

# Mathematics Education

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ARCHWAY CLASSICAL ACADEMY – CHANDLER

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# Math Placement

## Past and Current Practices

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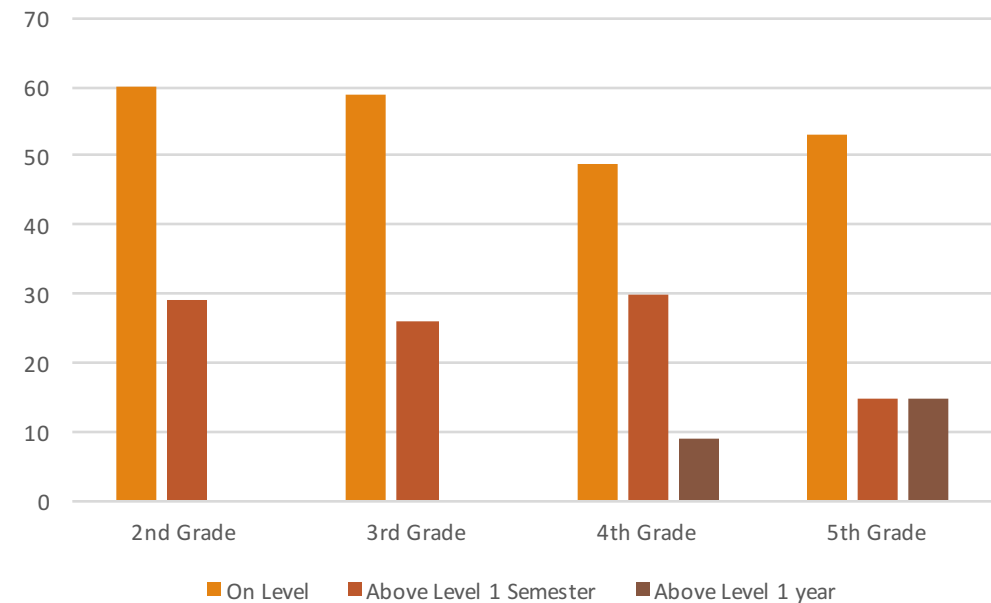
Incoming students in Kindergarten were observed for 30 days and assessed on a range of skills including reading before being considered for promotion to a higher math sequence.

Students in grades 1-5 were tested and placed in math either one semester ahead or one year ahead.

Teaching Assistants were used to teach math classes

Note that we stopped advancing students a full year ahead because we were encountering problems with mastery of basic skills and both parents and teachers were having children back-up and repeat math because of how tenuous the skills were and the impact to confidence.

Projected Distribution of Students 2016-2017



# What We Know

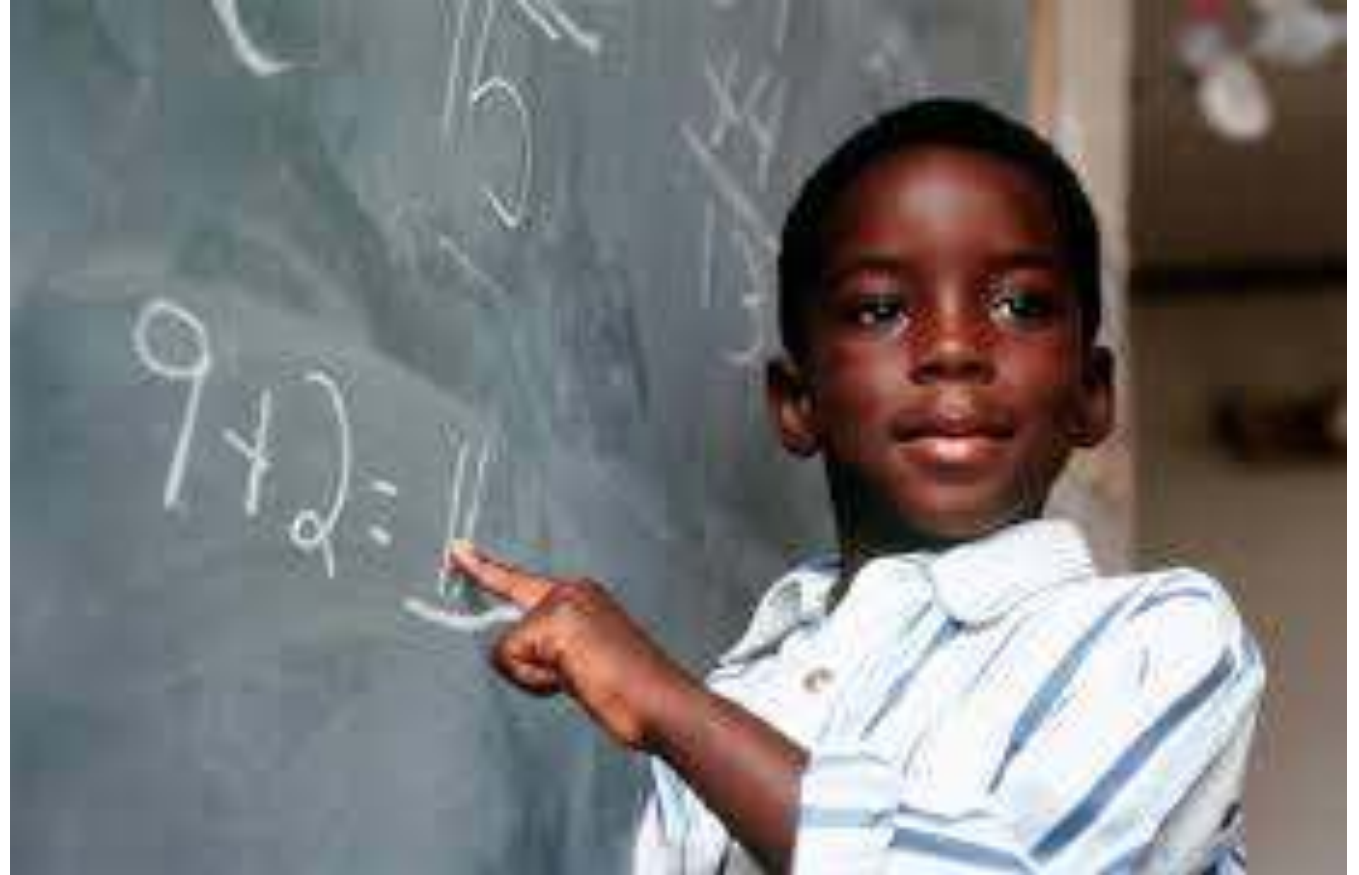
Students that are pushed ahead tend not perform as well on cumulative tests.

Students that are pushed ahead perform no better on standardized tests (AIMS, AzMERIT, Galileo, Stanford 10)

Students that are pushed ahead tend not to perform as well on end-of-course exams as compared with other Archway students testing over the same material in grade level math courses.

Students that are pushed ahead appear to *manage* the new concepts and skills but often are unable to show strength, depth and confidence in these skills. The retention of these skills are tenuous as compared with well practiced, repeatable and confident math skills.

Accelerating students even by one semester breaks the intended sequence and flow of the math curriculum. Students need more time on all basic math skills.



# The Impact of Hurried Math

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## STUDENTS HAVE A MORE TENUOUS HOLD ON THEIR MATH SKILL SET

Students in advanced math classes often *scrape by or just keep up*.

They are able to add new skills but these skills are fragile. They pass chapter tests but often fail cumulative exams. They learning the skills for a short test or quiz but don't retain the skills for later recall.

Students often have one way of solving a problem but are never solid and confident in the skills and patterns of mathematics to solve problems in different ways.

Students require more re-teaching because they do not have the benefit of time with the material.

Students are learning things before they are developmentally ready.

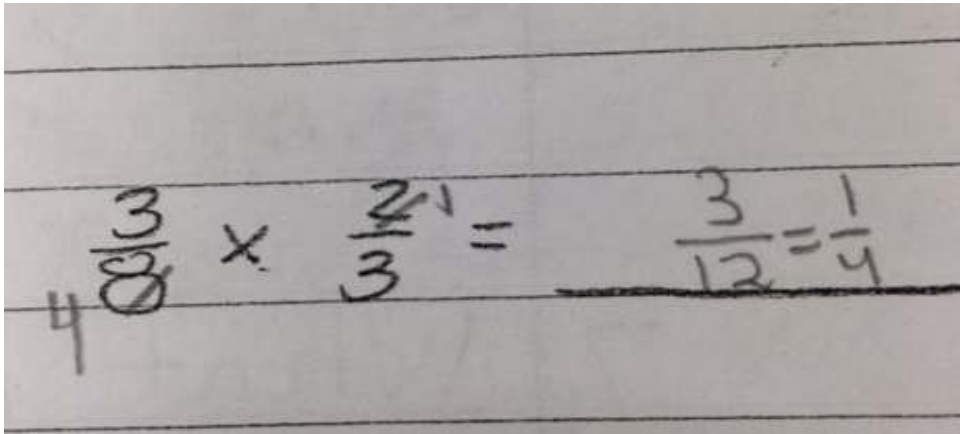
The curriculum dictates the schedule and mixed grade level classes are particularly pressed to keep the lessons on schedule. The children are not ready but must still move forward often at the pace of the higher and older students and at the expense of mastery and confidence.

As teachers and parents we assume that the high kids will "pick it up" or "figure it out". Multiple sources of data indicate that they do not "pick it up" and that, as we hurry, we leave holes in math understanding.

# Inconsistent Math Skills

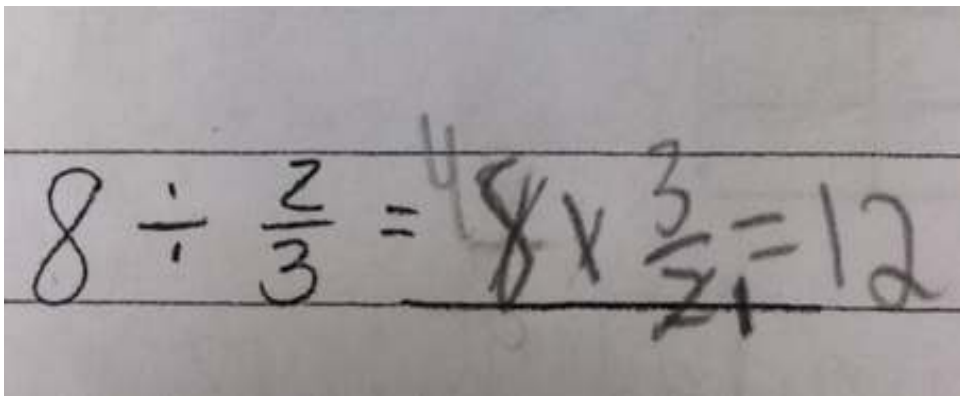
## Advanced 4<sup>th</sup> Grade Class

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A photograph of a student's handwritten work on lined paper. The student has written the equation  $4 \frac{3}{8} \times \frac{2}{3} = \frac{3}{12} = \frac{1}{4}$ . The number 4 is written to the left of the fraction  $\frac{3}{8}$ . The fraction  $\frac{2}{3}$  has a small '1' written above the denominator 3. The final result is  $\frac{1}{4}$ .

Student A correctly multiplies fractions



A photograph of a student's handwritten work on lined paper. The student has written the equation  $8 \div \frac{2}{3} = 8 \times \frac{3}{2} = 12$ . The number 4 is written above the first 8. The fraction  $\frac{3}{2}$  has a small '1' written below the denominator 2.

Student A correctly divides fractions

# Inconsistent Math Skills

## Advanced 4<sup>th</sup> Grade Class Continued

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Student A turns the page and is unable to add fractions

Student A is unable to subtract fractions

13. Add.  
~~(a)~~  $\frac{2}{5} + \frac{1}{3} = \frac{3}{8}$

14. Subtract.  
~~(a)~~  $\frac{3}{7} - \frac{1}{5} = \frac{2}{3}$

The image shows two handwritten math problems on lined paper. Problem 13 is labeled 'Add.' and shows the equation  $\frac{2}{5} + \frac{1}{3} = \frac{3}{8}$  with a diagonal line through the '(a)' label. Problem 14 is labeled 'Subtract.' and shows the equation  $\frac{3}{7} - \frac{1}{5} = \frac{2}{3}$  with a diagonal line through the '(a)' label. Both equations are underlined.

# Inconsistencies

## Advanced 2<sup>nd</sup> Grade Class

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18. Find the sum of 68 and 49. Round to the nearest 10.  
Use estimation to check if your answer is reasonable.

$$\begin{array}{r} 68 \\ + 49 \\ \hline 117 \end{array}$$

148 ✓✓

Estimation

$$\begin{array}{r} 160 \\ + 50 \\ \hline 210 \end{array}$$

Is your answer reasonable? 148

- Addition errors
- Inconsistent rounding skills in estimation portion of the problem
- Fails to answer the question “Is your answer reasonable”

# Inconsistencies

## Advanced 2<sup>nd</sup> Grade Class Continued

- Subtraction errors
- Inconsistent rounding skills in estimation portion of the problem
- Fails again to answer the question "Is your answer reasonable"

19. Find the difference between 83 and 69. Round to the nearest ten. Use estimation to check if your answer is reasonable.

$$\begin{array}{r} 83 \\ - 69 \\ \hline 14 \end{array}$$

48 ✓✓

Estimation

$$\begin{array}{r} 80 \\ - 70 \\ \hline 10 \end{array}$$

Is your answer reasonable? 48



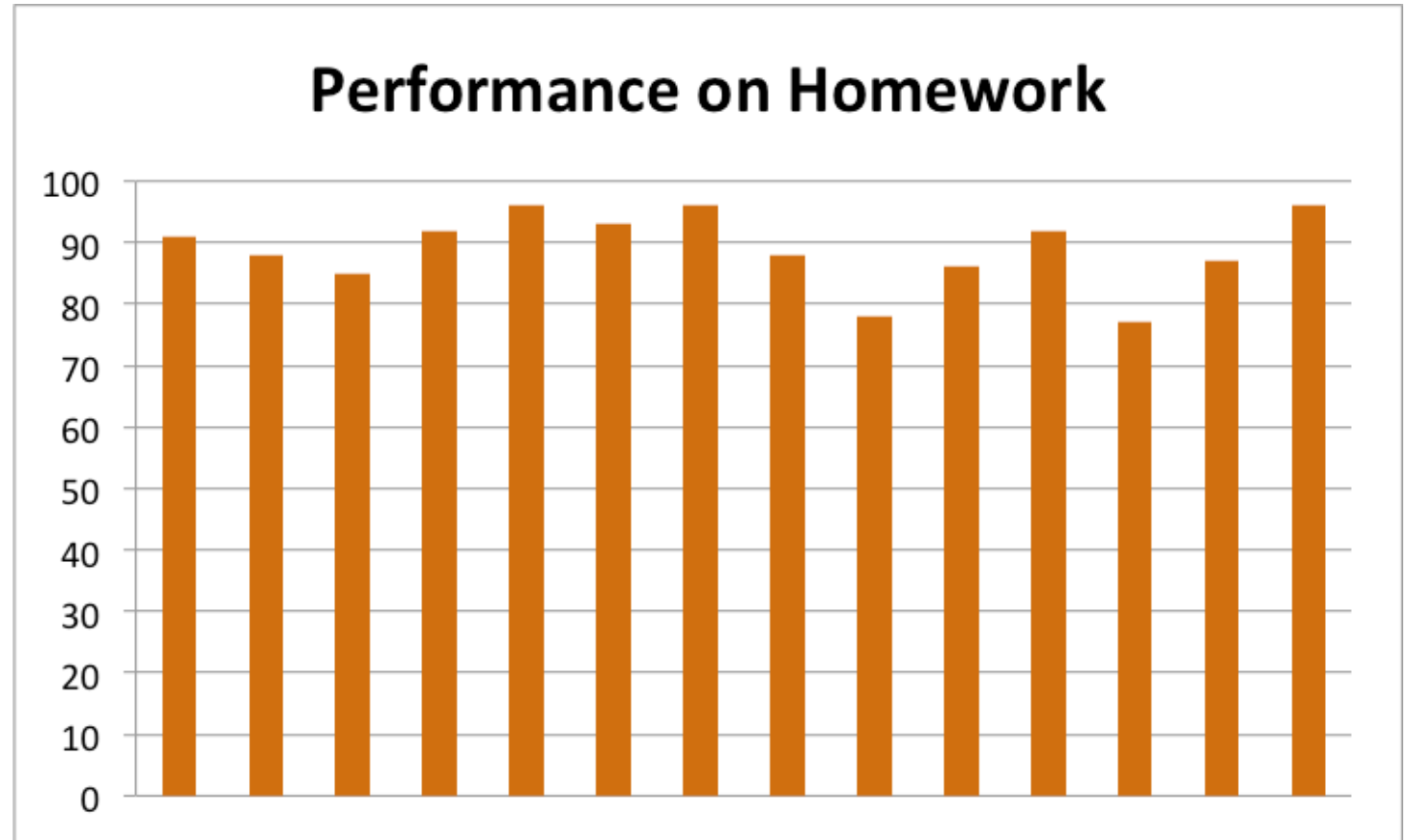
# Looking Closer A Fourth Grade Case Study

Homework performance is high

Class average is almost 90% over time

This is what we are used to from the highly committed families and the bright students at Archway

This is also why homework is not overly weighted as part of the overall grade



# Looking Closer A Fourth Grade Case Study

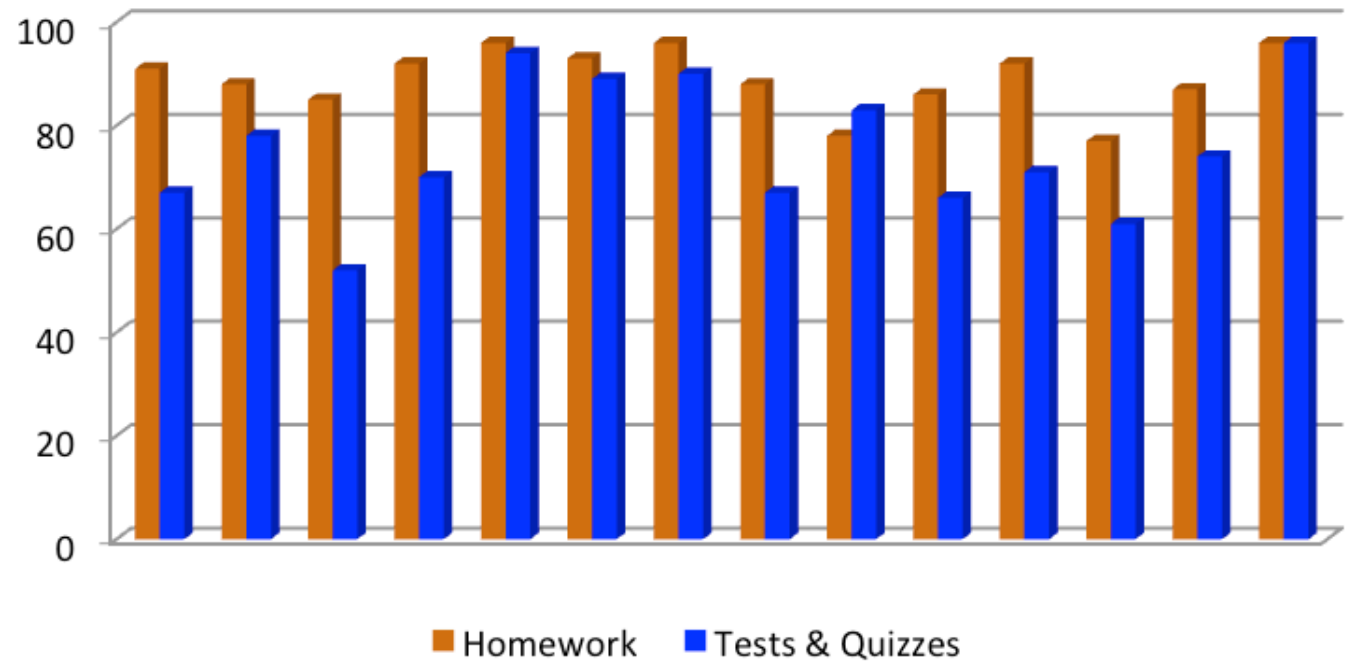
This chart shows test and quiz data for this same sample class as compared to the high homework performance on the previous slide

In general quiz data will assess knowledge and skills of content in the short term. A quiz might cover two days or four days of information and generally is a measure of mastery of smaller critical parts of larger skills

In contrast, tests will generally measure mastery of larger concepts which require students to demonstrate and combine skills previously taught incrementally.

This graph shows that even with a 90% average on homework that quiz and test data demonstrate a much lower level of content mastery.

## Performance on Homework Compared to Tests and Quizzes



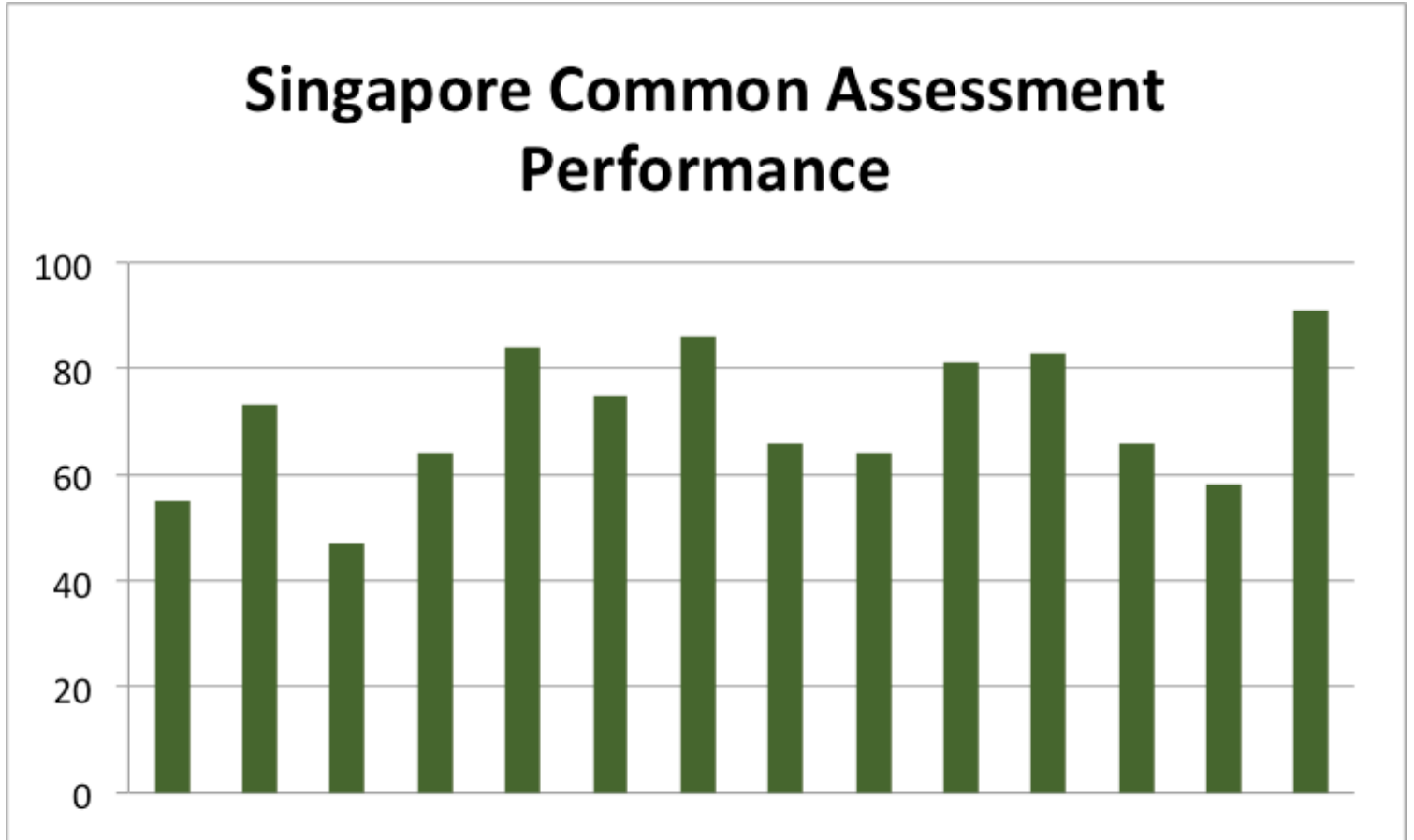
# Looking Closer A Fourth Grade Case Study

At all Archways, students take a Singapore aligned *Common Assessment* at the end of each semester.

This assessment is administered over several days and tests a range of skills not based on what state standards tell us they should know at their grade level but on the level of math they have been studying over the preceding semester

This is the best measure we have of cumulative mathematical knowledge, skill mastery, and retention. Think of this as the comprehensive final exam.

This data demonstrates that the essential skills and mathematical knowledge are more transient . There is less mastery, retention and depth for our students working ahead in math.



# What Does This Data Tell Us?

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Inconsistent skills today become gaps in understanding tomorrow.

Tenuous skills have a significant impact on students being able to retain and recall what has been taught over time.

Some students are not “picking it up”, “catching up”, or “figuring it out”.

Confidence is fostered by being at a developmentally appropriate level of math that is challenging but within reach.

Depth of knowledge comes from a solid mathematical foundation where underlying skills are in place for new skills to build upon.

Wonder comes from being secure and confident enough in understanding to be able to consider what is known in new and different ways.

# Our Solution

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## SINGAPORE MATH 2016 – 2017 CHANGES

All students will take math in their homeroom. The math will be at grade level and differentiated to provide both challenge but also deeper thinking and understanding of foundational math concepts.

Students working a full year ahead their homeroom and will be given an alternative practice book.



# Grade Level Math+ Different Challenges = Greater Confidence

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Time will be provided for mathematical depth. Students will become confident and familiar with grade level math concepts and skills.

There will be increased exploration of alternative solutions .

A New and challenging workbook that will be different from grade level peers will be provided.

Instruction and flexible grouping will be planned for differentiation.

Homework will be differentiated so that it provides practice but also challenge.

# Teachers are Planning for Differentiated Math Instruction

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Kindergarten has been teaching math with differentiated lessons in grade level math classes all this year. The results have been not just encouraging, but affirming. Data from this years Singapore Common Assessment showed improved performance in every skill area assessed over both grade level and accelerated kindergarteners' performance last year.

Teachers and Assistant Teachers have been participating in professional development activities related to differentiated instruction.

Grade level teams have already started building lesson plans that are designed to serve students that need skill mastery, as well as, students that need greater challenge and inquiry.

# What Does Differentiated Math Look Like?

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It is not more of the same kinds of math problems.

It will include dynamic grouping.

It may include one whole group lesson followed by groups practicing skills appropriate to their mastery level.

It will include different homework assignments based on the students level of mastery.

In our Kindergarten example shown here you will see students selecting different independent practice activities. Some will work on numbers to 10, numbers to 40, and numbers to 100.



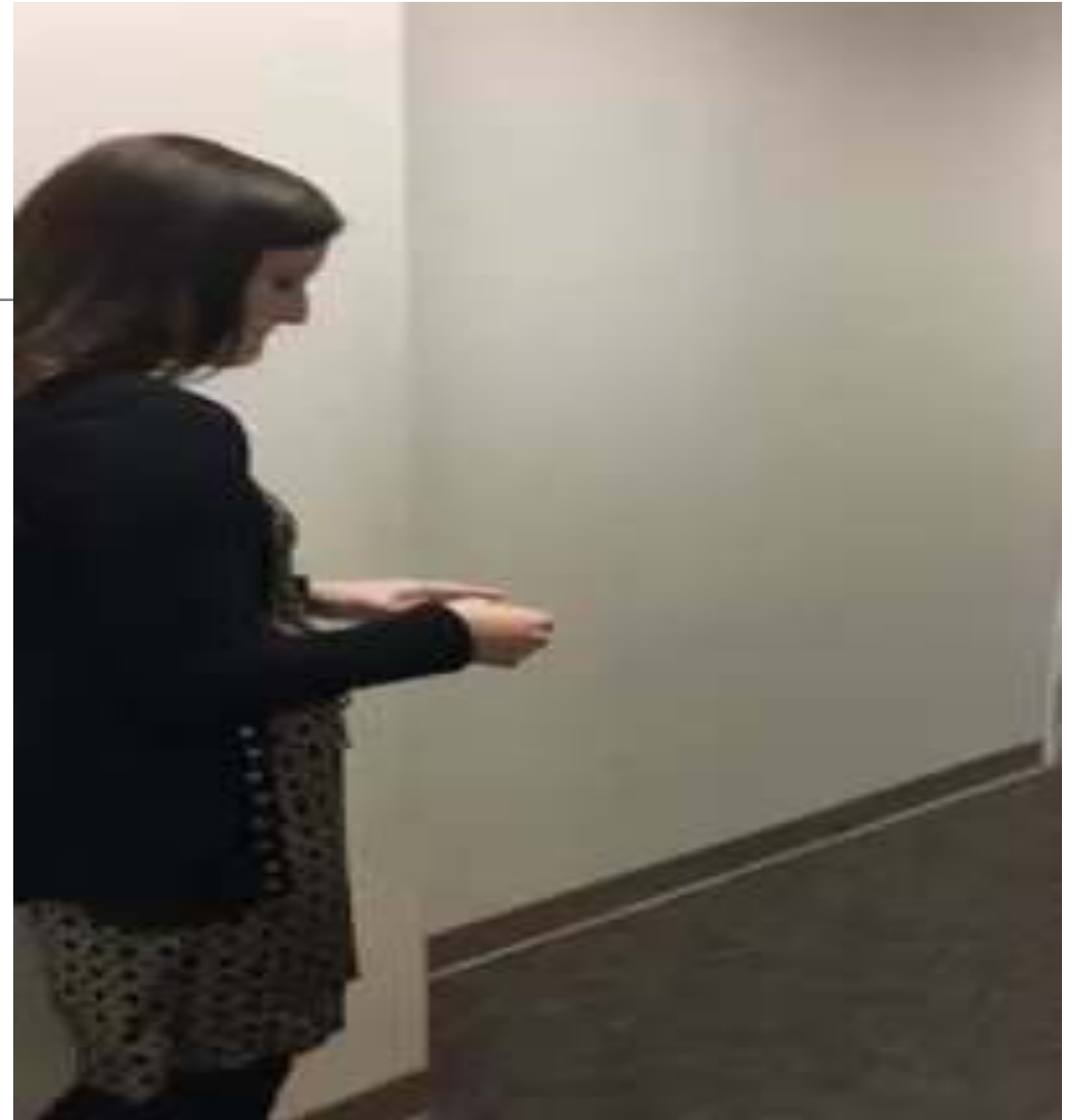


# Second Grade Place Value

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Students in the classroom with the Assistant Teacher are modeling three-digit numbers using place value disks.

Students in the hallway with Miss Carlson are performing addition and subtraction using mental math and place value.



# Fourth Grade

## Finding the Area of a Composite Figure

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Whole group lesson: finding the area of a composite figure by creating a rectangle and removing a smaller rectangle from it.

Two dynamic groups are created based on mastery of the concept being studied.

One group uses a concrete example of a large rectangle and removes rectangles to make a new shape.

Second group removed a rectangle and other shapes from inside a rectangle (not on an edge), then calculated area for precut shapes without grids, and created word problems.



# Mindset:

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## Fixed Mindset:

- Believe that intellectual ability is a fixed trait
- Do not recover well from setbacks
- Are afraid of effort because effort makes them feel dumb
- Reject opportunities to learn if they might make mistakes
- Seek tasks that prove their intelligence
- Make excuses to maintain the image of smartness

## Growth Mindset:

- Intellectual ability must be developed through effort and education
- When faced with challenges, escalate efforts and look for new learning strategies
- Display a desire for challenge and resilience in the face of failure

# Studies on Ability Grouping:

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Burris et al (2006)- When schools abandon ability grouping practice and move to mixed or heterogeneous grouping, achievement and participation improves significantly.

Nunes et al (2009)- Students taught heterogeneously performed significantly better on tests of mathematical reasoning. The only consistent effects of structured ability grouping were detrimental effects on social and personal outcomes for some children.

Linchevski and Kutscher (1998)- Students of average and below average attainment achieved at higher levels when taught in mixed ability classes and high attainers achieved at the same level as those taught in same ability classes.

Boaler (2013)- Ability grouping harms the achievement of students in low and middle groups and does not improve the achievement of high-attaining students.

# Encourage a Growth Mindset

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Regularly talk about things you have learned or challenges you have faced from childhood to adulthood.

Emphasize process/effort rather than achievement/outcome

Express failures as setbacks

Express criticism as feedback

Praise: Effort, Struggle, Applying strategies, Taking risks, Improvement, Persistence in the face of setbacks

Encourage students to look for ways that will “stretch” their understanding

# Final Thoughts

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Our mission is to always do what is the very best for our students.

Their academic achievement is at the heart of our decision making process in all things and indeed in this decision to modify the way we teach mathematics.

Please visit our display table located outside the Music Room.

Please visit with the faculty in attendance this evening about their experiences with differentiated instruction and math instruction at Archway.

Present this to your student as an opportunity to deepen their understanding.

# Questions?

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