

12-2017

A Program Evaluation of Double-Period Algebra

Jason Major

Follow this and additional works at: <https://digitalcommons.nl.edu/diss>

Part of the [Science and Mathematics Education Commons](#)

Recommended Citation

Major, Jason, "A Program Evaluation of Double-Period Algebra" (2017). *Dissertations*. 251.
<https://digitalcommons.nl.edu/diss/251>

This Dissertation - Public Access is brought to you for free and open access by Digital Commons@NLU. It has been accepted for inclusion in Dissertations by an authorized administrator of Digital Commons@NLU. For more information, please contact digitalcommons@nl.edu.

Double-Period Algebra Program Evaluation

Jason Major

Educational Leadership Doctoral Program

Submitted in partial fulfillment

of the requirements of

Doctor of Education

National College of Education

National Louis University

December, 2017

Double-Period Algebra Program Evaluation

Dissertation

Submitted in partial fulfillment
of the requirements of
Doctor of Education
in the Foster G. McGaw Graduate School

Jason Major
Full Name of the Doctoral Program

Approved:

Chair/Co-Chair, Dissertation Committee

Program Director

Member, Dissertation Committee

Dean's Representative

Date Approved

Copyright by Jason Major, 2017
All rights reserved

DISSERTATION ORGANIZATION STATEMENT

Though these three projects have different topics, the overall theme of doing education differently can be read throughout. We do not always have to do things the way that they have always been done. Schools need to re-focus on tasks, empowering students and teachers and providing them a voice to speak up for what is best. In a new age of information available anywhere at any time, schools need to adjust for that and re-think the way things are done to make sure for what students will need in their lives.

For the **Program Evaluation** candidates are required to identify and evaluate a program or practice within their school or district. The “program” can be a current initiative; a grant project; a common practice; or a movement. Focused on utilization, the evaluation can be formative, summative, or developmental (Patton, 2008). The candidate must demonstrate how the evaluation directly relates to student learning. In this program evaluation, an overall theme that originated was a re-focus on student problem solving and relationships with adults and students.

In the **Change Leadership Plan** candidates develop a plan that considers organizational possibilities for renewal. The plan for organizational change may be at the building or district level. It must be related to an area in need of improvement, and have a clear target in mind. The candidate must be able to identify noticeable and feasible differences that should exist as a result of the change plan (Wagner et al., 2006). An overall theme from this change plan that emerged was allowing students to throw away any semblance of a traditional curriculum and pursue their interests, find what their passions are, and explore and fail in a low-stakes environment.

In the **Policy Advocacy Document** candidates develop and advocate for a policy at the local, state or national level using reflective practice and research as a means for supporting and promoting reforms in education. Policy advocacy dissertations use critical theory to address moral and ethical issues of policy formation and administrative decision making (i.e., what ought to be). The purpose is to develop reflective, humane and social critics, moral leaders, and competent professionals, guided by a critical practical rational model (Browder, 1995). In this Policy Advocacy, top-down accountability was determined to have too much of a detrimental effect on the ways schools conduct business, creating an environment of compliance and rote tasks. Dropping high-stakes accountability allows schools to be schools.

Works Cited

Browder, L.H. (1995). An alternative to the doctoral dissertation: The policy advocacy concept and the policy document. *Journal of School Leadership*, 5, 40-69.

Patton, M. Q. (2008). *Utilization-focused evaluation* (4th ed.). Thousand Oaks, CA: Sage.

Shulman, L.S., Golde, C.M., Bueschel, A.C., & Garabedian, K.J. (2006). Reclaiming education’s doctorates: A critique and a proposal. *Educational Researcher*, 35(3), 25-32.

Wagner, T., et al. (2006). *Change leadership: A practical guide to transforming our schools*. San Francisco: Jossey-Bass.

6.20.16

ABSTRACT

Students in ninth grade traditionally take algebra courses, but many students come in lacking foundational skills in mathematics. High schools have tried to solve this problem by introducing double-period algebra courses with sporadic results. During this program evaluation, I interviewed an administrator and a teacher from two different high schools about the methods they used to begin and evaluate the program; I found that student-teacher relationships were the most important factor in the effectiveness of the program. Using quantitative data was a good starting point to determine the students who would benefit from the program and who would be successful, but analyzing the qualitative data—which is often unmeasurable, like student-teacher trust and rapport—was anecdotally the most effective path to predicting success in the program.

PREFACE

Working in multiple schools, with dozens of administrators and hundreds of teachers throughout the course of four years, plus another year in an internship role, opened my eyes to a point that I was almost afraid to say out loud at first—very few school programs work the way that they are intended to. This is not the fault of anyone in the school, whom I found to almost always have the best intentions for their students and staff. Rather, difficulties are because of the massive amount of planning, staffing, and follow-through that is necessary to insure a successful program. Purchasing a program or replicating one that has been “successful” elsewhere is eventually easier than really digging deep to see if a program will work in a school, and that is before including other factors like “what the district is telling us that we have to do.”

Because of this phenomenon, leading a department, school, or district requires juggling many factors when implementing a new program. One could analyze vast quantities of quantitative data before implementation, but it is important to remember not only the quantitative data, but the positive human relationships and interactions that are necessary for the successfulness of programs. Too often in education we do the same things that we have done for years, or even decades, simply because it has always been done that way. Educational leaders should stand up and challenge the status quo, avoiding compliance, and try things differently. Education is about human relationships, creativity, and getting the most of students’ abilities. As long as those running the show have those points in mind, and keep students’ best interests first, there are no bad ideas—it is simply a matter of trying them to see they work. The students and adults end up

increasing their creativity as a result of doing things this way, the way I believe things should be done.

TABLE OF CONTENTS

ABSTRACT.....	4
PREFACE.....	ii
TABLE OF FIGURES.....	vi
SECTION ONE: INTRODUCTION.....	1
Purpose.....	1
Rationale.....	3
Goals.....	7
Research Questions.....	7
SECTION TWO: A REVIEW OF THE LITERATURE.....	9
Growth and Expansion of Algebra.....	9
“Double Dose Algebra” in Chicago Public Schools.....	12
Views on Mathematical Pedagogy.....	16
SECTION THREE: METHODOLOGY.....	21
Research Design Overview.....	21
Participants.....	23
Data-Gathering Techniques.....	23
SECTION FOUR: FINDINGS AND INTERPRETATION.....	25
Scheduling of the Course and Selecting Students.....	26
Figure 1.1: Students at High School A.....	27
Figure 1.2: Students at High School B.....	30
Student-Teacher Relationships.....	31
Curriculum and Instruction.....	32
Statistics Regarding Exiting the Program.....	36
Comparing the Two Schools.....	37
Interpretations of the Findings.....	38
SECTION FIVE: JUDGMENT AND RECOMMENDATIONS.....	41
Recommendations.....	42
REFERENCES.....	46
APPENDIX A: CRITICAL THINKING PROBLEM.....	49
APPENDIX B: SAMPLE CAROL DWECK MINDSET SURVEY.....	50

APPENDIX C: THE CCSS FOR KINDERGARTEN OPERATIONS AND ALGEBRAIC THINKING	54
APPENDIX D: THE STANDARDS FOR COMMON CORE MATHEMATICAL PRACTICE	55
APPENDIX E: SMALL BOARDS	59

TABLE OF FIGURES

Figure 1.1: Students at High School A	27
Figure 1.2: Students at High School B.....	30

SECTION ONE: INTRODUCTION

Purpose

In Chicago Public Schools (CPS), policy dictates that all freshman students must take Algebra I during their freshman year. However, not all students are successful or ready to be successful in Algebra I their freshman year, which can set up students for problems. Based on district reports, there is a strong correlation between success in the freshman year of high school (i.e., not failing courses) and graduation rates three years later. Failing Algebra I during the freshman year drastically increases the chance that a student does not graduate from high school, as just 22% of students who fail more than one semester of a “core course” (including Algebra I) their freshman year graduate within four years (Allensworth and Easton, 2007). Additionally, many freshmen come in far behind grade-level expectations for math. Since skills in mathematics build upon one another, it is very difficult for students who enter far behind in math to pass Algebra I their freshman year without extra support. Because of this discrepancy in advanced mathematical skills versus fundamental mathematical skills, many schools have offered a double period course in Algebra I for students their freshman year.

CPS has specifically designed the freshman Double-Period Algebra I (DPA) class to help students catch up in their first year of high school by addressing concepts that they may have missed and/or were not taught in elementary school. In general, from personal experience, the purpose of the double period is to either move at a slower pace or to build in practice time for skills that were missed in earlier grades using technology, intervention materials, or teacher-created practice methods. Students in DPA are often many years behind in mathematics according to grade-level ability on the Northwest

Evaluation Association's Measures of Academic Progress (NWEA) assessment, the district-wide assessment in grades 2 through 8. For example, based on publicly available NWEA data, multiple schools in the district have fewer than 25% of students scoring above the 50th percentile on the assessment in eighth grade math.

DPA courses take different formats regarding the structure of the course, the curriculum, and the way that students are graded. In essence, it is a program where students take Algebra I twice during the school day. In some cases, the periods are back-to-back, with the same students, and with the same teacher. Other times, the periods are spread out and students have a different teacher. The course material also varies widely. There are curricula available specifically for this purpose, with one of the most popular being the Agile Mind Intensified Algebra (IA) program, which 650 teachers in 83 districts used in the 2012–2013 school year (Corona, 2013). In other cases, students use online learning systems for the second period, or students are simply working on materials that teachers assigned in the first period during the second block of time. In still others, the second period becomes a study hall for the students. Grading also varies widely. Some teachers count the second grade separately, while others use the exact same grade for both periods. The grading and the curriculum used in the course varies widely in CPS, sometimes widely even within the same school that offers DPA.

While I am most familiar with CPS' DPA program, I have chosen to evaluate this program in districts other than CPS because it became evident to me that there are few, if any, programs that do the job of helping students who are behind advance enough to pass Algebra I, even in the double period block, in Chicago. I am interested in seeing the makeup, philosophy, and execution of DPA classes in other districts to see what

takeaways exist in the organization of the program that could be applied to Chicago Public Schools in the future. I am simply looking for programs that increase students' knowledge in mathematics. My goal is to learn by looking at other districts' programs, in order to improve and evolve CPS' model into one that better suits students who need the extra block of math to catch up on skills from previous years. What are other districts doing that are similar to and different than what is going on in Chicago?

Rationale

An evaluation of DPA can symbolize a microcosm of other initiatives in districts across the country, as educational leaders adopt and implement programs due to success in pockets, thinking that the program itself is the magical potion that cures the original problems, rather than the planning and implementation that goes into making programs successful. Context is extremely important when considering which programs to implement based on the needs of the school or district.

In the educational system at large, the “algebra for all” initiative—the notion that all students should take Algebra I at the very latest by ninth grade, and should be *encouraged* to even by eighth grade—became popular within the last 15 years (Baker, 2013). If students are in no way prepared to deal with algebra, does taking the course matter? Correlation does not prove causation, and just because students who take higher-level math courses do better in college (Rech, 2000) does not necessarily mean that we should give every student higher-level math courses. So, is a DPA course the best way to engage students in learning these higher-level mathematical topics, or could there be another avenue by which to do so? This program evaluation will dive into possibilities to

improve current DPA models, or perhaps rethink the way that the period is being spent entirely based upon ways that other schools and districts are utilizing the time.

As an example, nationally, there has been a push in the past two decades to get students through Algebra I earlier and earlier (Baker, 2013). Back in the 1980s, there were examples of successful school districts in which a large quantity of students finished Algebra I by the end of grade 8. As students finished, they were then able to access higher-level mathematics in their high school years, such as calculus or statistics, resulting in an increase of students who were more attractive to colleges because of these high-level courses on their transcripts. Other districts began implementing Algebra I in the eighth grade, thinking that by merely offering the course—and, in some cases, going with an “algebra for all” approach—the district would become more successful. However, other issues are at play besides district success in student achievement. In addition, Algebra I is seen as a gatekeeper to higher education, as many junior colleges use algebra in placement and screener tests to get into the schools (Rech, 2000). Therefore, more and more high schools administrations want to make sure that students have completed this gatekeeping course.

The shift to the Common Core State Standards (CCSS) in mathematics has increased the necessity for students to possess solid algebra skills, as many of the topics are embedded in the standards set for students to meet by the end of eighth grade. Still, the long tradition of math course sequences has most high schools beginning with Algebra I in the freshman year. Due to the shift of algebra being embedded into the new standards beginning in kindergarten (see Appendix C) and lasting through the eighth grade year, as well as the increased rigor of the standards, many districts have eliminated any math

courses prior to Algebra I—such as pre-algebra—that may have been offered previous to the CCSS. One of these districts is CPS. In theory, students should be ready for Algebra I as freshmen because of the way algebra is embedded into the standards, but the reality is different. Many students are still entering their freshman year in no way ready for the rigorous Algebra I course, but policy dictates that they must take the course, which brings in the reality of needing programs—such as DPA—to help students catch up.

An evaluation of a program like DPA is important to CPS schools since each school is evaluated based on the School Quality Rating Policy (SQRP), which includes the freshmen-on-track (FOT) metric as 10% of it. FOT measures how many freshmen fail one or more courses throughout the year. Algebra I is the most-failed course in many high schools. For example, St. George (2015) found that 75% of students in Montgomery County failed their final algebra exam in the 2014–2015 year. If students fail Algebra I, they are much more likely to not graduate or drop out of school. The FOT research by Elaine Allensworth and John Easton (2007) indicated that failing one course more than doubles the chance of not graduating high school within four years. CPS and Mayor Rahm Emanuel often tout the rising graduation rate in Chicago (Vevea, 2015), and a way to improve that is to make sure more students are successful in mathematics during their freshman year of high school. This program evaluation will help to analyze if time is being used most effectively, as well as which programs are doing the best job of building the students' skills enough to pass the Algebra I course. Analyzing these aspects of the program in a view other than CPS gives another viewpoint that will bring different systems and structures that CPS could use to improve the program.

At the school level, programs like DPA have taken shape knowing that many students are going to need the additional push in order to pass the course their freshman year. The level of support and materials used vary widely from school to school, and this evaluation will analyze the practices that have shown the most student success based upon anecdotal information from those who have been involved with the program in other districts. Speaking to those who have experience doing what has proven to be effective can inform the practices of other schools and districts, as well as improve student learning.

Since I began working with seven high schools in November 2013 as a math instructional coach, I immediately noticed that a large portion of students failed Algebra I, and many of these students were ones that were several years behind in math. In talking to school administrators about what they were doing for the students coming into their school very far behind in math, DPA—sometimes called “Algebra Extended” by the school—was a common answer. It has become an interest of mine to find a program that works for these students who are very far behind, because ultimately these students who fail Algebra I their freshman year are much more likely to drop out or not graduate. As a former math teacher, I am personally interested in policies and programs related to mathematics. The majority of my teaching career was spent teaching in advanced/gifted programs, and it was eye-opening to see the other end of the spectrum, as well as realize how much work there is to do in order to get students the mathematics that they need in order to graduate. In my experience as an instructional coach, I have identified possible problems with the implementation of the program, including misplacement of students, an unrealistic expectation for teachers, teachers who are married to a curriculum that may

not be doing the job, and a lack of correct programming. Due to the fact that my personal experience in CPS has not uncovered a program that best fits the “perfect world” view of DPA execution, I wanted to look outside in other districts to see what takeaways may exist in better coordinating, planning, and executing the program.

Goals

From the national context down to the school level, a program’s rationale must be backed by explicit student learning goals that are measurable in order to truly evaluate the impact of the program. My goal is to gather information on practices that have been beneficial to schools and districts, as well as their attempt to catch up students and bridge the mathematical gaps in their learning during their freshman year of high school.

I want to look at the formats of the courses, as well as the teacher practices that correspond with the courses, that make up DPA. I will also look at the materials that teachers are using, supplemental programs that they have included in their curriculum, and their approach and philosophy behind solving difficult, yet accessible, problems. I will uncover how this has impacted student learning, as well as their personal approaches and confidence in mathematics based on anecdotal data from teachers who have experience instructing the course. Experiences of those in other districts can give CPS leaders ideas and insight on possible ways to tweak programs in their own schools, to engage and improve student learning.

Research Questions

To get to the heart of the DPA program evaluation, and to make sure that my goals and rationale were articulated as I approached the interviews, I used the following research questions as the overarching principles to guide my work:

1. Primary research question: What are various formats that DPA can take? How do teacher practices and philosophies fit these formats?
2. Secondary research question: Were there supplemental programs that seemingly had better results than others?

SECTION TWO: A REVIEW OF THE LITERATURE

The review of the literature around DPA fell into three categories that I felt were relevant to my study either directly or indirectly. First, the push from a national level to raise standards for mathematics led to more students taking algebra at a younger age, and in some ways the recent CCSS raised this bar even higher (Common... 2015). The higher standards for all students highlighted the achievement gaps in mathematics, requiring the need for programs like DPA in order to catch up students who are behind. The second area of research that I reviewed surrounds the history of DPA in large districts like CPS, and other smaller districts in the country, what reasons drove the policy into action, as well as how this particular course connected to other district initiatives and accountability measures. Third, I reviewed literature regarding the ongoing discussion around what makes a beneficial, rigorous, and relevant high school mathematics course that contributes to the theories behind offering a double dose of algebra, as well the students who make up the course and how they are selected—sometimes referred to as “tracking.” These three categories encompass the theories and policies behind enacting this program and provide insight into possible “best practices” around the actual instruction of the course.

Growth and Expansion of Algebra

The idea of all students taking algebra stemmed from the belief that it is a gatekeeper for higher levels of mathematics (Rech, 2000). This particular course, it is generally thought, is one that leads students to learn the high-level mathematical skills to be prepared for highly skilled jobs in the twenty-first century. Between 1988 and 2007,

the percentage of students taking algebra in eighth grade doubled (Clotfelter, 2011). In three states, the rate has reached 50%. In California, it has been a state requirement that all eighth graders take algebra since 2008. The idea of algebra being a gatekeeper was its main selling point, as Governor Arnold Schwarzenegger called mastering algebra the “key that unlocks the world of science, innovation, engineering, and technology” (Clotfelter, p. 12).

Nationally, a majority of ninth graders take algebra. The National Science Foundation released its 2014 report on science and engineering indicators that had further information on mathematical courses of study by U.S. students. It found that 52% of ninth graders reported enrollment in algebra, while 29% reported enrolling in classes higher than that, meaning that just 19% of students start high school below algebra (Chapter 1). All students nationwide have some access to algebra during their educational career. Of the 29% who started in courses higher than Algebra I, they would have taken algebra in eighth grade or earlier, and this was the reason behind the push to get more students into algebra courses in earlier grades.

After years of increasing the amount of students taking algebra in the eighth grade, two-thirds of eighth grade students were not “proficient” in math in the United States, according to the National Assessment for Educational Progress in 2011 (Taylor, 2014). Further research has shown that there have been negative effects of accelerating advanced levels of mathematics, such as algebra, into earlier grades in different parts of the country, especially for students who performed at or below the standard in mathematics. Clotfelter, Ladd, and Vigfor explained:

Our results indicate that Charlotte-Mecklenburg’s acceleration initiative worsened the Algebra I test scores of affected students and reduced their

likelihood of progressing through a college-preparatory curriculum. Moderately-performing students who were accelerated into Algebra I in 8th grade scored one-third of a standard deviation worse on the state end-of-course exam, were 18 percentage points less likely to pass Geometry by the end of 11th grade, and were 11 percentage points less likely to pass Algebra II by the end of 12th grade, compared to otherwise similar students in birth cohorts that were not subjected to the policy. Lower-achieving students who were accelerated into taking the course in 9th grade also exhibited significant declines in all outcomes considered. By contrast, higher-performing students who were accelerated into Algebra I in 7th grade, despite receiving lower test scores on the Algebra I test, showed no ill effects on subsequent course completion (p. 3).

These statistics show the potentially ill effects of pushing students into algebra in earlier grades when they are not prepared for it. If they do not have the necessary skills to be ready for the course, they will not be successful and it will be harder for them to move ahead into later subjects.

Students need to master mathematical concepts that come prior to algebra before being prepared to complete an Algebra I course. Without these base skills, the more advanced topics found in an algebra class will be foreign enough to the student that they will not be able to be successful in the course. Many students do not master these concepts even before ninth grade, so having them start earlier is simply making the problem begin earlier (Allensworth et al, 2009).

Still, some wonder if teaching everyone algebra is even a valuable practice at all. If algebra is the gateway to calculus, and this is why we teach it, what portion of the population really needs this? Hacker argued (2012):

Of course, people should learn basic numerical skills: decimals, ratios and estimating, sharpened by a good grounding in arithmetic. But a definitive analysis by the Georgetown Center on Education and the Workforce forecasts that in the decade ahead a mere 5 percent of entry-level workers will need to be proficient in algebra or above. And if there is a shortage of STEM graduates, an equally crucial issue is how many available positions there are for men and women with these skills. A January 2012 analysis

from the Georgetown Center found 7.5 percent unemployment for engineering graduates and 8.2 percent among computer scientists (p. 3).

Arguments against every student even needing algebra at all strengthen the case to utilize a second period of math instruction to focus more on problem-solving, critical thinking, and exploration in math, topics that are much more likely to show up in everyday life and skills that can be utilized in non-science, technology, engineering, and math (STEM) fields. As it stands now, algebra is a baseline topic that leads to the advanced studies of calculus. Arthur Benjamin, a math professor at Harvey Mudd College, wondered in a 2009 TED Talk if we should teach statistics as a culmination of mathematics instead of calculus. After all, assessing risk, analyzing finances, and making calculations play much more of a role in everyday life, rather than reciting the quadratic formula, solving large and winding equations with giant variable fractions in the denominator, or remembering slope-intercept form. Most people can rarely, if ever, recall having to use these memorizations in everyday life, but they can recall having to solve a complex problem.

The arguments against algebra as a necessity and as gatekeeper are in the minority, as the current CCSS remind us. These standards have increased the level of difficulty in algebra, as more of the concepts that were historically covered in high school are now put into middle school (Heitin, 2014). As standards have been raised and more districts and states have pushed algebra down to earlier grades, remediation in high school has become more of a necessity. DPA is one such strategy that schools have implemented to try to combat this issue.

“Double Dose Algebra” in Chicago Public Schools

In the 2003–2004 school year, CPS began a program for struggling students to have an extra period in freshman algebra. Though some students took algebra in eighth grade and tested out, the latest that students could attempt algebra was as a freshman in high school. No prerequisite course was offered in the high-school setting. Students who scored below the 50th percentile on the Illinois Test of Basic Skills (ITBS) in eighth grade were automatically placed into a two-period algebra course. The reason for this was that it was thought that students below the 50th percentile would have a harder time managing “grade level” material, which in this case was the Algebra I course. Students did, however, have an opportunity for their eighth grade teachers to petition to remove them from the course if he or she felt that the student’s work ethic could accommodate the rigor of an algebra course in a single-period setting. Once students were placed, one course was simply called “Algebra I,” while the other was called an “algebra problem-solving class” (“An Overview” p. 1).

During that school year, the Office of Math and Science (OMS) conducted a task force:

The taskforce met a number of times between March 2004 and June 2004 and collected and examined a wide range of data, interviewed a wide range of people including teachers, department chairpersons, and principals, as well as observing classes, consulting with mathematics education experts from other districts, and considered many alternative options. In response to the findings of this taskforce, the Algebra Problem Solving class has been restructured for the 2005-2006 school year. Principals of the schools were encouraged to identify the teachers of the course. Teachers of the course were expected to attend a three-day training to be familiar with the course and curriculum that they would be using the following year, and would be surveyed throughout the course.

The CPS OMS studied the effects of the problem-solving class, utilizing surveys and collecting data on its effectiveness. They strongly recommended that the two-period course was taught back-to-back with the same teacher and the same students (p. 4).

In 2003, Allensworth and Takako Nomi (2010) took a deeper look at this policy that used the problem-solving approach as part of the overall double-period strategy. They found that math test scores “rose significantly for students in double-dose algebra classes” and “teachers changed their practices in response to the professional development they received and the flexibility in time provided by two periods of instruction” (p. 5). Students were also more likely to report that they had learned math problem-solving skills, including writing sentences to explain how they solved a math problem, explain a problem to the class, discuss solutions, and write problems for other students to solve than students in a single-period algebra course. These strategies should be in every math class, but this particular course was forcing the hand to make sure that they were occurring. These findings put DPA into a positive light, and its results were promising.

An interesting by-product emerged, however, from the same study by Allensworth and Nomi (2010). Higher-skill students, who were not enrolled in the double period, became much more likely to fail their single-period algebra course. As the courses became more demanding and students with slightly above-average skills were now among the weaker students in the class, their teachers were more likely to give them lower grades as a result of this comparison. Overall, while failure rates dropped among the lowest students, they did not improve among all students. The study also found that for students with the weakest skills, skills that put them far below the 50th percentile on

the ITBS exam, the double-dose class was least effective (p. 7). Since these students were not able to keep up with the material of the course due to their lack of prior mathematical knowledge, they were more likely to fail the rigorous Algebra I course. While course failures did not decrease, causing many in Chicago to view the policy as a failure, there was evidence that all students—those in double-dose and single period—learned more mathematical content as a result of the policy of having single- and double-period courses for algebra. While the results were mixed depending on a student’s ability level, there was evidence that it had promise for lower-achieving students. It should be noted that the initial schools that were part of the study had more resources put toward insuring its success, and schools who came along later following any successes of the initial cohort would have been more likely just to begin the program in their school since it worked somewhere else, without necessarily putting the time and effort into making sure that all components were in place for its success. This program evaluation will serve to provide ideas for practices around placement, scheduling, and curriculum and instruction that have shown student success in other districts and can be replicated in CPS schools that have hit a stalemate.

Other locations have experimented with giving students extra time to learn Algebra I, but results have been mixed. Research by Eric Taylor (2014) found that students in middle school in Miami-Dade County had initial gains in a two-period “remediation” algebra course, but these gains were short-lived and eventually regressed back to their original level of math. He explained:

At the end of the school year during which they took two math classes, students who began the year with achievement near the 50th percentile (the assignment cut) scored 0.176σ (student standard deviations) higher than their otherwise identical classmates who attended just one math class.

At a second discontinuity in the probability of treatment, about the 24th percentile of prior achievement, treated students gained 0.166σ in math. However, one year later, after a full year back on the traditional schedule of just one math class, the gains had shrunk to one-half to two-thirds the original size. Two years later the difference was one-fifth to one-third the original gain.

Taylor's theory was that once the extra support and time was gone, students regressed in mathematics back to their skill level from previous years, as they lost the momentum of bridging skill gaps. While Taylor's research is valuable, his study did not go into discussions of teacher practice during the remedial portion of the double-period course. He said students were primarily chosen based on their math test scores (p. 11), but it was unclear whether the remediation course was simply the same material for all students, or if there was a differentiated approach to the work. Merely because a student has "low math test scores" did not necessarily mean that they were low in all aspects of math. It is quite possible that students were simply unable to think critically to solve difficult problems, at which point it may have been time to scaffold instruction to find accessible but difficult material for those students.

Views on Mathematical Pedagogy

Part of the discussion around teaching two periods of algebra regards how to actually teach it. Is the traditional model of algorithms and coverage of multiple topics still a valid way to instruct? Are there ways to utilize the mathematical practices of problem-solving to stimulate student interest in an additional period? What about the students themselves? Should their background knowledge play a role into placement in high school algebra?

Teaching math through problem-solving can be a highly beneficial way to learn lifelong skills simultaneously along with algebra. Richard Rusczyk was a former math Olympian for Team USA who started Art of Problem Solving, the most popular website on the Internet for high-ability mathematics students. Rusczyk explained why math through problem-solving is so powerful using the following anecdote (2015):

After MOP [Math Olympiad, a national mathematics competition for top students] I relearned math throughout high school. I was unaware that I was learning much more. When I got to Princeton I enrolled in organic chemistry. There were over 200 students in the course, and we quickly separated into two groups. One group understood that all we would be taught could largely be derived from a very small number of basic principles. We loved the class - it was a year-long exploration of where these fundamental concepts could take us. The other, much larger, group saw each new destination not as the result of a path from the building blocks, but as yet another place whose coordinates had to be memorized if ever they were to visit again. Almost to a student, the difference between those in the happy group and those in the struggling group was how they learned mathematics. The class seemingly involved no math at all, but those who took a memorization approach to math were doomed to do it again in chemistry. The skills problem solvers developed in math transferred, and these students flourished (p.1).

Ideally, learning problem-solving skills in a double-period algebra course would not only translate to understanding the topics in math and algebra more, but could also lead to an answer to the oft-heard question: “When will I ever use this in real life?”

Conceptual understanding in mathematics has been often missing in mathematics for decades, which was a major reason for the shift to the CCSS that were not “a mile wide and an inch deep.” Students may know the multiplication table, but do not understand how or why the concept of multiplication works. In algebra class, students may not connect that the different formulas for linear equations can all be derived from the original formula to find the slope between two points of a line. Connections like these and a deeper understanding of concepts make future mathematical concepts easier to

understand, but for many students who have fallen behind, they have spent years in math class seeing algorithms and formulas that have no deeper connection than to confuse the students further. Teaching math for students through the problem-solving approach gives students the ability to connect with the mathematics through rigorous, rich problems on a level that deepens their understanding of the concepts that they never truly learned in the first place. Missing these connections is a reason why a student could fall way behind in a short amount of time sitting in an Algebra I course, and it could be that the additional period should be used for solving complex problems to further deep understandings of concepts that students have never fully understood.

On the flip side, procedural mathematics has often been taught in the traditional mathematical sense. A teacher would stand at the front of the room and copy algorithms for students to replicate and practice with no further context or understanding other than completing a series of procedures, often times in the exact way that the teacher wanted them to be done. The CCSS for mathematical practice (see Appendix D) were a way to try to get beyond copying a series of algorithms multiple times, to solve problems that took in a variety of concepts and provided richer and deeper understanding. Utilizing a second period of algebra instruction—to move away from procedural instruction and into conceptual understanding—could give students accessible, yet challenging, problems and tasks that could pay benefits into their larger understanding of mathematics. Students who have fallen way behind in math have more than likely struggled for years in math, and this strategy could boost their confidence that they are able to do more than they previously thought. If these lower-performing students are given an opportunity to be in

the same class, but are given appropriately challenging material, it could be a way to avoid the potential pitfalls attached to “tracking.”

Essentially, DPA is creating a track for students based on their level of ability. Tracking is defined as the practice of assigning students to instructional groups on the basis of ability (Hallinan, 1994). If a student scores poorly in math, he or she is placed with peers who score similarly, which is what is being done by placing students in DPA. Alternatively, students who score highly are also placed with similar peers. Oakes (2005) argued that the students who performed the worst were being set up to fail, and then they continued on the same track with no opportunity to exit from that particular track. But tracking may not be all bad, as Allensworth (2010) explained in her study of CPS double-dose algebra:

Heterogeneous grouping requires teachers to be skilled at differentiating instruction to students with varying abilities and declining instructional quality for higher-skill students. Studies have shown that students—especially high-achieving students—perform better, on average, in tracked schools than in schools with a single track for all students (p. 8).

While tracking could have some positive effects for students at the high end, there are worries that once a lower-scoring or lower-performing student is set in his or her track, escaping it can prove difficult. Other worries include the facts that lower tracks are often dominated by minorities and students in poverty. Hallinan (1994) argued the following: “One unintended negative consequence of tracking is the way it segregates students by race or ethnicity and socioeconomic status. Since academic achievement is related to students’ background, minority and low-income students are disproportionately assigned to lower tracks” (p. 17).

Hallinan also argued that such tracking prohibits a population of low-achieving

students from receiving access to high levels of instruction. She also had a word of caution against programs like a DPA course, finding that “instruction in many low tracks can be characterized by uninteresting lessons and instructional materials” (p. 9).

However, by giving appropriately challenging mathematical tasks to students in an additional period, this could be a way to combat concerns like those Hallinan raised.

The larger mathematical context of considering what is important for students to know and to be able to do, the larger educational context of access to high levels of material and instruction, and the differences between policy and what is going on in the classroom are all important to bear in mind in looking at a program like DPA, as it acts as a microcosm of a variety of similar programs, initiatives, and policies in education today.

SECTION THREE: METHODOLOGY

Research Design Overview

Given the rationale and goals of this study, and after consulting the work of Patton (2015), interviews were the best approach to addressing my research questions. My research design helped to address my research questions by examining and looking for patterns from teacher responses. More specifically, I was able to look at commonalities and differences in philosophy. I am interested in the differences in the students who passed the course compared to those who did not, as well as each course's composition. In other words, what were the conditions of the course in which students had the most success? Were they back-to-back periods? Were students more homogenously grouped based on test scores or other factors? Were there supplemental programs that seemed to have better results than others?

In an ideal world, a double-period program would take students where they are mathematically, fill in all of the gaps from previous years, and provide them with enough knowledge to pass an algebra class. Which model of DPA was able to get closest to that particular ideal world?

Anecdotes from teachers, as well as the curriculum they used, and philosophies regarding the placement of students and pedagogy of teaching the course, helped me to answer my research questions because the information gave clear indications of where students started, where they ended, and how successful the program was in moving students forward in math while getting them a credit in Algebra I.

I then chose to focus on a teacher who taught a DPA course during the 2015–2016 school year, as well as a math department chair who oversaw a double-period course

throughout several recent school years. I interviewed these teachers using the following guiding questions:

1. What information do you use to understand where your students current stand in mathematics?
2. How do you approach planning a double-period algebra course based on what you know about your learners currently?
3. How do you decide on an appropriate mix of algebra and missing gaps in student learning?
4. How do you utilize problem-solving to build skills in your learners?
5. What does the structure of a typical day look like in each period of your algebra class?
6. What structures would you change of the makeup of the program itself?
7. What information did you receive on your students from their eighth grade year before their freshman year started?
8. What percentage of your students came in more than two years behind in math?
9. Is there anything else you would like me to know about your experiences teaching DPA?

Participants

The key participants for my program evaluation were a teacher who instructed the DPA course in one school, and a math department chair who oversaw the program in another school. These people were chosen because they both were able to provide different viewpoints on the program. From the department head's perspective, he could give insight on the overall processes and decision-making involved in implementing the program, and from the teacher's perspective, she could give the realities and challenges in teaching the program. Those two that were interviewed had the option to remain anonymous. I conducted these interviews on a one-on-one basis. I used pseudonyms for teacher names. I recorded each interview and stored the audio files on my password-protected laptop. I took notes during the interviews, and referred back to the audio for direct quotes. At the conclusion of the study, I deleted the tapes. I stored notes from the observations and interviews in a locked cabinet, and I destroyed them upon completion of the evaluation. For security purposes, the data I collected is on my laptop, which already contained a large amount of sensitive student data. The laptop is password-protected and remained locked every evening.

Data-Gathering Techniques

From the teacher interviews, I collected and analyzed the information in the table below.

Program
Number of teachers in class
Programs used to supplement
Base curriculum used in class
Periods scheduled
Usage of time in class (students working, teacher teaching)

A risk of this study included discussing sensitive information regarding mathematical practices that could reflect poorly on the school. However, I used pseudonyms when discussing the district, schools, and teachers to help decrease this risk. While there were limited direct benefits to participation for the teachers, there are greater benefits overall. One large benefit includes being a partner in figuring out what works best for students who are struggling in high school mathematics.

Data Analysis

Once I collected the interview data, I looked for trends and divided them into actual quotes from the participants underneath the different themes that emerged. I used an Excel spreadsheet to capture quotes and place them into different categories. For example, I noticed that one of the teachers talked a great deal about student engagement and motivation, so I included those tidbits into a portion regarding placement of the program. Since a good deal of my questions involved the curriculum of the course, I had a category dealing with curriculum and instruction. I also had a lot of questions regarding whether the program was working or not, so I included a coded section of my spreadsheet to include notes regarding exiting the program. In my second interview, many of the answers fell into the same categories as the first, which made for easier coding the second time around.

SECTION FOUR: FINDINGS AND INTERPRETATION

I conducted two interviews for the purposes of this study. One was with the math department chair of a suburban high school district outside of a large Midwestern city who has overseen, fine-tuned, and crafted the creation of the Algebra Extended program, including the hiring and placement of teachers who have taught the course since its inception. The second was a rural high school math teacher in the Midwest who taught a course called “Algebra Extended,” which takes a similar approach.

John Anderson has been the math department chair of a high school that I will call “High School A,” with 2,200 students. He has been responsible for the official observations of all of the teachers in his department, as well as placing teachers into courses that he feels they would be most successful in and what is best for the benefits of the students. His school has had the “algebra extension” course available for several years, which is what they are calling the “extended” period for a DPA class.

Debra Feener has taught the remediation math classes in a rural high school of 1,100 students, which I will call “High School B,” for five years. Her school has two different courses that they offer students who need to catch up, and she has taught both. There are students who take integrated algebra and geometry (IAG1), a course that provides the content of an Algebra I and geometry course over a three-year period and satisfies the requirement for high school graduation. There are other freshmen who are placed into Algebra I with an additional period for support, called “AT,” (Academic Tutoring), which would be the name for the second period of a traditional DPA course.

I felt that it was important to have two different views on DPA in two different districts, because it gave more of an opportunity to see how approaches varied. In the two

interviews, I noticed different themes coming together that fell into four overarching categories: scheduling and selection of students, student-teacher relationships, curriculum and instruction, and statistics regarding exiting the program. While some of the approaches of the schools were different in these categories, all of the answers during the interviews could be categorized into these four subtopics. I explored the answers in each subcategory and then did a bit of a comparison between the two schools.

Scheduling of the Course and Selecting Students

Anderson said that when scheduling the extension period, “We intentionally had it not back-to-back.” This means that while other districts scheduled two consecutive periods of algebra, and often have conversations on the timing of those periods—whether or not they should be the first two periods of the day or not, for instance—Anderson made a conscious decision to split the periods up and have the extension period at one time during the day, and the regular course period at a different time. He explained, “We want a break. They have extension, maybe go to PE, [and] have a brain break, then go back to [the regular] math [class].” In High School B, the periods were also not back-to-back. Feener said that it was mainly due to scheduling, but she also believed that two consecutive periods was “too much math” in a row and that it was nice to have a break.

In both schools, the extension period was also a credit-bearing course. For High School A, in one standard section of Algebra I, about eight students had the extension period, or about 25% of the class. Anderson said that it was important to not have more than 25% of one course in the extension period, as it would have been difficult for teachers to have that many students getting extra support in one class. The numbers broke down approximately as follows:

Students in freshman class	550
Students who started in a course above algebra	275 (50%)
Students who took Algebra I as freshmen	275 (50%)
Students who were in an algebra extension class	60 (11% of freshmen, 22% of algebra students)

Figure 1.1: Students at High School A

Thirteen teachers across algebra, geometry, and Algebra II taught the extension period, as it was offered as a support course for the entire sequence of high school mathematics courses. Six teachers were responsible for the Algebra I course. In selecting who specifically would teach the Algebra I extension, Anderson said, “I select them very carefully—I need powerhouses.” He believed that building relationships with these students was vastly important and that he needed to put some of his strongest teachers in these positions because of that. The teachers who were selected had a shared lunch and preparatory period together, so they could plan and discuss student work. Anderson said part of his selection process involved choosing teachers who were ready and able to have

those conversations around teacher practice, student work, and what was working or not in the classroom.

It was fascinating to listen to Anderson discuss identifying and placing students in the extension program, and how that had changed since the inception of the course. As the program continued, he realized that placement of the course should have been based more heavily on the personal factors of perseverance, grit, and student motivation, while still taking into account test scores. Originally, an “internal study said that a combination of math and science scores should be a cutoff for if students were in the extension class or not.” This score would be right at the 15 mark for mathematics, meaning students who scored 14 and below were automatically put into the extension program. This correlated with outscoring 41% of eighth graders nationally. Very few of these students, “less than 4%,” were coming in with scores below 12 on the Explore test, and most of these students would have individualized education programs and be placed in separate courses entirely. Eighth grade scores in mathematics from any of the four feeder schools that students came from were not taken into consideration.

After years of simply using Explore scores, Anderson wanted to try something additional and different to determine if a student would be successful in the course—primarily to see if one possessed the grit and motivation that successful students tended to have toward learning the material—as he said that “the motivation is a better predictor than Explore scores.” So, for the first time in the school year, administrators used a motivation survey “at the same time that administrators gave the Explore test” to try to identify those key factors that show success. Using a combination of available materials from Carol Dweck, KIPP Ascend Charter School, and the Achra assessment, this survey

gave a motivation score for each student in addition to their Explore score to measure those “nonacademic traits” of a potential student. (See Appendix B for an example of the Dweck motivation survey.) Math department administrators used this information to determine the placement with a teacher. For students who had a high motivation score, Anderson was “fine with them not having the same teacher in the extension, but all other kids we wanted to have the same teacher as the regular class for relationship purposes.” To Anderson, the key data piece had nothing to do with test scores; it was about motivation and the relationship between student and teacher. That being said, in the transition year, the department still used the Explore scores as a cutoff for the program. However, it also used the motivation survey to determine if students would be comfortable with having different teachers for the two different periods. It was being determined whether these students would be classified as a “risk” of failure by expecting them to develop a relationship with two different teachers in two separate periods, or if the relationship with one would foster more motivation to succeed in the course.

In High School B, students were selected and placed “based on where they are academically capable,” according to Feener. If a student scored below a 15 on the mathematics portion of the Explore test, they were automatically placed into the IAG1 course. For students who scored 15 or above, the counselor from the eighth grader’s school sat down with the math department chair and discussed if they should be in the regular single-period algebra course, IAG1, or AT.

Students in freshman class	250
Students who started in a course above algebra or below algebra	90 (36%)

Students who took Algebra I as freshmen	100 (40%)
Students who were in AT	60 (24%)

Figure 1.2: Students at High School B

Sitting down with the department chair and an eighth grade teacher provided an idea of the students’ motivation and capabilities, allowing for the chance to switch students into the higher course. The difference was that High School B had that lower-level course, which students could be placed in if they deemed it necessary. Students in the AT class also had an opportunity to receive some additional support in the summer. A freshman academy “summer enrichment” course met for two hours a day for two weeks to prepare those students for algebra during the regular school year. Fifteen students took the summer enrichment course this past year, but there is no data available showing how they compared to those who did not take it, because they had already fulfilled the goal of “transitioning out of the program,” which, according to Feener, was the goal of all of these support classes—to get students out of support and into a regular track.

Having the additional course option for students at High School B allowed for a more homogeneous group of students who needed additional support, as the lowest-scoring students could have taken an entirely separate course track. In the four sections of

AT, there were two teachers in the room, which allowed for an even smaller classroom environment for targeted attention to students. After the school year, there was a review process for students who were in the AT program. Since there was the additional course sequence, there were options for students based on how they had performed that year. Students could have either moved into the regular geometry course, or they could have moved back into the Integrated Algebra and Geometry Year 2 course.

Student-Teacher Relationships

So why did Anderson move more toward trying to measure the grit and motivation of students when trying to determine what worked for them? Because rather than test scores, he noticed from an anecdotal point of view that “the kids who move out of Extension are the ones who buy into Extension.” He further explained:

It’s about relationship building. The kids are going to be more successful when they have a trusting relationship with their teacher. For [Group A] it made a difference, a third it may have helped. There is [Group B] [who] we coddle too much; “support too much” is no longer support. Keep the training wheels on too long [and] they never learn to ride a two-wheeler. There is [Group C] who [just don’t care], they are not feeling it, they don’t like the math.

For Anderson, getting through to Groups B and C in the extension program was the key, and the relationships that they built with their teachers could have helped move some of the one-third into Group A. He found no correlation between their test scores entering the program and the group they fell into. “I still question how we do the placement; I would [instead] look at the motivation survey. I would love to spend more of our energies trying to measure that and how they buy into the program,” he said.

Anderson’s interest in attempting to measure “buy-in” used the motivation survey and entered it into a database. From there, he working on matching teachers with the program—those “powerhouse teachers” who could build those relationships and move

students into the one-third for whom the program worked. Their scores increased as a result. In general, that one-third of the students “appreciate being in the class and the feeling of ‘I can do this.’” If “[the student] can do it, [the student will] buy in.”

Finding a way to measure the motivation of students from the beginning was a starting point to try to move more students into the first one-third, and a key was trying to measure the components that moved students into that group. Some of the components were easy to describe but hard to measure, like a student’s improved confidence in mathematics. Anderson, said, “for some of these kids, it’s the first time they have raised their hand to answer a question, and there is real power in that. I think that speaks volumes.”

Feener used several phrases in her interview that made similar points, as well. She mentioned that some teachers had a tendency to pigeonhole students who were in the lower-level course, using phrases such as “his behavior is like [that of] an integrated [algebra and geometry] kid, [which] is what the course was trying to avoid.” Building the relationship with students was incredibly important to Feener, as she spoke of personal experiences in which she was able to reach students, connect with them, build a relationship, and get them out of the integrated or AT course. She said that “the ones that buy into it, make it.” She even used that word—“grit” —that Anderson used in his interview. Speaking to her, it was evident that she cared deeply for her students, and it came to mind that perhaps she was able to raise students’ performance more than other teachers in the program; however, she said that “no data existed comparing teachers.”

Curriculum and Instruction

Anderson's philosophy on his extension teachers was to give them free reign to do as they best saw fit for their students. "Teachers have total freedom to do what they want to do, to the point where some have too much freedom," he said. In its first couple of years, the new double-period program required giving teachers options and an almost prescribed curriculum to use in the extension program—the Assessment in Learning in Knowledge Spaces (ALEKS) online learning system, which "became a starting point to have something in place." ALEKS is an adaptable technology system that helps bridge the gap between basic skills and algebra instruction. For other supplemental materials that teachers use in class, it varies between each one as to where they are gathering these materials. Some teachers "even make it up on their own, many of them are veteran teachers that have collected a lot over the years," Anderson said.

The routine of the program in its first few years was to focus on pre-teaching. With this, Anderson said, "topics get foreshadowed. If we are doing graphing quadratics, we do factoring in extension." Part of the issue that the program teachers ran into with the pre-teaching was that, in the transition to CCSS, teachers were not using a universal textbook in the day-to-day algebra class, which was corrected in recent years with the adoption of Big Ideas Math, with some Eureka Math built in. This has made for an easier opportunity for teachers across the extension program to pre-teach some of the necessary skills for that day's lesson. Still, Anderson said, "I'm not convinced that the pre-teaching is the best strategy and whether extension should be tied to what is going on in class at all."

This is where the discussion gets a bit more philosophical and becomes intertwined with the grit and motivation factor. The question becomes "what is it that we

are trying to do in a math class?” In our discussion, Anderson stated, “I don’t think the Explore is measuring what we actually care about. It is about taking a leap of faith that if you focus on hard problems the other things will come.”

Anderson believed that by focusing on the standards of mathematical practice—persevering and solving problems—it would pay off toward learning mathematical content (see Appendix D). “I would like to hang out in the mathematical practices and not care about if it’s algebra or geometry,” he explained. “I would like to dabble into just doing rich problems and puzzles and focus on grit. We are starting to do that.” (See Appendix A for an example of the type of problem that Anderson spoke about.) To him, the extension period was a chance to explore what math should be about: critical thought, explorations, and problems; making connections and solving problems to understand the world; and having the perseverance.

Some teachers have used their freedom to explore in this way, taking problems from the Complex Construction Consortium and other sources to give students open-ended, difficult problems to explore as a group. “We want one problem that is open-ended and see what they can do,” said Anderson. He encouraged teachers to “throw out a hard problem and let’s see how they do it... how do they persevere?”

Anderson also believed that the motivation and grit piece extends to being self-reflective over one’s own work. Some teachers in the extension period utilized the time to look at previous work. “Here is your test, let’s correct it,” he explained. He has encouraged teachers to have students score their own tests, and then analyze how they did. He continued, “Compare and contrast, how did you think you did, compared to how you actually did? Did you over- or underestimate how you did?” Giving students more

control and ownership over their own learning helped move them into the “good third” of the students in the program.

It was clear that the extension program had evolved since its inception, into an area for teachers to freely explore a “perfect world” of mathematics, where students could explore rich and open-ended mathematical problems that hit on the Standards of Mathematical Practice without having to worry about covering a massive quantity of material that they “had to get to.” Anderson believed that the leap of faith needed to make it work is rare, but that it will pay off in the end as we develop good thinkers and problem solvers.

At High School B, there was also much flexibility given to teachers who were responsible for the AT course. Feener saw it as an opportunity for preteaching, but also “as a chance to do some different things” in class, to “get the kids up moving around,” and to “fill in gaps.” Teachers had a shared collection of supplemental materials that they had collected over the years of teaching the course.

Feener said that in addition to mixing it up with some different activities, she used the time to help the students review if there is a test coming up. She also spoke to the students’ regular algebra teacher to see if they were falling behind on homework, for example, and if so, would allow for the AT period to catch up. She also threw out a problem during “bell work” to see how the students as a whole performed, to “detect some prerequisite skill (deficiencies), then work on small boards while circulating the room... I am a big advocate of using the small boards while I walk around the room, and the students like them as well.” (See Appendix E for a visual of the small board.)

The regular period algebra class utilized the “Algebra I Common Core Edition” Pearson book, while the support class had the Kuta software available to generate remediation worksheets that teachers could use to individualize student instruction for specific skills. Another supplemental material that Feener suggested using is “Teachers Pay Teachers” for ideas about activities and CCSS math tasks going back as far as fifth grade, in order to find accessible material for students in the class.

Interestingly, while the AT course teachers were given loads of flexibility regarding how they utilized class time, Feener mentioned that the lower-level IAG1 course was “very prescriptive,” and that did not have the same opportunity for flexibility as the AT course.

Statistics Regarding Exiting the Program

At High School A, students took the Explore exam in eighth grade and the Plan exam in ninth grade. Based on the data collected, there was a small effect size on students who were in the extension program and their actual score compared to their predicted score. There was no control group available for those who just missed the cut into getting into the extension program. There was not (nor is there currently) a policy that dictated if students continued in the extension program for their sophomore year. Teachers simply got a “feel for” the students during the school year, and made a recommendation as to whether or not they should continue. About 20 students exited the program their freshman year, or the exact one-third number that Anderson mentioned in our discussion.

At High School B, there was an evaluation process for students who were in the AT class after the school year. Some students failed the course and had credit recovery in the summer, then moved onto geometry their sophomore year. Other students who failed

the course were moved down to the IAG2 course their sophomore year. A small number of students passed the Algebra I course and the extended course, but it was recommended that they move down to IAG2, as well. No data was available for the percentage breakdown of each, but Feener said that is something that they are beginning to track. She also added a word of caution regarding any conclusions one may come to regarding benefit of the support class:

One of the problems with drawing conclusions about the benefit of a support class (or anything else involving humans) is that you can't go back in time and see what would have happened if you had done it differently, because there are so many when working with kids. Also, when we were looking at the ACT [achievement exam] under No Child Left Behind, we were mostly focused on whether a student "met" or not so we didn't pay as much attention to the actual score.

Comparing the Two Schools

The most striking difference between High School A and High School B was the additional, lower-level course that High School B offered. While it did not do away with the traditional high school course sequence entirely—students were taking algebra and geometry, just over a longer period of time—it did allow for students coming in multiple years behind in mathematics to have more accessible material, as well as provided for an opportunity to exit the course if they were successful, and return to the traditional path. In placing the students and their scheduling, this was the main takeaway—that students who were not ready for algebra were given an entirely different course to take, rather than simply a period of extra algebra support.

High School A had become more progressive in looking at student-teacher relationships when placing students in the program. While High School B did recognize that there was surely a correlation between student-teacher rapport and success, it had not yet gone to the extent of making it part of its placement policy.

While both schools allowed for a great deal of freedom for teachers circularly in the extension program, High School A's leadership did give a bit more direction toward a problem-solving approach than High School B. Both schools had recently adopted more updated materials, but High School A was more likely to look for a "preteaching" method to preview the regular course's material before each class.

The number of students who exited from the extension program differed between each school. This was mainly due to the fact that High School B offered the additional lower-level course. Since there was no "extension" option for further courses in High School B as in High School A, moving students back to the IAG2 course was an additional option for those students in High School B.

Many similarities were present between the two schools as they related to the additional period of algebra. Both schools allowed for the flexibility of the teacher to do as they saw fit for student success. High School A was starting to move toward more of a motivation model to determine the best fit for students, while High School B mentioned motivation and grit as being part of student success once they were placed in the program. There were similar percentages of students that were coming in needing additional support as well, and both schools realized the difficulty of the task of making the leap into high school mathematics and how they needed to have systems in place for those who would need additional support.

Interpretations of the Findings

As someone who has worked with analyzing school data for more than three years, I was most curious about the fact that each interviewee went back to student motivation, student-teacher relationships, grit, and other complicated factors that one

cannot necessarily measure, rather than simply looking at what happened to math test scores. School reformers often point to school data as the end-all, be-all of school improvement, but the real world is much more complex—and some of the most important factors, namely those of motivation and a love of learning, are hard to measure. This is not to say that student test scores are unimportant or that we should not pay attention to them; it means that schools are complex institutions that deal with human interaction and many moving parts, and we must re-evaluate how we are evaluating them.

These findings are significant to me because I feel that they are indirectly a backlash against the data-driven environment that schools have operated under throughout the last decade. Students' habits provide valuable data on a daily basis, especially regarding the tasks that their teachers are giving them, and improving this data will inevitably improve the required metrics that any district or state sets forth. We should spend more time in our school-improvement efforts focusing on the things that schools deal with on a day-to-day basis and the work that students are being given, as well as talking to the people who are working with the students every day, namely the teachers and administrators inside the schools. I think speaking with those in schools who did actual work every day, and knew its direct impact, affected my findings; our conversations came down to the intrinsic motivations of students and teachers, rather than the test scores that they received on an end-of-the-year standardized test.

My big takeaway from the two interviews is to focus on giving the students interesting and challenging work on their level, and give teachers the flexibility and autonomy to do what they feel is best for students as professional educators. Also, that just offering a program like DPA is only the first step. In order for a program to be

successful, there are many pieces that must be in place, and it takes leadership to make sure that it happens. There must be teachers who are a good fit, students in the program who make sense for the program, a plan to fit students' needs, and the frequent follow-up and analysis of what is and is not working during the school year. Ultimately, what is essential is providing for students' needs, appropriately challenging them, and monitoring their progress.

SECTION FIVE: JUDGMENT AND RECOMMENDATIONS

My first research question was regarding the various formats that DPA has taken and the influence that teacher practice has on them. In both high schools, there were similarities in that the teachers both had an incredible amount of freedom with the extra period to do what they deemed best fit their student population. They were also both strategically chosen to fill separate periods throughout the day—the extension course and the regular course were not back-to-back. In the discussion with the math department chair, I learned that the variance from class to class is great between just the few teachers who instruct the program due to their freedom in choosing how to spend the extra time. In addition, no data was available about which teachers were exiting students from the program at a higher rate than others, so it is difficult to tell which teacher practices exiting students from the program, and which gets the highest effect size in test scores. Regarding test scores, it is now evident that other measures should be used in evaluating the placement of students into programs like DPA. By using surveys and interviews with students, and even their previous teachers, we can attempt to measure things such as the perseverance students have when solving problems, as well as their ability to get through open-ended, difficult problems and apply problem-solving skills. Feener agreed with this notion—that there were some students who “got” the program and for whom it worked, and then there were others who were just not going to “play school” and for whom the program itself would not matter.

My second research question was regarding supplemental programs that have emerged and which seemingly had better results than others. Both schools mentioned that providing students access to rich problems was key to moving forward, and they

gravitated to that option over using any online or supplemental program that they had purchased; based on the sample size, it seemed that having students attempt to solve complex problems was the best utilization of time.

I found the push in both schools toward more of a problem-solving approach to be a very positive finding. I think that when given the freedom and flexibility to come up with their own scope and sequence for a math course, teachers realize that giving the students interesting problems and tasks makes a lot of sense, and I hope that the implementation of the CCSS spreads this mentality around and allows for more teachers to take the “leap of faith” that doing interesting mathematics pays off in the understanding of a wide variety of mathematical concepts.

I was a bit disappointed, though not surprised, to find that the actual, pinpointed aspects of getting students caught up were unclear. In CPS, there is a gigantic problem of students often coming in more than two, and sometimes three or even five, years behind in mathematics, and I was hoping to find proven strategies that worked to get those students caught up in the context of a DPA course. I am left with no suggestions regarding what would truly work for this issue, other than simply recommending that schools have entirely different courses available for those students, as High School B did.

Recommendations

Taking into account what I learned from two other districts, my first recommendation for Chicago Public Schools is that schools offer a course for students who are not ready for Algebra I, whether it is called “pre-algebra” or another name. CPS needs to do away with mandatory Algebra I for all freshmen, because the reality is that there is too high of a percentage of students who are set up to fail, because their ability

level is coming in so far behind. The integrated algebra and geometry course from High School B is an interesting idea to consider for other schools. There are simply too many students who do not have the readiness level for Algebra I and do not have much of a chance to pass it from Day 1 of the school year. This course should build foundational skills and confidence, as well as problem-solving. The teacher selected for this must be able to adjust instruction on the fly, develop great relationships with students, and have the patience to go back as far as possible before finding challenging material that is accessible to the majority of the class. Offering a credit-bearing course that is not Algebra I, but still appropriately challenging, would reduce the failure rate in freshman year greatly. It does not have to be a watered-down curriculum if thought is put into the tasks, activities, and problems that make up the course. This would be a more effective use of the DPA system because it would eliminate the root cause of a lot of the failures for a high percentage of students—that they are simply not ready for Algebra I, and not even a double period of it is going to solve that problem.

My second recommendation is that CPS re-evaluate the course sequence of “algebra, geometry, Algebra II,” and offer different ways to get through the mathematical cycle in high school. A mathematical sequence of courses called “Problem-Solving and Challenging Tasks in Mathematics” would be interesting, real-world applicable, and get to the root of conceptual knowledge that the Common Core State Standards is attempting to get to, namely “what does the math mean?” I would also be fine with this course being the “extension” portion of a DPA course, not touching the content that is taught regularly in the algebra class, but instead building a foundation of problem-solving and critical-thinking skills. Students could be graded based on the Standards of Mathematical

Practice, and take some cues from High School A by measuring student progress on how well they improve their perseverance and struggle with solving problems.

My third recommendation is to implement a better data-collection system in order to determine if programs actually work. An analytical approach to programs would be beneficial to truly see the impact of enacting these courses. In both of my interviews, there were often answers about data not existing, or not being collected, or the process having just started. These are not the faults of the interviewees; this type of culture must start at the top of the district or school to evaluate whether things are working, and to go further in on ones that are working. In CPS, schools and administrators too often buy into a program without seeing it through long enough to evaluate what is going on and whether it is actually working. Choosing a new way to teach a sequence of math courses in a couple of schools—one that has heavy buy-in from the administrative team, math department chair, and teacher of the program—would allow for the creation of a new model that could be replicated in places where those strong teams are already in place.

Limiting my research to two interviews does pose some limitations on making judgments and recommendations for the CPS program. It would be beneficial to talk to directors of curriculum, heads of districts, superintendents, and even students and parents regarding the implementation of Double Period Algebra and its lasting successes, challenges, and legacies. These stakeholders would be important for information because they could help to paint the overall picture and see the program from different viewpoints.

The reality is that a high portion of freshmen in Chicago are coming in far behind grade level. The high rate of failure in Algebra I will continue even with a double period

if no schools pursue new ideas on how to possibly lower failure rates, allow students to continue in high school math, and eventually graduate.

REFERENCES

- Allensworth, E., & Easton, J. Q. (2007). *What matters for staying on-track and graduating in Chicago high schools*. Retrieved from Chicago Consortium website: <https://consortium.uchicago.edu/publications/what-matters-staying-track-and-graduating-chicago-public-schools>
- Allensworth, E., & Nomi, T. (2010). *Are two algebra classes better than one?* Retrieved from Chicago Consortium website: <https://consortium.uchicago.edu/publications/are-two-algebra-classes-better-one-effects-double-dose-instruction-chicago>
- Baker, C. (2013, April). New research says the push to have students take algebra by 8th grade has hurt, not helped, students. *Deseret News*. Retrieved from <http://www.deseretnews.com/article/865577774/New-research-says-the-push-to-have-students-take-algebra-by-8th-grade-has-hurt-not-help-students.html>
- Benjamin, A. (Speaker). (2009, February). *Teach statistics before calculus!* [TED Talk]. Available from http://www.ted.com/talks/arthur_benjamin_s_formula_for_changing_math_education?language=en
- Cascio, E. U., & Staiger, D. O. (2012). *Skill, Standardized Tests, and Fadeout in Educational Interventions*. National Bureau of Economic Research (Working Paper 18038).
- Clotfelter, C. T., Ladd, H. F., & Vigdor, J. (2011). *The Aftermath of Accelerating Algebra: Evidence from a District Policy Initiative*. National Bureau of Economic Research (Working Paper 18161).
- Corona, F. *Intensified algebra program helps freshmen stay on track for success*. Retrieved from University of Illinois at Chicago Learning Sciences Research Institute website: <http://www.lsri.uic.edu/institute/project-story/intensified-algebra-program-helps-freshman-stay-track-success>
- Cortez, K., Goodman, J., & Nomi, T. (2013). *Intensive math instruction and educational attainment: long-run impacts of double-dose algebra*. Retrieved from Harvard Kennedy School of Government website: <https://research.hks.harvard.edu/publications/getFile.aspx?Id=928>

- Gamoran, A. (1987). The Stratification of high school learning opportunities. *Sociology of Education*, 60(3), 135–155.
- Hacker, A. (2012, July 28). Is algebra necessary? *The New York Times*. Retrieved from <http://www.nytimes.com/2012/07/29/opinion/sunday/is-algebra-necessary.html>
- Hallinan, M. (1994). Tracking: From Theory to Practice. *Sociology of Education*, 67(2), 79–84.
- Heitin, L. (2014, July). A double dose of math has diminishing returns, study finds. *Education Week*. Retrieved from http://blogs.edweek.org/edweek/curriculum/2014/07/math_class_time.html.
- Heitin, L. (2015, June). Common-core algebra seen as tougher. *Education Week*. Retrieved from <http://www.edweek.org/ew/articles/2015/06/03/common-core-algebra-seen-as-tougher.html>
- Hoxby, C. (2002). The power of peers: how does the makeup of a classroom influence achievement? *Education Next*, 2(2), 57–63. Retrieved from <http://educationnext.org/the-power-of-peers/>
- National Science Foundation. (2014). *Science and engineering indicators 2014*. Retrieved from <https://www.nsf.gov/statistics/seind14/>
- Nomi, T. & Allensworth, E. (2009). ‘Double-dose’ algebra as an alternative strategy to remediation: effects on students’ academic outcomes. *Journal of Research on Educational Effectiveness*, 2(2), 111–148.
- Oakes, J. (2005). *Keeping track: How schools structure inequality* [2nd ed.]. New Haven, CT: Yale University Press.
- The Charles A. Dana Center, The University of Texas at Austin. *Overview of two-period algebra*. Retrieved from <http://www.utdanacenter.org/wp-content/uploads/ia-factsheet-dec2010.pdf>
- Patton, M. (2008). *Utilization-focused evaluation* [4th ed.]. Thousand Oaks, CA: Sage Publications.

Rech, J. & Harrington, J. (2000). Algebra as gatekeeper: a descriptive study at an urban university. *Journal of African American Men*.

Ruszczak, R. What is problem solving? Art of Problem Solving. Retrieved from <http://artofproblemsolving.com/articles/what-is-problem-solving>

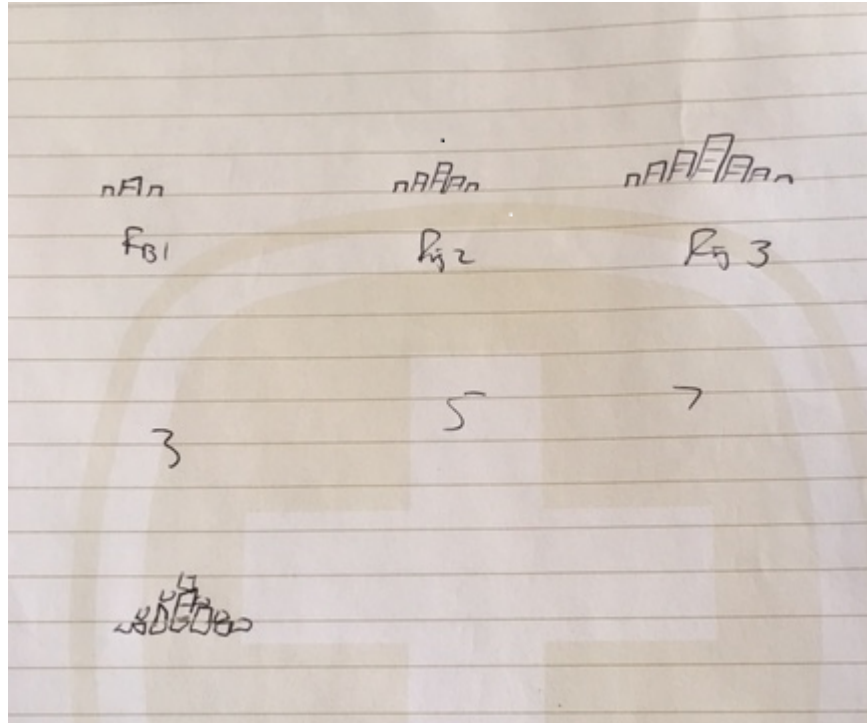
St. George, D. (2015, July 22). Three out of four high schoolers failed Algebra 1 final exams in Md. District. *Washington Post*, p. 2.

Taylor, E. (2014). Spending more of the day in math class. Stanford University dissertations.

Vevea, B. (2015). Emanuel touts bogus graduation rate. WBEZ News. Retrieved from <http://www.wbez.org/news/emanuel-touts-bogus-graduation-rate-112163>

APPENDIX A: CRITICAL THINKING PROBLEM

An example of the type of problem that Anderson believed was appropriate for fostering student critical thinking is below. In this program, the only question is to “explain how this figure is growing.” It opens up a wide variety of ideas that can run from elementary mathematics all of the way through to the most advanced high school courses, because there are so many different directions to take and ways to explain.



APPENDIX B: SAMPLE CAROL DWECK MINDSET SURVEY

1. No matter how much intelligence you have, you can always change it a good deal.

Disagree A Lot

Disagree

Disagree A Little

Agree A Little

Agree

Agree A Lot

2. You can learn new things, but you cannot really change your basic level of intelligence.

Disagree A Lot

Disagree

Disagree A Little

Agree A Little

Agree

Agree A Lot

3. I like my work best when it makes me think hard.

Disagree A Lot

Disagree

Disagree A Little

Agree A Little

Agree

Agree A Lot

4. I like my work best when I can do it really well without too much trouble.

Disagree A Lot

Disagree

Disagree A Little

Agree A Little

Agree

Agree A Lot

5. I like work that I'll learn from even if I make a lot of mistakes.

Disagree A Lot

Disagree

Disagree A Little

Agree A Little

Agree

Agree A Lot

6. I like my work best when I can do it perfectly without any mistakes.

-
- Disagree A Lot
-
- Disagree
-
- Disagree A Little
-
- Agree A Little
-
- Agree
-
- Agree A Lot

7. When something is hard, it just makes me want to work more on it, not less.

-
- Disagree A Lot
-
- Disagree
-
- Disagree A Little
-
- Agree A Little
-
- Agree
-
- Agree A Lot

8. To tell the truth, when I work hard, it makes me feel as though I'm not very smart.

-
- Disagree A Lot
-
- Disagree
-
- Disagree A Little
-
- Agree A Little
-

Agree



Agree A Lot

APPENDIX C: THE CCSS FOR KINDERGARTEN OPERATIONS AND ALGEBRAIC THINKING

Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.

CCSS.MATH.CONTENT.K.OA.A.1

Represent addition and subtraction with objects, fingers, mental images, drawings¹, sounds (e.g., claps), acting out situations, verbal explanations, expressions, or equations.

CCSS.MATH.CONTENT.K.OA.A.2

Solve addition and subtraction word problems, and add and subtract within 10, e.g., by using objects or drawings to represent the problem.

CCSS.MATH.CONTENT.K.OA.A.3

Decompose numbers less than or equal to 10 into pairs in more than one way, e.g., by using objects or drawings, and record each decomposition by a drawing or equation (e.g., $5 = 2 + 3$ and $5 = 4 + 1$).

CCSS.MATH.CONTENT.K.OA.A.4

For any number from 1 to 9, find the number that makes 10 when added to the given number, e.g., by using objects or drawings, and record the answer with a drawing or equation.

CCSS.MATH.CONTENT.K.OA.A.5

Fluently add and subtract within 5.

APPENDIX D: THE STANDARDS FOR COMMON CORE MATHEMATICAL PRACTICE

CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them.

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to *decontextualize*—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to *contextualize*, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others.

Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

CCSS.MATH.PRACTICE.MP4 Model with mathematics.

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another.

Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically.

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

CCSS.MATH.PRACTICE.MP6 Attend to precision.

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

CCSS.MATH.PRACTICE.MP7 Look for and make use of structure.

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many

sides the shapes have. Later, students will see 7×8 equals the well remembered $7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y .

CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning.

Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y - 2)/(x - 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x - 1)(x + 1)$, $(x - 1)(x^2 + x + 1)$, and $(x - 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.

APPENDIX E: SMALL BOARDS



A small board that Feener highly recommends as a way to see multiple students' work as she circulates the room