CSUN Math Camp Projects

SUMMARY

Two different projects/research:

1) 4-week high school math camp (for incoming 9th graders) at Northridge Academy High School (This is our 5th year and have so far served about 700 students)
2) 2-week elementary (3rd – 5th) and a 2-week middle school (6th – 8th) math camp in Val Verde School District, Riverside (This is our 2nd year and we have served about 600 students)

All 3 camps (high school, elementary, and middle) have their own separate mathematics curriculum (based on grade level standards), which I created. Each of the 3 curriculums incorporate a 20 minute mindfulness lesson (content differentiated by age group) and a 15 minute "Fresh Start" team-building game throughout each day, along with two conceptual mathematical tasks. Students spend approximately 3 – 3.5 hours at camp each day (depending on the district's needs)

Sample mindfulness lessons for students include:
<u>High School:</u> Mindful breath, Cortisol/neuroplasticity, Positive self-talk, Noise Pollution (internal/external), Changing Your Perspective
<u>Elementary/middle school:</u> Mindful breath, mindful thoughts, and read books: *Captain Snout, Mindful Monkey Happy Panda*, and *Book of Mistakes*

After the students leave camp, teachers stay and work with me on reviewing the lessons for the next day, including the mindfulness lessons. These PD/debrief sessions last anywhere from 1.5 hours to 3 hours (depending on the district). The goals of the high school sessions are slightly different than the elementary/middle school sessions, i.e. elementary and middle school goals focus on sharpening teachers' math conceptual knowledge and skills and introducing them to different pedagogical approaches, whereas the high school sessions dive deep into the mathematical connections between function representations and how to bring them out pedagogically. Although, in each I challenge the teachers mathematically and raise their anxiety levels around mathematical concepts they have never thought deeply about before and must learn. After they succeed, they can better understand their students' daily anxiety as they try to learn new math concepts.

LITERATURE

Acknowledging that students often face math anxiety (Dowker, Sarkar, & Looi, 2016) or poses a fixed mathematical mindset of "I'm not a math person" (Dweck, 2006a, 2015), the overall design of Math Camp was grounded in establishing a welcoming, positive, safe, and fun atmosphere for learning, socializing, and thinking, where every student's thoughts are valued. Studies have shown that emotional factors may play a large part in mathematical performance, with mathematics

anxiety playing a predominantly large role (McLeod, 1992; Ma and Kishor, 1997; Ho et al., 2000; Miller and Bichsel, 2004; Baloğlu and Koçak, 2006). Anxiety can disrupt mathematical learning and performance, by causing avoidance of activities and by overloading and disrupting working memory during tasks (Dowker, Sarkar, & Looi, 2016). Along with anxiety, mindset is also a factor in determining students' success in mathematics because when students think that they are bad at mathematics, they are more likely to be anxious when they are asked to perform and overtime, develop negative attitudes towards learning mathematics. Furthermore, studies suggest that negative attitudes towards mathematics increases throughout childhood and adolescence (Wigfield and Meece, 1988; Ma and Kishor, 1997) and ultimately, whether a student likes or fears mathematics will influence whether they take higher-level mathematics courses and pursue careers that require mathematics (Chipman et al., 1992; Brown et al., 2008). Therefore, the importance of acknowledging the roles anxiety, attitudes, and mindset play, and that many students do not view math as fun, safe, or obtainable, was crucial in our Math Camp design.

The challenge was to establish an atmosphere that was different than those students had experienced in the past; where they developed their mindset, anxiety, and attitudes. Structurally, this meant removing evaluative factors such as grades, tests, and homework, all of which cause anxiety and are used by students to label themselves as "not a math person". Schinske and Tanner (2014) stated,

> "Grades appear to play on students' fears of punishment or shame, or their desires to outcompete peers, as opposed to stimulating interest and enjoyment in learning tasks. Grades can dampen existing intrinsic motivation, give rise to extrinsic motivation, enhance fear of failure, reduce interest, decrease enjoyment in class work, increase anxiety, hamper performance on follow-up tasks, stimulate avoidance of challenging tasks, and heighten competitiveness" (p. 161).

This also meant taking into consideration that just coming to school, for some students, causes anxiety or negative feelings, so Math Camp incorporated a morning welcome activity for all students in the gym. Each day started with a "Fresh Start" rally for all, where students and teachers competed in fun camp-like games that required teams to collaborate, intended to develop communication, team-effort, and problem solving, mirroring interaction norms necessary during mathematical tasks.

Beyond structural design, the curriculum created for Math Camp also took into consideration students' anxiety and mindset by combining mathematical tasks with lessons focused on mindfulness practices and neuroplasticity. There were two math lessons per day that consisted of floor-to-ceiling small group tasks that allowed for multiple entry points, varied solution strategies (Boaler & Staples, 2008; Hiebert et al., 1997; Stein, Smith, Henningsen, & Silver, 2009), and offered connections to multiple representations (NRC, 2001; Lesh, Post, & Behr, 1987; Marshall, Superfine, & Canty, 2010; Tripathi, 2008; Webb, Boswinkel, & Dekker, 2008). The mathematics curriculum of Math Camp is unique in that, the tasks are "safe" where students' work is centered more on interpretation and exploration, rather than just answers. Tasks

provided opportunities for students to explore using manipulatives, visualisations, and art, as well as to communicate their thinking in text, talk, or on a poster. The object of the tasks was not to find the right answer, per se, but rather to explore and listen to all the other ways people thought about it.

Before each math task and in between math task one and two, students participated in activities and lessons aimed at decreasing and controlling their anxiety, as well as promoting a growth mindset. Each day, after students finished the Fresh Start, all-together in the gym, they went to their assigned classrooms and had a short mindfulness lesson, teaching students how to "reset with a breath," what it means and feels like when you "flip your lid" when your cortisol levels are high, and how to focus on positive self talk. Research that has looked at mindfulness-based practice in children have reported that it leads to a decrease in symtoms of anxiety (Semple et al., 2005), and increases in optimism and improvements on dimensions of teacher rated classroom social competent behaviors (Schonert-Reichl and Lawlor, 2010). The results from another study from Broderick and Metz (2009) suggest that mindfulness is a potentially promising method for enhancing adolescents' emotion regulation and well-being. In between math task 1 and 2, students would also take a "mind break" with a 20-minute mindful lesson.

Mathematics Content

For elementary Math Camp, the foci were on developing students' conceptual understanding of fractions and number sense; more specifically, unit fractions, fraction equivalence and number patterns. For middle school math camp, the foci also included developing students' conceptual understanding of fractions and number sense. However at this grade level students explore fraction models, and operation representations, as well as connections to the number line and area models.

The reasoning for this is two-fold: 1) knowledge of fractions that children develop in the elementary grades provides an essential foundation for the study of algebra and more advanced mathematics, and 2) the understanding of unit fractions is crucially important for elementary school children's development of number sense (CCSS 2010). Siegler et al.'s (2012) analyses of nationally representative data sets from the United Kingdom and the United States demonstrated that competence with fractions in fifth or sixth grade predicted performance on algebra five or six years later. National and international comparisons of student achievement indicate that it is between 4th and 8th grade where U.S. students in general, and minority and high poverty students in particular, fall rapidly behind desired levels of achievement (Beaton et al., 1996; Schmidt et al., 1999). This points to the importance of supporting students in the understanding of fractions in elementary and middle school grades and validates the decision for the Math Camp curriculum foci.

For high school Math Camp, students explore proportionality, function representations (linear, quadratic, power), sequences, and fractals. The role of

multiple representations in learning algebra is of utmost importance for students' success in high school mathematics and algebra 2 (Brenner 1997). The National Council of Teachers of Mathematics states:

> Studies have found that a strong foundation in proportional reasoning can support students' understanding of linear functions and graphs, linear equations in the form $y = mx$ and $y = mx + b$, and measurement situations.

By combining growth mindset, mindfulness, and mathematics, Math Camp's curriculum design takes into account many different theories that support students' success in mathematics. The overall structural design also considers theory and research that contributes to lowering anxiety and boosting collaboration. Both contribute to improving students' mathematical knowledge and confidence.

Results for High School Math Camp

Math Camp Summer 2015 Pilot Data

During the 2015 pilot, 162 incoming freshmen attended camp for four weeks and explored foundational concepts of Algebra 1 such as proportionality, functions, and pattern modeling. Concepts were studied in group-based projects as well as individual writing tasks. In addition to mathematics intervention, students also participated in daily morning team-building activities meant to raise their self-esteem and improve communication skills. To help ease students' math anxiety and allow them to explore mathematical concepts without the fear of being wrong, students did not earn a grade for camp or on projects. Attendance was not mandatory, and students did not receive credits toward graduation, yet over four weeks the attendance rate was 85%. A comparison of pre- and post-tests from Math Camp 2015 showed overall, 80% of the students increased their scores and increases ranged from 4% to as much as 52%. The mean increase for students was 8%, which is significant enough to raise a letter grade.

At the end of semester one, in the 2015-2016 school year, less than 50% of students are passing Algebra 1, Geometry, or Algebra 2; however, looking at freshmen that attended Math Camp last year, 30% are failing Algebra 1. Thirty percent is a sizable failure rate but considering that this group consisted of all at-risk students and given that it is 20% less than the school-wide failure rate, this is a meaningful accomplishment for the Math Camp pilot. When comparing Math Camp students' semester one Algebra 1 grade to their semester two mathematics grade in eighth grade, 28% of students who attended Math Camp increased their grade from eighth to ninth grade, out of the remaining students enrolled in Algebra 1 that did not attend Math Camp, only 19% increased their grade.

Interviews with students revealed that Math Camp was effective in the enculturation of students into their new high school atmosphere, as well as decreasing anxiety and helping to build friendships. One student mentioned, "I used to hold my breath every day I walked into middle school, because I was so nervous, but not here. It's comfortable here because I don't get lost in a big classroom and the teachers care what I think." Students also commented about how Math Camp was "cool because

problems weren't boring, and it wasn't always about the right answer. Sometimes, they just wanted to know what I was thinking."

Surveys administered to students at the beginning and end of Math Camp show similar results to the interviews. What makes the survey results unique is that all students were surveyed, compared to the 36 student volunteers interviewed, showing a bigger picture of students' attitudes and how they shifted after four weeks of Math Camp. Statistical significance (p-value < 0.1) was found for certain survey items that indicated a more positive attitude at the end of Math Camp: 1) anxiety at school; 2) like to go to the board and share ideas with peers in math class; 3) enjoy hearing the thoughts and ideas of peers in math class, and 4) enjoy being part of larger groups. Students' level of anxiety stood out the most; at the beginning of camp, on a scale of 1 to 4, students were much more anxious about school than by the end of Math Camp. Figure 1 below shows the shift in students' anxiety level. On the histograms, being anxious at school would be to the right on the graph, towards 4, and the less anxious are the numeric values on the left towards zero.

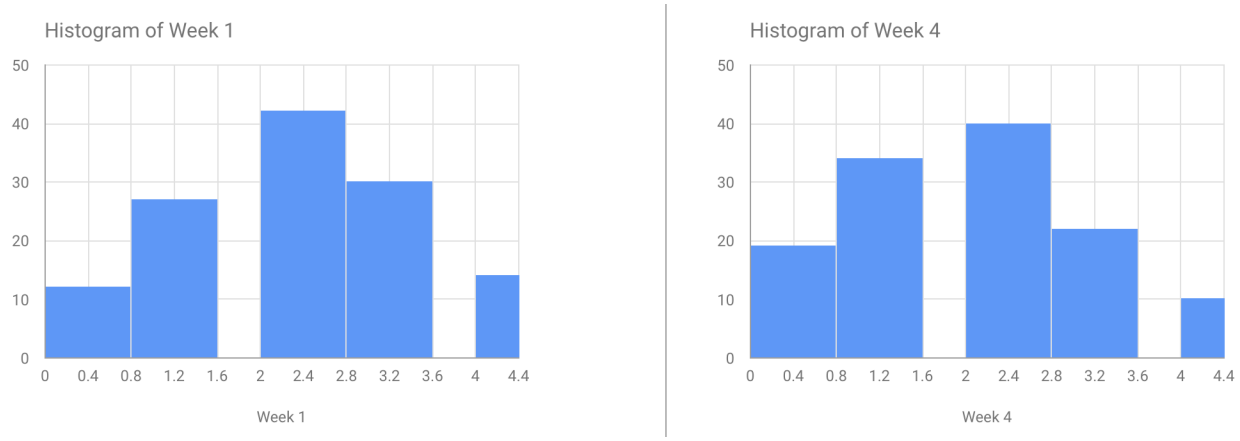


Figure 1. Comparison of survey question about anxiety.

Knowing that 4 weeks of summer camp will not support struggling students during the school year, Math Camp Continued (MCC) was created to extend support both the students who attended Math Camp and to older students struggling in their mathematics courses. MCC takes place two days a week after school, supervised by six teachers (3 of whom taught at summer Math Camp), for an hour and a half. This intervention is individualized through the web-based system ALEKS, where students are given opportunities to master mathematical concepts at their own pace and in their own space. At the end of semester one at NAHS, 109 students were participating in MCC, and the failure rate was 5% for those attended MCC, which is much better than the school norm of around 50%. Surveys to students and teachers show that students feel MCC is helping their mathematical skills and teachers claim to notice the difference in grades, participation, and engagement. ALEKS interventions have been so successful that Math Camp 2016 plans to implement its use in the summer and allow students to continue their ALEKS licenses for the school year in MCC.

Math Camp Summer 2016 Data

125 students attended, and we invited all incoming freshmen. We had students entering algebra 1, geometry, and algebra 2, with the majority (75%) entering algebra 1. The attendance rate over four weeks was 78%. New this year, 17 "Math Camp Ambassadors" volunteered for service learning credit, 15 of which were returning "Math Campers" from last year. They were responsible for welcoming new students, helping out teachers, and designing several of the Fresh Start morning team-building activities. There were also four volunteer undergraduate math majors from CSUN's math department that participated. All teachers that taught at Math Camp were from NAHS. Also new this year was the use of the online program ALEKS in order to provide individualized intervention, as well as implementation of a mindfulness curriculum for "Mindfulness Fridays" in order to address students' anxiety and stress.

Student Pre and Post Tests

On average, students gained 9% - 15% on pre and post assessments. Below shows a breakdown of incoming freshmen (28 students did not take both the pre and post assessments).

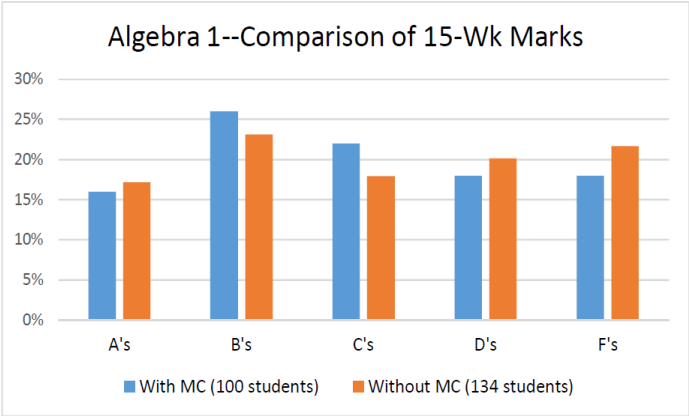
14.30%	**AVERAGE Gain for ALEKS Pre-Algebra**	**(75 Students)**
10.97%	**AVERAGE Gain for ALEKS Algebra 1**	**(12 Students)**
9.28%	**AVERAGE Gain for ALEKS Geometry**	**(2 Students)**

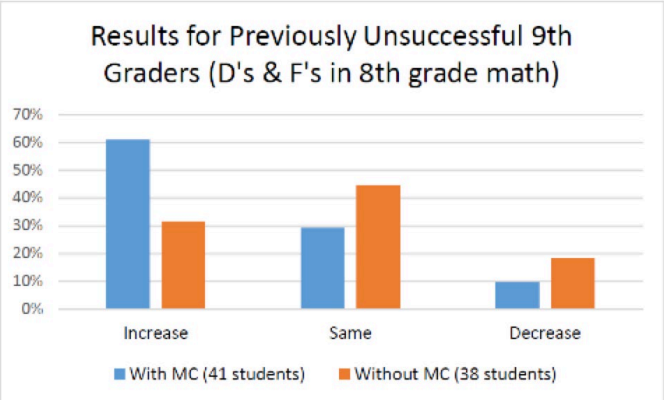
Percent Average Growth Breakdown by Standard (2 Geometry students not included)

Whole Numbers & Integers	Fractions	Decimals	Ratios, Proportions, & Measurement	Percents	Equations & Inequalities	Graphing, Functions, & Sequences	Exponents, Polynomials, & Radicals	Data Analysis & Probability
16.6	5	7.1	3.15	3	6.7	5.6	2	1.2

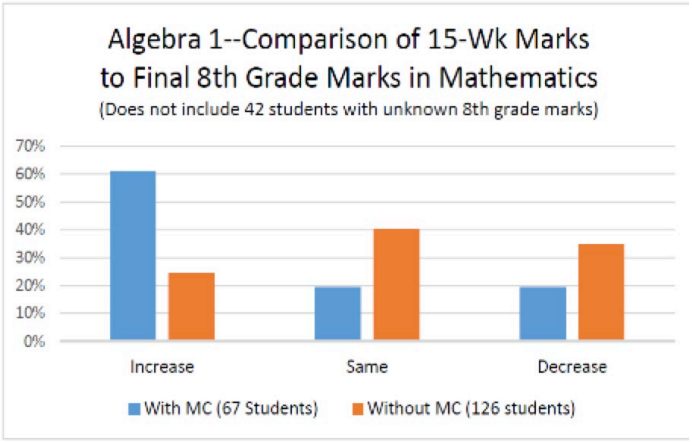
Average Growth Breakdown by SUBGROUPS

16% Average Gain for Female students
12% Average Gain for Male students
11% Average Gain for students with IEPs
9.1% Average Gain for ESL students





Participants were twice as likely to increase their 8th grade letter grade in math during their first semester freshmen year, compared to nonparticipants, 60% of those students had D's and F's in 8th grade. Looking at the comparison in 9th grade algebra 1, the graph is skewed left, suggesting students that attended Math Camp performed better overall.



<u>Student surveys</u>

Overall, items found to have a significant increase included:

- I like to go to the board and share my answers with peers in math class
- I enjoy using a computer when learning mathematics
- When using technology for learning mathematics, I feel like I am in my own private world

Overall, those that showed significant decrease:

- When I see a math problem I am nervous

When separating female and male survey results, the findings are important to point out. For **female** students, items found to have significance were:

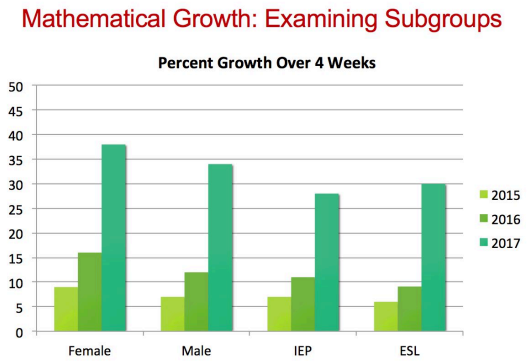
- Technology can make mathematics easier to understand (increased)

- When I see a math problem, I am nervous (decrease)
- I enjoy working in groups better than alone in math class (increase)
- I enjoy hearing thoughts and ideas of my peers in math class (increase)
- I enjoy using a computer when learning mathematics
- When using technology for learning mathematics, I am in my own private world

For **male** students, items of significance were:

- I enjoy using a computer when learning mathematics (increase)
- I enjoy hearing thoughts and ideas of my peers in math class (increase)

2017 Results



By end of the school year, D's and F's are about the same but lower fail rate is among Math Camp students is significant.