

Abstract:

Instructional Strategies for Teaching Pre-Algebra  
to a Diverse Group of Learners

Planning effective instruction for a classroom full of learners demands that the educator know what works and more importantly what works better for the group of people residing in the educator's classroom today. This action research study tested the efficacy of using the full compliment of assessments included in the curriculum adoption at the researchers school and that of guided note taking. Each strategy was implemented in its own separate unit of a pre-algebra class.

The researcher used student growth, which was determined by the difference observed between a student's pre-test percentage score and their final unit test percentage score, as the metric by which to evaluate each strategies efficacy.

Measurable growth was observed with both strategies. The All Assessments strategy showed greater and more consistent growth among learners than that which was observed during the Notes strategy. These findings indicate that more research is needed on the effectiveness of using assessments for learning and a need for further study to evaluate the efficacy of guided note taking. Findings in this study should be considered as illuminating but not conclusive as the sample used is not generalizable.

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Instructional Strategies for Teaching Pre-Algebra  
to a Diverse Group of Learners

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## I. The Problem

Today's classroom is a diverse place where students from a myriad of backgrounds and abilities are brought together with the expressed purpose of developing knowledge and skills that will assist students in growing as individuals while preparing them for the next level in their academic lives. The classroom where this study took place embodies these conditions and strives towards these intentions. To effectively realize success as measured by today's formal assessments this researcher recognizes the need to find, specialize and implement a system of instructional strategies which will help assure that each of these groups of learners are engaged, challenged and trained to use their skills and knowledge to any challenge life throws at them.

The students comprising the sample in this study class are energetic, curious and reside in a supportive and peaceful mountain community. In pre-algebra the half are performing at grade level with about 25% below and about 25% or so above. Are there ways challenge each learner and teach them in a way that best meets their needs while doing so for all learners? Are there instructional strategies that could be implemented that would yield better results for more students? Can this be accomplished within the confines of the time currently used to plan? A safe assumption is that there is likely to be many permutations of strategies that can be implemented in this classroom that will yield a different result as represented by student performance on chapter tests. The purpose of this action research study will be to evaluate the specific effectiveness of several strategies as used by this researcher in this classroom.

The study sample of students are distributed by their performance on the 2009 California Standards Test for Math as, Advanced 24%, Proficient 29%, Basic 41%, Below Basic 6%, Far Below Basic 0% (CST Report, 2009). It has been observed by the researcher that this group of students are generally encouraged to keep up with their

academic work. The group is comprised of fifteen students, most of whom have been in the same class together for the duration of their school years.

Finding the right strategies for today's students is important, but so is developing strategies that can be used as a base program from which to specialize for the next year's students who will come with unique instructional requirements.

### Purpose of Study

This action research study sought to locate and evaluate instructional strategies for use in teaching pre-algebra to a specific group of seventh grade students. The purpose for doing so was to improve the effectiveness of instruction as determined by measurable student growth observed during a series of instructional units.

### Definition of Terms

In this study I will be using the term "self-contained" which is defined as a group of students who are taught all core academic subjects, physical education and art by the same teacher. When referring to the subject I will at times use the term "diverse population" when doing so I am referring to the distribution of math scores as reported by the 2009 CST test and formative assessments administered by this group's regular school teacher, myself. The abbreviation CST stands for the California Standards Tests. The term STAR refers to the California's Standardized Testing and Reporting.

### Research Questions

What strategies can I use in my self-contained classroom during math that will allow me to meet the needs of my advanced, grade level and low performing students? Can an improvement in student scores on summative assessments be accomplished without

significantly increasing planning time? Which strategy or combinations of strategies when used result in an improvement in the consistency and quantity of growth each student experiences as measured by comparing a unit's pre-assessment and the unit's summative assessment?

## II. Literature Review

A person's ability to reflect on his/her work is important for the process of learning to be successful. McMillan and Hearn explain, "Evaluating what they learned, what they still need to work on, and how they can get there can all support deeper understanding rather than superficial knowledge" (2008). Reflection can take many forms including, students grading their own assessments which are then used to guide them in their learning. To be effective reflection must include opportunity to improve performance and new opportunities to demonstrate learning and skill development.

Formative assessment can provide valuable information students need. As stated by Campos and O'Hern, "feedback from... assessments can be used to help students with goal setting. This allows the students to take responsibility for their learning and become more independent learners" (Campos, 2007). Developing students into self-motivated learners likely requires shifting the reins of their learning into student hands. Access to control over their learning appears to motivate personal responsibility and a genuine desire to improve.

Providing feedback through frequent assessment can influence learning and achievement. Evertson and Neal discuss the use of assessment, "ongoing formative assessment [is] a means for determining what [has] been learned and what else [is] needed... Although often neglected in U.S. classrooms, there is considerable evidence that formative assessment is an essential component of classroom work that facilitates learning and can substantially raise student achievement" (2006). Students

who receive regular and specific feedback in the form of formative assessment should score higher than when formative assessment is largely absent.

Intrinsic motivation is key to success. The road to intrinsic motivation requires thoughtful planning and experimentation as Oginsky recalls, "even through research supports and I believe, that non-controlling, positive feedback leads to a positive classroom environment, and thus to an increase in intrinsic motivation, increasing positive non-controlling feedback to students did not increase intrinsic motivation in this classroom study" (2003). The group who are being taught must be carefully considered when determining what type of feedback will aid them in developing their own internal motivation for learning.

The objective of assessment must be consistent with the nature of its implementation, "the goals for developing diagnostic item models for formative assessment are quite different from... [research] goals... First, we are less concerned with generating instances with psychometric parameters that can be predicted very accurately, and more concerned with generating instances that consistently measure patterns of understanding with accuracy sufficient to focus instruction" (Graf, 2009). Formative assessment that guides instruction must be constructed and evaluated so as to provide the information that will aid in planning effective instruction in addition to supporting feedback for students.

When construction assessment which will determine the efficacy of certain strategies it is necessary to determine the appropriateness of the assessment choice. "Often the instruction in the classroom is not geared toward the same objectives as those measured on the assessment, or the assessment may, in fact, fail to provide information about student's strengths and weaknesses as real targets for further instruction" (McDivitt, 2003). What is assessed is what should be instructed or the results cannot be trusted as being the results of instruction, rather the product of other means.

Learning can occur in two phases, encoding/writing and external storage/studying, when notes are involved as a tool for recording new information and during the process of reviewing those notes prior to an assessment. In a study examining the efficacy of students copy and pasting notes from internet sources Igo, Bruning and Riccomini explain that, "students might not learn much during the encoding phase if they do not engage in deep mental processes as they take notes... in the external storage phase of note learning, students learn as they study a set of notes that already have been created" (Igo, 2009). It is important that when notes are used as a tool for study that they should be created carefully so as to assure their legibility and accuracy. One of the concerns the study raised was that when students reviewed using their own hand created notes they often reinforced errors and omissions that were recorded or missed in the encoding phase.

Benefits in performance can possibly be realized if students are guided in how to choose items to include while note taking. Igo suggests that educators, "teach students how to evaluate which ideas to include in their notes, [as it] could have positive consequences for both the encoding and the external storage phases of note learning" (Igo, 2009). If taught to strategically consider the content they include in their notes, students should benefit by having both less to study which will be more time and energy efficient and the information they will be reviewing will be of a higher quality.

In a study by Neil Toporski and Tim Foley the need for a streamlined interactive approach is indicated. The researcher studied the unique needs of the modern distance education class setting. In this report it was explained that there exists a trend towards providing "theatrical" and "diverse... presentation methods." The authors list strategies formulated during the study that promote a successful schooling experience, they, "make it interactive,... keep it engaging and motivating,... put things in context,... maintain diversity,... use collaborative strategies,... reduce cognitive Load,... [and] provide adequate scaffolding" (Toporski, 2004). Mr. Toporski and Mr. Foley's

conclusion validates the conclusions of similar studies that a more effective classroom can be created in the physical space of a classroom or within the e-classroom by using differentiated approaches that stimulate the many people take in new information.

Katherine Gibson studied how teachers perceive strategy based reading instruction and its affect on comprehension. Her study was based on a small sample of teachers who had a positive attitude going into the study about using strategy based reading. She discovered that, "[teachers] surveyed have positive feelings towards strategy based reading instruction... [and] find strategy based reading instruction an effective way to improve reading comprehension," (Gibson, 2009). Ms. Gibson's study supports the idea that attitude can influence success.

In his article in *Education Leadership Using Data to Improve Student Achievement - How Classroom Assessments Improve Learning*, Thomas Guskey suggests giving students the opportunity to improve their performance on assessments through a second chance (Guskey, 2003). This researcher is curious if modifying the current method of assessment to include several "chances" to hit the mark will yield higher scores on these assessments overall.

In Robert J. Marzano's article in *Educational Leadership What Works in Schools* he reports study results that show a average 34 point percentile gain and a 0.50 standard deviation from the mean for a subject who uses the strategy of note taking and summarizing (Marzano, 2003). In this study I will evaluate the effectiveness of, "asking students to generate verbal summaries, asking students to generate written summaries,... asking students to revise their notes, and/or correcting errors and adding information" (Marzano, 2003). Specific importance seems to reside in the retooling of notes after first taking them. They should be regarded as a malleable model which represents the learners current understanding of and needs for the focus content.

The literature concerning differentiating instruction calls for many approaches, attitudes and methods of implementation. Some have advocated for diving in where the

whole system is transformed rapidly, while many more have called for a gradual adoption process with a long term more is better philosophy. Sondergeld and Shultz advise: "use content you feel comfortable teaching; do not attempt to differentiate every lesson you teach—you will get frustrated and feel burnt out; begin slowly, with maybe only one or two differentiated units a year; invite parents or classroom aides into the classroom to assist with" (Sondergeld, 2008). Change in the classroom routine and lesson design should be gradual so as to maintain the energy and vigor of learners as well as educators.

Self evaluation is key to understanding what is working and what can be improved. Friend and Pope outline what each teacher needs to focus on in and some simple guidelines for success, "First, sometimes the most successful way to go about changing is to do so in small increments... Second, find colleagues with whom to share your efforts... Third, set goals for yourself and celebrate when you accomplish them... Finally, remember that working on differentiation is a clear example of lifelong learning," (Friend, 2005). This descriptive report reinforces what has been stated by the Center for Comprehensive School Reform and Improvement.

The basic philosophical orientation of the educator is important to understanding the expected response from students as initiated by the nature of the relationship between the student and educator. In "Theories of Intelligence, Learning and Motivation as a Basic Educational Praxis," Steven Van Hook examines the nature of this relationship. The term "andragogy" is used to describe the paradigm shift that is and must happen in education. Whereby "pedagogy" is rooted in the concept of the teacher guiding the child in learning, andragogy instead views the learner in terms of participating in their own self-actualized learning experience (Van Hook, 2008). This calls to mind the concept of "ownership" often used to describe when students are observed applying the concepts they have learned in new novel ways.

Summary and note taking when properly executed require extracting the essence of the information being studied. Marzano explains, "students must analyze the information in depth... in order to decide what information is important to make notes about and information that is not, students must be able to mentally sift through and synthesize information" (Marzano, 2000). An ongoing use of note taking as a regular component of learning will likely result in the development of students abilities to pick out the information they will most likely need to know for later use. Motivating students to use this strategy to in a meaningful way might be accomplished by allowing the use of student generated notes during assessment tasks.

### III. METHODOLOGY

Each strategy selected for evaluation in this study was implemented in this researchers classroom for two weeks in the following manner. Each new strategy was isolated from influence by the other strategies during evaluation to the degree practical in this real classroom environment. Students were instructed using in the researcher's normal teaching style that included working problems as a group until it was clear to the researcher that the majority of students were able to continue independently. At this point instruction continued on a case by case basis as the need presented itself. This was determined through teacher observation or through the direct request of students. Efforts were taken to maintain a consistency of instruction during each strategy evaluation. Before beginning instruction on the unit's lessons a pretest was administered. During the course of the unit, quizzes were administered. The number of quizzes was determined by the strategy being evaluated. Each quiz was given the afternoon the day reteaching for the lesson being quizzed had been completed. A mid-chapter quiz was given after the sixth or seventh unit lesson had been corrected and retaught. This was followed by more lesson quizzes administered as previously

described. The unit was completed with a final chapter test consisting of questions from the whole unit. During testing students were directed to move into "test mode" where they moved their desks so they had a one foot gap between their desk and their nearest neighbor. This was done to minimize distractions that might impact assessment results. Students were not allowed to talk to each other during quizzes and tests. They were allowed to ask the researcher for clarification on questions. Each quiz and test was corrected in class by the students and then reviewed by the researcher. This was done to provide students with immediate feedback on their work.

#### Strategy 1: All Assessments with Second Chance

All unit assessments included with the textbook adoption were used. After each assessment was given and corrected, either a quiz or test, students were offered the chance to correct the problems they missed, while displaying their work, for additional credit. In the case of quizzes, students were offered the chance to earn back all credit by working the problems out again and resubmitting their corrected quiz. On tests students were offered the chance to correct their missed problems for half the credit missed. The researchers intention was to determine if student performance could be influenced by a greater frequency of assessments, coupled with immediate feedback and the opportunity to correct assessments for additional credit. Only raw uncorrected scores were used in this study. The improved scores were used only for calculating student grades.

#### Strategy 2: All Assessments, Summarizing and Note Taking

During instruction students were asked to divide a page down the middle. In the left margin students were directed to take notes that included lesson examples and vocabulary. In the right margin students were directed to expand on notes with their

own examples and explanations. A pre-test assessment was given the first day before instruction. Midway through the unit a mid-chapter test was given. At the end of the Unit a chapter test was administered.

#### Data Collection and Recording

Data used to evaluate the instruction strategies was collected through formative assessment, observation and summative assessment. Each strategy received a one unit time frame, which generally worked out to a two week period. The first day of each unit a complete chapter test was be administered. The score of these assessments was converted to a percentage mean for the whole class and compared on an individual basis with mid-chapter assessment scores and the chapter summative assessment scores.

Unit formative assessments consisted of several lesson quizzes given the day after formal instruction on the quiz content had been completed and only after a session of homework correction and reteaching. Copies of all assessments were kept to allow for comparison among content areas as determined by the lesson designation printed in each section of each assessment. These were used to determine any changes in performance as related to each lesson area.

#### IV. Study Results

To compare the two strategies it was necessary to find a way to measure the efficacy of each strategy for the class as a whole. The researcher chose to compare growth in scores from the pretest to the final test (Figure 1 and 2). A mean of this set of differences was calculated for each strategy as was the standard deviation for each. The justification for comparing the two strategies in this manner was that this measure quantified the growth students made during each strategy and provided a clear picture of how

consistently this growth was seen over the population (as shown by the standard deviation).

Figure 1 All Assessments Pre-Test and Final Test Raw Percentage Scores

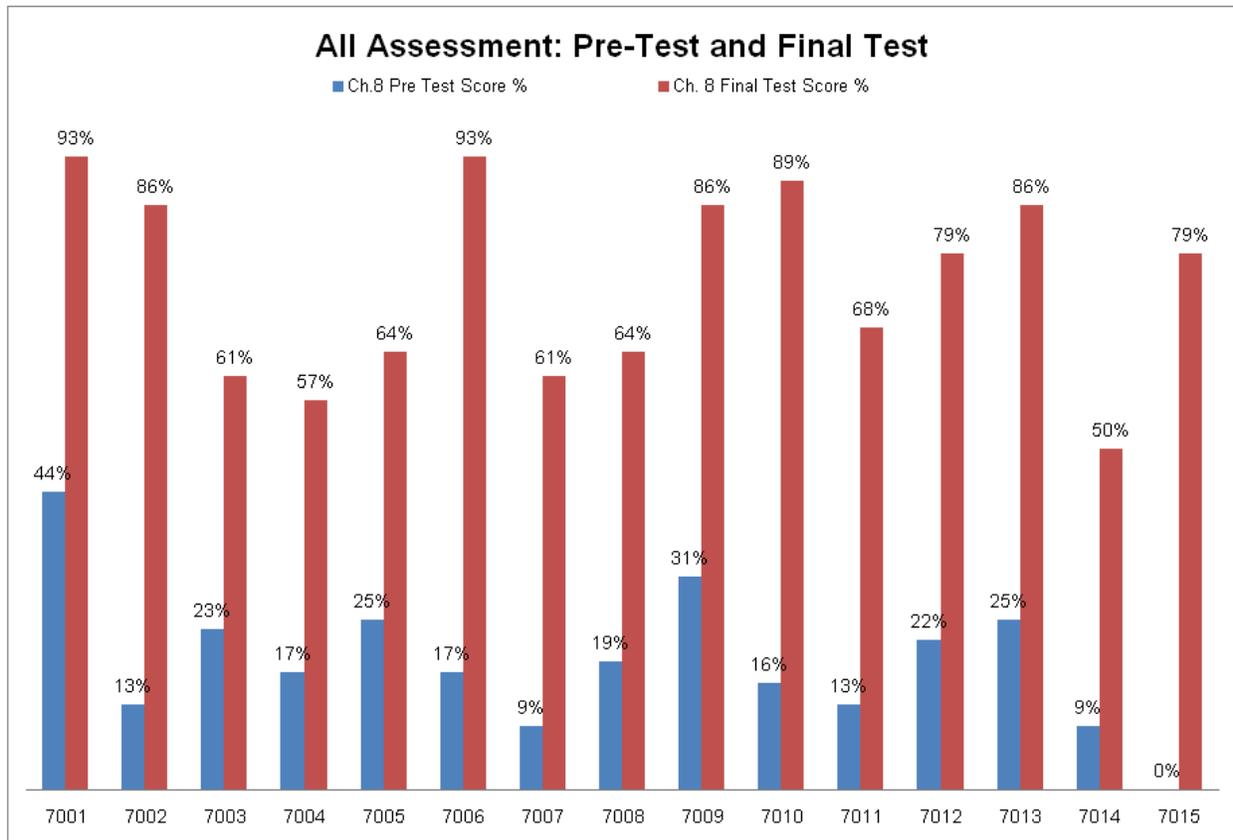
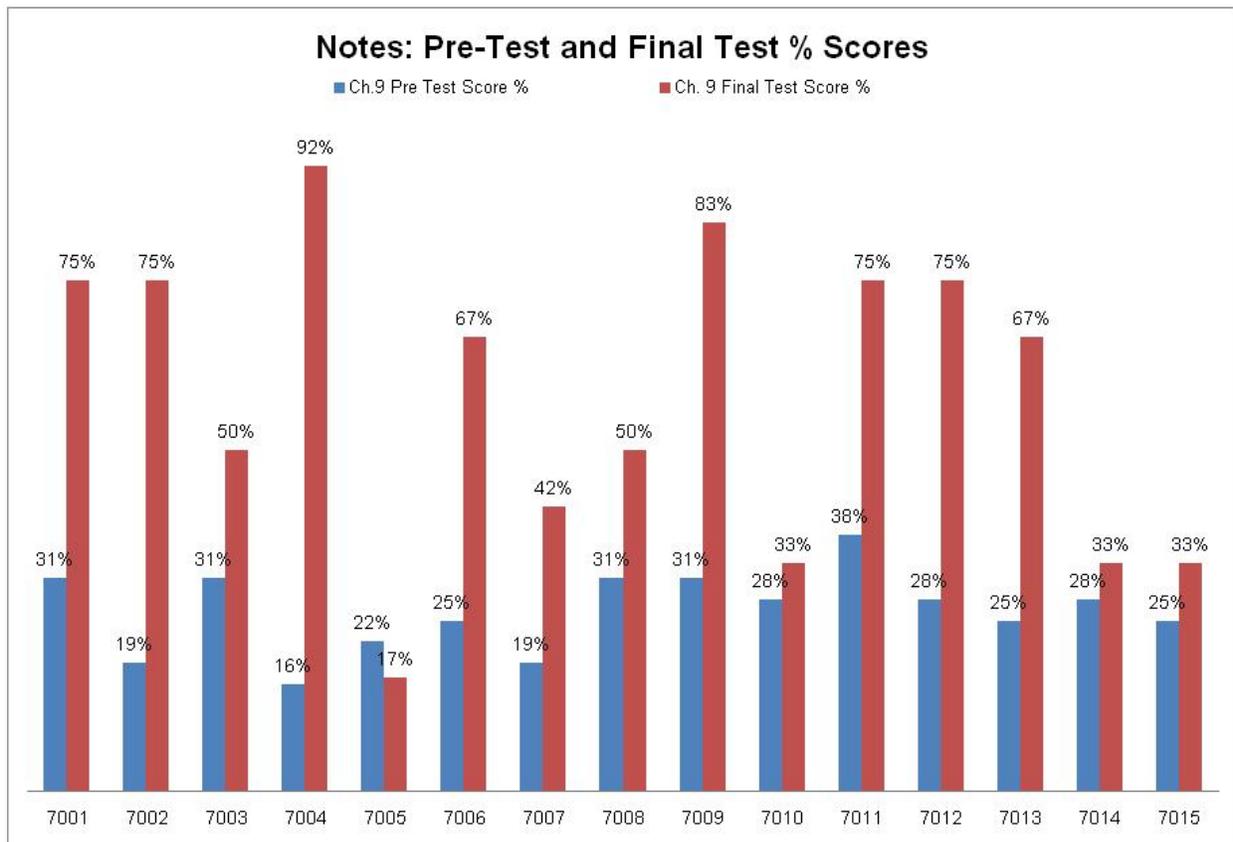
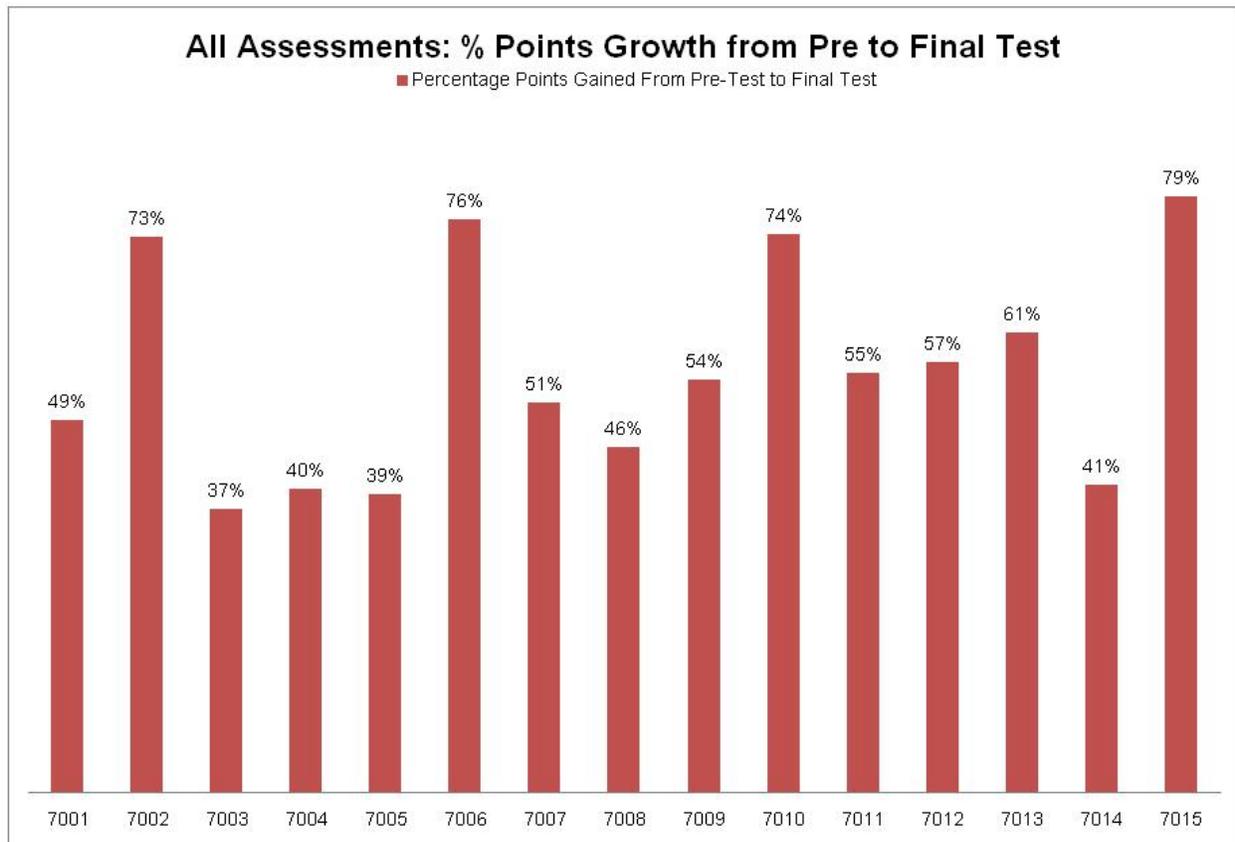


Figure 2 Notes Pre-Test and Final Test Raw Percentage Scores



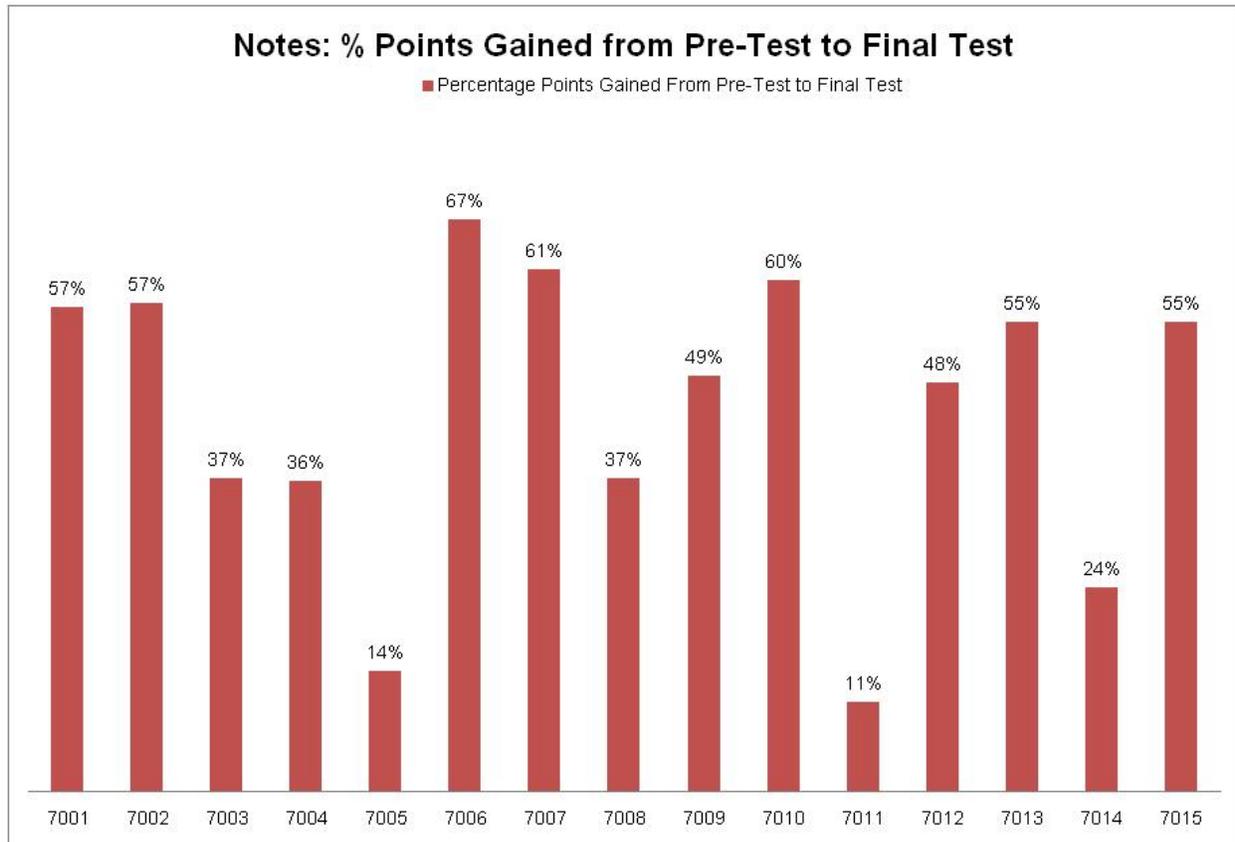
The subjects showed a mean growth of 55 percentage points in the All Assessments unit of the study. Individual scores fell within a standard deviation of 14.21 percentage points of the mean. The highest growth in percentage points observed was observed in subject 7015 at 79 percentage points of growth. The lowest observed growth was observed in subject 7003 at 37 points of growth (Figure 3).

Figure 3 All Assessment % Points Growth from Pre-Test to Final Test



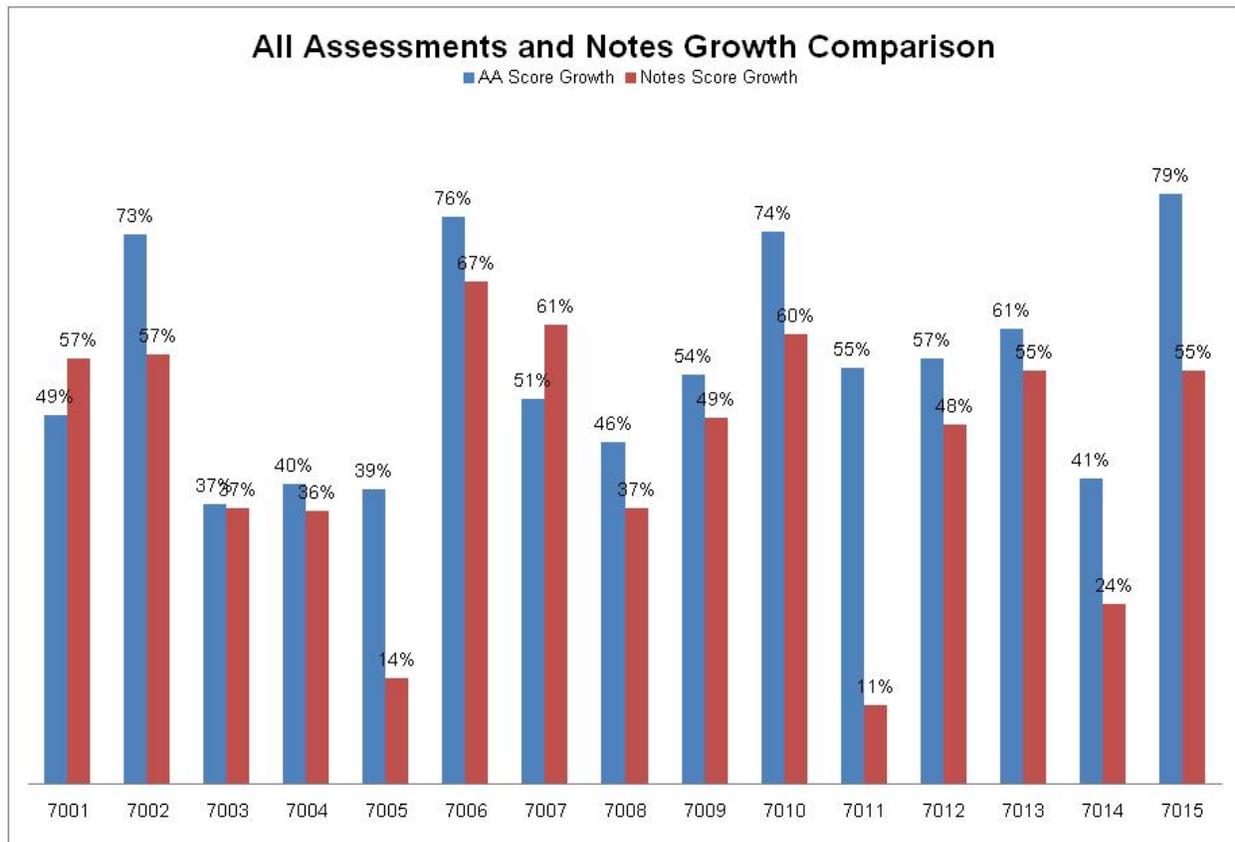
During the Notes unit subjects showed a mean growth of 31 percentage points. In this unit scores fell within a standard deviation of 22.86 points from the mean value. The highest growth was observed with subject 7006, who showed a 67 percentage point growth from their pretest score. The lowest growth observed during this unit was that of subject 7005, who showed a -5 percentage points loss from their pre-test score to the final score (Figure 4).

Figure 4 Notes % Points Growth from Pre-Test to Final Test



Differences were observed with the two strategy unit mean growth measures (Figure 5). A difference of 24 percentage points separate the two strategy growth means. Data distribution, as determined by the standard deviation, showed a 9 percentage point difference in the growth range. The All Assessments strategy elicited greater and more consistent growth from this population of students. Conversely the Notes strategy showed less growth and less consistency in the growth students experienced during that unit.

Figure 5 All Assessments and Notes Growth Comparison



## V. Conclusions

It is difficult to determine what to include when planning instruction. There are endless variables to consider that may or may not have a significant impact on the engagement and subsequent retention of learning expressed by students. This research study was motivated by a desire to compose a means of comparing the efficacy of different strategies. Prior to this study, using all the included assessments that come with a given curriculum adoption had not seemed, to the researcher, to be of obvious

benefit. However, the results of this study are convincing enough for this researcher to consider more carefully the role assessment can play in aiding student learning.

The results of the note-taking unit came as a surprise. It was assumed that the notes unit would show at least as good a growth as the unit using all assessments. After all, the strategy of guiding students to expand on their notes both during and after instruction is frequently and widely encouraged. During the All Assessments unit, students were not asked to do anything with their notes beyond recording what was necessary for them to get started on their assignments. If these findings illuminate anything it is that it is highly beneficial for the educator to have a measure for determining and to reflect on what kind of growth is occurring during each instructional units. It is also important to consider carefully what is being included in lessons and whether or not each of those things is worth the planning and instructional time.

Student motivation may have played a significant role in why the All Assessment strategy showed greater success. The ever present pressure of a coming formal assessment coupled with the immediate feedback offered by each student's correcting of his or her own paper and immediately being given time to correct their errors for additional credit may be a motivating force. In many ways having frequent assessment is like the immediate feedback individuals receive when they play a video game. If a mistake is made the player knows right away and begins looking for ways to complete the task successfully. Subjects in this study were observed to be highly motivated to correct their mistakes for additional credit, which in turn provided needed review for content they were weak on.

## VI. Concerns, Limitations and Future Research

This study was conducted with a very small sample of students and should not be considered generalizable. As is the nature of action research, in many ways the study

was designed and redesigned while the units were being instructed. Where it casts light it exposes even more shadows. Comprehensive and comparable pre-tests were not available so final chapter tests were given in their place. Growth was assessed based on the differences between the pre-test score and the final unit test score. In the case of the all assessments unit it is the researcher's belief that the pre-test given was of greater difficulty than the final test for that unit. Which if true could mean that the benefits of that strategy were greater than the data indicated.

For this study to be statistically testable it would need to be replicated, a control established where neither strategy was in use and a larger data set compiled to compare each strategies performance as averaged over several units time. This study should be considered as a preliminary work, wherein it is this researcher's belief a need for additional study is indicated by the findings.

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