The 90 Minute Math Block

"Putting All the Pieces Together"

An instructional and structured format to heighten the efficacy of elementary and middle school daily math pedagogy

PART 1 of 3

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Executive Summary

In only one school year – regardless of student socioeconomics, it is possible to achieve stellar academic student outcomes in any elementary school. Accelerated academic student success has been consistently replicated and sustained in urban Title 1 elementary schools after implementing a daily stop-gap numeracy program and a spaced repetition (instructional) system. These two systems overcome the following common instructional hurdle primarily associated with Title 1 elementary and middle schools. Curriculum instructional and core resources are specifically designed for grade level instruction; however, a significant percentage of second through sixth grade students possess prior grade level arithmetic skill gaps. These math fact and math processing skill deficiencies impair students' ability to readily engage in current grade level instruction. Consequently, regardless of the core curriculum and the problem solving instructional resource effectiveness, many classroom teachers experience difficulty implementing the adopted curriculum with fidelity in a typical Title 1 classroom. The end result of these issues is consistent substandard student achievement outcomes.

"The 90 Minute Math Block – Putting All the Pieces Together" presents a pedagogical process that overcomes these obstacles, leading to heightened mathematics in both rural and urban Title 1 elementary and middle schools. The 90 minute math block is parsed into four separate sections. The first section of this paper focuses on the academic need and implementation of a differentiated and individualized daily "Stop-Gap" numeracy program. The second part of the 90 minute math block is a 'spaced repetition system (SRS)' – a daily short instructional math skill review prior to beginning the daily core math lesson. These two sections are unique in pedagogical design since they are symbiotically and interactively connected. When both systems are used in conjunction, they dramatically impact classroom instruction and student performance. This white paper has two companion papers that provide a basis in the rationale, background and understanding of these two essential systems. Both the "*Accelerated Math Fact Student Mastery*" and "*Spaced Repetition System (SRS) – Application: General Math Skill Mastery*" are available for immediate download at the website address located in the footer below. The third section of the 'The 90 Minute Math Block' discusses the common instructional elements of the core mathematics lesson; whereas, the last section's content focus is on daily student problem solving prowess using Bridge Resources. After each of the four (4) instructional components of the standard 90 minute math block, there is a brief 'Pragmatic Implementation' to specifically assist educators in the practical execution at their campuses.

The inherent advantage and power of an individualized, differentiated daily numeracy program and a spaced repetition system (SRS) is their independence from an adopted school or district mathematics curriculum. School and district personnel may select any mathematics core program since both the numeracy program and the SRS math components are platform independent. The daily numeracy program and SRS math block components remedy prior skill gap deficiencies as well as ensure grade level skill mastery. Since the core curriculum program is designed for grade level skill instruction, both math components are the underpinnings of core curriculum effectiveness. However, despite the fact that a school or district may select any core mathematics program, there are primary instructional features and pedagogical design to any effective core math lesson. Similarly, there are key attributes to a systemic approach when a rigorous grade level problem solving instructional resource or methodology is implemented. These critical pedagogical factors for both 90 minute math block components are outlined in conceptual and pragmatic detail in this white paper. Finally, due to the recent changes in the Texas Math Standards in 2012, the pedagogical processes outlined in all three white papers are viable and valid for both the Texas Essential Knowledge and Skills (TEKS) and Common Core State Standards (CCSS).

These four (4) components to the standard 90 minute math block are effective in all classroom settings; however, with any pedagogy and instructional resource methodology, there exists an ever-present caveat of efficacy in every classroom. It is imperative that teachers and administrators develop positive relationships with their students as well as maintain both effective student management and daily routines in the classrooms to preserve daily instructional minutes. If these classroom relational dynamics are not nurtured and consistently maintained, the overall efficacy of a successful pedagogical resource and instructional system will be significantly impaired.

Finally, the process and pedagogy presented in this document and both companion white papers have produced two (2) urban Title 1 National Blue Ribbon Schools, and both schools are featured for academic excellence by the United States Department of Education as National Blue Ribbon Profile Schools. Graham Elementary and Blackshear Elementary Fine Arts Academy in the Austin Independent School District (Austin ISD, Texas) have also earned multiple-year Gold Ribbon School (At-Risk Children) awards and a myriad of Texas Education Agency (TEA) high academic performance recognitions.

Qualifying Statement

This white paper entitled "90 Minute Math Block – Putting All the Pieces Together" is part 1 of a 3 part series intended to expound upon improving elementary school mathematics by closing the achievement gap via math skill gaps – both process math skills and the 4 operational math facts. The document also presents all four components of a typical 90 Minute Math Block. However, the other two parts of this series (e.g. Part 2 – "Spaced Repetition System (SRS) – Application: General Math Skill Mastery" and Part 3 – "Accelerated Math Fact Student Mastery") provide specific detail so the described pedagogical process may be completely understood and replicated by interested educators.

It is paramount that students master their arithmetic process math skills(e.g. doubles, halves, even/odds, place value, rounding, computational skills, etc.) and four operational math facts while in elementary school to ensure students possess both a fundamental and foundational skill base that foments a pragmatic command of problem solving applications in their current grade level.

The core math adoption and problem solving instructional resources are independent of the pedagogical process outlined in these three (3) documents. However, if both of these instructional resources are to used to their fullest potential, then effective teaching attributes must be consistently implemented during daily lessons. These common pedagogy traits are presented in detail in this document.

This three part series will assist teachers at any elementary and middle school and achieve heightened academic achievement – regardless of typically challenging Title 1 urban and rural student demographics. It is also important to note that this pedagogical process is valid and viable for the Texas Math - TEKS and Common Core (CC) Standards.

And,

as students enter algebra or geometry classes in middle and high school, their arithmetic math process skills and math fact efficacy are at proficient and mastery levels and do not negatively impact their learning and understanding. If an educator has any questions or suggestions to improve this process, please contact us via the web-site address in the footer. It is our overarching hope and objective that children become more adept mathematics students. If your comments or questions can facilitate the learning process, any and all constructive criticism is highly appreciated and welcome.

Amara 4 Education Writers

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The 90 Minute Math Block

"Putting All the Pieces Together"

In real estate, there is an old adage that states that the most important aspect of a property's value is its "location, location and location." In Title 1 elementary and middle schools, teachers should employ a similar maxim aimed at achieving academic student success: "structure, structure and structure." Organizational structure is imperative to the heightened performance of any entity regardless of the industry. Public schools are not an exception. High levels of schoolwide and classroom structure lead to consistent daily routines and predictability not only in classroom management but in lesson preparation, curricular sequencing and instructional delivery. Analogously, campus administrators should use similar philosophical and pragmatic approaches to organize all campus classrooms and student movements to ensure not only student safety but schoolwide, consistent academic focus as well.

In order for a Title 1 elementary or middle school to achieve heightened and sustained academic mathematics success, a structured block of time must possess effective and efficient daily pedagogical patterns – both horizontally and vertically across grade levels. A standard 90 minute elementary math block should be parsed into four (4) instructional pieces. These individual four (4) components of the math block and their symbiotic interaction determine the overall efficacy of the daily instructional system. If the teaching block composition consists of random and non-sequitur activities from day to day, then instruction will also be haphazard, negatively impacting student outcomes. It is also critically important that a carefully planned and sequenced mathematics instructional block occur each school day throughout the school year.

This document subdivides the <u>daily</u> 90 minute mathematics block into four (4) main program activities: an individualized, differentiated daily numeracy program, a spaced repetition system (SRS) – an instructional methodology for general math skill mastery, the daily core math lesson and a daily word problem solving session using Bridge Resources. Figure 1 below is an illustration of these four (4) instructional elements within a standard 90 minute elementary school math block.

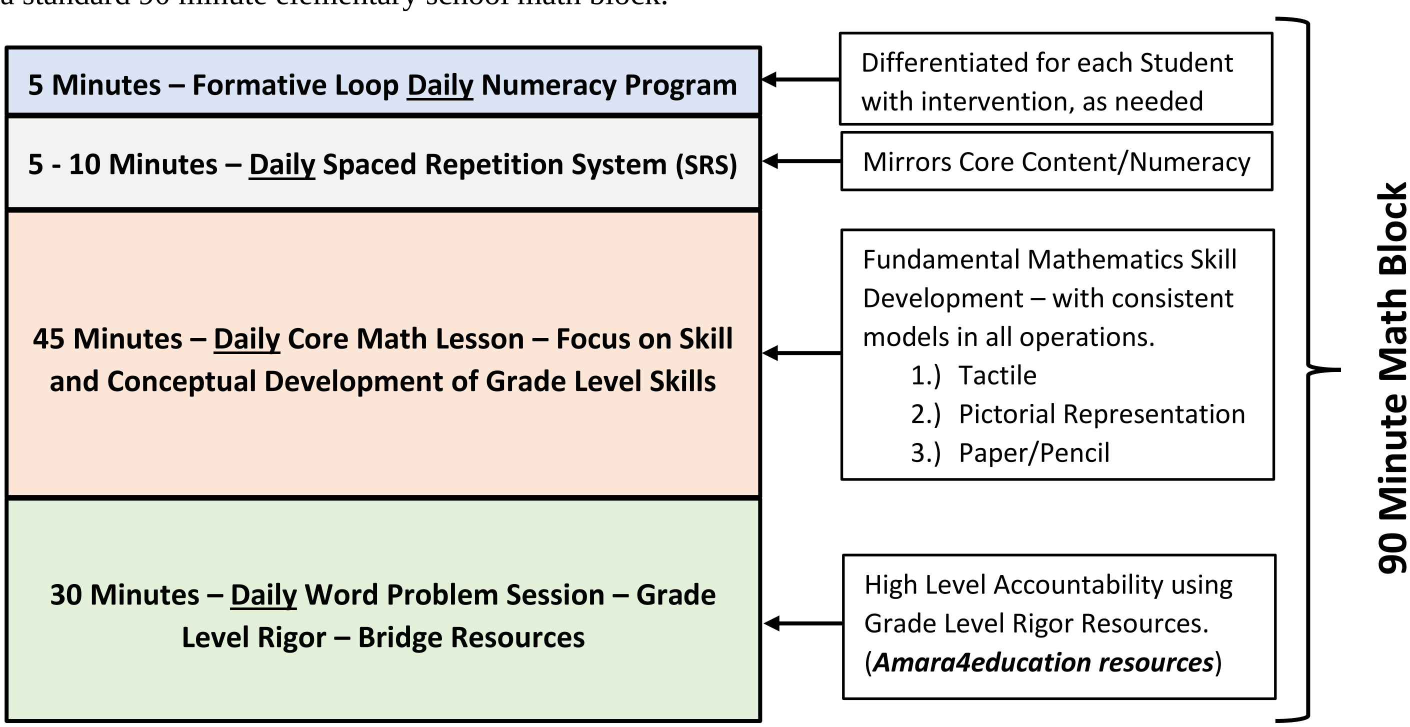
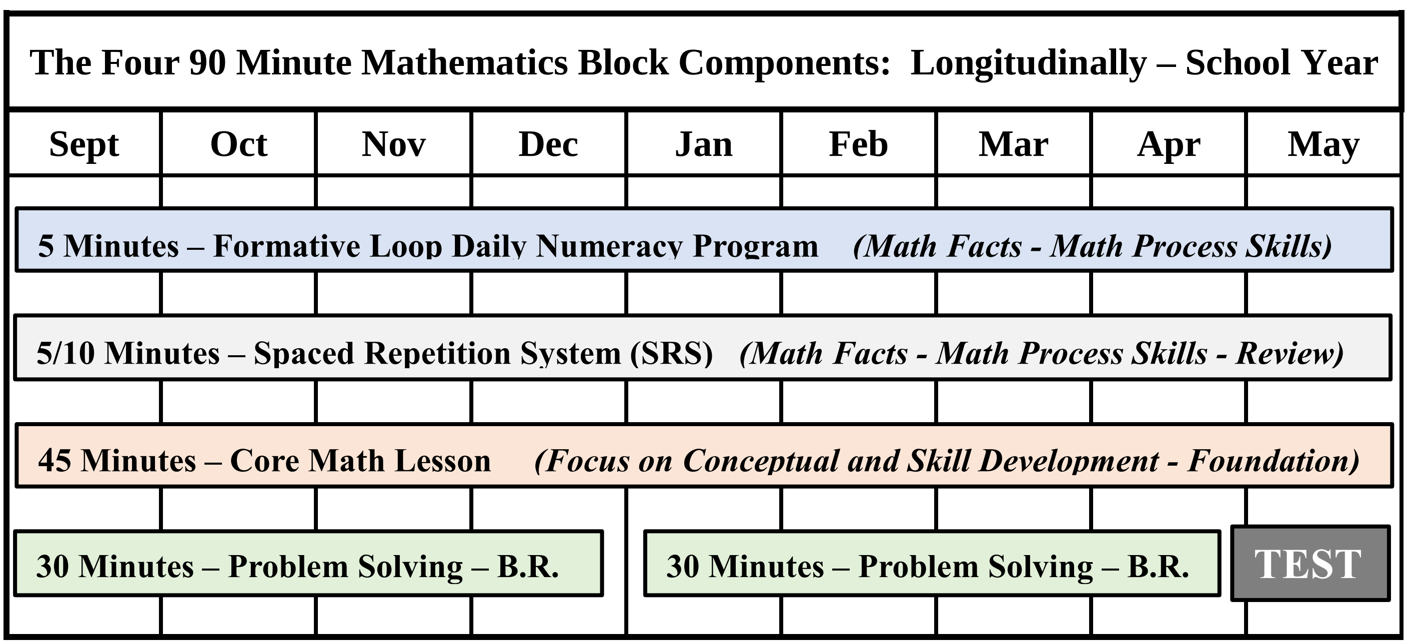


Figure 1: The Four (4) Components of a Standard 90 Minute Math Block

In the next four (4) sections of this document, each of the four (4) instructional components of the 90 minute math block will be discussed singularly in detail. In Section 1, the significant attributes of a daily numeracy program will be presented including its functionality demands, both numeracy and grade level numeracy streaming and the pragmatic schoolwide program implementation. A spaced repetition system (SRS) instructional methodology to ensure general math skill mastery is presented in Section 2. Both sections 1 and 2 are critical to the academic turnaround of Title 1 elementary schools regardless if State Mathematics Standards are aligned to Common Core State Standards (CCSS) or the Texas Essential Knowledge of Skills (TEKS). The tremendous flexibility of these pedagogical resources and methodologies yield heightened mathematics student outcomes independent of the math standards alignment as well as the district's or school's core curriculum adoption and problem solving instructional resources. Despite the independent selections of these two (2) 90 minute math components, both sections 3 and 4 highlight the effective pedagogy practice attributes and the importance of consistent daily routines that should be included in the daily core lesson and the problem solving session using Bridge Resources, respectively.

Figure 2 illustrates the daily interaction of the four (4) daily 90 minute math block components to provide an overarching perspective of the typical academic calendar school year. The standard 90 minute math block structure shown in Figure 1 is repeated each day of the school year. As expected, unit math tests, weekly or biweekly assessments and district/school benchmark testing occurs during the 45 minute core lesson and 30 minute problem solving instructional allotments, when needed.



*B.R. = Bridge Resource

Figure 2: Daily Math Block Four (4) Components – School Year

SECTION 1

Individualized, Differentiated Daily Numeracy Program – 5 to 10 Minutes

Functionality Requirements, Sequencing, Streaming and Blended Digital/Paper-Pencil System

The goal of modern day math classrooms is to equip students to solve everyday math problems. There are many successful approaches to developing problem solving skills. But without a foundation of numeracy, students will not be able to reach their full problem-solving potential. Good problem solving is universally dependent on students' possessing core numeracy skills.

In a way, numerical fluency is like reading fluency. Both are the building blocks of success in reading or mathematics. As is widely known, reading fluency – being able to decode words – impacts reading comprehension. Many language arts teachers have observed students with poor phonetic decoding and sight word recognition skills read so slowly that many times they are unable to understand the very sentence they just read.

Poor numerical fluency has the same negative effect in mathematics. Numerical fluency is the ability to work fluidly with numbers in a variety of mathematical situations. When a child's numerical ability is lacking, they struggle to solve multi-part math problems. Students that are competent and proficient in numeracy possess the ability to hold a multi-part problem in their working memory, use their math skills to resolve each part and solve the problem as a whole.

A daily numeracy program (stop-gap resource) plays an essential role in academic Title 1 school turnaround. Since a high percentage of Title 1 elementary and middle school aged students have NOT mastered prior grade level math skills, a global daily numeracy program is needed that efficiently and effectively addresses and closes students' mathematics academic skill gaps. A numeracy program not only academically accelerates struggling students to grade level, but the individualization aspect of the program presses and challenges on-grade level and gifted students beyond current grade level math standards.

From a pragmatic perspective, the numeracy program must address the four (4) basic operational math facts (e.g. addition, subtraction, multiplication and division) as well as the math process skills (e.g. place value, rounding, computational skills, perimeter, etc.). When the daily differentiated numeracy program and the spaced repetition system (SRS) are used in combination, both instructional systems directly impact numeracy. This symbiotic relationship between these daily two (2) 90 minute math block components is expatiated in great detail in the companion white papers, "Accelerated Math Fact Student Mastery" and "Spaced Repetition System (SRS) – Application: General Math Skill Mastery."

Section 1 – PART A:

Functionality and Fundamental Numeracy Program Requirements

In the last decade, many educational companies and public school districts have attempted to implement various numeracy methodologies to elevate students' mathematical ability, but with limited success. A major reason for this lack of success are overcoming both the internal and external systemic challenges in the pragmatic implementation of an effective and efficient school-wide daily numeracy program. The following six (6) system design stipulations expatiate the functionality demands and differentiated math skill layering issues of a daily numeracy program.

1.) All math curriculum at each grade level beginning in first grade assumes prior, prerequisite numeracy skills have been mastered, and all too often, this is not the case for many students – especially children enrolled in a Title 1 school. Hence, an effective numeracy "Stop-Gap" program must be streamlined to include the paramount math skills from prior grade levels, and the parallel sequencing of specific numeracy skills with respect to a Bloom's Taxonomy hierarchy to ensure student readiness for subsequent skills.
2.) Students must have the ability to progress at different rates through grade level numeracy sequencing; consequently, an efficient numeracy program must afford every student the ability to proceed independently. This system requirement dictates numeracy skill differentiation throughout the daily

program. In short, in a typical classroom on any given day, every student may be on a different numeracy skill that addresses each student's current skill-level need.

3.) The numeracy program must also be scalable to varying school enrollments, but the daily numeracy system and student delivery implementation must be efficient and effective since instructional minutes must be preserved.
4.) Each student daily numeracy assessment must be graded, recorded and tracked. The pragmatic aspect of the program requires the daily tracking of each student's performance and skill level in every classroom in the school or district. The only effectual means to accomplish this repetitive daily task is to use an electronic system possessing high-end computer programming and digital monitoring.
5.) The numeracy program must be simply designed so that any classroom educator – regardless of the number of years of teaching experience – can operate the daily program with efficacy. It should be noted that public education is a unique professional field when it comes to entry-level work assignments. There are no entry-level teaching assignments with regard to responsibility. A first-year teacher is given the exact same teaching assignment as that of a seasoned teacher with double-digit years of experience in an adjacent classroom.
6.) A numeracy system must be a foundational platform that provides numeracy support independent of the adopted school or district curricular math program. Consequently, a numeracy system must augment the classroom's curriculum and simultaneously strengthen the classroom teacher's daily core math lessons, ultimately increasing the overall efficacy and mathematics performance of their students.

Each of these six (6) numeracy program requirements must be directly addressed in order to develop a highly functional, pragmatic, and replicable numeracy system. However, with the latest mathematics standard adoption in Texas in 2012, the current Texas Essential Knowledge and Skills (TEKS) and the Common Core (CC) math standards are very closely aligned. Consequently, an individualized, differentiated numeracy "Stop-Gap" program is a viable mathematics tool in almost every elementary or middle school in the United States.

Section 1 – PART B:

Numeracy Skill Sequencing – Elementary Grades 1 - 5

Basic numeracy skills in an elementary school can be separated into nine (9) main areas. Those fundamental areas establish a layering of arithmetic dependent math skills. If and only if students possess a rudimentary numeracy foundation, they are capable to successfully navigate successive, dependent numeracy skills. Put simply, a student must master specific math skills to efficaciously engage a dependent skill. For example, a third grade student must possess mental fixity of a whole number's physical location on a number line and place value number sense/understanding to correctly sequence a given set of whole numbers in ascending or descending order as well as correctly 'round' whole numbers to specific value. Another numeracy layering example occurs when intermediate elementary grade level students require math fact competency to efficiently compute sums, differences, products and quotients of multi-digit numbers.

In the elementary school years, the grade level numeracy sequencing of the most basic nine (9) numeracy areas are vertically ordered (e.g. hierarchal) by grade level in Figure 3. Although the same numeracy skill area is listed in different grade levels, the specific math standard for that grade level is more rigorous in comparison. For instance, place value is a common area listed in all five elementary grades; however, the math standards requirements for whole number place value expansion and the inclusion of decimal place value in fifth grade is significantly different than math standard student expectations for third grade. With few exceptions, these nine (9) skill areas represent the foundation for elementary level arithmetic numeracy. Invariably, other math processing skills build upon these basic numeracy skills.

Geometry math skills like perimeter, area and volume are highly dependent on student mastery of these nine (9) rudimentary math facts and math processing skill areas. Those geometric skills are pragmatic extensions of addition and multiplication math facts and associated computational skills. Additionally, it is important to note that measurement skills – using customary and metric rulers are not included in this initial list for similar reasons. This exclusion is due to the necessary student mathematics foundational proficiency of basic fractions and decimal understanding as well as number lines (e.g. whole number and fractional forms) to fully understand the composition of metric and customary measurement tools. In effect, student mastery of fundamental grade level numeracy skills is essential if mathematics proficiency of dependent math processing skills and problem solving applications can be realized.

Fundamental Grade Level Numeracy Sequencing – The Essential Nine (9) Areas				
Grade 1	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
Basic Whole Number Concepts	Place Value	Whole Number Lines	Place Value	Place Value
Place Value	Math Facts (+/-)	Generating Multiples (1-12)	Multiples (1-12) & Multiples (10-100)	Multiples (1-12) & Multiples (10-100)
Multiple Strings	Multiples (1, 2, 10, 5)	Place Value	Math Facts (all 4)	Math Facts (all 4)
Whole Number (WN) Lines	Whole Number (WN) Lines	Math Facts (all 4)	Rounding Whole Numbers (WN)	Rounding WN & Decimals
Math Facts (+/-)	Doubles/Halves	Rounding Whole Numbers (WN)	Computational Skills - Algorithm	Computational Skills - Algorithm
Doubles/Halves	Ordering & Comparing Numbers	Computational Skills - Algorithm	Fractions	Fractions
Ordering/Comparing Shapes & Numbers	Fraction Concepts	Basic Fractions	Decimals	Decimals
Fraction Concepts	Time & Money	Basic Decimals	Fraction-Decimal Number Lines	Fraction-Decimal Number Lines
Mathematics Vocabulary	Mathematics Vocabulary	Mathematics Vocabulary	Mathematics Vocabulary	Mathematics Vocabulary

Figure 3: The Essential Nine (9) Numeracy Areas – by Elementary Grade Level

Section 1 – PART 3:

Longitudinal Numeracy Streaming - Elementary and Middle School Grades – Formative Loop

Both math facts and math process skills must be mastered at designated proficiency levels if students are to develop grade level problem solving application skills. The student objective with the daily numeracy plan is to efficiently and effectively **verify student mastery** of a math skill that was previously taught during the core math lesson – as well as **identifying and remedying** any fundamental math skill deficiency from a prior grade.

The preponderance of individual numeracy skills on each grade level as well as the six (6) functionality numeracy requirements previously identified create an arduous daily organizational task for any classroom teacher. Fortunately, the differentiation, sequencing, tracking, monitoring and organization is no longer a viable problem. The Formative Loop Numeracy Program (Grades 1 through 8) is an individualized, differentiated numeracy program that utilizes a five (5) minute paper-pencil assessment with a digital tracking, monitoring and numeracy skill distribution system. Formative Loop offers different combinations of longitudinal numeracy streaming. Figure 4 provides the numeracy streaming options for grades 1 through 8.

The Formative Loop numeracy loop streams (e.g. single streaming or double streaming) may appear confusing, but they are not. The numeracy streams afford school personnel the ability to select different implementation numeracy options. The options provide flexibility, philosophy, academic need and personnel decisions to select a numeracy streaming that best fits their campus' mathematics' needs. For example, school personnel may select in grade 3 – a double streaming option of both separate numeracy sequencing of both math facts and math process skills to ensure that third grade students parallel both skills simultaneously. Of course, this requires two (2) daily five (5) minute student assessments in lieu of the single streaming option of a single five (5) minute daily assessment in 3^{rd} grade when the two skill areas are both sequenced simultaneously. In a single streaming option, students do not progress as quickly through the numeracy program as when the math facts and the math processing skills are individually assessed.

Formative Loop Numeracy Streaming Options (1^{st} – 8^{th} Grade)

Grade Level	Single Streaming – Math Fact and Math Process Skills Option	Double Streaming – Only Math Process Skills Option (Math Fact Only Option used in Conjunction)	Math Fact Only Option	Companion White Papers Applicability
1	X			Ώ
2	X			Ώ
3	X	X	X	Ώ , β
4	X		X	Ώ , β
5	X		X	Ώ , β
6	X		X	Ώ , β
7	X		X	Ώ , β
8	X		X	Ώ , β

Figure 4: Formative Loop Numeracy Streaming Options – by Grade Level

Ώ references the companion white paper: "*Spaced Repetition System (SRS) – General Math Skill Mastery*"

β references the companion white paper: "*Accelerated Math Fact Student Mastery*"

Part 3A.) *1^{st} and 2^{nd} Grade Numeracy Streaming*

With the exception of first and second grades, all other grade levels have two (2) numeracy streaming options. First and second grades must implement a ***single streaming numeracy*** of combined both math facts (addition and subtraction) and grade level processing math skills (place value, multiples, ordering and comparing numbers, whole number lines, etc.). Hence, each class day, a first or second grade classroom teacher would distribute one (1) five (5) minute numeracy paper assessment – either a math fact or a math processing skill depending upon a student's location in that numeracy stream. The numeracy assessments would be collected and ordered in numerical student order (including any absent student), graded and quickly entered in the Formative Loop digital system as either 'Pass (P) or Fail (F). The Formative Loop numeracy digital program keeps track of all the results, and moves the child to the next numeracy skill in the sequence if they

Passed (P) or the student would take a different version of the same assessment the next day if they were not successful - Failed (F). If the student who was not successful required an intervention or assistance, the teacher or faculty member would help the child rectify their mathematical misunderstanding. In either case – Pass (P) or Fail (F) on the daily assessment, the next day five (5) minute numeracy assessment and related homework is automatically printed out in sequential order on a printer or Xerox copy machine.

Part 3B.) *3rd Grade Numeracy Streaming Options*

If the child is in the third grade, school personnel may decide to select one of two different numeracy sequencing possibilities. They may select the same option as a first or second grade teacher is using – a ***single streaming numeracy*** consisting of both math facts and math process skills. A daily (5) minute assessment is proctored each day, checked and the results are entered into the Formative Loop Numeracy digital interface. Based on the student's results (pass – P or fail – F), the 3rd grade teacher makes the same intervention decisions as would a first or second grade teacher described above.

However, the teacher or campus administration may decide in implementing the other option – ***double streaming numeracy***. In this case, the teacher provides each student with two (2) five (5) minute numeracy assessments each day. As detailed above, both assessments sheets are checked, entered into the Formative Loop Numeracy Program's digital interface as either Pass (P) or Fail (F) – and repeat the process as previously described. When a student has passed all of their math facts, they would have only one (1) five minute daily assessment – a math process skill (e.g. place value, making 10, multiples, rounding, etc.)

The ***double streaming numeracy*** option is commonly selected since students may become mired down in math facts, and they do not progress as quickly as in their math processing skills. However, if two (2) – five (5) minute (e.g. 10 minutes total) numeracy assessments are implemented each day, students progress through both their math facts and math processing skills, simultaneously.

Regardless if the ***single streaming numeracy*** or ***double streaming numeracy*** option is selected, the symbiotic interaction of the spaced repetition system and the Formative Loop Numeracy Program is a viable pedagogical option. This process accelerates elementary and middle school students toward math fact mastery beginning in third (3rd) grade. This process is laid out in detail in a companion white paper to this document entitled, "*Accelerated Math Fact Student Mastery*." That paper is available for immediate download on the website address in the footer. Finally, if third grade students master their four (4) math facts and process math skills – in effect, students possess general math skill mastery – as students enter the fourth and fifth grades, teachers are able to focus more instructional time on reading, writing and science since students are capable to readily engage in grade level curriculum.

Part 3C.) *4th – 8th Grade Numeracy Streaming Options*

These grade levels are given only the ***single streaming numeracy*** option; hence, both math facts and math processing skills are included in the same numeracy stream. There are sound pedagogical reasons for this type of numeracy sequencing. First, if there was a full numeracy focus during the students' while in 3rd grade, the vast majority of the incoming 4th grade students previously mastered all four (4) math fact operations; hence, these students successfully 'pass' their mixed assessments in **all** four (4) math fact operations in the first school week of fourth (and fifth grade). Hence, that large group of students immediately continue to build his or her math process skills (place value, rounding, multiples, etc.) foundation required at that grade level. Consequently, within the first 5 to 7 days after the first day of school, they are not mired down in their math facts. Second, newly enrolled students or students that did NOT master their math fact skills during their third grade school year, teachers have a viable numeracy option. Those students can be placed in a ***math fact ONLY numeracy sequence*** and skipped in the Formative Loop single numeracy stream to the beginning of math processing skills. Those students are able to academically 'catch-up' on their math fact proficiency and simultaneously build their math processing skills prowess each day in parallel with their peers. Of course, this methodology requires two five (5) minute assessments each day for those select students. But, using the Formative Loop digital tracking process, it is not an arduous task for the classroom teacher or daily grader with two (2) numeracy assessments for that small group of students. However, if it is the first year of initiating a daily numeracy program at a school, the administration may opt to decide to implement two (2) daily numeracy assessments for ALL 4^{th} and 5^{th} grade students. It is almost guaranteed that the vast majority of students – whether the school is classified as Title 1 or not – do NOT possess math fact competency. The first year of front-end loading a dual numeracy assessment in both 4^{th} and 5^{th} grade can be taxing. Of course, it is only one school year of focused effort – and in the end analysis, school and district personnel must make those decisions with regard to their students' educational needs.

Section 1 – PART 4:

Using a Blended Digital System and Paper-Pencil 5 Minute Assessments

The implementation of an effective numeracy program must address the six (6) functional requirements listed above to develop a highly functional, pragmatic, and replicable numeracy system. These six (6) functionality constraints in conjunction with as many as a thousand five (5) minute numeracy assessments distributed every school day necessitates a digital tracking system.

The blending of a paper assessment with a digital conduit has distinct advantages. First, every student does not require direct access to be on a computer for only five minutes per day. Second, the daily assessment can be run at any time of the day without travel to a computer lab. Third, a teacher can quickly diagnostically examine each child's sheet and forensically evaluate common student math skill misconceptions – a quick and effective intervention. Lastly, students can be grouped for interventions in common skill misunderstandings – for instance, all students requiring an even/odd number intervention or an expanded place value expansion intervention, etc.

The Formative Loop Numeracy Program affords two different methods to grade and record the daily student work. Both methods require completed student numeracy sheets to be individually graded each morning; however, this is a relatively easy task since most practice sheets are not that complicated to quickly review for accuracy – and there is an associated answer key for each numeracy sheet as the grader selects 'passed' versus 'not passed' for each completed student numeracy assessment. Additionally, there is a 'solid black star' on each answer key that indicates a recommended level of student mastery; however, each teacher or grader should individualize for their students if special learning circumstances are present.

Again, the student assessments may be graded using two different methodologies. One way this can be accomplished is when each teacher quickly grades and records "Pass or Not Passed" in the Formative Loop program. The other means to grade and record the student sheets is using outside classroom support personnel (e.g. math coach, clerk, teaching assistant, etc.). Each methodology has its advantages.

The advantages if a **teacher grades and records** the daily numeracy assessments are the following:

1.) Flexibility with the daily classroom schedule as to when the process is started and completed.
2.) The teacher has intimate knowledge of individual student academic and social needs in their classroom.
3.) Interventions conducted, as needed, at convenient transition times or during independent work times.

The advantages of employing **outside classroom support** (e.g. clerks, math specialists, counselors, parent support specialists, school volunteers, administrators) **to grade and record** the student assessments as opposed to the classroom teacher completing the work are the following:

1.) Eliminates the need of classroom teacher using their planning time or instructional time to grade and record daily student numeracy work. Note: A student collates the assessments in numerical order including any absent student (blank) assessments.
2.) Overall high quality controls of the numeracy program regardless of the number of teachers or student enrollment. A global systematic and standardized process for the program is established for the entire school for all grades and all teachers. Note: It is beneficial to have the same person grade the same grade level or classes each day. The grader slowly learns each students' academic patterns.
3.) There is no break of the daily classroom numeracy routine if the classroom teacher is absent – the numeracy program is consistently implemented on a daily basis.
4.) If the same person grades and records each day, all children are held to the same mastery standard and quality of work for an entire grade level regardless of student enrollment size or the number of classroom teachers.
5.) The school's administration has a much higher confidence level of a consistent standard for individual student performance since the grading and recording is completed external to the classroom, affording less grading variations.
6.) All student numeracy assessment papers that **require an intervention** should be rotated at ninety (90) degrees from other student assessments, so they are easily and readily identified. Student interventions can be completed in any number of combinations. Either classroom teachers, support personnel or a combination of folks can complete student interventions, as needed. However, if a child is not understanding place value expansion, for example, it is imperative that the student receives immediate corrective feedback, or they will continue to lack proficiency on that math skill day-after-day.

Differentiated Formative Loop Daily Numeracy Program

Pragmatic Implementation Steps

1.) ***Select the numeracy sequencing:*** Single **or** Double Streaming beginning in third grade.

2.) ***After contacting Formative Loop:*** Enter teacher/student names, link computers used for inputting to a printer or copier to sequentially print homework and five (5) minute daily numeracy assessments.

3.) ***Decide who grades and inputs the five (5) minute daily numeracy assessments:*** Classroom Teachers or Outside Classroom Support Personnel.

4.) ***Determine who conducts student interventions, as needed:*** Classroom Teachers or Support Personnel – or possible a combination of the two faculty groups.

5.) ***Set-up school-wide and classroom systems:*** Daily numeracy student assessment distribution and active monitoring during classroom daily five (5) minute assessments; Digitally monitoring individual student and adjacent classroom progress via Formative Loop student data and digital reports; Pressing and encouraging students to succeed; and, Recognizing student accomplishments – math fact driver license incentive or alternative incentive program!

6.) ***Incorporate a Spaced Repetition System (SRS) into 2nd grade through 5th grade classrooms:*** Read companion white papers on spaced repetition and math fact mastery – implement symbiotic instructional system to heighten student academic performance.

The daily numeracy process has produced a proven results-based system that affords classroom teachers the ability to systematically address their students' numeracy needs. It is essential that the program be implemented **every** school day, and that the principal is involved in the program – supporting and monitoring student progress. Frequently, the daily five (5) minute numeracy assessment or two (2) five (5) minute daily assessments are completed at the onset of the school day. In doing so, the math block instructional minutes are preserved and there is additional time to check and record student assessments. Finally, if the five (5) minute daily numeracy assessment indicates the child does not possess skill proficiency, an intervention usually remedies the math skill deficiency. If a sufficient number of students demonstrate a lack of understanding in a specific math skill area, the classroom teacher should consider the inclusion of that math skill into the daily spaced repetition system (SRS) sequencing to ensure more frequented exposure and guarantee student retention.

SECTION 2

Spaced Repetition System (SRS) – 5 to 10 Minutes

Instructional Methodology – Daily

A Spaced Repetition System (SRS) is a powerful pedagogical tool that ensures student mastery of content skills in writing – grammar, vocabulary, geography, science and mathematics. It affords classroom teachers with a highly efficient process using a variety of formats. In as little as 5-10 minutes per day in a standard 90 minute mathematics or core curriculum block, a teacher is capable of presenting both prior and current grade level skills over consecutive days until students repeated daily practice results in ingraining the skill, long-term.

Academic research supporting Spaced Repetition System (SRS) has been conducted since the late 1900's. Although its use in public education and daily curriculum design appears most often in the form of spiraled curricular instructional resources, there are additional direct teach methodologies that stress brief and repeated exposure over several class days that increase content retention for children and adults alike. However, there are noteworthy advantages of using both a daily individualized, differentiated numeracy program in conjunction with a daily instructional spaced repetition system (SRS). First, children are accelerated back to grade level since math skill gaps are rapidly closed. These skill gaps surface and are readily apparent when children of color and children of poverty are assessed on standardized text and their academic performance is compared directly with their more affluent peers. In short, the skill gaps foment cumulatively into an achievement gap. Second, all curricular resources are designed for specific grade level skills and math standards; hence, using both differentiated numeracy program and the SRS instructional approach, students are pressed back to grade level academic understanding.

These two (2) 90 minute math block components also affect the core lessons and problem solving sessions in several ways. Students readily understand daily core lesson content as the grade level curricular resource was originally designed and created. Since teachers are much more pedagogically effective in their classrooms, professional frustration and faculty turnover at typically challenging Title 1 schools is reduced. Additionally, due to the simplicity of these two (2) systems, teachers of any experience level are capable of implementing both math block components with high efficacy. Finally, both math components not only afford schools and districts absolute independence in selecting core math adoptions, but those systems are so fundamentally based that they are **independent** of either Common Core (CC) or the Texas Essential Knowledge and Skills (TEKS) math standards.

In order to fully realize the advantage of SRS mathematics process skill and math fact learning objectives, there must be a consistent, deliberate and intentional practice session during each 90 minute mathematics block – see Figure 1 on page 1 of this document. The 90 Minute Math Block companion white paper, "*Spaced Repetition System (SRS) – Application: General Math Skill Mastery*," part two of this three part series delves into the benefits of this methodology. Using both Spaced Repetition pedagogy and the Formative Loop Numeracy Program, students rapidly acquire mastery level proficiency of their four (4) math fact operations and math processing skills. That symbiotic pedagogical process for rapid math fact proficiency is described in detail in the "*Accelerated Math Fact Student Mastery*" white paper. Both of these documents had a dual design purpose. They are designed as standalone pedagogy papers as well as companion white papers to "*The 90 Minute Math Block – Putting All the Pieces Together*." All documents are available for immediate PDF downloaded at the website address located in the footer below.

Spaced Repetition System (SRS) – General Math Skill Mastery

Pragmatic Implementation Steps

1.) ***Read both companion white papers:*** Available for immediate download on the website address in the footer, under "Expertise" tab.

2.) ***Prepare a 'Scope and Sequence' of current math grade level skills:*** List both math processing skills (i.e. even/odd numbers, place value, multiples, etc.) and math fact (i.e. addition, subtraction, multiplication and division single digit facts) resource sheets for current grade level. Recommend using the scope and sequence available in Formative Loop Resource Library and core math adoption to initiate list.

3.) ***Review Formative Loop Numeracy math skill sequencing:*** Add prior grade level math skills to the List in step 2.) above.

4.) ***Select SRS options:*** Implement system with paper-pencil, white boards or in combination using a physical paper math warm-up.

SECTION 3

Core Mathematics Lesson – 45 Minutes

Common and Effective Lesson Attributes

There are general traits and commonalities in all forty-five (45) minute daily core math lessons that significantly impact its efficacy. First, the core math lesson should be conceptually driven and instructionally designed with strong math skill base learning. Generally speaking, both arithmetic design and student learning should always be based on the following instructional sequence: tactile, pictorial representation, and then, paper-pencil. As expected, the learning process begins with a hands-on concrete manipulative and transitions to an abstract one. Developmentally speaking, elementary-aged children require a concrete to abstract learning approach when taught math concepts that they have not previously encountered. Of course, students can memorize the abstract paper and pencil mathematics, but the conceptual question remains, *"Do students understand the physical model that the paper-pencil math calculations represent?"* This reflective pedagogical question can only be answered if students are capable of explaining their solution through a correctly worded written response or by drawing a pictorial representation of their solution.

A common pedagogical mistake of entry-level teachers is to begin every core lesson with a tactile manipulative regardless of context or skill. Core lesson content and design is highly dependent on the instructional circumstances. If the mathematical concept being presented is new to students, then a tactile manipulative is always the place to begin the core lessons. For example, in the primary grades, if basic addition and subtraction are new concepts to students, it is advisable to start with a tactile manipulative and transition to a pictorial representation using a whole number line and student drawn pictures. After student understanding is demonstrated, the teacher may transition to paper-pencil math computations. Revisit the tactile manipulative as needed, but it is highly recommended that concepts are spirally reviewed in periodic intervals throughout the school year with pictorial representation models for both addition and subtraction to ingrain the physical meaning of each.

If the mathematical situation is not new to students and the math concept is presented as a spiral review, then it is usually not necessary to use the manipulative. The lesson may begin with the pictorial representation of the math concept. For example, if a third grade teacher introduces basic addition and subtraction concepts previously learned from the primary grades, the teacher may begin with pictorial representation models and transition to paper-pencil as students demonstrate physical understanding mastery. Finally, core lesson closures should always assess the skill lesson objective or concept to ensure what was taught – was indeed learned. Recently taught grade level skills should be included in the daily numeracy listing of the Spaced Repetition System (SRS) to ensure each math skill is mastered – over time. It is also recommended to review the major topics in the scope and sequence of grade levels prior to your current teaching assignment; this process will assist new teachers in determining the grade level when specific math content was first introduced. Of course, if students are struggling to understand a concept either pictorially or via paper-pencil computations, it is helpful to reintroduce tactile instruction regardless of the grade level the math concept was first introduced.

Additionally, the Formative Loop differentiated numeracy program provides the student mastery verification for both the pictorial paper representation and paper-pencil learning in a daily five (5) minute assessment. Hence, two of the three learning modes are embedded within the daily numeracy sequencing, and teachers are assured that previously taught mathematical concepts and skills were retained. Simply put, there is an important redundant confirmation of skill mastery of content taught in the core lessons.

The overarching benefits of a mathematics system that possesses inherent flexibility to permit school select any core curriculum adoption is powerful. If classroom teachers are structured in their daily classroom routines and student management as well as implementing the first two components of the 90 minute math block each day, heightened student achievement outcomes will be realized. Another flexible feature of this four (4) component 90 minute block is that the classroom teacher may opt to switch the sequencing of the thirty (30) minute problem solving session and the forty-five (45) minute core math lesson. The teacher may prefer to introduce the problem solving component first and then end the lesson with the core math lesson. This is a common instructional practice since it is often easier for a teacher to control the length of the core math lesson than a daily word problem solving session.

In conclusion, the core curriculum adoption may be selected based on philosophical curriculum opinions of school and district officials. However, the general format of daily lessons should always follow a concrete to abstract sequencing, and the core lessons must focus on both math conceptual development and skill base practice. It is heightened numeracy skill proficiency that foments problem solving efficacy.

Core Math Lesson – Common and Effective Lesson Attributes

Pragmatic Implementation Steps

1.) ***Select Core Math Program:*** District or school personnel choice based on student need or mathematics philosophy.

2.) ***Core Math Program Sequencing:*** Classroom teachers should review the math adoption skill sequencing. Process math skill sequencing should closely correlate to daily numeracy program and spaced repetition system (SRS). Note: All core programs generally begin with place value, etc.

3.) ***Lesson Plan Design:*** Teacher created or District/Vendor scripted lesson plans – the lesson plans should be sequentially designed with a focused content on concept and skill base development. Lesson design should follow a manipulative, pictorial, paper-pencil methodology to ensure student physical understanding of the arithmetic computations on all newly presented math concepts.

4.) ***Lesson Closure:*** All daily lessons should have a closure that quickly assesses that the content of the lesson was understood. Closure can vary from oral to written – quick comprehension assessment to ensure student learning and students demonstrate proficiency to progress to next sequential progression of skill level or development.

SECTION 4

Daily Word Problem Solving Session – 30 Minutes *(Bridge Resources)*

Benefits and Pragmatic Implementation Guidelines for Grade Level Rigor

Similar to the independent selection of the adopted core lesson curriculum, the daily instructional problem solving resources are also an agnostic selection decision in the standard 90 minute math block. However, as with the daily core math lesson, there are common implementation strategies regardless of the chosen problem solving resource that significantly impact its overall efficacy.

The daily teaching of math word problems is essential if students are to become adept problem solvers. The consistency of a daily routine has a critical emotional benefit and builds student confidence to the daily learning as well as the more apparent academic aspect. There is a white paper devoted to this topic entitled, "*Accelerated Student Achievement in American Title 1 Elementary Schools, 'Stop-Gap and Bridge Resources' – Part 2 of 2."* That paper is available for free download at the website address located in this document's footer.

Section 4 – PART 1:

Six (6) Benefits of Daily Math Word Problem Practice

1.) Application of a core skill based curriculum – discrete skills presented in a real world scenario.
2.) Repeated practice of specific content (e.g. area or volume) establishes mastery and retention.
3.) Embedded discrete math skills in word problems are practiced securing endemic mastery.
4.) Provides young students with perspective, rationale and importance in learning discrete math skills.
5.) Student confidence and self-esteem are heightened as word problems are readily solved accurately and independently.

6.) Establishes elementary students a foundation in developmental critical thinking in preparation for more difficult algebraic and geometric level mathematics.

Beginning in third grade, if students practice 4 to 8 math ‘word’ problems with accountability every day, they will be surprisingly adept problem solvers in only four to six weeks. Equally important, students develop the true nature of problem solving efficacy without realizing it. For example, as expected, students master solving a specific content word problem with associated practice, but they are also able to apply that learned solution technique to derivative problems and solve those problems as well. This type of problem solving mastery is an implicit developmental goal of all teachers at any level, and when provided a daily diet of math word problems, elementary students naturally develop this ability. However, teachers must provide deliberate instruction for students to develop good problem solving skills. As with their students’ developmental learning, pedagogy mastery is attained via consistent daily practice – teaching utilizing an effective and consistent instructional methodology.

Section 4 – PART 2:

Five (5) Basic Pedagogy Traits Needed in Developing Students’ Problem Solving Abilities

1.) Provide 4 to 8 word problems (Standards based) per day – teacher/school/district constructed or via a commercial vendor (i.e. Bridge Resources – Fall and Spring Semesters). Examples of a high quality daily grade level rigor product in both Texas and Common Core are ‘Daily Rigor’ for the fall semester, and ‘Countdown to STAAR’ for the spring semester. Both products are available from the vendor, Mathwarm-ups.com. Additionally, Formative Loop also provides free downloads of thirty (30) problem solving preparatory STAAR (State of Texas Assessment of Academic Readiness) formatting for third through fifth grades. Pragmatically, it is recommended that daily word problem solving resources be spirally bound “in a book style fashion” to facilitate efficient daily use.

2.) Direct modelling for students to establish clear expectations on problem solving methodology. It is also recommended teachers model this process with their elementary students 4 to 5 days and slowly wean them to work problems independently. *Teaching is communicating thinking.* This problem solving process should not be a discovery method. The teacher should provide a method so students ‘discover’ an effective and consistent means to become adept problem solvers. In this situation, students should *emulate* a method before they *innovate* with their own methodology. As expected in almost all human experience, student innovation naturally occurs over time after a foundational method is soundly established.

3.) Use a set procedural method with students that they follow on all word problems – <u>For example</u>: **RACE**
   a.) **R**ead the problem and underline the last sentence (So students know what they are trying to find)
   b.) **A**ll needed information circled – words and numbers. (Cross out extraneous data)
   c.) **C**alculate a solution showing all work – neatly and organized (No mental math)
   d.) **E**valuate. Does the solution make reasonable sense? (Write a short sentence explaining answer)

4.) Teachers should check and actively monitor independent student work in real time and not allow short-cuts to problem solving methodology – regardless if the correct answer is on the student’s paper without related work. If permitted by the teacher at the onset of practice, students will practice similar short-cuts in the future – frequently with negative outcomes.

5.) High levels of student accountability when checking students’ daily work. It is highly recommended that teachers check the vast majority of students’ work as they complete each problem. Hence, the teacher should be walking around the classroom checking and monitoring student work as the students are working. If the content material is monitored in this fashion, students’ speed at completing the work is increased as well as the teacher’s ability to diagnostically evaluate concepts that require additional focus. Clear expectations and routines must be established for students who complete their work ahead of others, so they do not distract peers still finishing their work. Finally, the teacher should praise students when work is completed correctly, recognizing their efforts and building students’ self-esteem.

This '**RACE**' process should appear on an anchor of support on the classroom wall in easy view of all students. The children should also write '**RACE**' above each problem – checking off each letter as they complete that step. It is highly beneficial if the problem solving methodology is standardized both horizontally on the grade level and vertical between grades. In a relatively short time, students will demonstrate proficiency at solving word problems – again, assuming they possess mastery of grade level numeracy skills. There are many other effective methodologies (other than RACE) that provide similar specificity and effectiveness, but if students are consistent during the daily math block, they become adept problem solvers in a short period of time. As children ingrain a structured learning process, their self-confidence is heightened, and they eventually develop creative ways to consistently and successfully solve word problems. It is of paramount importance the teacher implements an accountability system when checking and monitoring student work to ensure their problem solving methodology is followed, or students will not commit the process to memory.

The solution to developing better problem solving math students is not confined to the fact that they simply require more practice. Of course, it is one of the keys. But, the other issue is ensuring students have high skill level proficiency in both math facts and math process skills (i.e. place value, fractions, algorithm – computations, decimals, etc.). It is these two important factors in combination that successfully ready young students in a word problem solving environment.

In conclusion, daily word problems may be either teacher/school district generated or purchased from a commercial vendor. Regardless of the resource, the word problems must be representative of a Standards base grade level mathematics curriculum. Ideally, the word problems should closely follow the skill base portion of the daily core lessons. However, if the word problems are randomly sequenced from a commercial product, there are a couple options. First, the teacher can cut and paste the word problems from the vendor resource and create a resource that parallels the sequencing of the daily core math lessons. The second option is for students to collectively work the non-sequential problem with the teacher whereas the teacher provides a basis of conceptual understanding. Further, the classroom teacher may also prepare similar problems on subsequent days with only the numbers changed from the original word problems until students are capable to work the problem type independently. After a tactile manipulative is introduced – as needed, this paper-pencil learning process is easily adaptable to the spaced repetition system daily instructional format. In six (6) to ten (10) repetitions of a new problem type, perimeter or area, for example, students invariably demonstrate high levels of proficiency.

Whenever a task or endeavor is consistently practiced with good habits, competence will follow in a relatively short amount of time. Math word problems are not an exception to this thinking

Daily Word Problem Solving Session

Pragmatic Implementation Steps

1.) ***Select Problem Solving Bridge Resource:*** District or school personnel choice based on student need or mathematics philosophy. Recommend a grade level rigor – Texas TEKS or Common Core Math Standards based resource. Commercial Vendor or District/School created options.

2.) ***Daily Word Problem and Skill Application Practice:*** Each 90 minute math block students should engage in 4 to 8 representative word problems – discrete skill application from SRS, core lessons and daily numeracy.

3.) ***Teacher should Model Problem Solving Methodology:*** Teacher should model with students for 4 to 5 class days as students emulate classroom or school's problem solving expectations – method ("RACE", for example) and acceptable student work – neatness and approach.

4.) ***Teacher should Check Student Work:*** The teacher must ensure high student accountability to student daily problem solving work and method compliance. Recommend using daily session as a diagnostic assessment to success of both skills and problem solving prowess over time.

SECTION 5

Conclusion

This white paper is intended to provide the overall structure of a daily 90 minute math block with consistent implementation over the course of a normal school year. The document is designed as part one (1) of a three (3) part series. The other two (2) white papers were designed as companion and supporting documents to the 90 minute math block as well as standalone papers. Those documents are titled, "Spaced Repetition System (SRS) – Application: General Math Skill Mastery" and "Accelerated Student Math Fact Mastery." Another paper that is also referenced is on problem solving is, "Accelerated Student Achievement in American Title 1 Elementary Schools, 'Stop-Gap and Bridge Resources' – Part 2 of 2." As with this paper, all referenced white papers are posted to the website address listed in the footer below and are available for immediate download.

The highest levels of academic success in both elementary and middle schools invariably result in classrooms with consistent instructional focus, effective classroom management, well run daily routines and well defined content program structure. In order for any curricular system to work, classroom teachers require efficacy in effective classroom management and daily routines to preserve instructional minutes. The loss of instructional time is a critical factor that has a cumulative impact on student achievement over the course of a school year. With those daily systems established, the four (4) instructional components of a 90 minute math block – Figure 1 – provide the replicable pedagogical focus and program structure both horizontally and vertical at an elementary school.

The first two (2) components of the 90 minute math block: the daily numeracy program and the spaced repetition system (SRS) are essential to the academic success of Title 1 elementary and middle schools. They generate an acceleration of struggling academic students back to grade level as well as provide an instructional conveyance of current grade level math facts and math processing skill mastery. These two programs operate symbiotically and provide support for both the daily core math lesson and problem solving components of the math block. The two (2) first math components – a differentiated daily numeracy program and a spaced repetition system (SRS) afford school and district personnel to independently select the adopted core curriculum and problem solving resources. The flexibility of these two (2) components are also viable for either the Common Core State Standards (CCSS) or the Texas (TEKS) math standards.

Daily consistency, student accountability, pressing students for academic success, and effectively monitoring all students' progress will be key factors in the success at any given school. The school's administration and teachers must collaboratively ensure students are academically successful in every mathematics classroom. The principal must set the tone for this impactful relationship and support classroom teachers in effective classroom management and individual student accountability. Children must be guided for success by all faculty members each and every school day. A culture of instructional and academic excellence does not occur by accident. It happens with a structured academic plan that engages each child enrolled at the school. The 90 minute math block and its two companion white papers create the structure and connect all instructional pieces for stellar academic success – regardless of a school's student demographics. Academic turnaround in mathematics can be accomplished in one school year regardless if the school is classified as a Title 1 school or not.