Michigan, and received his master's degree from Eastern College in St. Davids, Pennsylvania. Richard has been an adjunct professor in the University of Central Florida's Non-Profit Management Program since 2000. Under his leadership, the CFHLA has developed an Adopt-A-School Program with Orange County Public Schools, provided free lodging for new teachers through its Teacher Relocation Program, given educators hands-on experience in local hotels through its Teacher Academy and awarded grants to the district's hospitality programs.

Richard serves on the boards of many organizations, including Florida's Blood Centers, Valencia Community College Foundation, Central Florida Boy Scouts, the Orange County Regional History Center and the UCF Non-Profit Curriculum Advisory Council.

ROBERT MANDELL Robert Mandell is chairman and CEO of The Greater Construction Corp., doing business as Greater Homes. His company has been building communities in Central Florida since 1965. He graduated from the University of Florida with a bachelor's degree in 1969 and a Juris Doctor degree in 1972. In addition, he graduated from the Harvard Business School in 2000.

Currently, he serves on the Board of Trustees of the University of Central Florida Foundation, the Central Florida Advisory Board of Wachovia Bank and the Board of Directors of Florida Hospital. Additionally, Robert serves as a member of Orange County Chairman Richard Crotty's Transportation Commission.

He is the father of two boys: Zack, 19, and Xan, 13.

DR. PAMELA McCAULEY-BELL Dr. Pamela McCauley-Bell is an associate professor of Industrial Engineering and Management Systems at the University of Central Florida. She also is president and owner of Tech-Solutions, a small business that provides technical consulting and research services. She obtained her bachelor's, master's and doctor of philosophy degrees in Industrial Engineering from the University of Oklahoma.

She received both the College of Engineering Award for Excellence in Undergraduate Teaching and the Teaching Incentive Program Award during the 1996-97 academic year. Pamela has served on various boards including the Beta Teen Parent Program Board of Directors, Girls, Inc. and the Women in Engineering Program Advocates Network, which is a national organization to increase the presence of women in engineering.

She published her first book, "Winners Don't Quit – Now They Call Me Doctor," last year. Her daughter, Annette, is a graduate of the Seminole County Public Schools and is currently a student at the University of Phoenix in Oklahoma City, Oklahoma.

LYNN MEDEROS Lynn Mederos is a science teacher at Maitland Middle School. She earned both her bachelor's and master's degrees from the University of Central Florida. Lynn has been teaching in Orange County Public Schools since 1983, and also was an adjunct instructor at Seminole Community College for seven years.

She was selected as the district's Teacher of the Year in 2002. Lynn also is a National Board Certified Teacher in early adolescence/science. She has won Walt Disney World Teacherrific Awards and received grants for her creative teaching strategies.

She is active in Maitland Middle's PTA and is a member of the Florida League of Teachers.

RICHARD MORRISON Richard Morrison has worked for Florida Hospital for 23 years. He is currently a regional vice president with responsibility for government and public affairs, the Community Health Improvement Council and regulatory affairs. He graduated from Florida State University, Phi Beta Kappa, and did post-graduate study at the University of Central Florida.

He facilitated the development of the Central Receiving Center at the Orange County Jail; the new 2-1-1 Information and Referral system; and the Senior Health Assessment Center. Richard serves on a number of civic and community boards. He chairs the Orange County School Readiness Coalition, Orange County Emergency Medical Services Advisory Committee, and the UCF College of Health and Public Affairs Advisory Board.

Richard is married with four children and two grandchildren.

LORENZO "LO" PHILLIPS Lorenzo "Lo" Phillips was appointed principal of Jones High School in 2003. He holds a bachelor's degree from Florida A&M University and a master's degree and an Educational Specialist degree from Rollins College. He previously was principal at Westridge Middle, where he was responsible for curriculum improvement that led to improved student performance on the FCAT for three consecutive years.

Prior to becoming principal at Westridge, Lo worked as assistant principal at Winter Park High for nine years. He began his career with OCPS as a teacher at Liberty Junior High in 1977.

Before entering education, Phillips served in the U.S. Army for 11 years.

ALZO J. REDDICK, SR. Alzo J. Reddick, Sr. is the director of Defense Transition Services at the University of Central Florida. In this position, he coordinates the Soldiers to Scholars program, which is designed to recruit former members of the military to address the critical teacher and nursing shortages. He graduated from Jones High School in 1956. He received his bachelor's degree from Paul Quinn University, a Master of Education degree from Florida A&M University and a Doctorate of Education from Nova University in 1977.

After earning his bachelor's degree, he served in the U.S. Army. When he returned home, Alzo taught at Phyllis Wheatley High School and Winter Park High. In 1971, he joined the staff of Rollins College where he served as a professor and administrator for 12 years. Prior to his position at the University of Central Florida, he worked as an administrator at Valencia Community College.

Alzo also served in the Florida House of Representatives from 1982 until 2000. He and his wife Elouise have been married since 1961 and have two daughters, a son and several grandchildren.



RONALD O. ROGERS Ronald O. Rogers serves as Orlando Area Director for Williams-Russell and Johnson, Inc., one of the largest African-American-owned Design Firms in the country. He is a graduate of Jones High School and Florida A&M University. Ronald is also a product of the Georgia Institute of Technology Graduate School of City Planning with advanced study at Harvard University.

Ronald is a former City Administrator with the Town of Eatonville where during his tenure, the Town experienced unprecedented growth and development. During the past 27 years, he has served on the boards of several civic and community organizations, including the first Orange County Charter Review Commission, Valencia Community College Board of Trustees, Ninth Judicial Circuit Nominating Commission, and Leadership Orlando (Class 7 - 1978).

Ronald currently serves on the Executive Board of the Greater Orlando Regional Chamber of Commerce, Boys and Girls Town of Central Florida Board of Directors, Citrus Club Board of Governors, City of Orlando Development Review Committee, Orange County-Membership Mission Review Board, African-American Chamber of Commerce Board of Directors and President of 100 Black Men of Orlando, Inc.

JOAN RUFFIER Joan Ruffier has worked in the corporate world as a Certified Public Accountant and small business owner. She earned her bachelor's degree from the University of Florida and her MBA from the Crummer Graduate School of Business (Rollins College). She also is a product of Orange County Public Schools, having graduated from Edgewater High School.

Joan is a former member of the State Board of Regents, and chaired that governing body of the state university and community college system from 1987-1989. She was the first woman to hold that position. In addition, she is a former member of the Federal Reserve Bank of Atlanta (Jacksonville Branch) and former president of the University of Florida Foundation.

She currently serves on many corporate boards, including the FPIC Insurance Group, the Winter Park Health Foundation and the University of Florida Foundation. Joan and her husband Dan have three children and four grandchildren.

JIM SCHOTT Dr. Jim Schott is an assistant professor of Educational Leadership for National-Louis University, the Tampa-Orlando campus. He also is the founder and president of Creative Education Solutions, Inc., an educational consulting company. He earned his B.A. degree from Marian College, Indianapolis, Indiana; his M.S. degree from Butler University, Indianapolis, Indiana; and his Ph.D. degree from Purdue University, West Lafayette, Indiana.

Jim served as superintendent of Orange County Public Schools for nearly 13 years with prior service as deputy superintendent of Instruction. He is a former Latin and English teacher, high school coach, and director of studies in Indianapolis. He served as an assistant superintendent in Upper Arlington, Ohio, and high school principal in Oak Ridge, Tennessee. He was an adjunct professor in curriculum and instruction and educational leadership at Butler University in Indiana and at Rollins College.

He was the president and an original trustee of United Arts of Central Florida. Jim has served on a variety of community boards, including the Heart of Florida United Way and Junior Achievement. He and his wife Ginny have two daughters, Susan Martucci and Cathy Keller, and five grandchildren.

LINDA SUTHERLAND Linda Sutherland is executive director of the Orange County Healthy Start Coalition, a non-profit organization that works to reduce early childhood problems such as low birth weight and infant mortality. She also serves as a peer reviewer for “The Maternal Child Health Journal,” and as a consultant for superintendent searches for the Florida School Boards Association. She earned her A.A. at Marymount College and her bachelor’s degree in Business Administration from Buxton University.

Linda is former Orange County School Board Member, elected countywide in 1990 and served until 2002. She was school board chairman during 1995-96. In addition, she served as president of the Florida School Boards Association in 1996-97 and represented our district and Florida on several national education related boards. She is also a lifetime member of the Florida and National PTAs. Linda is involved with many community boards, including the Orange County Readiness Coalition, Children’s Advocacy Center, School Health Advisory Committee, Teen Pregnancy Prevention Coalition, Safe and Drug Free Schools Committee and the Florida Children’s Campaign. She has been married since 1974 to Douglas Sutherland and they have one son, Andrew, who went through Orange County Public Schools and has since earned his B.S. degree. He is married to an OCPS kindergarten teacher.

CLARA WALTERS Clara Walters is currently a self-employed educational consultant. She specializes in training, mentoring and coaching principals, assistant principals and deans. Clara earned her bachelor’s degree from Florida Memorial College in Miami, Florida, her master’s degree from Rollins College and her doctorate degree from Nova University.

Clara served as senior director of Student Services for Orange County Public Schools, providing the resources to meet the diverse needs of students. Prior to that, she was responsible for distributing district resources and supervising the school improvement process as senior director of Secondary Education Services. She is a former language arts teacher and served as assistant principal at Wymore Career Education Center and Oak Ridge and West Orange high schools. Clara worked as principal of Carver Junior High for two years and principal of Jones High for nine years.

She has worked in the community with many organizations, including the Department of Juvenile Justice District Advisory Board, the Southwest Boys and Girls Club Advisory Club and the Youth Commission to develop the Orlando/Orange County Compact Program.

THOMAS YOCHUM Thomas Yochum joined SunTrust Bank Central Florida in 1998 and serves as its chairman, president and chief executive officer. He earned his bachelor’s degree from Rollins College in 1974.

He is vice chairman of the University of Central Florida Board of Trustees and serves on the UCF Foundation board of directors. He is a board member of the Orlando Magic Youth Foundation, Florida Hospital and serves on the United Arts executive committee. Past organizational chairmanships and memberships include the Valencia Community College Foundation, Economic Development Commission of Mid-Florida, Rollins College Crummer Graduate School Board of Overseers, Heart of Florida United Way, and the American Cancer Society.

Thomas is a member of the Florida Bankers Association, the Orlando Regional Chamber of Commerce, and is an alumnus of Leadership Florida. He and his wife, Penny, live in Winter Park.

**APPENDIX B: FUZZY MATHIMATICAL MODELING OF THE PUBLIC  
EDUCATIONAL DELIVERY SYSTEM SURVEY**

# FUZZY MATHIMATICAL MODELING OF THE PUBLIC EDUCATIONAL DELIVERY SYSTEM SURVEY

**Topic:** Survey Information for Fuzzy Modeling of Public Educational Delivery System Performance

**SME/Preparer:**

**Date:**

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- **Survey Purpose**

What is the significance of the Parental and Community Support Factor and its impact on public educational delivery system performance? By quantifying qualitative data into an equation format we can obtain repeatable and measurable results that may be utilized by public educational delivery system administration to aide in decision-making activities through a process known as Analytic Hierarchy Process (AHP). AHP determines factor relative weighting and significance by assessing pair-wise comparisons and their relative.

- **Instructions**

*(Section 1)* Please answer questions A and B as they relate to the question being asked.

Section 1 Length: 22 questions

Section 1 Estimated Completion Time: 30 min.

*(Section 2)* This is the Fuzzy linguistic level assignment and evaluation guide for deemed sub-models of the Parental and Community Support Factor. During the evaluation of student and the performance of the public educational delivery system, the SME conducting the evaluation will determine the appropriate level of significance as determined by personal expertise and observed criteria compliance.

Section 2 Length: 27 questions

Section 2 Estimated Completion Time: N/A

***Section: 1 (Factor Weighting Calculation)***

Question (Factor Level)

1. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant

**a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system

performance and student performance? To what degree of significance exists based on the rating

scale below? *(See Definitions and Description Section for further Factor detail at the end of*

*Section 1)*

A. “Parental and Community Support Factor” vs.

“Early Childhood Education Factor”

B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Factor Level)

2. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant

**a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system

performance and student performance? To what degree of significance exists based on the rating

scale below? (*See Definitions and Description Section for further Factor detail at the end of*

*Section 1)*

A. “Parental and Community Support Factor” vs.

“Student Performance Factor”

B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Factor Level)

3. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? *(See Definitions and Description Section for further Factor detail at the end of Section 1)*

- A. “Parental and Community Support Factor” vs.  
“Teacher Performance, Retention, and Pay Factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

Degree of Relative Significance	Definition
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Factor Level)

4. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? (*See Definitions and Description Section for further Factor detail at the end of Section 1*)

- A. “Parental and Community Support Factor” vs.  
“Education Management Factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

Degree of Relative Significance	Definition
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)



Question (Factor Level)

5. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? (*See Definitions and Description Section for further Factor detail at the end of Section 1*)

- A. “Parental and Community Support Factor” vs.  
“Media/Social Perception Factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

Degree of Relative Significance	Definition
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 1 Level)

6. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? *(See Definitions and Description Section for further Factor detail at the end of Section 1)*

- A. “Parental Support factor” vs.  
“Community Support factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Parental Support)

7. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? *(See Definitions and Description Section for further Factor detail at the end of Section 1)*

A. “Communicating factor” vs.  
“Decision-Making factor”

B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Parental Support)

8. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? *(See Definitions and Description Section for further Factor detail at the end of Section 1)*

- A. “Communicating factor” vs.  
“Learning At Home factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Parental Support)

9. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant

**a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system

performance and student performance? To what degree of significance exists based on the rating

scale below? *(See Definitions and Description Section for further Factor detail at the end of*

*Section 1)*

A. “Communicating factor” vs.

“Parenting factor”

B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Parental Support)

10. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant

**a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system

performance and student performance? To what degree of significance exists based on the rating

scale below? *(See Definitions and Description Section for further Factor detail at the end of*

*Section 1)*

A. “Communicating factor” vs.

“Volunteering factor”

B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Parental Support)

11. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? *(See Definitions and Description Section for further Factor detail at the end of Section 1)*

- A. “Decision-Making factor” vs.  
“Learning At Home factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Parental Support)

12. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant

**a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system

performance and student performance? To what degree of significance exists based on the rating

scale below? *(See Definitions and Description Section for further Factor detail at the end of*

*Section 1)*

A. “Decision-Making factor” vs.

“Parenting factor”

B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

Degree of Relative Significance	Definition
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)



Question (Sub-model 2 Level Parental Support)

13. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? (*See Definitions and Description Section for further Factor detail at the end of Section 1*)

- A. “Decision-Making factor” vs.  
“Volunteering factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

Degree of Relative Significance	Definition
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Parental Support)

14. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? *(See Definitions and Description Section for further Factor detail at the end of Section 1)*

- A. “Learning At Home factor” vs.  
 “Parenting factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

Degree of Relative Significance	Definition
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Parental Support)

15. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? *(See Definitions and Description Section for further Factor detail at the end of Section 1)*

- A. “Learning At Home factor” vs.  
 “Volunteering factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

Degree of Relative Significance	Definition
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Parental Support)

16. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant

**a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system

performance and student performance? To what degree of significance exists based on the rating

scale below? *(See Definitions and Description Section for further Factor detail at the end of*

*Section 1)*

A. “Parenting factor” vs.

“Volunteering factor”

B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Community Support)

17. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant

**a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system

performance and student performance? To what degree of significance exists based on the rating

scale below? *(See Definitions and Description Section for further Factor detail at the end of*

*Section 1)*

A. “Availability of Appropriated Physical and Financial Resources factor” vs.

“Existing Community Collaborations with Schools factor”

B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Community Support)

18. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? *(See Definitions and Description Section for further Factor detail at the end of Section 1)*

- A. “Availability of Appropriated Physical and Financial Resources factor” vs.  
 “Mentoring Opportunities between Community Orgs. and Administration factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

Degree of Relative Significance	Definition
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Community Support)

19. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? *(See Definitions and Description Section for further Factor detail at the end of Section 1)*

- A. “Availability of Appropriated Physical and Financial Resources factor” vs.  
 “Mentoring Opportunities between Community Orgs. and Students factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

Degree of Relative Significance	Definition
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Community Support)

20. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant

**a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system

performance and student performance? To what degree of significance exists based on the rating

scale below? *(See Definitions and Description Section for further Factor detail at the end of*

*Section 1)*

- A. “Existing Community Collaborations with Schools factor” vs.  
“Mentoring Opportunities between Community Orgs. and Administration factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)



Question (Sub-model 2 Level Community Support)

21. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant **a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system performance and student performance? To what degree of significance exists based on the rating scale below? *(See Definitions and Description Section for further Factor detail at the end of Section 1)*

- A. “Existing Community Collaborations with Schools factor” vs.  
 “Mentoring Opportunities between Community Orgs. and Students factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

Degree of Relative Significance	Definition
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

Question (Sub-model 2 Level Community Support)

22. Which factor of the following pair-wise comparisons is (if perceived to be) a more significant

**a. POSITIVE and b. NEGATIVE** influencer of public educational delivery system

performance and student performance? To what degree of significance exists based on the rating

scale below? *(See Definitions and Description Section for further Factor detail at the end of*

*Section 1)*

- A. “Mentoring Opportunities between Community Orgs. & Administration factor” vs.  
“Mentoring Opportunities between Community Orgs. and Students factor”
- B. Rating: Positive \_\_\_\_\_ Negative \_\_\_\_\_

**Rating Scale**

<b>Degree of Relative Significance</b>	<b>Definition</b>
1	Equal Significance
2	Intermediate Between 1 and 3
3	Weak Significance (Of One Over Other)
4	Intermediate Between 3 and 5
5	Strong Significance (Of One Over Other)
6	Intermediate Between 5 and 7
7	Demonstrated Significance (Over Other)
8	Intermediate Between 7 and 9
9	Absolute Significance (Of One Over Other)

## **(Section 1) Definitions and Descriptions**

### Factors:

#### 1. Early Childhood Education Factor

- Issues that may impact or impede a child's ability to learn be it physical, medical, or mental. Ages 0-4

#### 2. Student Performance Factor

- Examines current student performance and the quality of existing programs and curriculum. For instance do the latest findings and technological discoveries in education improve student performance? Are remedial programs worth the resources?

#### 3. Teacher Performance, Retention, and Pay Factor

- Teacher quality and performance may impact the success of the public educational delivery system. Recruiting and retaining quality teachers is a challenge. Does certification actually make a significant difference in teacher instruction quality? Also salary issues are points of contention.

#### 4. Parental and Community Support Factor

- Is an aggregate of activities in which parent/caregiver engages in that have been scientifically proven to impact student learning and public educational delivery system performance. The scope of this factor is out of the control of teachers and administrators. Also community partnerships with organizations have traditionally provided some positive partnering experiences with educational institutions.

#### 5. Education Management Factor

- What organizational, managerial, and administrative actions impact student performance and achievement? Education administrators are responsible for the efficient operations of the public educational delivery system as a whole. Policy and politics exist at the administrative level. Educational legislative mandates have impacted administrative operations.

## 6. Media/Social Perception Factor

- The media is the major feedback to the public detailing how the public educational delivery system is performing. Biased reporting can skew the perception of how well or not the system is operating. In turn, this perception presented by the media filters from adult to the student. System stakeholders also are impacted by the media.

## 7. Parental

### Sub-model 2 level factors

#### P1. Communicating:

- There is clear and regular communication between home and school

#### P2. Decision Making:

- Parents feel like viable partners in the decision-making process of schools and educational governing

#### P3. Learning At Home:

- Parents promote at home learning activities such as focusing on homework completion and quality

#### P4. Parenting:

- Positive Parenting skills are practiced and supported at home

#### P5. Volunteering:

- Parents feel free and welcomed to volunteer at student's school and do participate

## 8. Community

### Sub-model 2 level factors

#### C1. Availability of Appropriated Physical and Financial Resources:

- Appropriated Physical and Financial resources are accessible to the school in which the evaluated student attends that promote Community involvement

#### C2. Existing Community Collaborations with Schools:

- There exists Community collaborative partnership activities for the student being evaluated, between Community Organizations and the school the student attends

#### C3. Mentoring Opportunities between Community Organizations and Administration:

- There exists mentoring activities for the student being evaluated, between the Community Organizations and the Administration of the school in which the student attends

#### C4. Mentoring Opportunities between Community Organizations and Students:

- There exists mentoring activities for the student being evaluated, between Community Organizations and the student

## ***Section: 2 (Fuzzy Linguistic Level Assignment)***

- Parental and Community Support Factor Sub-models

### **Fuzzy Linguistic Level Rating Scale**

<b>Very Significant (4)</b>	<b>Significant (3)</b>	<b>Moderately Significant (2)</b>	<b>Not Significant (1)</b>
1 - .75	.74 - .50	.49 - .25	.24 - 0

The following sub-model level factors contained within this Section 2 were determined as a result of scientific studies performed by the National PTA (Parent Teacher Association) and the resultant National PTA Standards. Also information from the OCPS Blue Ribbon Panel Final Report (2005) is included as a resource for providing insight for potential areas of interest addressed within the Parental and Community Support Factor and its component sub-models.

### Question (Sub-model 2 Level Parental Support and Community Support)

1. To what degree of existence (determined by the degree of criteria compliance) does the indicated sub-model level factor contribute to **a. POSITIVELY and b. NEGATIVELY** impacting public educational delivery system performance and student performance as observed during this evaluation period? *Note: This evaluation is to be administered on a case-by-case basis by an SME.*

A. P1 Communicating: Communicate with families about school programs and student progress through effective school-to-home and home-to-school communications.

▪ Criteria:

- a) Does the Parent/Caregiver Review Student's Progress Reports? Yes/No
- b) Have the Parent/Caregiver and Teacher had at least 1 face-face meeting about student related issues, i.e. Open House, Parent Teacher Conference? Yes/No
- c) Does the Parent/Caregiver provide periodic feedback of Teacher's performance to the Teacher? Yes/No

*Note: Yes answer indicates Positive Impact/ No answer indicates Negative Impact*

B. P2 Decision-Making: Include families as participants in school decisions, governance, and advocacy through PTA/PTO, school councils, committees, and other parent organizations.

▪ Criteria:

- a) Is the Parent/Caregiver involved in the designated PTA/PTO at the evaluated student's school on a regular basis? Yes/No
- b) Does the Parent/Caregiver attend or observe OCPS School-board meetings via, television or through actual attendance? Yes/No
- c) Does the Parent/Caregiver provide periodic feedback to OCPS via annual survey or other identified feedback methods? Yes/No

*Note: Yes answer indicates Positive Impact/ No answer indicates Negative Impact*

C. P3 Learning At Home: Involve families with their children in learning activities at home, including homework and other curriculum-linked activities and decisions.

▪ Criteria:

- a) Does the Parent/Caregiver provide outside school learning aides such as tutoring and academic related activities for evaluated student? Yes/No
- b) Does the Parent/Caregiver aid in or facilitate learning at home activities such as homework? Yes/No
- c) Does the Parent/Caregiver ensure that the student's homework is completed and prepared in an acceptable manner to be turned in to the Teacher of the evaluated student? Yes/No

*Note: Yes answer indicates Positive Impact/ No answer indicates Negative Impact*

D. P4 Parenting: Assist families with parenting and child-rearing skills, understanding child and adolescent development, and setting home conditions that support children as students at each age and grade level. Assist schools in understanding families.

▪ Criteria:

- a) Does the Parent/Caregiver provide structured and consistent discipline when appropriate? Yes/No
- b) Does the Parent/Caregiver provide a living environment that is minimally conducive as determined by the State of Florida Dept. of Children and Family (DCF) services criteria? Yes/No
- c) Is the Parent/Caregiver aware of how to improve their parenting skills and the resources that will enable improvement of their parenting shortcomings? Yes/No



E. P5 Volunteering: Improve recruitment, training, work, and schedules to involve families as volunteers and audiences at the school or in other locations to support students and school programs.

- Criteria:

- a) Does the Parent/Caregiver participate in volunteering activities such as OCPS ADDitions or school sponsored volunteering? Yes/No
- b) Is the Parent/Caregiver aware of school volunteering activities? Yes/No
- c) Does the Parent/Caregiver feel comfortable, or empowered and encouraged to participate in school volunteering activities? Yes/No

*Note: Yes answer indicates Positive Impact/ No answer indicates Negative Impact*

F. C1 Availability of Appropriated Physical and Financial Resources: The availability of appropriated physical and financial resources is key to the successful implementation of planned community support and involvement activities. Do schools get the needed resources they are entitled to?

- Criteria:

- a) Are there known community support resources that have been allocated to the evaluated student's school via Partnerships and Collaborations? Yes/No
- b) Do the appropriated community support resources reach their intended destination, the evaluated student's school? Yes/No
- c) Are the received community support resources disbursed to the teachers at the evaluated student's school? Yes/No

G. C2 Existing Community Collaborations with Schools: Community partnerships with organizations with area businesses and foundations have been proven to be appreciated sources of needed income that supplement appropriated funds. Not only is the school a benefactor, community organizations have a chance to fulfill their community service commitments. Advertisement and recognition to the public are benefits that the sponsors enjoy as a result of the partnership.

▪ Criteria:

- a) Are the existing community Partnerships and Collaborations maintained and supported by school administration? Yes/No
- b) Are the Partnerships and Collaborations advertised and made known to the Parent/Caregiver of the evaluated student? Yes/No
- c) Have community organizations benefited from existing Partnerships and Collaborations with the evaluated student's school? Yes/No

*Note: Yes answer indicates Positive Impact/ No answer indicates Negative Impact*

H. C3 Mentoring Opportunities between Community Organizations and Administration/

Teachers: School administrators and teachers have a need for professional development and can benefit from a mentoring relationship with administrators of other non-educational based organizations.

- Criteria:
  - a) Do mentoring opportunities exist between Community Organizations and the Administration/Teachers of the evaluated student's school? Yes/No
  - b) Are these mentoring opportunities advertised or made public? Yes/No
  - c) Are these mentoring opportunities funded by the evaluated student's school or other sources? Yes/No

*Note: Yes answer indicates Positive Impact/ No answer indicates Negative Impact*

I. C4 Mentoring Opportunities between Community Organizations and Students: Student life enrichment that may lead to educational achievement can be experienced through community mentoring programs.

- Criteria:
  - a) Do mentoring opportunities exist between Community Organizations and the evaluated student? Yes/No
  - b) Are these mentoring opportunities advertised or made public? Yes/No
  - c) Are these mentoring opportunities funded by the evaluated student's school or other sources? Yes/No

*Note: Yes answer indicates Positive Impact/ No answer indicates Negative Impact*

## **(Section 2) Definitions and Descriptions**

### Factor Sub-model 2 Level

- Parental

1. Communicating: Communicate with families about school programs and student progress through effective school-to home and home-to-school communications.

2. Decision Making: Include families as participants in school decisions, governance, and advocacy through PTA/PTO, school councils, committees, and other parent organizations.

3. Learning At Home: Involve families with their children in learning activities at home, including homework and other curriculum-linked activities and decisions.

4. Parenting: Assist families with parenting and child-rearing skills, understanding child and adolescent development, and setting home conditions that support children as students at each age and grade level. Assist schools in understanding families.

5. Volunteering: Improve recruitment, training, work, and schedules to involve families as volunteers and audiences at the school or in other locations to support students and school programs.

- Community

1. Availability of Appropriated Physical and Financial Resources: The availability of appropriated physical and financial resources is key to the success implementation of planned community support and involvement activities. Do schools get the needed resources they are entitled to?

2. Existing Community Collaborations with Schools: Community partnerships with organizations with area businesses and foundations have been proven to be appreciated sources of needed income that supplemental appropriated funds. Not only is the school a benefactor, community organizations have a chance to fulfill their community service commitments. Advertisement and recognition to the public are benefits that the sponsors enjoy as a result of the partnership.

3. Mentoring Opportunities between Community Organizations and Administration: School administrators have a need for professional development and can benefit from a mentoring relationship with administrators of other non-educational based organizations.

4. Mentoring Opportunities between Community Organizations and Students: Student life enrichment that may lead to educational achievement can be experienced through community mentoring programs.

**APPENDIX C: CURRENT ORANGE DISTRICT (48) FCAT  
PERFORMANCE STATUS 2005**

## CURRENT ORANGE DISTRICT (48) FCAT PERFORMANCE STATUS 2005

The table below provides the percent of students in the district scoring 3 and above in FCAT reading, mathematics, and writing. Students that score in FCAT Achievement Levels 3, 4, and 5 in reading or mathematics are considered on grade level, proficient, or advanced. Students that score 3 and above on FCAT writing have scored at or above a minimally acceptable level. The Florida Comprehensive Assessment Test is based on Florida's curriculum frameworks, the Sunshine State Standards.

<b>District Percent Scoring Three and Above</b>															
Grade Level	Reading					Math					Writing				
	2001	2002	2003	2004	2005	2001	2002	2003	2004	2005	2001	2002	2003	2004	2005
3		52	58	62	<b>65</b>		54	59	59	<b>66</b>					
4	46	49	55	66	<b>70</b>		48	50	61	<b>59</b>	79.0	75.0	90.0	91.0	<b>88.0</b>
5		47	56	54	<b>63</b>	40	42	49	46	<b>53</b>					
6		46	49	53	<b>54</b>		40	44	45	<b>46</b>					
7		44	45	48	<b>55</b>		42	43	45	<b>53</b>					
8	40	41	44	40	<b>42</b>	52	50	52	53	<b>57</b>	83.0	87.0	89.0	88.0	<b>91.0</b>
9		27	29	29	<b>34</b>		45	48	51	<b>56</b>					
10	36	34	34	33	<b>28</b>	59	58	59	61	<b>58</b>	87.0	91.0	89.0	92.0	<b>87.0</b>

The table below provides the district mean Scale Scores in reading and mathematics and the combined mean writing scores for FCAT. The Scale Score is a score used to report test results on the entire test. Scale Scores on the FCAT Sunshine State Standards tests are 100 through 500 for each grade level and content area. A computer program is used to analyze student responses and to compute the Scale Score.

<b>District Mean Scores</b>															
<b>Level</b>	<b>Reading Scores</b>					<b>Math Scores</b>					<b>Writing Scores</b>				
	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>
3	279	282	293	297	<b>301</b>	282	293	303	302	<b>313</b>					
4	287	289	298	313	<b>315</b>	277	288	291	307	<b>305</b>	3.2	3.2	3.6	3.7	<b>3.6</b>
5	268	275	288	287	<b>298</b>	302	307	316	314	<b>323</b>					
6	283	281	287	295	<b>296</b>	283	291	297	299	<b>303</b>					
7	285	287	289	292	<b>301</b>	284	286	288	292	<b>303</b>					
8	290	288	293	287	<b>295</b>	304	301	307	306	<b>310</b>	3.5	3.7	3.8	3.7	<b>3.7</b>
9	284	285	286	290	<b>297</b>	280	284	289	291	<b>296</b>					
10	306	301	302	299	<b>289</b>	322	319	319	321	<b>317</b>	3.7	3.8	3.8	3.8	<b>3.7</b>



## **APPENDIX D: LITERATURE REVIEW MATRIX**

ID	Source Article	Chapter #								Support Evidence For
		1	2	3	4	5	6	7	8	
1	Good Predictors of School FCAT Reading Performance (OCPS Department of Accountability, Research, and Assessment Office of Data Analysis and Reporting .PDF)	x	x		x					FCAT Reading Regression Models
2	How We Know What Isn't So: The Fallibility of Human Reason in Everyday Life, Gilovich Thomas (ISBN: 0029117054)	x			x				x	Why Scientific Research & the De-Politicizing of Public Ed.
3	<a href="http://deming.org">http://deming.org</a> (Quality Guru W.E. Deming)	x	x						x	Quality Resource Philosophy and Latest Findings
4	<a href="http://en.wikipedia.org/wiki/Regression_fallacy">http://en.wikipedia.org/wiki/Regression_fallacy</a> (Causality vs. Correlation)				x				x	Fallacious Logical Reasoning
5	<a href="http://nces.ed.gov">http://nces.ed.gov</a> (National Center for Education Statistics)	x			x	x	x			The US Source for Public Education-Related Data
6	<a href="http://nces.ed.gov//programs/coe/statement/pdf/commissioner_slides.pdf">http://nces.ed.gov//programs/coe/statement/pdf/commissioner_slides.pdf</a> (National Center for Education Statistics The Condition of Education)	x			x	x	x			The Condition of US Public Education Presentation 2004
7	<a href="http://nces.ed.gov/ccd/ccseas.asp">http://nces.ed.gov/ccd/ccseas.asp</a> (All State Education URL Links)	x	x	x		x	x		x	National Education Resource (NCES)
8	<a href="http://nces.ed.gov/ccd/pub_100_largest.asp">http://nces.ed.gov/ccd/pub_100_largest.asp</a> (National Center for Education Statistics 100 Largest School Districts)	x	x			x	x		x	Benchmark Data of the 100 Largest School Districts
9	<a href="http://www.2005summit.org/">http://www.2005summit.org/</a> (National Education Summit on High Schools) Achieve Inc. & National Governors Association	x	x		x	x	x		x	Governors and CEO's Align Secondary Ed. To Industry/Social Needs
10	<a href="http://www.abe.villanova.edu/proc2000/n156.pdf">http://www.abe.villanova.edu/proc2000/n156.pdf</a> (Multicollinearity Discussion)				x					Multicollinearity and Regression Model Bias
11	<a href="http://www.abo.fi/~rfuller/fuzs.html">http://www.abo.fi/~rfuller/fuzs.html</a> (Fuzzy Resources)				x	x	x			Fuzzy Set Theory Resources and Journals
12	<a href="http://www.asq.org">http://www.asq.org</a> (American Society For Quality)	x	x						x	Quality Resource Philosophy and Latest Findings
13	<a href="http://www.asu.edu/educ/eps1/EPRU/documents/EPRU%202002-101/Chapter%2006-Downey-Final.htm">http://www.asu.edu/educ/eps1/EPRU/documents/EPRU%202002-101/Chapter%2006-Downey-Final.htm</a> (ASU Parental Involvement Research)					x			x	Arizona State University Parental Involvement Research EPSL
14	<a href="http://www.blueribbonschools.org/blueribbon/default.htm">http://www.blueribbonschools.org/blueribbon/default.htm</a>	x	x			x			x	OCPS Blue Ribbon Panel Homepage
15	<a href="http://www.blueribbonschools.org/blueribbon/documents/BRPSurveypresentation1.pdf">http://www.blueribbonschools.org/blueribbon/documents/BRPSurveypresentation1.pdf</a>	x	x		x	x			x	OCPS BRP Survey Results Teacher/Administrative
16	<a href="http://www.blueribbonschools.org/blueribbon/Documents/I1-GAP%20Study%20November%206%202002.OCPS.ri.pdf">http://www.blueribbonschools.org/blueribbon/Documents/I1-GAP%20Study%20November%206%202002.OCPS.ri.pdf</a> (Closing the Gap OCPS)	x	x		x	x	x		x	OCPS Closing the Academic Achievement Gap
17	<a href="http://www.blueribbonschools.org/blueribbon/Documents/I2-Gap%20Update%20October%202003.OCPS.ri.pdf">http://www.blueribbonschools.org/blueribbon/Documents/I2-Gap%20Update%20October%202003.OCPS.ri.pdf</a> (OCPS GAP)	x	x		x	x	x			OCPS Academic Achievement Gaps Exists (Presentation)
18	<a href="http://www.cde.ca.gov">http://www.cde.ca.gov</a> (California Dept. Education)				x	x	x		x	Benchmark States With Similar Growth and Demographic Trends
19	<a href="http://www.ed.gov">http://www.ed.gov</a> (suppsvcsguid.doc) (NCLB Supplemental Educational Services)	x	x						x	NCLB Supplemental Educational Services Guide

ID	Source Article	Chapter #								Support Evidence For
		1	2	3	4	5	6	7	8	
20	<a href="http://www.ed.gov/about/offices/list/ies/index.html">http://www.ed.gov/about/offices/list/ies/index.html</a> (Institute of Education Sciences)	x				x			x	The US division of DOE focus on Scientific Research of Programs
21	<a href="http://www.ed.gov/about/overview/fed/10facts/index.html">http://www.ed.gov/about/overview/fed/10facts/index.html</a> (10 Facts of K-12 Education Funding)	x	x						x	US K-12 Education Funding Facts
22	<a href="http://www.ed.gov/legislation/ESEA/Title_I/parinv.html">http://www.ed.gov/legislation/ESEA/Title_I/parinv.html</a> (Parental Involvement ESEATitle I)	x	x			x			x	Outline of Research on Parental Involvement under Title I
23	<a href="http://www.ed.gov/nclb/accountability/state/improvementlists.pdf">http://www.ed.gov/nclb/accountability/state/improvementlists.pdf</a> (Archived Information The Facts About...NCLB Accountability)	x	x						x	NCLB Accountability /State Improvement/ Appropriations
24	<a href="http://www.ed.gov/pubs/FamInvolve/index.html">http://www.ed.gov/pubs/FamInvolve/index.html</a> (Family Involvement In Children's Education)	x				x			x	Successful Local Approaches to Parental Involvement Programs
25	<a href="http://www.epinet.org/content.cfm/books_privatepublic">http://www.epinet.org/content.cfm/books_privatepublic</a> (Can Public Schools Learn from Private Schools?)				x				x	Education Press Release and Findings Research (EPI)
26	<a href="http://www.expertchoice.com/customerservice/ahp.htm">http://www.expertchoice.com/customerservice/ahp.htm</a> (Analytic Hierarchy Process Software)				x	x	x			Analytic Hierarchy Process Assists in Factor Weighting
27	<a href="http://www.firn.edu/doe">http://www.firn.edu/doe</a> (Florida Department of Education)	x	x		x	x	x		x	Florida Dept. of Education
28	<a href="http://www.firn.edu/doe/sas/fcat/pdf/fc_ufr2004.pdf">http://www.firn.edu/doe/sas/fcat/pdf/fc_ufr2004.pdf</a> (Understanding FCAT)			x	x					FCAT & NRT Scores Explained
29	<a href="http://www.firn.edu/doe/sas/fcat/pdf/fcatfact.pdf">http://www.firn.edu/doe/sas/fcat/pdf/fcatfact.pdf</a> (FCAT Fact Sheet)			x	x	x	x			Informative flyer on mitigating FCAT Testing Variation
30	<a href="http://www.hcz.org">http://www.hcz.org</a> (Harlem's Children Zone)	x				x			x	The Impact of Community Support
31	<a href="http://www.iienet.org">http://www.iienet.org</a> (Institute of Industrial Engineers)	x	x	x	x	x	x		x	Industrial Engineering as a partner in Education Reform
32	<a href="http://www.incose.org/practice/whatissystemseng.aspx">http://www.incose.org/practice/whatissystemseng.aspx</a> (International Council on Systems Engineering)		x						x	Systems Engineering ties to Industrial Engineering
33	<a href="http://www.isbe.net">http://www.isbe.net</a> (Snapshot of Illinois School Report Cards Dec. 2004) (Illinois State Board of Education)	x				x	x		x	Benchmark States With Similar Growth and Demographic Trends
34	<a href="http://www.juran.com">http://www.juran.com</a> (Quality Guru J. Juran)	x	x						x	Quality Resource Philosophy and Latest Findings
35	<a href="http://www.myflorida.com/myflorida/government/governorinitiatives/aplusplan/aplusplan_newsarticles.html">http://www.myflorida.com/myflorida/government/governorinitiatives/aplusplan/aplusplan_newsarticles.html</a> (Florida Governor's Office A+ Plan Info.)	x	x			x			x	Florida Education A+ Plan
36	<a href="http://www.ncsl.org/programs/educ/PInvolve.htm">http://www.ncsl.org/programs/educ/PInvolve.htm</a> (National Conference of State Legislatures)	x			x	x	x		x	Parental/Community Involvement Impacts and Resolutions
37	<a href="http://www.nea.org/parents/index.html">http://www.nea.org/parents/index.html</a> (National Education Association)	x				x			x	Parental Involvement Fosters Academic Success

ID	Source Article	Chapter #								Support Evidence For
		1	2	3	4	5	6	7	8	
38	<a href="http://www.nysed.gov">http://www.nysed.gov</a> (New York State Education Department)					x	x		x	Benchmark States With Similar Growth and Demographic Trends
39	<a href="http://www.ocps.k12.fl.us/\$zr1\$6f726095ade51bf0a1071e42e72b36eb\$7baddecc89fb/pdf/at_a_glance.pdf">http://www.ocps.k12.fl.us/\$zr1\$6f726095ade51bf0a1071e42e72b36eb\$7baddecc89fb/pdf/at_a_glance.pdf</a> (OCPS Stat FACTS)	x	x					x		OCPS Statistics and Facts
40	<a href="http://www.parent-institute.com/educator/resources/10things/10things.php">http://www.parent-institute.com/educator/resources/10things/10things.php</a> (The Parent Institute)					x			x	10 Things Any School Can Do to Build Parent Involvement
41	<a href="http://www.philiprosby.com">http://www.philiprosby.com</a> (Quality Guru P. Crosby)	x	x						x	Quality Resource Philosophy and Latest Findings
42	<a href="http://www.projectappleseed.org/chklst.html">http://www.projectappleseed.org/chklst.html</a> (The Parental Involvement Checklist)	x							x	The National Campaign for Public School Improvement
43	<a href="http://www.pta.org">http://www.pta.org</a> (National PTA)					x			x	National Parent Teachers Association Standards
44	<a href="http://www.quality.nist.gov/index.html">http://www.quality.nist.gov/index.html</a> (Baldrige National Quality)	x	x			x			x	Quality Resource Philosophy and Awards bolster Social Acceptance
45	<a href="http://www.tea.state.tx.us">http://www.tea.state.tx.us</a> (Texas Education Agency)				x	x	x		x	Benchmark States With Similar Growth and Demographic Trends
46	<a href="http://www.urbanext.uiuc.edu/succeed/03-stress.html">http://www.urbanext.uiuc.edu/succeed/03-stress.html</a> (Helping Children Succeed in School)								x	General Education Tips (University of Illinois)
47	<a href="http://www.whitehouse.gov/infocus/education/">http://www.whitehouse.gov/infocus/education/</a> (Transforming the Federal Role in Education)	x							x	Education Reform is Needed
48	<a href="http://www.whitehouse.gov/omb/budget/fy2006">http://www.whitehouse.gov/omb/budget/fy2006</a> (US Budget 2006)	x	x						x	The Amount of Appropriations for Education is more than enough
49	<a href="http://www.w-w-c.org/">http://www.w-w-c.org/</a> (What Works Clearinghouse)	x			x				x	Scientific Research and Evidence is Required What Works ?
50	Identifying and Implementing Educational Practices Supported By Rigorous Evidence: User Friendly Guide (U.S. DOE Institute of Education Sciences National Center Education Evaluation and Regional Assistance/Coalition For Evidence-Based Policy)	x	x	x	x	x	x		x	Scientific Research and Evidence is Required What Works ?
51	OCPS Florida A+, US NCLB Adequate Yearly Progress 2004 (.PDF)	x	x						x	Florida NCLB Adequate Yearly Progress is Sluggish
52	Quality is Free The Art of Making Quality Certain, Crosby Philip (ISBN: 0451625854)	x	x						x	Quality Resource Philosophy (defined Quality Approach)
53	Statistics for Engineering and the Sciences 4th ed., Mendenhall W. (ISBN:0023805811)				x					Multicollinearity and Regression Model Bias

ID	Source Article	Chapter #								Support Evidence For	
		1	2	3	4	5	6	7	8		
54	The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation, Saaty T.L. 1980				x	x	x				Analytic Hierarchy Process Assists in Factor Weighting
55	The Expectations Gap, A 50-State Review of High School Graduation Requirements (Achieve Inc.)	x	x							x	A Total Quality Ed. system aligns with Stakeholder expectations
56	The Management and Control of Quality 5th Ed., Evans and Lindsay (ISBN: 0324066805)	x	x	x							Quality Management and Principles
57	McCauley-Bell Fuzzy Rating Scale (FRS) McCauley-Bell, Crumpton, Badiru 1999)				x	x	x			x	Fuzzy Set Theory and Its Usage
58	Savage Inequalities (Kozol, Jonathan )	x	x								Public Education History and Information
59	The Good High School	x	x								Public Education History and Information
60	Amazing Grace (Kozol, Jonathan )	x	x								Public Education History and Information
61	<a href="http://www.microrate.com/ENGLISHsite/PDF/MSMTechnical%20Guide.pdf#search='efficiency%20ratio%20organizational%20performance'">http://www.microrate.com/ENGLISHsite/PDF/MSMTechnical%20Guide.pdf#search='efficiency%20ratio%20organizational%20performance'</a> (Efficiency Ratios)				x						Efficiency Ratio Usage in Business as a Performance Indicator
62	<a href="http://www.ocps.k12.fl.us/\$zr1\$9c7fa7754b1a2ce6683c21040063911e\$4df8c92ad7c0/pageView.rhtml?pageID=47">http://www.ocps.k12.fl.us/\$zr1\$9c7fa7754b1a2ce6683c21040063911e\$4df8c92ad7c0/pageView.rhtml?pageID=47</a> (Academic Achievement)		x								Training System Functional Objectives (OCPS Ends Policies)
63	<a href="http://www.fuzzy-logic.com/">http://www.fuzzy-logic.com/</a>			x	x						Fuzzy Logic Resource (Beginner)
64	Development Of A Comprehensive Quantitative Ergonomic Evaluation Methodology For Bio-Defense Detection Systems (Picciuto Jr. John)		x	x	x	x					Fuzzy Model Methodology and Reliability
65	Using SAS for Item Analysis and Test Construction", Yu, C. (2001) <a href="http://seamonkey.ed.asu.edu/~alex/teaching/assessment/alpha.html">http://seamonkey.ed.asu.edu/~alex/teaching/assessment/alpha.html</a>						x				Model Error and Reliability Rating
66	Coefficient Alpha and the internal structure of test. Psychometrika, 16, 297-334 (Cronbach, L. 1951)			x	x	x	x				Consistency Tests and Reliability
67	Psychometric theory (2nd Ed.) (Nunnally, J.C. 1978)			x	x	x	x				Consistency Tests and Reliability
68	Examination of the biasing properties of Cronbach Coefficient alpha under conditions of varying shapes of data distribution: A Monte Carlo simulation.			x	x						Cronbach Coefficient alpha usage

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