

THE EFFECTIVENESS OF USING HANDHELDS COMPUTERS
WITH FORMATIVE ASSESSMENTS

A Paper

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CHAPTER 1 INTRODUCTION

The creation of No Child Left Behind (NCLB) in 2001 has significantly impacted education (U.S. Department of Education, 2004). NCLB challenges schools to work continually on improving both teacher and student performance as measured by standardized tests. Further, NCLB charges schools with closing achievement gaps and aiming for 100 percent of students to be proficient by 2014 (Guilfoyle, 2006). Schools must administer tests in core curriculum areas in various years throughout students' education. In this endeavor, states must quantify student success as they "set challenging expectations for what students should know and be able to do" (Toch, 2006, p. 54).

To prove proficiency, states determine many facets of the quantification of Adequate Yearly Progress (AYP). There is no requirement that states adhere to nationally designated standards, but states generally look towards industry-created expectations including those identified by national organizations, such as the National Council for Teachers of Mathematics (NCTM). While one state may require assessment of individual items, other states may not. The potential for disparity exists. The State of Kansas challenges every school with a wide variety of competencies that students must show in reading and mathematics from early elementary through high school as demonstrated on standardized assessments administered annually at the school level. Data are gathered, and schools with an inadequate number of proficient students either as a whole, or within predefined subgroups, are considered not making AYP. There are a variety of interventions and consequences for these failing schools so they can turn around and help students excel.

These assessments tie curricular areas to individual tested indicators. Completion of these key assessments provides educators with information about the student population and the

educator's teaching strengths or opportunities for improvement. Tested indicators that are particularly low in one year should result in changes to teaching strategies and methodologies. While a list of possible changes seems endless, it is up to the educators to use their professional experience coupled with implementation of research-based strategies to show improvement.

As the educator focuses on improvement of tested indicators, it is appropriate to determine the specific cause of the changing scores. Indeed, it is difficult for the educator to tell whether the changes are a result of heightened awareness, greater time-on-task, or the specific changes implemented. The endless list of possible changes includes technology to improve assessment results. An examination of the use of technology and time-on-task improves assessment results more than only time-on-task. Additional changes should consider whether other research-based strategies, such as cooperative learning could produce better results.

This project considers one tested indicator - student's ability to classify numbers within the real number system (real numbers, integers, whole, irrational, and rational). All students will receive direct instruction and complete a homework assignment. One-half of the students will have one additional direct instruction lesson towards the end of this project. The other half of the students will continue studying this topic weekly and take formative assessments through a variety of media. These media include cooperative learning, traditional bubble sheets, and the use of handheld computers with a classroom assessment software management package. In this project, comparative results will be produced for the two large groups and the various formative assessment subgroups.

CHAPTER 2 REVIEW OF LITERATURE

This review addresses traditional classroom strategies to teach mathematics concepts employed in this project. A brief overview of the use of handheld computers is provided. In addition, formative assessments with handheld computers and their effectiveness are reviewed.

Traditional Classroom Strategies

The implementation of this project involves several traditional classroom strategies. First, classification methods of information will be considered. Next, a brief look at cooperative learning is appropriate. Finally, the importance of formative assessments is discussed.

Throughout classrooms, graphic organizers to classify information are common. Examples include K-W-L Charts, Mind Maps, Venn Diagrams, and sorts. The impact of classification on learning has been examined (Marzano, Pickering, & Pollock, 2001). They found that identification of similarities and differences increase student learning around 27 percent and nonlinguistic representations of data, graphic organizers, improve learning around 31 percent (Marzano et al., 2001).

Modern educational pedagogy describes that cooperative learning is an integral part of teaching. Spencer Kagan has popularized these methods with a large number of books containing strategies; others have also worked in this area (Kagan, 2007). The impact of cooperative learning is documented and quantified. The analysis indicates that cooperative learning does have a meaningful positive impact on education with an average gain of 27 percent over students who did not experience cooperative learning (Marzano et al., 2001).

Formative Assessments

In Chappuis' 2006 work, she considered the importance of formative assessments and its ability to improve performance. Formative assessments have been associated with learning.

They indicate that giving feedback to students increases learning around 25 percent, with the most significant gains being realized with feedback immediately after the test gains (Marzano et al., 2001). The importance of quick feedback continues to be confirmed (Heinze et al, 2005). These gains are partially attributed to the fact that formative assessments provide students with feedback on their performance while helping students understand steps needed to improve.

In Shepard's analysis, she identifies scaffolding and formative assessments are necessary "to move learning forward in the zone of proximal development" (Shepard, 2005, p. 67). For this case study, students must understand numbers, fractions, and decimals in order to move toward the categorization of individual numbers to the real number system. Sadler published in the area of formative assessment indicating there were three criteria for an assessment to be formative. The students must: 1. come to hold a concept of quality roughly similar to that of the teacher, 2. be able to compare the current level of performance with the standard, and 3. be able to take action to close the gap (Sadler, 1989). Without exception, effective classroom teaching indicates that formative assessments throughout a unit of study are important. Knowing a student's level is necessary for both students and teachers (Black & William, 1998). Formative assessments are one small part of mastering a topic (Starkman, 2006).

Important in the discussion of formative assessments is the consideration of student motivation. Consideration of how some students will work hard and thrive on formative assessments while other students remain defeated (Shepard, 2000). Further, Shepard suggests implementing classrooms, which encourage peer assessment, with opportunities for shared thinking and discussion of peer learning (Shepard, 2005).

Technology

When considering the technological aspects of formative assessments, choices include traditional computers, handhelds, and other devices. As technology has evolved, computer capabilities have grown exponentially and the cost spirals downward. Today, computing capabilities are available on small devices, Personal Digital Assistants (PDA). These small handheld devices include pocket computers and have a wide range of capabilities including calculators, games, email, portable media players, Internet browser, global positioning, smartphones, and more (Kadel, 2005; Palm Inc., 2006). For the purpose of this project, the generic term 'handheld' refers to these small handheld computers manufactured by Palm®, Zire®, and others.

These handhelds are powerful enough to run a version of Microsoft Office®, classroom management tools including grade books, educational software games, electronic book readers, and personal management applications (Swenson, 2002). Information is shared by beaming files or information to another handheld or a device to a computer (Minkel, 2003). Handhelds are highly effective when used with special needs students (Vitek, 2004). Today's new handhelds are Bluetooth and WiFi capable that provide increased functionality including wireless beaming.

Role of Technology and Formative Assessments

With increasing availability, technology can play a major role in formative assessments. As these assessments are administered through technology, a wide variety of information can be produced (Miller, 2001; Swenson, 2002). Recently reports indicate that teachers have switched their paradigm, from not wanting formative reports to relying on them for important teaching decisions (Starkman, 2006; Heinz, 2005). In this analysis, Starkman indicates that there are

important criteria to determine if assessments are effective including getting the correct data right away within a management system.

The use of handhelds to gather formative assessment data is appropriate and a new application. In 2006, an industry expert indicated, "Today, the bleeding edge of assessment is written for personal digital assistant (PDA) operating systems and is administered on handheld technology: various devices from Palm" and others (Milner, 2003, ¶ 6). There are other options to formative assessments with handhelds and include web-based tests by various Application Service Providers. With competing demand for limited laptops and computer labs and the low cost of handhelds, formative assessments through classroom assessment software seem optimum.

The question at hand is whether the ease of formative assessments with handhelds produces better results than other methods. Other assessments provide challenges including the delay in getting results that are meaningful and allow the teacher and students to implement changes in a timely manner (Milner, 2006). There are numerous reports of results taking up to a month to have returned. I have experienced this unsatisfactory situation myself. With handhelds, if answers can be entered and beamed (electronically transferred) to the teacher, the results are instantaneous and help to provide both students and teachers with the feedback they need.

Classroom Assessment Software

Handheld applications include the use of varied assessments and practice tools such as 'To Do' list and classroom assessment software. Creation of test review tools is done by the student and shared within a classroom. There is a wide of variety of information available when handhelds are used with classroom assessment software and turns the use of handhelds into one of significant data collection (Swenson, 2002). Of particular interest in this study is the use of formalized classroom assessment software, Classroom Wizard ®, for formative assessment.

This propriety software by Scantron® utilizes both handhelds and the web with tests and class management residing online. Students can beam their answers to a computer through an IRDA (Infrared Device Attachment) and the Classroom Wizard software provides immediate scoring and feedback, see Figure 1 for a schematic drawing. These capabilities allow the teacher to have instant access to help determine student mastery levels. Teachers can create tests with varied types of questions, unique versions, and scoring schema.

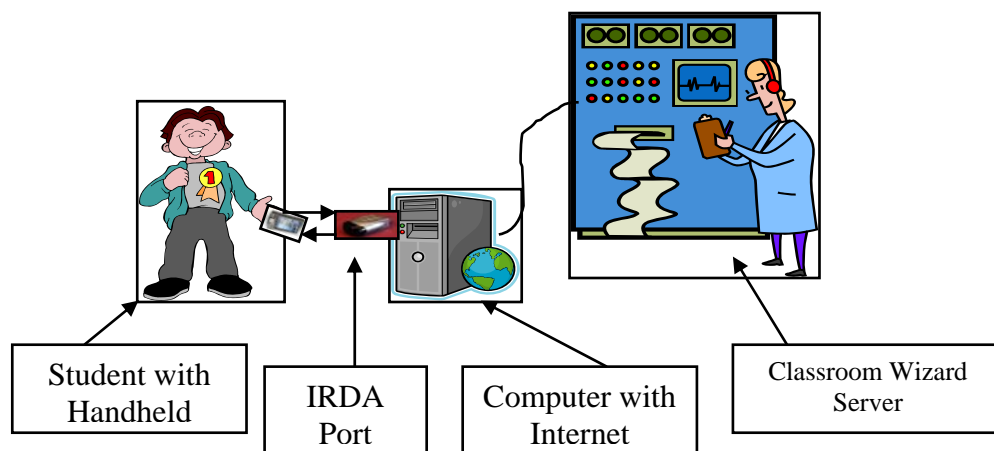


Figure 1 Handheld to Classroom Wizard

There are advantages to using Classroom Wizard for assessments, "In a glance, the instructor can immediately identify and follow the comprehension level of each individual in the entire class, make necessary adjustments to the lesson or assist individual students who need a little extra help." (Hudgins, 2001, ¶ 8). With the use of handhelds, students look forward to testing in this unique manner (Hudgins, 2001). To summate, "Available information and the ability to track standards, assessments, and student progress are critical to school improvement and, more importantly, increased student learning. Handheld computers are part of the solution" (Swenson, 2002, ¶ 6).

CHAPTER 3 DESIGN MODEL

In the instructional design process, it is necessary to follow a standardized model for creation through completion of a project. For this project, the five-step ADDIE model is employed with components of Analyze, Design, Develop, Implement, and Evaluate (Morrison, 2004). A description of the ADDIE model component and its application is below.

Analysis

During this first phase, the instructional problem and objectives are described within the learner's environment. In addition, the set of learner existing knowledge and skills are identified. This application is used with 8th grade students at Santa Fe Trail Junior High School (SFT) in Olathe, Kansas. Situated within the suburbs of the Kansas City area, SFT, with 545 students, is a land-locked junior high (Kansas State Board of Education, 2006).

The demographics of SFT indicate that ten percent are African American, twelve percent are Hispanic, and seven percent are other ethnic minority. The school is economically disadvantaged with thirty-eight percent population receiving free or reduced lunch benefits. There are multiple programs in the school including programs for the sixteen percent learning disabled students. In 2006, SFT was designated an English Language Learner (ELL) site which altered its population. At last report, there are approximately twelve percent of the student populations receiving some level of ELL services (Kansas State Board of Education, 2006).

All of the approximately 190 8th grade students are enrolled in a math class in junior high. For 8th grade students, there are two levels of classes available: Algebra 1, the advanced course, and Math 8, the regular 8th grade math course. Additionally, up to sixteen 8th grade students per semester can be enrolled in a second hour of math help -- primarily for remediation.

The content of the Math 8 course reviews the previous year's concepts by beginning with addition and subtraction, moving through simple algebra, reviewing basic geometry, and ending with plotting points on a grid. There are few new concepts in the curriculum. These new concepts include real number system, compound probability, and graphing equations.

During the 2005-2006, the State of Kansas initiated math assessments for 8th grade. The State has defined proficiency or passing level for the test. In the 2005-2006 year, that level is 58 percent, meaning that individuals who score 58 percent correct 'passed the test' (Corkins, 2006). For schools and districts to make AYP in the 2006-2007 school year, 67.2 percent of the students must perform at the proficient level (Kansas State Board of Education, 2006). To combine these two facets together, a passing score for a school is that 67.2 percent of the students scored 58 percent correct or better on the test. The minimum percent of students who must be proficient increases over time.

Statewide, the performance level of 8th grade math students indicates that 70.6 percent of students were proficient. In the Olathe District Schools, 76.1 percent of the students were proficient. For Santa Fe Trail, the results were not as high with 70.6 percent of the 8th grade student population were proficient. While this is good, Kansas examines the subgroups to ensure that they are also proficient. At SFT, the African American and low SES subgroups were proficient however; the Special Education subgroup did not perform satisfactorily, with only 45 percent proficient. Interestingly, the percentage for both the district and the state were very similar. According to NCLB, this means that Santa Fe Trail Junior High is a failing school because it did not make Adequate Yearly Progress (Kansas State Board of Education, 2006).

When looking at individual tested indicators, several were relatively low. One of these indicators, categorization of numbers within the real number system was very low at Santa Fe

Trail. At SFT, around 48 percent of the students passed (Olathe District Schools, 2006). The decision was made that this would be one of the indicators of focus during the school year.

At SFT, there are two eighth grade math teachers. Both are highly qualified in mathematics and have taught for several years. Both teachers believe that the concept of categorizing numbers should be relatively easy to teach and for student success however, students struggle with this concept. In my classroom, there is one set of handhelds available for student use. At the beginning of the school year, Olathe District Schools require students to sign a computer usage agreement. Additionally, my students sign a handheld contract to have the privilege of using this device. Students may select a wide variety of applications on the handhelds that cover core content areas. For math, the students beam their answers to weekly review questions resulting in student familiarity with the handheld applications.

The importance of the Kansas Math Assessments coupled with accessibility to handhelds provides an opportunity to inquire if the use of handhelds can improve performance on a specific indicator. Since only one teacher will use the handhelds, there is a natural control group in which to compare the sets of students. Within my classes, students can be divided into technology based formative assessment groupings and non-technology based formative assessment groupings. Recognizing that time on task should help student mastery, this must also be considered in the analysis. Therefore, the objective of this project will be to determine if the use of handhelds for completing formative assessments leads to student performance at a higher level than groups that do not use the handhelds.

Design

The second phase of the ADDIE model is Design. This phase involves creating a systematic, logical method of identifying, developing, and evaluating what needs to be done.

This step includes components, such as defining the project's instructional and technical strategy, creating mockups, designing the user interface, and creating a prototype for actual use.

In Santa Fe Trail's 8th grade math courses, comparatively low scores means that it is appropriate to design a system with numerous teaching sessions that rely upon multiple learning styles and attempt to reach students in any manner possible. The design of this project includes visual representations, kinesthetic construction, mnemonic devices, and simple repetition. For all 8th grade math students, the lesson begins with traditional lecture and visual representation. Students will practice by homework problems. One additional lesson will be completed three months later, with homework problems assigned followed by a test. Two months after that, a mini-lesson will be taught, and students will complete their third test.

My classes will also receive additional instruction on a weekly basis, for nine weeks, as they construct the real number system with a graphic organizer inside a portfolio. This organizer matches the visual representation on the wall. Students will complete a weekly formative assessment on this topic and record their results inside their portfolio. The formative assessment method will differ between my classes with different hours taking the assessments on traditional bubble sheets, using a Kagan cooperative learning strategy, and a completion with handhelds. The data disaggregation into small groups will provide information if time on task or technology produce different student success levels. Additionally, a post-survey is planned for the students.

Development

Within the ADDIE model, the development phase is where the project is created, assembled, and tested. This project called for limited creation, since most of the tools were already in place for testing. The portfolios and the graphic organizers were developed. The weekly mini-lessons were chunked to coincide with the creation of the graphic organizer.

Then, the formative assessments and corresponding answer keys were written matching the concepts of the mini-lessons. The weekly lessons covered these topics: 1. Real Numbers, 2. Rational Numbers, 3. Terminating Decimals, 4. Repeating Decimals, 5. Irrational Numbers, 6. Integers, 7. Whole Number, 8. Natural Numbers, and 9. Mixed Review. The actual piloting of this process was completed mentally as there were limited components to test.

Implementation

The implementation phase of my project began on Monday October 23, 2006 and continued for the next nine weeks. Weekly mini-lessons were given as the students constructed their graphic organizer. Weekly formative tests were taken in the variety of modes by class. Results were shared with students as they progressed. Previously, a test was given to the students that provided some information about their performance on this indicator.

When the major implementation phase of this project was done, the students completed a summative test. Those results were also shared with students. In early February, 2007, students were presented with another review lesson. At the end of February, students were provided with the last summative assessment on the Real Number System.

Evaluation

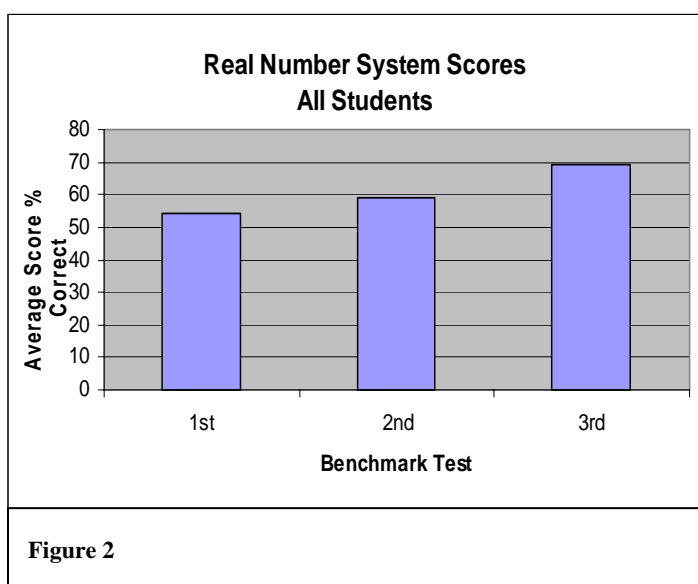
Within ADDIE, the evaluation phase usually contains assessments however this project is about the mode of the assessment. A post-project survey was completed by the students which asked if they liked this approach to learning. The other portion of evaluation comes from the instructor as she reflects on the project. Some changes are appropriate if this project were to be implemented again and are shared later in this paper. Primarily the evaluation of the project is contained within the data located in the results portion of this paper.

CHAPTER 4 RESULTS

Completing the project had a few challenges. Serving as both subject matter expert and instructional designer, the teacher had everything within her power to make modifications as necessary. Over the course of the nine-week period, both the students and teachers learned many things. Some of these are lessons learned for the future while others were organizational.

Student Average Results

Overall students' performance improved during the time of this project. We know from research that time on task helps student mastery, and this is evident in our exercise. From Figure 2, the results show that student average performance increased from 54 percent proficiency on the



first test to 59 percent and further increased to 69 percent on the third benchmark test. For all students who learned in the traditional classroom, one additional lesson occurred between Benchmark test 2 and 3, providing these students with an additional opportunity to learn. This did not occur for the formative assessment students.

When looking at the students at an aggregate level, some clear results are confirmed.

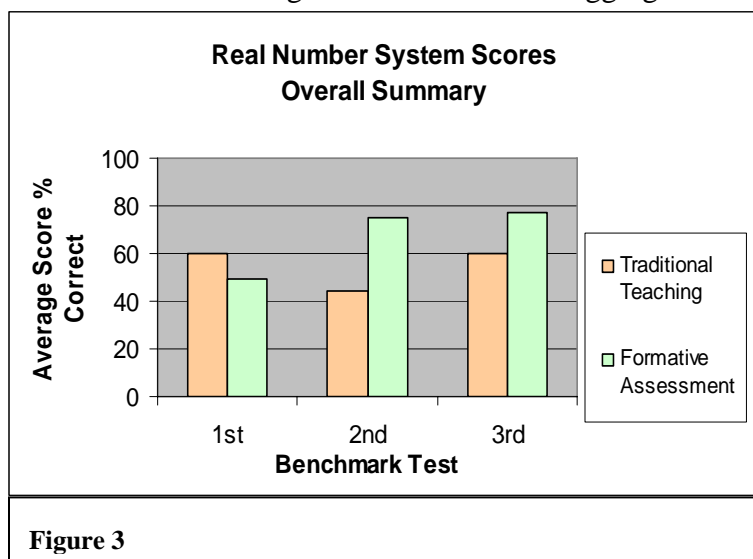
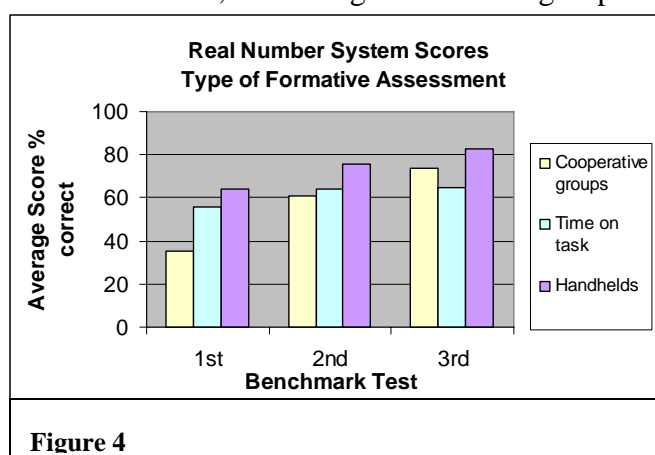


Figure 3 shows the impact of this project on overall student performance. Students who received traditional one-time teaching scored high in the beginning, around 60 percent, then fell to 44 percent before returning to their original 60 percent when the 3rd benchmark test was

completed -- no change in the results.

This differs from students in the group that had the weekly mini-lessons and completed formative assessments. These students began comparatively low, at 49 percent average score. For all of these students, regardless of what mode the assessment took, their scores rose to 75 percent average by the second benchmark test. Between the second and the third Benchmark test, the material was not routinely revisited, nevertheless, these students continued to increase to 77 percent on average-- a continual climb.

Examining the different modes for completing formative assessments produces similar positive results. For the three different modes of interventions, the average score of all groups improved. In Figure 4, the improving results are clear. Students who participated in only the time on task intervention, improved from 56 percent correct on

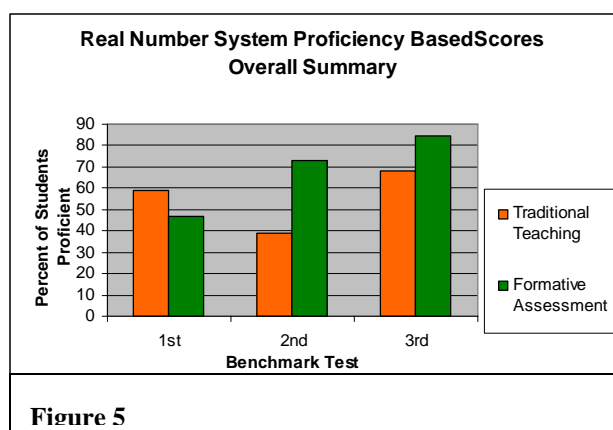


Benchmark Test 1, to 64 percent on Benchmark Test 2, before finishing at 65 percent on Benchmark Test 3. Starting out at the lowest percent correct, 35 percent, students who received the cooperative learning intervention moved up the most and ended up at 74 percent correct which is a drastic improvement even though no additional teaching occurred. Starting at a high average score of 64 percent, the students who used handhelds for ease of formative assessments, improved to 76 percent correct. This group ended at the highest level of the three different modes of taking assessments with an average score of 83 percent correct.

Student Proficiency Results

The previous information compares average scores of different student groupings. In light of NCLB, the State of Kansas looks at the level of proficiency, defined as 58 percent correct and says that in 2007, 67.2 percent of students must be above this level. Using this view, the results of this study are somewhat different.

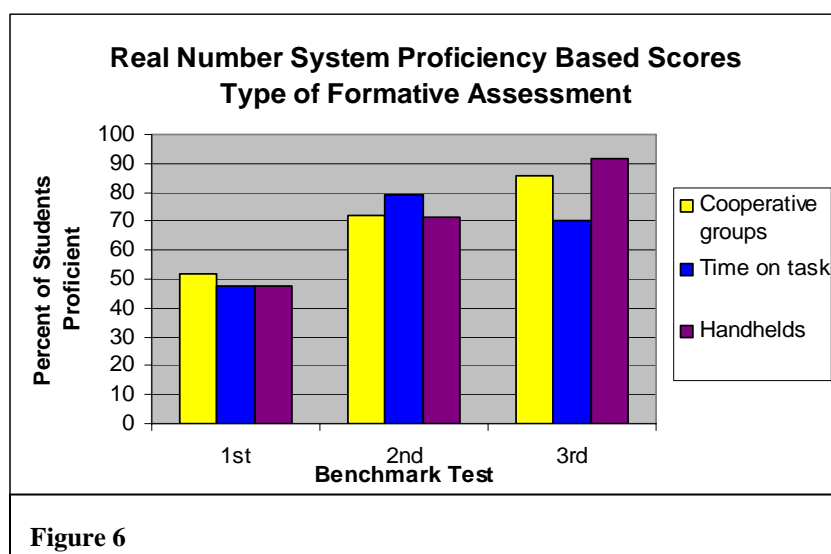
With the traditional teaching method, the percent of students who are proficient began at 59 percent, fell to 39 percent, and then increased to 68 percent by the completion of Benchmark Test 3, see Figure 5. Recall, that these particular students did have an additional lesson on the Rational Number System before the third test. With the requirement of 67.2 percent proficiency, these students would be considered just making AYP. For



the students participating in formative assessments, at first 47 percent were proficient, rising to 73 percent proficiency before ending at 84.6 percent -- making AYP.

Again, if the mode of formative assessment delivery is examined, favorable results occur. Students completing the cooperative grouping for formative assessments went from a failing proficiency rate of 52 percent, to 72 percent, before rebounding back to 85.7 percent for Benchmark Test 3, see Figure 6. This result for this group is clearly proficient.

Students who received the time on task instruction started at 47 percent proficient, a failing rate, before improving to 79 percent proficient for Benchmark Test 2 and falling slightly to 70.2 percent for

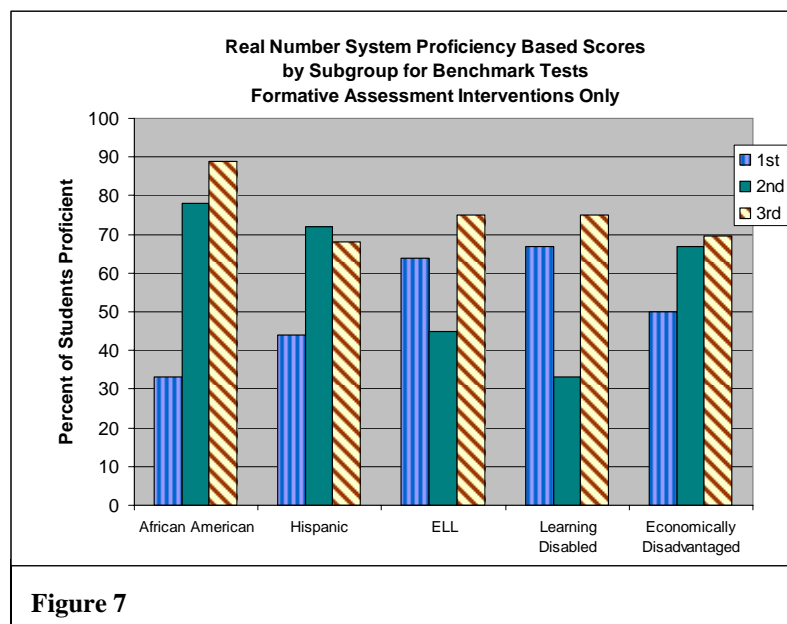


benchmark test 3. Although, this group had the highest proficiency rate after the second benchmark test, their score dropped a little and all of the other groups significantly outpaced their performance.

The group we are considering, the students that used handhelds for ease of formative assessments, began at 47 percent proficient, which is a failing rate. This group initially improved to 73 percent proficient - a large increase. At the end of the period, the group that used handhelds for ease of formative assessments increased to 91.6 percent proficient--near perfection.

In the end, the group that used the handhelds remained at the highest level of proficiency of all interventions that occurred. This would imply that using handhelds for ease of formative

assessments is more effective than time on task and cooperative learning strategies. This is the most significant positive finding in this analysis.



Subgroup Results

A brief analysis of the information by subgroups for students who participated in formative assessments proves informative. From Figure 7, the results show that most of the subgroups improved between the first and the second benchmark test and

every subgroup improved between the first and the third benchmark test. The largest growth, with the African American subgroup, shows a nearly tripling of proficiency levels. All of the subgroups scored the minimum 67 percent proficiency level. In terms of the implementation of NCLB, the students who participated in the formative assessments can be considered passing this indicator.

Teacher Results

The administration effort for this topic varied across assessment mode. In all classes, creating and discussing the real number system through the graphic organizer seemed to work smoothly. What was challenging is how to handle absent students which was not considered. Although all students were given the opportunity to catch up during the next mini-lesson, it became more difficult over time as the same students seemed to be missing multiple times. Additionally, students who moved into the school were excluded, because they did not

experience the continuum of learning. Finally, students who moved away were also excluded from the data analysis. In total, eighteen students out of around 190 students were excluded from the results. This is relatively small when considering the data just was not available. No students were randomly excluded from the data analysis.

The creation of the portfolio helped to keep the students organized. The students seemed highly engaged with the kinesthetic creation of the real number system through the graphic organizer. This served to reduce classroom management issues. Portfolios were never allowed to leave the classroom, because 8th grade students lose papers. With paper and pencil tests inside the portfolio, students were able to reflect on their mistakes. Additionally, the section of the portfolios that recorded student performance helped the students to recognize their progress.

Students who participated in the cooperative learning approach to testing were placed into heterogeneous groups. Interpersonal dynamics became apparent, as students had to be reassigned to different groups. Some students actively participated in the cooperative learning structure while others refused to respond in any manner. This group of students seemed to like the instant grading response.

Those students completing formative assessments with bubble sheets had to wait the longest for their results. Before the teaching of the next concept, this group reviewed their results. A few students complained that this took too long for them to know how they performed. The length of time to administer their formative assessment was shortest.

Lastly, the group that completed formative assessments with handhelds experienced several delays. The process involved was for students to take the tests through Classroom Wizard's Dynamic Mode. This means that students had to stand in line to get their test from the teacher's computer, answer the test, and then beam the answers back to the teacher's computer.

Students were told they could use any part of their classroom period to get these steps done.

Despite their best efforts, there was a line of up to fifteen students long to either get the questions or send back the answers. This caused some minor classroom management issues but nothing insurmountable. With WiFi or Bluetooth capable handhelds, this could be done from student desks mitigating this factor.

CHAPTER 5 CONCLUSION

This project, determining if handhelds were effective for ease of formative assessments, provided positive results. At initial glance, the data supported the use of this technology. After further analysis and reflection on the data, these results are reaffirmed. Students who used handhelds and time on task interventions ended with a 92 percent proficiency rate, which is an incredible increase from the initial rate of 48 percent. Students who used cooperative learning and time on task ended with an 86 percent proficiency rate, a passing grade. Lastly, students who used only time on task scored 70 percent proficiency, a passing grade. All subgroups who participated in the formative assessments also passed.

This project attempted to control for time on task. Additionally, similar lessons were taught to all students and identical expectations were presented. Although this test was completed on only one tested indicator in one classroom, the results are sufficiently positive to consider generalization to a larger population.

A few things might make this project more meaningful when expanded to the general population. First, the use of Bluetooth or WiFi would improve classroom efficiency. Alternative methods of assessment should be considered. Additional tested indicators should be measured to determine if these results are unique to the Real Number System or another indicator that looks at categorization.

With these suggestions being made, it is encouraging to know that handheld technology for ease of use of formative assessments can have a positive impact on student performance. In today's world of high-stakes testing, the classroom teacher must find every way possible to improve student learning and retention. It is academically sound that handhelds belong on the continuum of teaching and learning in a modern classroom.

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