The Relationship Between Double Dosing and Middle School Math Student Achievement

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ABSTRACT

This study examined the following research question: Is there a significant difference in math performance between the total sample of below grade level 6th, 7th, and 8th grade students engaged in double dosing and the sample of below grade level 6th, 7th, and 8th grade students not engaged in double dosing? Double dosing means pulling struggling students from elective classes during the school day in favor of an extra remediation class generally in the areas of reading, writing and math. The practice of double dosing is more prevalent within the elementary schools; however, as a result of the high stakes brought about through No Child Left Behind (NCLB), the practice is gaining popularity at the secondary level. The literature supports instructional time being positively correlated with student achievement; however, the literature is limited and dated regarding double dosing and remediation as sources for this increase in time. An independent samples *t*-test was utilized to compare existing data in the form of grades and standardized test scores between a total sample (N=109) of below benchmark middle school students who were and were not double dosed. Statistically significant results were found between the dependent variable of standardized test scores and the independent variables: math lab (M=60.48) and no math lab (M=51.93), t=-1.848, p=. 004. Likewise, statistically significant results were found between the dependent variable of grades and independent variables: math lab (M=3.77) and no math lab (M=3.27), t=2.449, p=. 0001. The findings provide evidence that there is a significant difference in middle school math achievement between students who are and who are not double dosed. This study may be used to inform K-12 school districts, policy makers, school reform, as well as future research.

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Chapter 1

Introduction

"If students are to be held more accountable for their academic performance and held to high educational standards, schools must provide adequate opportunities for students to meet expectations on timeò (U.S. Department of Education, 2009).

In the type of educational environment that exists today as a result of No Child Left Behind (NCLB) and with the varying backgrounds of students (i.e. English Language Learners-ELL, Special Education-SPED, Socio-Economic Status-SES), school districts are forced to adapt. Schools are also under the added pressure of federal mandates, ratings, and possible penalties of withheld monies, and/or staff take-over. The sense of urgency within school districts has escalated. New systems, new strategies, and new interventions are constantly being explored in attempts to increase student achievement. The pressure of NCLB, political demands, the achievement gap of many of our sub groups (i.e., ELL, SPED, Low SES), high stakes testing, and higher graduation requirements has increased the stakes for every educator, student, and parent throughout the K-12 landscape. This sense of urgency is apparent at the middle-school level and has initiated immediate and consistent reflection on current practices (Malmgreen, McLaughlin, & Nolet, 2005).

Research documents that increasing standards-based instructional time for struggling students is one of the most effective academic interventions if done by a trained teacher (American Federation of Teachers, 1997). Extending learning time for students can happen in several ways. Schools can use flexible and creative scheduling during school hours or extra time outside of the regular school day (Cosden, 2001).

There are after-school programs, Saturday school, and summer school in many schools. Schools can also add an extra period in the problem subject area. This intervention strategy is called remediation or ñdouble dosingò (Hanley, 2005).

For the purpose of this study, I focused upon the intervention strategy commonly referred to as ñdouble dosingò and this study looked at the effect in math achievement. Double dosing is an intervention strategy widely used at the elementary level intended to catch students up in the area of reading. Intervention programs such as Read 180 and Language Exclamation Point are two interventions that require ninety minutes of remediation instruction in conjunction with regular instruction within the classrooms. At the secondary level, school districts are steadily beginning to employ double dosing in reading and math, sacrificing elective courses. Schools are pulling students from electives and placing them in remedial classes in conjunction with their regular grade level class. The premise behind double dosing or remediation makes sense; however, it comes at the cost of elective offerings and programs.

An emerging consensus of research and expert opinion is that it is important to build the basic or foundational skills in mathematics of all students who need remediation, while also providing them with access to grade level concepts and content (National Council of Teachers of Mathematics, 2006). This double dosing is the foundation to Response-to-Intervention models commonly referred to as RTI. Response-to-Intervention (RTI) models provide an excellent venue for accelerating achievement in foundational skills and proficiencies. In an RTI model, students receive daily help learning not only so-called ñbasic skillsò (i.e., mathematics facts and computation) but also higher order skills, such as problem solving, and the critical content in the discipline.

Increasing instructional time for struggling learners has been prevalent in the post-secondary environment through remedial math courses; however, remediation of secondary school children has not routinely been offered during the school day. School districts have often relied on interventions such as after-school tutoring and/or summer school (Attawell, 2006; Bahr, 2007). However, the introduction of NCLB, changes to Individuals with Disabilities Education Improvement Act (IDEIA), and the onset of RTI have begun to change the delivery of remediation to students (Wirt et al., 2004). Schools are offering remediation during the school day in the form of double dosing.

Providing a curriculum that challenges and motivates students is another difficult task for remedial education but is essential to success (Bahr, 2007; Bahr, 2008). Remedial instruction must be more than simply repeating instruction (Bahr, 2007). Repeating the same instruction that the students did not understand the first time will not assist students in gaining the needed concepts. Students must be taught by using engaging curriculum. Bahr (2007, 2008) has found that the depth and breadth of the curriculum can affect student success. ñDepth of remedial instruction need refers to degree of deficiency in a given subject, while breadth of remedial need refers to the number of basic skill areas in which a given student requires remedial assistance (Bahr, 2007, p. 698). The challenge of creating a curriculum that is engaging and at the correct depth and breadth for a class of individual students is difficult (Gersten et al., 2009). Remedial math instruction, which includes explicit and systematic instruction, must also provide opportunities for students to work with visual representations of math, with devotion of at least 10 minutes per class to build fluent retrieval of basic math facts (Bahr, 2007). Building and teaching an engaging curriculum that fits the needs of individual students is essential in the success or non-success of a secondary remediation or double dosing program.

Due to NCLB, students across the country are required to show proficiency in reading and math in order to graduate from high school. For many students, these expectations, although understood and needed to help ensure success in college or the work force, are quite daunting. As a result of these expectations school districts across the country, despite decreasing staff and resources, are charged with finding ways to catch students up in the areas of reading and math. With this added emphasis on the tested subjects of reading and math, elective classes such as band, art, and shop are perceived as expendable. School districts are replacing these classes with more reading and more math classes. There is an ongoing divide in education about what schools should be focusing on: more core classes or the ñwhole childò approach with more elective offerings. In schools today, one can assume that schools that incorporate numerous interventions such as double dosing may, in fact, not have electives such as art and band. Should schools and school districts reallocate their FTE (Full Time Equivalent) or teachers from elective programs such as band and wood shop move into school-wide interventions such as double dosing? Will double dosing yield the results needed in preparing students to graduate from high school? Despite the popularity of the double-dose strategy, there has been little research on the implementation of these reforms, or on their effectiveness.

Statement of the Problem

The purpose of this study was to examine the effectiveness of double dosing in math at the middle school level as indicated by the academic performance of a sample set of 6^{th}, 7^{th}, and 8th grade students who are below benchmark in math as measured by grades and standardized testing. Specifically, I used a quantitative analysis using existing data to ascertain the relationship between academic performance to an increase in instructional time through math labs that focused on pre-teaching and remediation. The objective of the study was to gain greater understanding about the connection of math achievement in below grade level middle school math students to double dosing.

Research Questions

Research Question #1:

Is there a significant difference in math performance between the sample of below grade level 6^{th} grade students engaged in double dosing and the sample of below grade level 6^{th} grade students not engaged in double dosing?

Research Question #2:

Is there a significant difference in math performance between the sample of below grade level 7^{th} grade students engaged in double dosing and the sample of below grade level 7^{th} grade students not engaged in double dosing?

Research Question #3:

Is there a significant difference in math performance between the sample of below grade level 8th grade students engaged in double dosing and the sample of below grade level 8^{th} grade students not engaged in double dosing?

Research Question #4 (This question was tentative depending on sample size):

Is there a significant difference in math performance between the sample of below grade level English Language Learners engaged in double dosing and the sample of below grade level English Language Learners not engaged in double dosing?

Research Question #5 (This question was tentative depending on sample size):

Is there a significant difference in math performance between the sample of below grade level Special Education students engaged in double dosing and the sample of below grade level Special Education students not engaged in double dosing?

Key Terms

Double Dosing: Double dosing refers to pulling students from elective classes during the school day in favor of a remedial class in one of the core subject areas. Core subjects generally include reading, writing, and math. Double dosing is also used for enrichment purposes in some schools.

Growth Percentile: The growth percentile provides context for a studentės progress from year to year. It provides a comparison of the studentės growth compared to all other students in the state with the same test scores in previous years.

Growth Target: Growth targets are assigned by the Oregon Department of Education (ODE) to students who did not meet the benchmark the previous year on the state assessments. If students who are below benchmark keep meeting their growth targets every year then theoretically the likelihood that they will meet the benchmark their junior year increases. Growth targets are measured via the Oregon Assessment of Knowledge and Skills (OAKS).

No Child Left Behind (NCLB): Federal Law passed in 2001 under the George Bush Administration that placed more accountability on how students perform in the areas of reading and math.

OAKS: Oregon's state assessment known as the Oregon Assessment of Knowledge and Skills. OAKS reading and math are given in grades 3-8 and in high school. Science is given in grades 5, 8 and in high school. High school students in Oregon must pass reading and math or successfully complete a reading and math work sample in order to graduate.

Proficiency Grading: Proficiency grading refers to allowing students multiple opportunities to show proficiency on the standards. Students are not deducted points for late work and students are allotted multiple opportunities to retake assessments. The goal of proficiency grading is to ensure that the grades students receive are indicative of student proficiency of the content standards.

Standards-Based Grading: Grading based primarily on the state standards. Behavior elements such as extra credit and lateness are completely taken out of a student's grade. The goal of standards based grading is to ensure that the grades students receive are more indicative of student proficiency of the content standards.

Typical Growth: The amount of growth students who score in a certain range on OAKS generally grow from year to year. Typical growth for low scoring students ranges between 4 and 5 points. It is important to note that below benchmark students are looking to meet their growth targets, which are above their typical growth.

Limitations and Delimitations

This study was a comparative quantitative design that looked at the differences in achievement between two groups of below-benchmark math middle school students. Existing data from the 2012-2013 school year was utilized. One group of students was double dosed while the other was not. Two forms of measureable data were used centered upon scores from the Oregon Assessment of Knowledge and Skills (OAKS) and student grades received in grade level math classes. An inherent disadvantage to this type of study was the obvious lack of anecdotal testimony from the students and teachers as to the effectiveness of double dosing. The perceptions of students and teachers would be significant sources of data in an effort to successfully triangulate the effectiveness of the double dosing strategy. Because of the use of existing data, the samples were already chosen not allowing for as much control of certain variables that could potentially influence the study. Additional limitations included: 1) Not accounting for type of instruction utilized within math lab or regular math class, 2) Background information on whether or not students involved in double dose have received double dosing prior to the 2012-2013 school year, and 3) Family backgrounds of students.

Utilizing a comparative quantitative design with existing data provided a significant glimpse into the relationship between double dosing and student achievement. Due to the fact that the Oregon Department of Education (ODE) has adopted the Colorado growth model, I was able to see how students fared in comparison to students who scored similarly the previous two years. The growth model was an appropriate model because it provided the opportunity for fair comparison of student scores despite English Language Learner (ELL) or Special Education (SPED) designation. The parameters for the data collected included: the groups utilized were from the 2012-2013 school year. The groups received similar instruction within the double dose; however, specific pedagogical philosophy per individual teacher was not analyzed.

Chapter 2

Review of the Literature

Introduction

In this section, I review the research surrounding secondary (6-12) remedial math instruction or double dosing and its impact on math achievement for struggling students. Specifically, the following is addressed: (a) a review of the No Child Left Behind Act which has precipitated intervention strategies such as double dosing; (b) Response-to-Intervention; (c) the definition of double dosing; (d) the possible positive and/or negative results for students and schools who double dosing in math; (e) the overall effectiveness of math double dosing and the reasons why it was effective or ineffective (f) gender differences as it relates to math achievement, and (g) ELL and Special Education designation as it relates to math achievement. Data are reviewed from schools employing double dosing as a primary mode of math intervention. I also identify gaps in the research and offer suggestions for future research are brought forth.

No Child Left Behind

The No Child Left Behind Act (NCLB) was passed by legislators in 2001, and with its passing the landscape within education was forever changed. With NCLB came an increased emphasis on standardized testing in the subjects of reading and math. Schools and school districts are held more accountable for the achievement of their students in the areas of reading and math. More emphasis was placed on the performance of subgroup populations: Special Education, English Language Learners, Low Socio-Economic Students (SES), Hispanic, and African-Americans.

NCLB is based upon four pillars that include stronger accountability for more results, more freedom for states and communities, proven education methods, and more choices for parents. The idea behind NCLB is to improve the education of the children of the United States.

The first pillar of NCLB is more accountability for more results. With the passing of NCLB states are required to create content standards to be measured by a state created standardized test. In Oregon, this state assessment is known as the Oregon Assessment of Knowledge and Skills (OAKS). The OAKS is given to students in the areas of reading and math beginning in the 3rd grade and is given every year through 8th grade. Once a student is in high school, he/she has four years to pass the OAKS. Standardized test scores are also used to determine student promotion from one grade to the next (US Department of Education, 2004).

Student performance on OAKS is used to create the annual state and local school district report cards mandated by NCLB. From these report cards schools, school districts, and states, are issued a Federal rating noting Adequate Yearly Progress (AYP). Schools that receive federal funding are subject to federal sanctions should they not meet AYP. Sanctions include but are not limited to offering parents a choice to leave neighboring schools, or to the outright firing of administrators and teaching staff.

The second pillar of NCLB involves more freedom and flexibility for schools, school districts, and states. Although NCLB is about providing increased accountability for student performance, there is also unprecedented flexibility in what that accountability looks like. For example, states can decide what type of test is given and how often the test is given. States can determine the minimum subgroup size for accountability. States can also use Federal funds with increased flexibility depending on the schoolsô needs (US Department of Education, 2004).

The third pillar of NCLB involves the utilization of best practices according to research. Schools that receive federal funding and are designated ñNeeds Improvementò because of failure to make AYP must incorporate research-based instruction and programs. Educational programs, staff development, and/or after school programs are examples of research based assistance and are supported federally through NCLB.

The fourth and final pillar of NCLB involves school choice for parents. Schools that receive the ñNeeds Improvementò mark must offer transfers to parents who wish to leave the school. Districts must provide transportation should a student decide to transfer and the school must continue with any supplemental services that were previously provided the student(s).

NCLB has changed how we operate in K-12 education. It has brought about more accountability and districts are particularly more cognizant about subgroup achievement. This accountability is generally seen as a positive. The increased accountability in the areas of reading and math has forced districts to implement more interventions within these areas for students who are below benchmark. Unfortunately as a result, electives have been sacrificed as to provide more instruction in reading and math. We have seen NCLB also affect other education legislation including the Individuals with Disabilities Education Improvement Act (IDEIA). In 2004, IDEIA was reauthorized and aligned with the goals of NCLB. In both Acts, the emphasis is on best practices research, with the main focus on early, targeted interventions (Hanley, 2005).

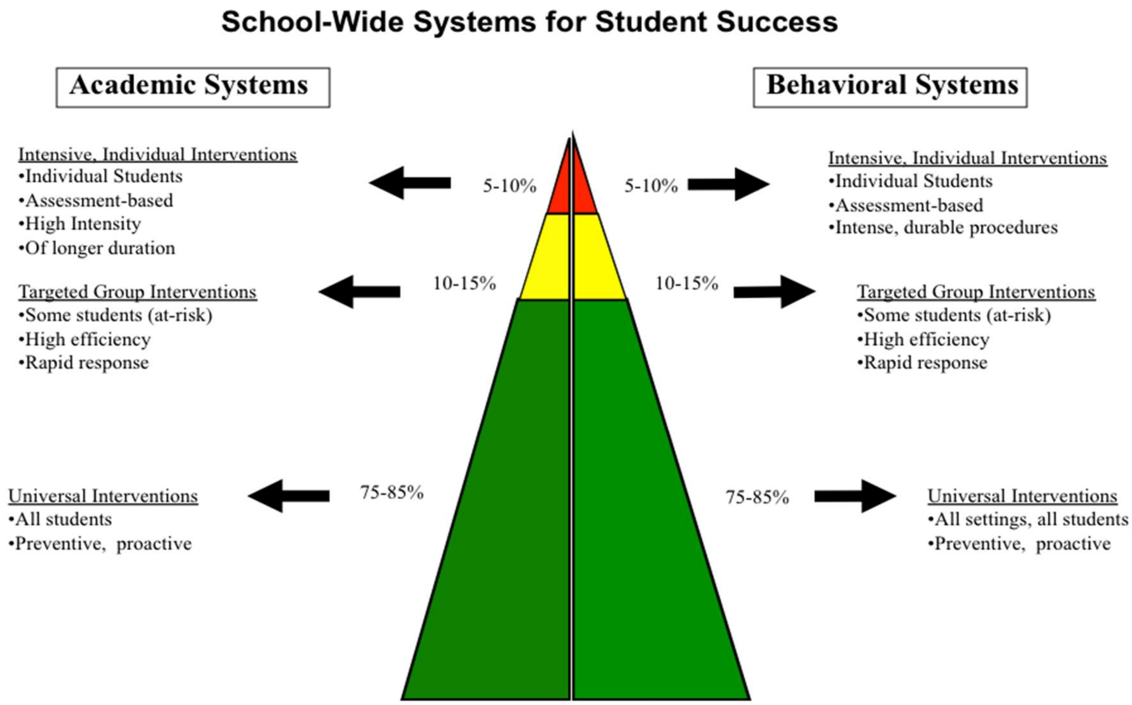
Response-to-Intervention (RTI)

Response-to-Intervention (RTI) is the practice of providing high-quality instruction and intervention matched to student need, monitoring progress frequently to make decisions about change in instruction or goals and applying child response data to important educational decisions (NASDSE, 2005). RTI is a process described in IDEIA 2004 for identifying students with learning disabilities. IDEIA legislation introduced RTI and invited ñschools to use 15% of their special education money for regular education interventionsò (Johnston, 2010, p. 602). RTI is either required or offered in all states. In Oregon it is not required; however, many districts are utilizing RTI. Oregon's RTI Initiative (OrRTI) is intended to provide skills and knowledge districts need to build systemic, accurate, and sustainable academic support for all students, and provide guidance to districts to support implementation of IDEIA policy for RTI (Oregon Department of Education, n.d.). In 2005-2006, ODE partnered with the Tigard-Tualatin School District (TTSD) to provide training and technical assistance to participating districts. TTSD has developed a RTI training program for ODE, as well as assisted 42 school districts with implementation. New districts are added to this program every year in an effort to reach all parts of the state (Oregon Department of Education, n.d.).

Oregon has adopted four Core principles within its RTI framework:
(a) Use research-based scientifically validated interventions/instruction; (b) Monitor student progress to inform instruction; (c) Use data to make decisions. A databased decision regarding student response to intervention is **central** to RTI practice; and (d) Use assessment for screening, diagnostic and progress monitoring purposes. Oregon school districts that chose to implement RTI adopted this framework, but were given

autonomy to develop a system of support suitable to their needs. Conceptually, Oregonφs RTI framework warrants the incorporation of academic and behavior systems as modeled below through the Positive Behavioral Interventions and Supports (PBIS) triangle. Generally, schools use double dosing as a yellow or red zone academic intervention.

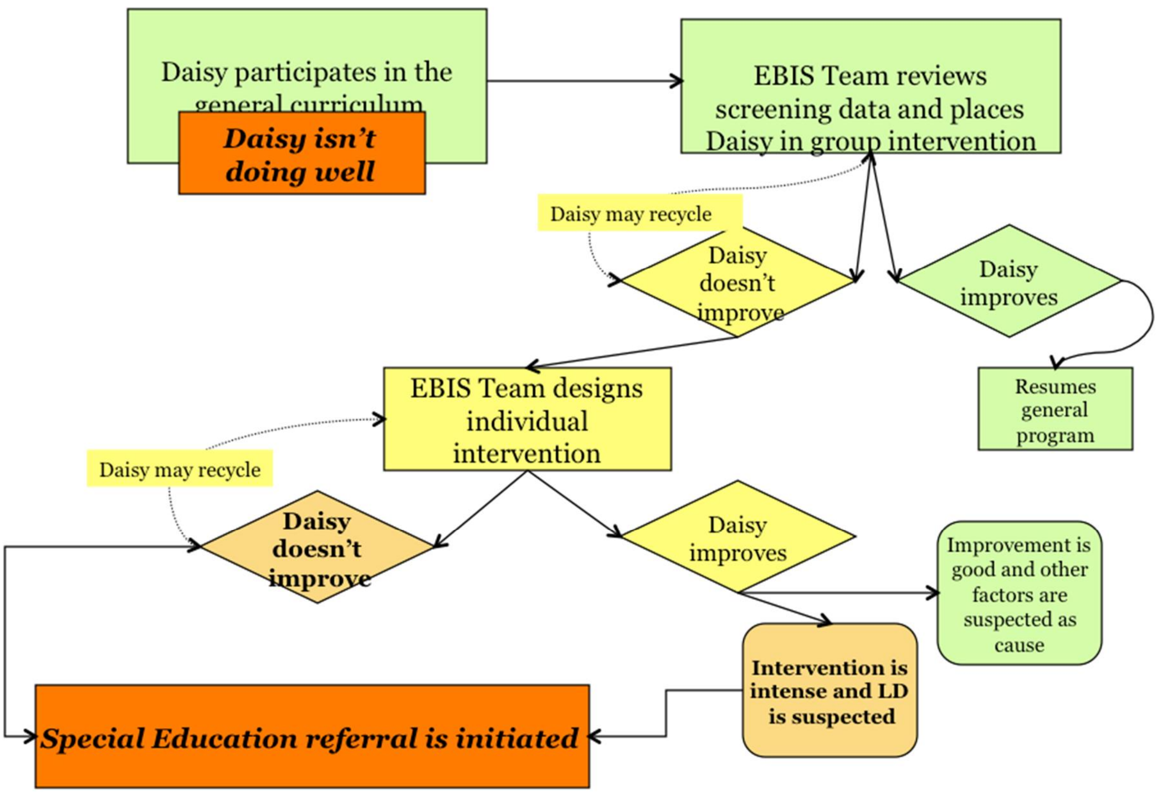
***Figure 1*. School-Wide Systems for Student Success**



(Note: from *Tigard-Tualatin School District*, (n.d.), Oregon Department of Education.)

As previously stated, Oregon districts were granted autonomy in how to implement RTI. Most districts chose to implement a model of delivery similar to Tigard-Tualatin School Districtφs model. Tigard-Tualatinφs School Districtφs model involves a very specific process of an RTI team, specific targeted interventions, and consistent progress monitoring. The diagram below represents Tigard-Tualatinφs RTI delivery model and is provided to show the importance of incorporating school wide interventions for struggling learners. Interventions can range from after-school homework club, to tutoring, to Saturday school, but because of resources, cost, and perceived effectiveness, more schools have decided to employ double dosing during the school day.

***Figure 2*. Possible RTI Model of Delivery**



(Note: from *Tigard-Tualatin School District*, (n.d.), Oregon Department of Education.)

The sanctions imposed by NCLB and the push from IDEIA to implement a system of support for struggling learners has forced schools to look for research-driven interventions to assist students not meeting the required standards. Research-driven teaching strategies, tutoring, and summer school programs are all viable interventions to be utilized; however, time requirements and cost may be a reason for schools to look at additional interventions to assist struggling students. Remedial programs through double dosing, which could serve as an intervention, are a resource that schools can use to address student discrepancies.

Double Dosing

Schools around the country are asking the question of whether or not more time can make up for a studentôs lack of readiness as they create specialized programs to offer increased instructional time for underachieving students. In theory, more time on concepts in which the student is deficient would help the student catch up. Increased instructional time can happen through after-school homework club, tutoring, or increased time during the school day. Increasing the amount of instructional time for a struggling student in the form of an extra class during the school day is the basis for a common approach known as ñdouble dosing.ò The double-dosing strategy is an intervention utilized by schools at all levels due to the increased accountability of NCLB and is utilized as a RTI, or multi-tiered intervention (MTI) strategy. Since double dosing is the intervention strategy of placing struggling students in regular general education courses but supplementing those courses with additional instructional time, generally, the extra class offered the struggling student is a remedial class in one of the core content areas of reading, math and/or writing. The extra mandated class takes the place of an elective class or a physical education class. Double dosing has generated modest short-run gains in some settings and no gains in others. Perhaps because of perceived effectiveness at raising short-run achievement levels, the double-dose strategy has become increasingly common, with half of large urban districts reporting it as their most common form of support for struggling students (Nomi & Allensworth, 2009).

Colleges and universities have provided remediation to students for many years.

Student scores on entrance exams and/or standardized testing, such as the ACT and SAT, are used to determine if students will be required to take remedial courses in reading, writing, and mathematics. According to a study published in 2000 by the U.S. Department of Education, 22% of entering college freshmen were enrolled in a remedial math course (Wirt et al., 2004). While remedial courses, specifically math courses, have been prevalent in the post-secondary environment, remediation of secondary school children has not routinely been offered as a course during the school day. However, the introduction of NCLB, changes to IDEIA, and the onset of RTI have begun to change the delivery of remediation to students. Schools are required to provide struggling students with support using the RTI model. Students who are not successful in the classroom or do not meet the standards on standardized tests are moved into interventions.

Positive Results of Double Dosing. Numerous studies indicate that increasing the amount of time spent in mathematics instruction is positively correlated with student achievement. A finding in *The Nations' Report Card: Mathematics 2000, NAEP* showed that the average scores of 4th and 8th graders generally increased as the amount of instructional time for mathematics increased. Furthermore, the way in which time is utilized in mathematics class can be paramount to the degree of student achievement. Additional time is recommended to be spent in direct instruction as opposed to seatwork or written drill. The 1999 Third International Mathematics and Science Study (TIMSS) video study indicated that nations scoring higher than the United States on tests of mathematics achievement in 8th grade devoted more time on the average to studying new content (a range of 56% to 76% of lesson time) than reviewing previous content. In the United States, there was no detectable difference between the average percent of lesson time devoted to reviewing previous content and studying new content (53% and 48% of lesson time, respectively).

Research has long demonstrated the important relationship between time spent on instruction and student learning outcomes (Clark, McGrath, Orlone, & Suarez, 1991). This relation is stronger when the time is spent on instructional strategies that are appropriate for studentsô individual needs. Woodward, Baxter, and Robinson (1999) indicate that some low-achieving students require considerable time to learn certain math concepts, time that teachers often underestimated. The amount of math instruction schools provide to students with disabilities and other struggling learners and the scheduling arrangements schools use to deliver instruction may therefore affect student math outcomes.

Double dosing enables teachers to address puzzling problems in unorthodox ways. Not only do double dosing opportunities present more time for work on foundational math concepts and vocabulary, but they present extra time for more work outside of the math text book, which can be confusing for many low achievers (Kohn, 2006). Many teachers voice frustration over studentsô refusal to do homework. Some students receive little encouragement from parents, who often work late and arenôt there to prod their children (Flemming, 2011). The extra period allows teachers to devote some of that time for assignments that students would normally be expected to do at home.

The extent of the studentsô opportunity to learn mathematics content bears directly and decisively on student mathematics achievement. Opportunity to learn (OTL) was studied in the First International Mathematics Study (Husén, 1967), where teachers were asked to rate the extent of student exposure to particular mathematical concepts and skills. Strong correlations were found between OTL scores and mean student achievement scores, with high OTL scores associated with high achievement. The link was also found in subsequent international studies, such as the Second International Mathematics Study (McKnight et al., 1987) and the TIMSS (Schmidt, McKnight, & Raizen, 1997). Based on these findings, research seems to suggest that it may be prudent to allocate sufficient time for mathematics instruction at every grade level, thus calling into question short class periods in mathematics, instituted for whatever practical or philosophical reason.

While teaching remedial math courses can be a challenge for educators, remediation has been shown to improve the math performance of students in secondary schools (Bottge, Chan, Heinrichs, & Serlin, 2001; Fletcher, 1998; Mross, 2003; Schultz, 1991). Research completed by Bottge et al. (2001) and Fletcher (1998) revealed that middle school students taking remedial math courses were able to improve their grades in mathematics after remediation. Secondary education students participating in the research completed by Fletcher (1998) were said to go from failure to honor roll. Students in these remedial programs gained organizational skills and increased understanding.

A diverse set of reformers and policymakers argue that growing numbers of students are leaving high school lacking the math skills necessary to succeed in college and careers (Grubb, 1991). Consequently, states and districts have sought to increase the rigor of math coursework both in the middle grades and in high school. Despite these efforts, many students are still entering high school unprepared for Algebra I, which is the gateway course for more advanced math. In response to the problem of weak math preparation, districts and schools around the country are developing curricular supports for struggling high school students. Double dose algebra in which less-skilled students take two periods of algebra in one year is one such support strategy that is growing in popularity. The two-period time block allows teachers more flexibility in teaching grade level content in conjunction with remediation (Nomi & Allensworth, 2009).

In 2003, Chicago Public Schools (CPS) became an early adopter of the double dose algebra strategy, requiring all 9th graders with low entering test scores to take two periods of algebra. To inform double dose efforts in Chicago and nationally, researchers at the Consortium on Chicago School Research (CCSR) at the University of Chicago spent two and a half years studying the implementation of the double dose algebra policy in Chicago. They found that the double dose algebra strategy, when accompanied by additional supports for teachers, had significant promise for improving the academic skills of all students. Yet, while Chicagoôs double dose policy improved studentsô math test scores, it also led to higher failure rates and lower grades among students enrolled in regular single period algebra courses. This is a substantial concern because grades and course failures are strong predictors of important outcomes like high school and college graduation. Thus, even successful reform efforts like double dose algebra may not lead to sustained improvements in later student outcomes without a set of complimentary efforts to improve studentsô effort and grades (Nomi & Allensworth, 2009).

Schools and districts in a number of states employ double dose instruction as a student support strategy, and some have seen higher test scores among students who are enrolled in the classes. Some schools offer one instructional period followed by a second ñshadowò or ñsupportò period, while others utilize block scheduling that changes the length of one class to two periods (Chait, 2007). For example, in Maryland, more than half of all high schools offer extended instruction time or double dose class periods to 9^{th} graders (Balfanz & Letgers, 2004), and a study of students in Baltimore reported that those in double dose classes scored a half-year higher on standardized tests (Legters & Kerr, 2000). Many Catholic schools have traditionally enrolled struggling students in two periods of a subject when they seem unprepared for high school curriculum, and their test scores have been higher than those of public schools (Bryk et al., 1993).

Another example of double dose instruction occurs within the Talent Development High School Model, a comprehensive reform model being implemented in 15 states and the District of Columbia. The model high schools offer double dose instruction as one of several supports that have produced positive effects on student achievement in Baltimore and Philadelphia (Balfanz et al., 2004). Surveys revealed that 75% of students in Talent Development High Schools felt they understood math better because of their specific class, compared with 53% of students in other schools with similar characteristics. A 2005 study found students in Talent Development schools showed improved attendance rates, course completion, and promotion rates; however, evaluations of Talent Development schools have not examined the effectiveness of the double-dose strategy on its own without the other instructional supports.

While it is clear that the math achievement of students increased as a result of remediation, this achievement has varied and has not been consistent in regards to achievement measured by grades and test scores. Researchers have failed to conclude the impact of remedial instruction on standardized testing. A limited number of research studies on secondary remedial math courses examine standardized test scores. These studies do reveal significant improvement on standardized test scores after the completion of a remedial math course (Mross, 2003; Schultz, 2001). In the age of NCLB and RTI, standardized test improvement is extremely important for students and school systems. Improving standardized test scores can assist students in grade level promotion and schools in making AYP. However, despite positive results, the studies are limited and dated. More research is needed before concluding that remedial math courses can assist students in increasing their standardized test scores.

Negative Effects of Double Dosing. There is sufficient anecdotal evidence that the high stakes testing environment and lack of resources in K-12 education may lead to fewer elective opportunities for our students. The elective courses are being replaced with a double dose remedial math or reading classes intended to help raise achievement in tested subjects. Although other strategies could be adopted, such as after-school tutoring, this solution provides the least amount of disruption to the school day and also costs the least amount of money (Ashford, 2004). Therefore, from an administrative standpoint, elective replacement seems a logical solution. However, in classes such as a music ensemble, in which each student relies on the others for success, this kind of policy can sabotage the success of the entire group, particularly if students are pulled out or added midyear. In other arts classes, a student who is withdrawn may lose his or her only outlet for creative expression, and may, therefore, lose interest in school altogether leading to increased probability of dropping out (Abril & Gault, 2006).

Remedial teachers, as well as principals, use ñenrichmentò (i.e., non-tested or arts) subjects to bribe or reward classes (Chapman 2004; Dillon 2006) by reminding students that they can return to their ñfunò class if they work hard in the remedial class. Although this inducement may help motivate the student at that moment, the underlying message is that the arts do not require skill, knowledge, commitment, or work, and that as long as a student produces something, the quality of performance does not matter. This kind of comment also ignores the state and national arts standards for grade appropriate performance. Students who remain in arts and music classes receive the message that the effort they have put into learning these subjects is not valued. Finally, treating arts classes as merely ñfunò courses undermines the professionalism and knowledge of any arts educator, casting them as peripheral, rather than as essential players in the studentsô education (Pedersen, 2007). These attitudes are underlined by NCLBôs allowance of schools to bypass traditional undergraduate teacher training by hiring ñteaching artistsò in place of certificated arts educators (Chapman, 2004).

The scheduling problems caused by double dosing for remedial reading or math instruction are more far reaching than just student class placement, although that is generally the first symptom noticed by classroom teachers. Some middle schools have changed their bell schedules to match high school schedules, offering longer, but fewer, class periods (Gerber & Gerrity 2007). Other schools have reduced their course offerings to only physical education, math, and reading (Dillon, 2006). A survey administered by The Council for Basic Education (2004) of elementary school principals, as cited by Abril and Gault (2006) and Chapman (2004), found that since the passage of NCLB, instructional time for tested subjects in 75% of those schools had increased and instructional time for the arts had decreased. The survey included schools from all fifty states, indicating that this problem is a national trend and is not limited to just a few states or urban or high-risk areas, although Dillon (2007), Chapman, and Frierson-Campbell (2007) suggest that the effects were more exaggerated in those schools. It is troubling that these issues are more prevalent in at-risk populations because these same students typically benefit the most from a rich and diverse curriculum.

The double-dosing math intervention may improve confidence given that students have more time to gain a deeper understanding of the subject. However, so much focus on math may harm a studentôs confidence due to a possible stigmatization developed by being pulled out of the regular math class. The student may be called out by other students or simply learn to dislike math even more if he or she does not experience success. More time may simply mean that the student is more often reminded of how poorly he or she performs in math. It is entirely possible that despite the double dose in math, students may still fail their regular math class, potentially causing increased emotional damage. Placing students in a double dose, in high school in particular, means that they must pass three additional credits to graduate high school (double-dose classes are generally for no credit) and must perform well in course assessments in order to be attractive to colleges and employers.

Ideally, the double-dose math intervention should boost studentsô abilities to succeed by earning grades higher than the minimum passing percentage in their future math classes. Further research is needed to determine if extra time in math helps a student sustain his/her proficiency the following year if the intervention is removed. A recent change in the Oregon graduation requirements entails successful passing of the math OAKS and completion of at least Algebra II in order to graduate. Students who are unsuccessful in math any of the four years in high school will put their graduation in jeopardy. The double-dose math intervention must not only catch students up to their peers, but also help students maintain a record of passing grades in future math courses in order to graduate on time.

Double dosing in math consumes significant resources. With budgets increasingly tight, increased graduation requirements, and constant pressures from district and state leaders for accountability, we can no longer afford to run programs on assumptions of success. We also need to consider possible costs to the students who we double dose. Bower cites the ñlong-term stigma and stagnation of the traditional math labò (2008, p. 29). He explains that students have suffered from being isolated from other math students and been followed by a ñstigmaò for being singled out as underachieving math learners.

As stated previously, students double dosed in math lose elective opportunities. In reality a student required to receive the double-dose math intervention gives up one opportunity to study another subject. It is difficult for decision makers to know whether or not such a ñstigmaò plagues the math labs or whether the cost of giving up the opportunity to study an additional subject is worth improving in math. Money and resources have been funneled into the math department in order to make double dosing a reality. The prevailing assumption is that the double math requirement is worth the investment, but the empirical evidence is limited.

Gender Differences in Math. When considering interventions for students, schools must look at gender to determine if a discrepancy exists. Research on gender differences in math has historically shown that boys outperform girls on mathematic assessments; however, current research reveals disparities occur in the upper grades, with the lower grade-level students showing little to no difference in mathematics ability (Ai, 2002). Research on the differences in male and female math ability is not clear as to which grade level the inequality of math ability begins to occur. Liu and Wilson (2009) showed differences at age 15, while Mau and Lynn (2000) reported differences in 10th through 12th grades. More research is needed to determine at exactly what age significant differences in ability begin to occur.

While much of the research on math ability related to gender supports equality between the sexes until the upper grades, research on standardized testing in mathematics shows significant differences in performance by gender (Liu & Wilson, 2009). Liu and Wilson (2009) reported that differences in standardized test scores between male and female students revealed a male advantage that was small but consistent. Other researchers have disputed these claims, finding that over time, growth trends on standardized tests were the same for both males and females (Din et al., 2006; Rosselli, Ardila, Matute & Inozemtseva, 2009).

In order to make learning effective for both genders, schools must consider the needs of both genders (Kommer, 2006). Teachers of remedial courses must use methods that are effective for both genders by learning to balance techniques preferred by males with techniques preferred by females. Research has provided information concerning preferred learning styles. This research reveals that since most females are left-brain dominant they learn best with concrete concepts; whereas, males are right-brain dominant and learn easily from abstract concepts (Kommer, 2006; Sax, 2006). Additional research points to social conditioning and textbook bias as a reason for gender discrepancies in math (Shaffer & Shevitz, 2001). In order for remediation to be an effective intervention, teachers of these courses must be aware of the differences in learning preference and bias that are related to gender.

English Language Learners. In the United States there are approximately five million English Language Learner (ELL) students enrolled in public schools (National Clearinghouse for English Acquisition, 2007). In some states, ELLs represent a significant subset of a schoolôs population. For example, in California, more than 25% of the public school population is comprised of ELLs (National Center for Education Statistics, 2007).

In some states the ELL population is not that large; however, the percent increase in recent years is significant. For example, in the southeastern United States the ELL population has increased more than 200% (National Clearinghouse of English Language Acquisition, 2007) in the last ten years.

The educational background of ELLs varies. U.S. public schools must adapt to ELL students who have recently arrived with little or no schooling, or interrupted schooling in their country of origin, to those with a high degree of literacy in their native language. There are also those who have been in the United States for one or two generations who have been attending school but have still not developed English language proficiency to be successful in academic settings. We commonly see these students speaking their native language in their households.

ELLs are enrolled in different programs in the United States depending on the philosophies of the state, district, and school. Many states offer bilingual education in the studentsô native language and in English. Dual language programs provide ELLs increased literacy education in their primary language while learning academic content in

English. The knowledge ELLs receive in their primary language improves their comprehension of content they hear and read in English (Secada, 1992).

In places where resources do not support bilingual education, ELL students are placed in English-only classrooms. In some schools they receive English Language Development (ELD) as part of their day. In Oregon, ELL students are required to have thirty minutes of ELD per day. Some school districts also offer newcomer programs to those who recently entered the country.

Statistics on mathematics achievement show that ELLs are significantly underrepresented in all scientific and engineering careers in direct proportion to the amount of mathematics required for a particular job (Secada,1992; National Research Council, 1989). A factor in the low levels of achievement among ELL students may be the misconception among educators that since mathematics uses symbols, it is therefore ñculture freeò and ideal for instructing students who are still learning the English language (California Department of Education, 1990). This misconception ignores the vital role of language in the development of mathematical concepts. Mathematics power is rooted in a strong conceptual understanding of mathematics, and this conceptual base is best developed through concrete experiences and language (National Council of Teachers of Mathematics [NCTM], 1989).

The relationship between language proficiency and mathematics achievement has been documented by researchers such as De Avila and Duncan (1981), who found that the low achievement of ELLs in math could be attributed to low levels of English proficiency. A lack of understanding about the role of language in mathematics instruction has led either to unreasonably high expectations for ELL achievement in situations in which they receive no linguistic support or to lowered expectations that deny equal access to mathematical skills and reasoning (Secada, 1992).

The dilemma faced by the mathematics teacher of ELLs is this: How should mathematics be taught to make a meaningful and powerful curriculum accessible to ELLs? It is also important to note that when implementing systematic math interventions for ELLs, time is not the only factor. Teachers must understand that ELLs are charged with the acquisition of a second language and content simultaneously. ñIt is critical to set both content and language objectives for ELLs. Just as language cannot occur if we only focus on subject matter, content knowledge cannot grow if we only focus on learning the English languageò (Hill & Flynn, 2006, p. 22).

Special Education Students. ñIt has long been assumed that children with moderate, mild, and borderline mental retardation or learning disabilities are not capable of meaningful or conceptual mathematical learning and, thus, unlike other children, have to be taught by roteò (Kilpatrick et al., 2001, p. 341).

The alignment of IDEIA and NCLB has placed achievement of students with disabilities in the spotlight. The expectation of both pieces of legislation is that students with disabilities will perform at similar standards as students without disabilities. The problems of students with math disabilities has been downplayed in the literature in comparison to students with reading disabilities, despite the rising numbers of low performing student in math over the last 20 years (Swanson, 2001). It is estimated that approximately 5% to 8% of children have learning disabilities in the area of mathematics (Fuchs et al., 2005; Geary, 2004).

Research suggests that less attention has been given to math deficits even though the number of children with math disabilities is comparable to that of children with reading disabilities (Mazzocco & Myer, 2003). Gregiore and Desoete (2009) investigated the research interest in math by conducting a search of the internet spanning the years 2000 to 2008. Their findings yielded 413 articles related to math disabilities and/or dyscalculia, compared to 3,220 articles on reading disabilities and/or dyslexia.

The first step towards achieving growth in math with special education students is to believe that these students can achieve in math. Accordingly, teachers need to better understand the nature of the studentsô mathematical disabilities and reevaluate their perceptions or beliefs about the learning capabilities of these students. Leaders in mathematics education must confront the inappropriate use of labels that have been used to describe students with special needs and replace the casual labeling of students as ñlazy, dumb, special needs, and not capableò that result in lower expectations and less engagement, with more diagnostic language describing the learning requirements of the students. Diagnostic language such as a student has a visual spatial learning issues and struggles to interpret graphs, or a student has conceptual issues and can identify a pattern, but is not able to generalize it helps define the learning needs of individual students and necessary next steps. Students who are labeled often become dependent on teachers, refuse to engage in a problem until help is available, and thus demonstrate a learned helplessness. Teachers consequently view students as passive and often continue to lower the expectations for these students (Parmar & Cawley, 1991).

The acknowledgement of learner differences and the willingness of teachers to further examine the complexities of the learnersô engagement with the mathematics help teachers create safe and productive learning environments. Two important instructional strategies working in combination that can facilitate a supportive learning environment are: (a) scaffolding the learning experience by moving from concrete stages of understanding to more abstract comprehension, and (b) incorporating both receptive and expressive response formats when asking students to demonstrate mathematical understandings (Allsopp, Kyger & Lovin, 2008).

With the wide range of learners appearing in todayõs classrooms, instructional practices need to engage students in the learning of mathematics. To accomplish this, instruction must be aligned with the strengths of the learners. Teaching, therefore, calls for an extended repertoire of instructional practices that are well known and used by general education and special education teachers throughout the school year. Relevant instruction that permits compensatory strategies can help students reach higher levels of mathematical understanding (Berch, 2007).

Conclusion

While the benefits of double dosing or remedial math seem to outweigh the challenges, NCLB and RTI specify that strategies used to assist students be research based. In spite of the research that has been completed, the availability of research on remediationõs role in achievement in secondary schools is dated, limited, and insufficient. Further, researchers are calling for more research on mathematics because existing research is outdated or minimal (Foegon, 2008; Gersten et al., 2009). Gersten et al. (2009) supported the need for additional research, stating, ñlittle research has been conducted to identify the most effective ways to initiate and implement RTI frameworks for mathematicsò (p. 4). Additional research on double dosing is needed to provide schools with the necessary data and information to determine if double dosing can be successfully used as an intervention to assist at-risk students. More research is also needed on the impact of remedial math courses on standardized test scores.

Schools must look at interventions that best fit the needs of their students and that are the most cost-effective solutions. Remedial programs conducted during the school day as an elective course appear to be beneficial in terms of sustained learning and additional cost. Remediation can serve as an intervention and assist with high-stakes testing achievement. Additionally, conducting these programs during the school day allows for teacher collaboration, which has been the shortcoming of research on tutoring programs. However, remediation done during the school comes generally comes in the form of double dosing which means struggling students lose elective opportunities.

Research on gender differences is unclear. A study by Ai in 2002 claimed that low performing girls show significant growth in mathematics at a faster rate than boys. The inability to determine if differences exist and how quickly skills can be gained is an area that should be addressed when considering interventions for at-risk middle school students. Students should be monitored for growth to determine if gender differences in mathematics ability exist.

The research on effective instruction as it pertains to ELL and special education students is more pronounced, however resources often dictate the types of programs that can be offered. Strategic customization of instructional practices and effective use of accommodations are important in meeting the needs of a wide range of students, particularly students with special needs. ñThe purpose of accommodations is to allow students with disabilities to demonstrate their knowledge on assessments without interference from their disabilities, as their nondisabled peers are able to do, while not giving students with disabilities an unfair advantage over their peersò (Edgemon et al., 2006, p. 85).

In order to close the achievement gap between ELLs and native English speakers (non ELLs), language support programs must be well implemented, not segregated, sustained for five to six years, and demonstrate achievement gains of more than the average yearly progress of the non-ELL group each year until the gap is closed (Thomas & Collier, 2003). The problem here is that the achievement gap is, at best, a moving target since non-ELLs progress academically each year for their grade level, while ELLs typically fall further behind with each grade level. Thus, even the most effective language support programs can only close half of the achievement gap in two to three years. For ELLs, it is clear that an increase in instructional time is not enough.

Remedial programs can provide the assistance needed to help students close gaps in achievement and provide a safe environment where students can feel as though they belong, were more likely to participate, and can feel that they are of value to the classroom. Serving as an intervention, remediation can result in academic gains for students, making high-stakes testing requirements more attainable, thus creating schools where AYP is reachable and no longer an intimidating concern. These are the very reasons why districts are choosing remediation through double dosing and why they are willing to pull struggling students from electives offerings. Schools do this at cost of the elective courses that provide the rich and diverse curriculum, which benefit struggling students.

The importance of Adequate Yearly Progress (AYP), as a result of NCLB, is at the forefront of concern for state and local school systems. These agencies must find a way to assist students and teachers to meet these requirements. Through early identification of student needs and explicit instruction in remedial programs, schools can decrease the number of students who fail to succeed (Hanley, 2005). Remedial programs or double dosing are the obvious choices for assisting students and teachers in closing achievement gaps. Use of double dosing may benefit all involved stakeholders under NCLB, IDEIA, and the requirements of RTI. However, more research is needed to determine the effects of remedial instruction on standardized test scores (Burns, Klingbeil, & Yesseldyke, 2010).

Chapter 3

Methods

Introduction

Using existing data in the form of math grades and standardized test scores, the purpose of this study was to examine whether there existed a significant relationship between double dosing and the middle school math achievement of below grade level math students. This study utilized appropriate statistical analysis within a quantitative study comparing the math achievement of 6th, 7th, and 8th below grade level math students who have been double dosed to those who have not been double dosed.

Setting

The study took place in a small suburban community south of Portland located in the Willamette Valley of Oregon. This district enrolls over 5,000 students out of a total population of 25,000. The middle school where the study took place is one of two middle schools in the district. It educates roughly 650 students in 6th-8th grade and houses two special education programs for the district. During school year 2013-2014, this middle school is the current middle level English Language Learner (ELL) site for the district (see table 1 below).

Table 1

Middle School Demographics (650 students)

Demographics	Percentage of MS Student Body
Caucasian	74%
Hispanic	17%
African American	2%
Asian/Pacific Islander	2%
Other	5%
Boys	60%
Girls	40%
SES	41%
LEP	12%
SPED	19%

Participants and Sampling Strategy

For the purpose of this study, I compared the student achievement of students who were double dosed through a math lab to those students who were not placed in a math lab. Existing data in the form of standardized test scores from the Oregon Assessment of Knowledge of Skills (OAKS) and student grades were utilized.

The goal of the study was to determine if double dosing was an effective strategy to employ for below-benchmark students in the area of math. In order to gather comparable data from this study, analyzing the achievement of all the students involved in a math double dose and all students not involved in a math double dose provided a sufficient sample size for this study. Utilizing data from this existing data set also provided data on any reported differences in the achievement between 6^{th}, 7^{th}, and 8^{th} grade below benchmark students in math as opposed to just one grade level.

The number of students within the math labs was less than 20 as it was considered an intervention. See Table 2 and Table 3 below for the exact number of below math benchmark students in and out of math labs.

Table 2

Number of (Below Math Benchmark) Students per Math Lab

Grade	Number of Students
6th Grade	19
7th Grade	15
8th Grade	19

Table 3

Number of (Below Math Benchmark) Students not Double Dosed in Math Lab

Grade	Number of Students
6th Grade	19
7th Grade	21
8th Grade	16

There were two teachers involved with the instruction of these students. The experience of the two teachers varied, as one has taught for thirty years and the other completed her fifth year in the classroom. Both teachers were highly respected members of the MS staff and employed similar pedagogical techniques within the classroom. I considered them both ñoutstandingò teachers as indicated by their positive teacher evaluations.

Research Design and Nature of the Data Set

This study was a comparative quantitative design that utilized the existing OAKS and grade data from the 2012-2013 school year. The purpose of the study was to examine the relationship in math student achievement in below benchmark students to double dosing. The dependent variables within the study were math proficiency scores and grades with the independent variable being the double dosing strategy. In order to explore if there existed a relationship between the variables, I used an independent samples *t*-test. Utilizing this analytical procedure, I compared the math achievement of two groups:

1. Below benchmark math students involved in a double dose via a math lab.
2. Below benchmark math students not involved in a double dose via a math lab.

Student achievement is measured by growth performance on the Oregon Assessment of Knowledge and Skills otherwise known as OAKS. Successful student performance on OAKS entails a meeting/exceeding RIT score or sufficient growth as indicated by a previously created growth target. The Oregon Department of Education (ODE) establishes growth targets for all students that did not meet the benchmark the previous year on OAKS. Oregon has also recently adopted a percentile growth model for students in grades 3-8 in the subjects of reading and math. Students are given a number based upon performance on OAKS. The number percentile growth indicates from year to year if they have taken the reading and math tests in consecutive years.

Students are compared to their academic peers, who are the other students in the state who have a similar history of OAKS test scores. This means the growth of a low achieving student is compared to that of other low achieving students, and the growth of a high achieving student is compared to that of other high achieving student. A student with a growth percentile of 60 (for example) would have shown growth that was as high or higher than 60% of the stateôs students with similar past test scores. This particular student has shown above average growth. The growth model is a good model because it provides the opportunity for fair comparison of student scores despite English Language Learner (ELL) or Special Education (SPED) designation.

The term RIT score is short for Rasch Unit, a scoring scale named for Georg Rasch, a Danish mathematician. The scale is continuous from 0 to infinity (most scores range in the 150 to 300 range) with equal intervals between score points across the full range. The continuous scale means that a student who improves by 10 points between 3rd and 4th grades (moving from 204 to 214) has improved just the same as a student who improves by 10 points between 5th and 6th grades (moving from 219 to 229).

The OAKS test is a criterion-referenced test, which is a test in which questions are written according to specific predetermined criteria. For example, Oregon's state tests (OAKS) are constructed based on standards set by the state, and students are evaluated on the tests based on how well they demonstrate proficiency towards those standards.

Student achievement is also measured through performance within the studentôs grade level class as indicated by grades received. Grades are based on a traditional grading scale. It is important to note that math teachers in this school do have consistent grading procedures, most notably, that 80% of studentsô grades are based upon assessments. The middle school incorporates a standards based and proficiency based grading model. This grading policy ensures that grades are directly correlated with a studentôs comprehension of the math standards.

Table 4

Reading Oregon Achievement Standards

Grade	Meeting	Exceeding
6th	226	237
7th	229	241
8th	232	242

Table 5

Math Oregon Achievement Standards

Grade	Meeting	Exceeding
6th	227	237
7th	229	242
8th	234	245

Table 6

Traditional Grading Scale

Percentage	Grade
90-100	A
80-89	B
70-79	C
60-69	D
59 and Below	F

Placement within the math labs is a process that involves a number of stakeholders including the principal, assistant principal, counselors, and teachers.

Placement into the lab is based primarily on performance on OAKS; however, there are other criteria. Students who are placed in math labs must meet the following criteria:

- Did not pass the OAKS assessment the previous year
- Recommended by preceding math teacher due to performance in math
- Good attendance
- On track for a regular diploma

It is important to consider that all students in a math lab are on track for a regular diploma. Students are kept in math labs until the first round of the OAKS test is completed in April. If a student passes the OAKS test then the student has the option to re-join his/her elective class.

It is also important to note that because of the transition to the new growth model, students were compared to similar students with similar abilities. This model allowed us to account for the variables of ELL or SPED designation, as they were compared to students who had shown the propensity to score in the same range. ñOregon adopted this growth model as part of the process of obtaining a waiver from some of the requirements of the No Child Left Behind Act (NCLB)ò (Oregon, 2013, para 1). The new growth model provides a more complete picture of student growth than does the old growth model. By comparing a studentös growth to the growth of other students with similar test scores, this model helps provide a better evaluation of school and district progress. It is also important to note that students selected for math labs MUST be on track to graduate from high school with a regular diploma, and they must maintain satisfactory attendance. Students that do not maintain satisfactory attendance are dropped from the math lab with the slot potentially given to another student.

Research Ethics

George Fox University Institutional Review Board (IRB) approval was not required for this study. Existing data were used and institutional approval was granted from the original research site. More over, Oregon Assessment of Knowledge and Skills (OAKS) scores are publicly accessible. Further, all data was provided in anonymous form, thus participant anonymity and confidentiality were preserved.

Data Collection and Analytical Procedures

Standardized test scores were collected through the Willamette Education Service District (WESD) toolbox and grades were collected through teacher grade books. Standardized test scores and grades to be analyzed were from the 2012-2013 school year. This study was a comparative quantitative design utilizing the existing OAKS and grade data. The purpose of the study was to determine the relationship in math student achievement in below benchmark students to double dosing. The dependent variables within the study were math proficiency scores and grades with the independent variable being the double dosing strategy. In order to determine if there existed a relationship between the variables I utilized an independent samples *t*-test.

Role of the Researcher

As a doctoral graduate student at George Fox University, I am fulfilling the requirements of a doctoral degree through research investigation. This research was of paramount interest to me not only through my aspirations to achieve a doctoral degree, but also through my role as a middle school principal. As a current school administrator, I am faced with ethical decisions on a daily basis, none seemingly more important than the decision on whether or not to pull a below benchmark student from an elective class in favor of an added math or reading class. As a principal and as a researcher, I am determined to explore whether double dosing makes a difference in the achievement of below benchmark students. The research and data collected took place within my middle school. The results from this study will influence my practice and could potentially influence the practice of many more schools and school districts that are faced with the dilemma about whether or not to employ double dosing at the cost of elective offerings.

Potential Contributions of the Research

The phenomenon surrounding double dosing is evident in public education everywhere. Poor academic preparation of students entering high school is often cited as a major source of such high dropout rates. Results from the 2011 National Assessment of Educational Progress report suggests that only 35% of students enter high school with math skills considered proficient. In addition, this report states the high school graduation rate for American students has declined since the 1970s to about 75%, with black and Hispanic graduation rates hovering around 65% (Heckman & LaFontaine, 2010, pp. 244-62). In this suburban town and in Oregon, students must not only earn upwards of twenty-four high school credits, but they must also take and pass state assessments in reading and math. With such high stakes on the line for middle school students, it is of no surprise that schools and school districts are utilizing the double dosing method to ñcatch kids up.ò Unfortunately, double dosing in its true form means pulling students from elective classes during the school day in favor of an extra remedial class usually in one of the core subjects (reading, math, science, and writing).

Additional research on double dosing is needed to provide schools with the necessary data and information to determine if double dosing can be successfully used as an intervention to assist at-risk students. More research is also needed on the impact of remedial math courses on standardized test scores. As stated in the literature, in spite of the research that has been completed, the availability of research on remediationôs role in achievement in secondary schools is dated, limited, and insufficient. This study provided current data as to the effectiveness of double dosing and remediation at one middle school. Further, researchers are calling for more information on mathematics because existing research is outdated or minimal (Foegon, 2008; Gersten et al., 2009). Gersten et al. (2009) supported the need for additional data, stating, ñlittle research has been conducted to identify the most effective ways to initiate and implement RTI frameworks for mathematicsò (p. 4). This study provided more data as support for double dosing during the school day at the cost of a studentôs elective class, or if schools should look to employ other options such as after-school tutoring.

The practical contributions of this research are substantial for those in K-12 public education. Double dosing during the school day at cost of elective classes is now more prevalent since the infusion of NCLB. We have seen double dosing at the elementary level to a much higher degree, but double dosing at the secondary level is now gaining more momentum. Because of the high stakes facing our students, along with the budget issues facing our schools, double dosing during the school day is growing in popularity. The data presented through this study, will help inform our decisions on whether or not to double dose our below benchmark students during the school day at cost of elective classes. Deciding whether or not to double dose could be the determining factor in a number of school decisions including RTI framework, elective offerings, and FTE. This research can help answer the question that I am struggling with: Should I pull struggling students from elective classes?

CHAPTER 4

Results

Introduction

Using existing data in the form of math grades and standardized test scores, I examined the relationship between double dosing and the middle school math achievement of below grade level math students. This study utilized appropriate statistical analysis within a quantitative study comparing the math achievement of 6th, 7th, and 8th below grade level math students who have been double dosed to those who have not been double dosed.

Findings

My original research questions dealt with the individual comparisons of math achievement by grade level and by ELL and special education designation. They were as follows: 1) Is there a significant difference in math performance between the sample of below grade level 6th grade students engaged in double dosing and the sample of below grade level 6th grade students not engaged in double dosing? 2) Is there a significant difference in math performance between the sample of below grade level 7th grade students engaged in double dosing and the sample of below grade level 7th grade students not engaged in double dosing? 3) Is there a significant difference in math performance between the sample of below grade level 8th grade students engaged in double dosing and the sample of below grade level 8th grade students not engaged in double dosing? 4) Is there a significant difference in math performance between the sample of below grade level English Language Learners engaged in double dosing and the sample of below grade level English Language Learners not engaged in double dosing? 5) Is there a significant difference in math performance between the sample of below grade level Special Education students engaged in double dosing and the sample of below grade level Special Education students not engaged in double dosing?

However, because of the small individual sample sizes of the grade levels, and of the ELL and SPED groups, I had to adjust my test of comparison to measure the ñtotalò sample of below benchmark math students who were double dosed to those who were not double dosed. This lead to the following adjustment to my research question(s): *Is there a significant difference in math performance between the total sample of below grade level 6th, 7th, and 8th grade students engaged in double dosing and the sample of below grade level 6th, 7th, and 8th grade students not engaged in double dosing?* In order to effectively analyze this question, I conducted an independent samples *t*-test.

Independent samples *t*-test

T-tests were used to determine the relationship between double dosing and middle school math achievement as measured by growth on the OAKS assessment and through student grades received. An independent-samples *t*-test was conducted to compare the math achievement between below benchmark students who were double dosed to those who were not. There was a significant difference in the growth of students who were double dosed through math lab (M=60.48, SD=28.258) in comparison to those who were not (M=51.93, SD=19.312); t (106)=-1.848, p = .004. These results suggest that among middle school students within this school, students who were and were not doubled dosed did differ significantly within their growth on the OAKS.

There was a significant difference in math student grades of those who were double dosed through math lab (M=3.77, SD=. 824) in comparison to those who were not

(M=3.27, SD=1.272); *t* (107)=-2.449, *p* = .0001. These results suggest that among middle school students within this school, students who were and were not doubled dosed did differ significantly within the grades they received within their grade level math classes.

Table 7

T-Test Analysis of Independent Variables

Variables	Math Lab	Mean	S.D	N	*T*	Sig.
Growth percentile	Lab	60.48	28.258	52	-1.848	.004**
	No Lab	51.93	19.312	56		
Grades	Lab	3.77	.824	53	2.449	.0001**
	No Lab	3.27	1.272	56		

*Notes: **p < .05, two tailed*
Scale/Labs: 1=lab, 2=no lab
Scale/Grades Received: 5=A, 4=B, 3=C, 2=D, 1=F

Summary

The findings provide evidence that double dosing below benchmark math students makes a significant difference in their academic growth as depicted through Oregon standardized test scores and grades earned in grade level math classes within this middle school. It should also be noted that the suitable sample size (N=109) does allow a generalization of the findings specific to this middle school. The findings can inform the intervention practices of school districts. The following chapter will discuss the findings of this study further, draw conclusions where appropriate, and make recommendations for future research.

Chapter 5

Discussion and Conclusions

Introduction

In this final chapter, the findings outlined in chapter 4 are discussed further, conclusions are drawn, and future research is considered. First, the chapter summarizes the findings as related to the research question: Is there a significant difference in math performance between the total sample of below grade level 6^{th}, 7^{th}, and 8^{th} grade students engaged in double dosing and the sample of below grade level 6^{th}, 7^{th}, and 8th grade students not engaged in double dosing? Secondly, the implications of the research are identified for educators and scholars. Limitations of the research are reviewed along with suggestions for revising this study if it were to be conducted again. Finally, the findings are compared to prior research and current trends in order to inform continued research related to double dosing and remediation.

Summary of the Findings

Existing data in the form of OAKS growth percentile data and student grades were used to determine the significance of a relationship between double dosing and student achievement. Due to the small sample size of below benchmark students in and out of math lab at each grade level, the grade levels were combined and the research questions were adjusted. The total sample (N=109) was used to conduct this comparison.

The strongest statistical test to utilize was the independent samples *t*-test. The *t*-test was used to compare the means of two samples (double dosed, not double dosed). In simple terms, the *t*-test compared the actual difference between two means in relation to the variation in the data (expressed as the standard deviation of the difference between the means).

As stated in chapter 4, there was a significant difference in the growth of students as depicted through standardized test scores, who were double dosed through math lab (M=60.48, SD=28.258) in comparison to those who were not (M=51.93, SD=19.312); t (106)=-1.848, p = .004. These results suggest that among middle school students within this school, students who were and were not doubled dosed did differ significantly within their growth on OAKS. Given the sufficient size of the sample, these results suggest that double dosing in math can improve performance on standardized tests.

Along with existing standardized test data, grades were also analyzed. Given that this school has incorporated a standard- based grading and reporting model, the grades could be seen as more accurate indicators of student proficiency on the content. As stated in Chapter 4, there was a significant difference in math student grades of those who were double dosed through math lab (M=3.77, SD=. 824) in comparison to those who were not (M=3.27, SD=1.272); t (107)=2.449, p = .0001. These results suggest that among middle school students within this school, students who were and were not doubled dosed did differ significantly within the grades they received within their grade level math classes. Given the sufficient size of the sample, these results suggest that double dosing in math can improve performance within student grades. Unfortunately, due to the size of the samples of ELL and SPED students, I could not conduct any statistical analysis of these groups.

Implications

This study addressed the following research question: Is there a significant difference in math performance between the total sample of below grade level 6th, 7th, and 8th grade students engaged in double dosing and the sample of below grade level 6th, 7th, and 8th grade students not engaged in double dosing? Two testing variables were examined including OAKS growth percentile scores and grades from the 2012-2013 school year. In both OAKS growth scores and in grades, students involved within the math labs performed better than students not involved in math labs. Using an independent samples *t*-test, the results proved to be statistically significant (p=. 004 for OAKS/p=. 0001 for grades). These results do carry significant implications for both practitioners in the public school setting and researchers looking to determine the impact of double dosing.

Implications for Researchers. Numerous studies indicate that increasing the amount of time spent in mathematics instruction is positively correlated with student achievement. Research has also long demonstrated the important relationship between time spent on instruction and student learning outcomes (Clark, McGrath, Orlone, & Suarez, 1991). A finding in *The Nations' Report Card: Mathematics 2000, NAEP* showed that the average scores of 4th and 8th graders generally increased as the amount of instructional time for mathematics increased. Given the results of this study and the sufficient sample size, one can conclude that increasing the amount of instructional time through double dosing is effective in increasing student achievement through grades and standardized test scores. The results of this study support the research concerning instructional time.

While it is clear in the literature that the math achievement of students can increase as a result of remediation, this achievement has varied and has not been consistent, most notably within standardized tests. There are a limited number of research studies on secondary remedial math courses that examine standardized test scores (Mross, 2003; Schultz, 2001). The limited number of studies has resulted in an inability of researchers to conclude the impact of remedial instruction on standardized test scores. The research from this study supplies more data that remedial math courses can improve standardized test scores.

The literature regarding math grades and remediation is more consistent. While teaching remedial math courses can be a challenge for educators, remediation has been shown to improve the math performance of students in secondary schools (Bottge, Chan, Heinrichs, & Serlin, 2001; Fletcher, 1998; Mross, 2003; Schultz, 1991). Research completed by Bottge et al. (2001) and Fletcher (1998) revealed that middle school students taking remedial math courses were able to improve their grades in mathematics after remediation. Secondary education students participating in the research completed by Fletcher (1998) were said to go from failure to honor roll. The results from this study provide more evidence that remedial math instruction improves studentsô math grades.

In regards to RTI, Gersten et al. (2009) supported the need for additional research, stating, ñlittle research has been conducted to identify the most effective ways to initiate and implement RTI frameworks for mathematicsò (p. 4). I am happy to say that as a result of this study, there is some additional research that can be used. Double dosing can be seen as an effective intervention at the middle school level within math.

Finally, there is not sufficient research regarding the effects of the actual practice of double dosing, which means pulling students from elective classes during the school day in favor of a remediation class. There have been case studies within school districts such as Chicago, Baltimore, and Maryland; however, the results have been mixed regarding achievement. For example, in a 2003 study within Chicago Public Schools, test scores increased but student grades did not (Nomi & Allensworth, 2009). Although the research from this study was only based on one year, it is clear that double dosing can have a positive impact on standardized test scores and grades.

Implications for Practitioners. The data from this research can provide schools with the necessary information to determine if double dosing can be successfully used as an intervention to assist at-risk students. The data gathered provides needed research on the impact of remedial math courses on standardized test scores. As stated in the literature, in spite of the research that has been completed, the availability of research on remediationҫs role in achievement in secondary schools is dated, limited, and insufficient.

The practical contributions of this research are substantial for those in K-12 public education. Deciding whether or not to double dose could be the determining factor in a number of school decisions including RTI framework, elective offerings, and FTE. Schools have to make difficult decisions on a daily basis regarding the well-being of students and the decision to embrace double dosing as a practice is one of these difficult decisions. The results of this study provide evidence that the double dosing strategy can facilitate student growth. As a result, this information can inform districts that are struggling to embrace double dosing as a practice. This research provides the necessary data to not only inform decisions, but also provides an effective communication tool when speaking with parents. In my role as a principal, I set out to determine if pulling students from elective classes is the right thing to do. In truth, I still do not know if it is; however, I take solace in the fact that there is more data to support double dosing.

Limitations of the Research

The purpose of this study and the research was to seek understanding about the effect of double dosing on middle school math achievement. There exists today a negative connotation surrounding the double dosing practice, and with good reason. This research provided a positive context about double dosing, but unfortunately the lack of anecdotal testimony from the students themselves could be considered a shortcoming. Information on the teaching styles and instructional techniques used within the labs were also not researched within this study.

The lack of a sufficient sample size of students within each grade level did not allow for a grade level comparison of achievement. Because of this, it is difficult to determine which, if any grade level made significant gains, or if a grade level struggled. Grade level analysis could have opened the door to more pertinent conversations about the philosophies, systems, and instructional strategies utilized at each grade level. It is also entirely possible that the results of this research could have been skewed due to the growth of one or two grade levels and not reflective of the whole. The lack of sufficient grade level sample sizes also did not allow a successful comparison of students actually meeting the grade level benchmarks, but instead I had to focus specifically on growth percentile data.

NCLB has brought about the importance of subgroup achievement. However, due to the small sample of ELL and SPED students, I could not analyze the effect of double dosing on these subgroups. I could not analyze their performance within individual grade levels nor as a whole group. As districts look for avenues to improve subgroup achievement, more information is needed on double dosing and subgroup achievement.

Suggestions for Future Study

NCLB has brought about numerous changes within education. School districts have been forced to adapt, searching for ways to improve student achievement many times sacrificing content areas outside of reading, math, writing and science. The strategy known as double dosing is more prevalent in education due to this added emphasis on standardized test score; however, there is not sufficient research to fully support its consistent implementation. Double dosing, in its true form means pulling students from elective classes during the school day in favor of an extra remedial class usually in one of the core subjects (reading, math, writing). This study provides more data as support for double dosing during the school day at cost of a studentôs elective class.

Although some of my initial questions have been answered surrounding double dosing, many questions still remain. This study can be the jumping off point for future research regarding instructional practices utilized within the math labs. In chapter 3, I mentioned the qualifications of the teachers teaching these math labs. The two teachers who taught the three math labs incorporate very specific, differentiated, skill based instruction. Within the labs are a combination of remediation of basic math skills, and the pre-teaching of concepts to be covered within grade level math classes. Bill Sanders, formerly at the University of Tennessee's Value-Added Research and Assessment Center, states, ñthe most important factor affecting student learning is the teacherò (Horn, Sanders & Wright, 1997, p. 57). My assumption is that this structure and effectiveness of the teacher contributed significantly to student achievement.

The results from this study support double dosing, but we need to know more information about why double dosing worked. Was it just about more exposure to the concepts because of the increased instructional time? Or was it because of the framework of the math labs utilizing remediation, coupled with pre-teaching? More research is also needed about the background of the students and whether or not double dosing was a part of their educational history leading to these results.

Finally, conducting research on subgroup performance is where scholars need to venture next. Given the high stakes environment of education today, it still needs to be determined if double dosing is/is not effective for low achieving subgroups.

Conclusions

Double dosing is a phenomenon that exists in education today due to NCLB, and also due to the environment of high stakes testing within the core subjects. As a middle school principal, to make a decision on whether or not to double dose a struggling student is agonizing. It is agonizing because of the very prospect that I could be taking away what a student enjoys most about school, namely an elective or PE class. These decisions to double dose students are made with the assumptions that what we are doing is right and assuming that double dosing will increase student achievement for our struggling learners. We did not have data to support these decisions, which was my motivation to conduct this research.

In reality, the decision to double dose a student will still be agonizing and will not be taken lightly. The comfort I have is that double-dosing students in math in this middle school has been proven to be effective. I have more confidence that a struggling student who we place in math lab will not waste his/her school year, and more often than not, the student will experience academic growth.

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