Emerging High School Math Pathways

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What is something you heard today that…

Is promising?
You are worrying about?
You are wondering about?

A Systemic Approach to Change

Transforming Mathematics Education

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"There is no way to ignore the fact that, since the 1990s, mathematics education reform has produced only marginal improvement and left many educators either searching for new and more productive solutions or unconvinced that the system is even capable of change. ***Too often we have tweaked the system at the margins and ignored critical alignments among components of the system.*** *We have made a lot of promises but have not yet found ways to keep them."*

NCSM (2014) "It's TIME: Themes and Imperatives for Mathematics Education"

Escondido Union High School District

- *5 high schools serving roughly 7,300 students*
- *situated in a relatively segregated community here in San Diego County*
- *Socioeconomically mixed, with 69% of students free or reduced lunch*
- *Predominantly white teaching staff serving a Latinx population*
  - *Students: Latinx 76%, White 16%, Asian 3%, Black 2%, Filipino 2%*
- *Racialized outcomes; deficit orientations; teaching that emphasizes compliance (mathematically and relationally)*

What are we trying to do?

Happy students, happy teachers

Build a meaningful mathematics education

Disrupt racialized outcomes (not only on standard measures)

Theory of Change: Fix the System, Not the Teacher

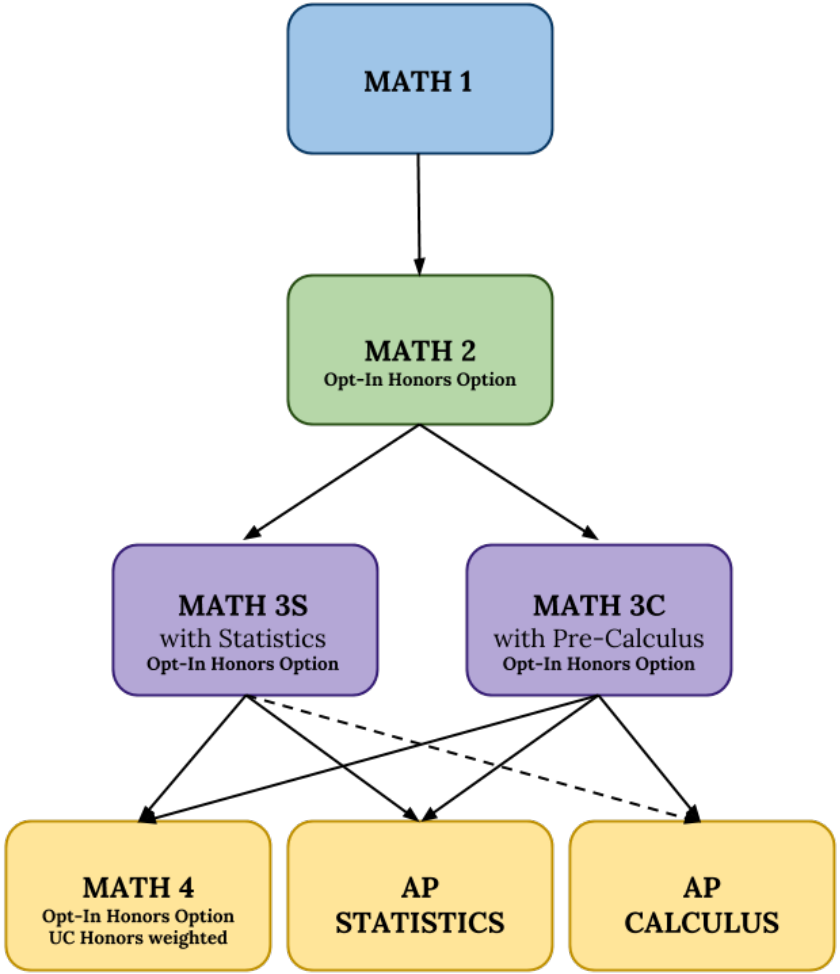
1. *We can’t just professionally develop teachers into overcoming the systemic racism of mathematics education.*
2. *Our local system(s) must change, but as leaders we can't just dictate this change.*
3. *Mathematics teacher (educator) beliefs are part of this problem, and are strongly resistant to change.*
4. *Significant change at the high school level is at least a 10-year process.*

Changes to the System

- ***integrated*** *mathematics courses/pathways*
- ***problem-based textbook*** *(Launch/Explore/Summarize; contextual; conceptual)*
- ***detracked*** *(including elimination of remedial classes)*
- *changes to remediation ("no marks;"* ***move students on to 2nd semester regardless****)*
- ***shared planning periods*** *for course-alike teachers*
- ***all*** *teachers regularly participate in* ***teaching studios*** *(study of teaching practice)*
- ***"teacher partnership"*** *(structure to allow embedded peer observation, co-teaching, etc.)*
- *revamped* ***hiring*** *process to align with values of mathematics program*
- *summer workshops for all teachers* ***(a 3-4 year teacher curriculum)***
- *community articulated* ***vision for discourse-rich, thinking classrooms***

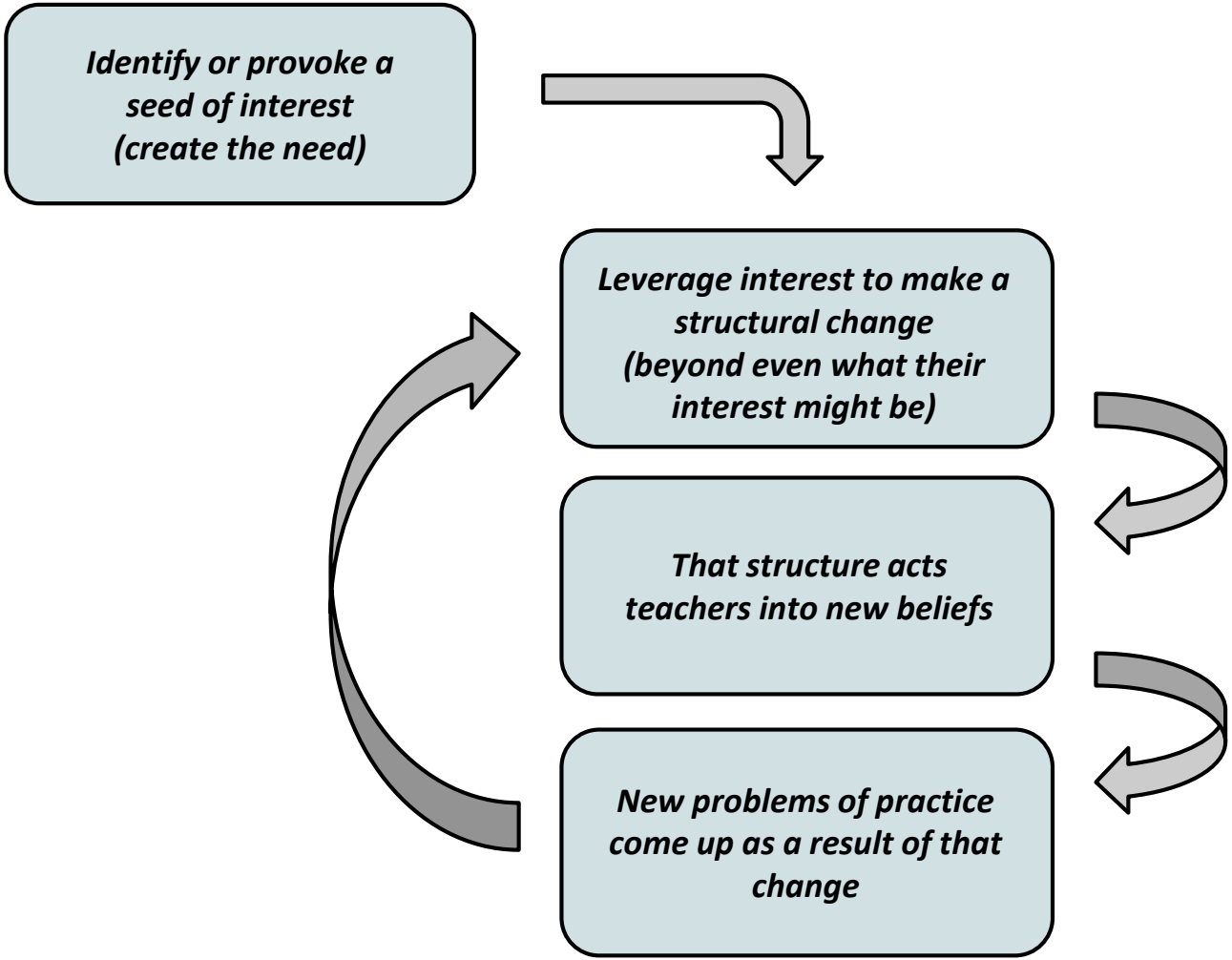
Our De-Tracking Efforts

1. Identified a lever for change
    a. (CCSS - SMPs - instruction and outcomes must change - very clear message from the top)
2. Researched previous pathways students had navigated through our system
    a. found multiple (dysfunctional, inequitable) pathways with predictable racialized outcomes
3. Recognized willingness of feeder districts to stop acceleration
4. Began conversations and learning of Supe and Ass't Supe about research-base supporting detracking
5. Convened leadership team for learning and pathway creation
    a. choice of strong, NSF-grant funded, researched integrated curriculum helped considerably
6. Parent and school board info meetings
    a. made lots of promises to surround efforts with support structures
7. Pathway proposed and approved by board


MATH 1
MATH 2
Opt-In Honors Option
MATH 3S
with Statistics
Opt-In Honors Option
MATH 3C
with Pre-Calculus
Opt-In Honors Option
MATH 4
Opt-In Honors Option
UC Honors weighted
AP
STATISTICS
AP
CALCULUS

Four-Year Teacher Trajectory

	Problem of Practice	***Opportunities***	***Structures***	***What is Learned***
Year 1	*I need to restructure my classroom for students to think and interact*	*Learn a new role for themselves in the classroom*	*Curriculum* *Students in groups, students present, no supplementing*	*I have a very different role in this classroom; learning to listen to kids mathematics; there is value to kids thinking and interacting; I need to manage student discourse*
Year 2	*I need to figure out how to make my groups work better*	*C.I. to address deficit orientation to children; explicit conversation about social inequalities replicated in the classroom; routines for supporting groupwork & discussion*	*C.I. Multiple Ability Treatment, status treatments; skill builders; whiteboards*	*I need to include all students in conversations; a way to reconcile their deeply held beliefs that all children are smart with why not expressed in the classroom*
Year 3	*I now see learning and understanding differently. How do I grade?*	*Shift from answer-getting environment to focus on understanding*	*Invitation to grade differently, reorganize pacing around big ideas, collect and provide feedback on student work*	*Effort in Years 1 & 2 pay off (faith); some sort of competency-based grading & student ownership is important; and feedback important*
Year 4	*This work is complex and interconnected. I understand equity issues differently.*	*Divergent equity interests; leadership; re-imagining assessment*	*Implement revised, district-wide unit exams (toward understanding instead of procedures)*	


Identify or provoke a seed of interest (create the need)
Leverage interest to make a structural change (beyond even what their interest might be)
That structure acts teachers into new beliefs
New problems of practice come up as a result of that change

Identify or provoke a seed of interest (create the need)

Initiate a focus on program of study.
We need to create course pathway(s) for our new integrated courses

Leverage interest to make a structural change (beyond even what their interest might be)

Committee organized to study options; expert shares research base. Detrack the mathematics program

That structure acts teachers into new beliefs

Perception that unteachable kids are now in my class.
1. I have to teach all children
2. The students aren't really different

New problems of practice come up as a result of that change

1. I have to teach all children; **how do I do that?**
2. **Maybe all kids can do mathematics / belong in a 9th grade class.**

Some Indicators of Impact

Percentage of students taking grade level (or higher) mathematics courses

	10th	**11th**	**12th**
2010	67%	54%	56%
2018	88%	81%	82%

Some Indicators of Impact

Percentage of students enrolled in AP mathematics

	AP Stats	**AP Calc**
2010	2.7%	2.2%
2018	5.8%	6.2%

Some Current Tensions

- New leaders, new teachers are a constant
    - How do we support their learning and entry into our system with dwindling resources?
- CAASPP test scores have yet to show positive change
    - New leadership values this over any other metric
- We need a portfolio of metrics that measure what we ***value*** in a child's education
    - The bigger system outside our school district needs to value these metrics, too

Zooming Back Out

Detracking on its own will not save the day

The whole (complex) system needs change

Status quo is maintained through power, privilege, and belief systems

The current system of mathematics education is designed to get the results it does

The work necessary is more than a series of technical fixes

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The work necessary is more than a series of technical fixes

Our changes will not survive without changes to the broader system of mathematics education.

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A Timeline for Change

	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
Structuring Schools for Adult Learning	Classroom visits w SMPs	Teaching Studios Coaching	Summer Workshops Teaching Studios Coaching Common Preps Teacher Partnership	Summer Workshops Teaching Studios Coaching Common Preps	Summer Workshops Teaching Studios Coaching Common Preps Teacher Partnership
Curriculum as a Lever for Change	Integrated v Traditional pathway	Curriculum review Adopted CPMP	Year 1 of curriculum roll out; Structuring classrooms for thinking and interacting	Year 2 of curriculum roll out; Complex Instruction - treating expectations for competence	Year 3 of curriculum roll out; Complex Instruction cont'd and Assessment for Learning
Changing Inequitable Structures		Begin some discussion of tracking structures	Pathways committee meets over course of year to build new pathways; eliminate tracking	Year 1 - no tracking in 9th grade	Year 2 - no tracking in 9th or 10th grade
New Vision and Measures				Committee meets over the year to build a vision statement for math classrooms	Committee meets to determine new measures of success toward vision

Discrete Math Project Collaborative

https://dmpc.sdsu.edu/

Osvaldo Soto (SDSU & UC San Diego)
Trang Vu (San Diego Unified School District)
Anne Marie Almaraz (Sweetwater Unified High School District
Melody Morris (Sweetwater Unified High School District
Clara Mateo (SDSU & San Diego City College)

San Diego State University

Sweetwater Union High School District

Center for Research in Mathematics and Science Education

Agenda

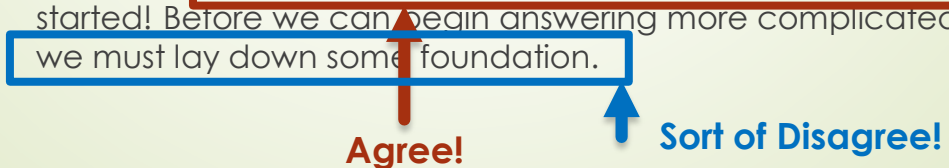
- Course Background & Info
- Target students — preparation level, interests/aspirations
- Equity considerations
- Preliminary data

DMPC Background

- Began with CA Mathematics Readiness Challenge Initiative (2016)
  - Ovie Soto (Director), Bill Zahner (SDSU Math Dept), Randy Philipp (SDSU College of Education), Mike O'Sullivan (SDSU Math Dept. Chair), Vadim Vadim Ponomarenko (SDSU Math Dept.), Trang Vu (SDUSD) and SUHSD ToSA's
  - Define College Readiness using ICAS (2013) - Statement on Competencies in Mathematics Expected of Entering College Students
  - We saw that DM allowed us to:
    - ***Non-traditional topics (Access!) … for teachers and students***
    - ***Advance Students' Mathematical Ways of Thinking (Standards for Mathematical Practice - Harel)***
    - ***Support desirable pedagogical shifts (TRU Math Framework – Schoenfeld et al)***
    - ***Helping Students Find Something to LOVE in math for everyone! (Identity)***

How many mathematicians does it take to… define Discrete Math?

- Oscar Levin (Discrete Mathematics: An Open Introduction)
  - Defining discrete mathematics is hard because defining *mathematics* is hard.
  - DM encapsulates a large number of BIG, *DRY* topics: Combinatorics, Graph Theory, Number Theory, Symbolic Logic, Recurrence Relations …
  - Levin chose **four main topics: combinatorics (the theory of ways things combine; in particular, how to count these ways), sequences, symbolic logic, and graph theory.**
  - Ultimately the best way to learn what discrete math is about is to do it. Let's get started! Before we can begin answering more complicated (and fun) problems, we must lay down some foundation.



A Typical Day: Goals

What do *STUDENTS* DO in a DMPC class?

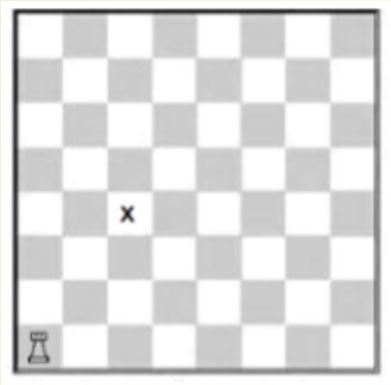
- **Learn through problem-solving**
- **Present their thinking**
- **Write and reflect** on *their* work and peers' work
- Engage in **sense-making**
- Propose and **refine: definitions, conjectures, generalizations and justifications**
- **Habitually ask "Why?"**
- Reason at a variety of levels of formality

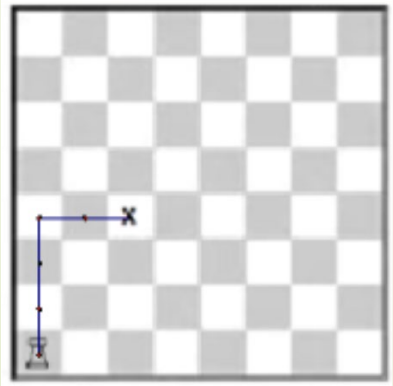
College Readiness:

- **Attend to Students Ways of thinking and Intellectual Need***
- **Status**
- **Agency, Ownership, Identity****
- **Content knowledge**

***Harel (2008a,b, 2013)**
****Schoenfeld (2018)**

Example: **Moving Rooks: Games Unit**





- One Rook is placed on the top-right corner of an 8 by 8 grid. On each player's turn, they move that rook as many squares as they want, either horizontally to the left or vertically downwards. The player who places the rook on the bottom-left corner of the grid wins.
- This is a two-player game. You take turns playing on the same piece.
- Can you win this game every time? If so, how?
- **How do the rules of the game cause the winning strategy to work? (Are all the rules necessary?)**

Emergent Concepts

- Control
- Winning position (“magic numbers”)
- Losing position (“death numbers”)
- State of the game
- Winning Strategy (and types of winning strategies)
- Isomorphic games*

What's in our Discrete Math Course and why DM?

- Games
- Graphs: Connectivity/Traceability
- Graphs: Planarity/Colorability
- Iteration & Recursion
- Sequences & Series
- Cryptography
- Counting

- What fields might it align with?
  - Mathematics, Computer Science, Legal Studies, Philosophy, Political Science, Journalism, Liberal Arts, Military Service…

DMPC's (Original) Target Student Population

- College-intending **Seniors**
- 'STEM undecided' (… but we want them back)
- Passed Int 1 – 3 with "C" or better or struggled in IM 3
  - Already took pre-calc
  - Did not want to take calculus
  - Intending computer science majors
  - Already took calculus
- ***Can it (or a variant) work as a 3rd year course?***

Where is it being taught?

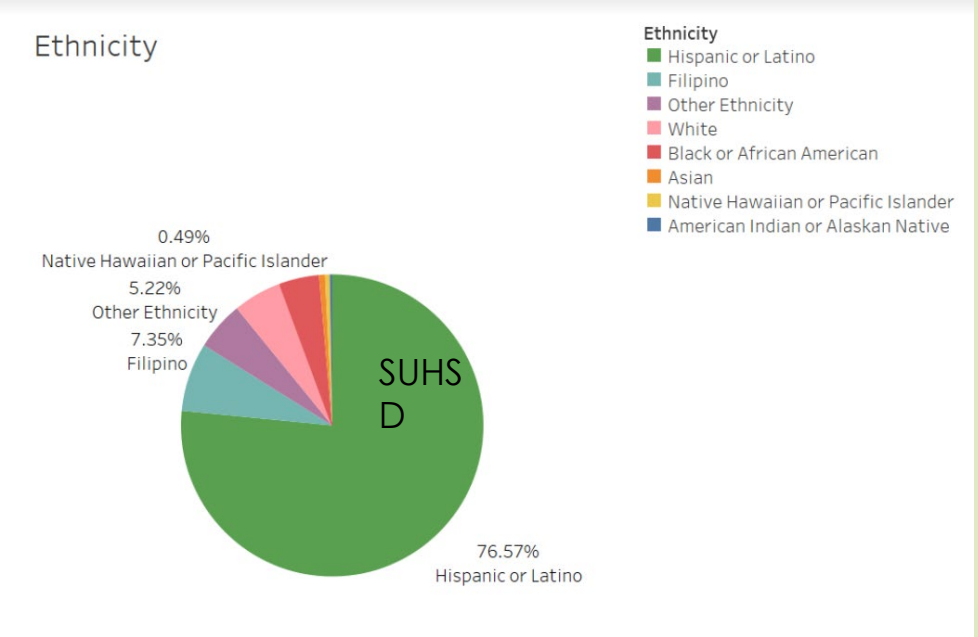
- **Sweetwater Union High School District**
  - 12 high schools, largest 7-12 district in the state (feeder, Chula Vista, is largest elementary in the state)
  - Math requirement for graduation: 3 years… Some require 4 years
- **Other Districts Implementing DMP**
  - Oceanside, Mission Vista HS, Red Oak (Iowa) Santa Fe Christian (small scale implementation), Oceanside High School

DMPC's Target Student Population: A DMPC Teacher's Perspective

Students who:

- Could benefit from looking at math from a problem solving perspective
- Believe ***all*** of math is symbol manipulation
- Have potential math skills that have not been tapped in previous courses

Pilot Year: 2017-2018



DMPC's SUHSD Student Population

Year	17-18	18-19	19-20
American Indian	0.2	0.0	0.0
Asian	8.0	5.7	6.5
Black or African American	4.2	3.1	3.6
Hispanic or Latino	76.3	81.4	80.0
Pacific Islander	0.5	0.4	0.1
Two or More Races	5.3	4.7	5.4
White	5.5	4.8	4.3
	100.0	100.0	100.0

17-18	18-19	19-20	Totals (n)	Percent
3	0	0	3	0.1
100	56	63	219	6.9
52	30	35	117	3.7
949	799	773	2521	79.0
6	4	1	11	0.3
66	46	52	164	5.1
68	47	42	157	4.9
1244	982	966	3192	100

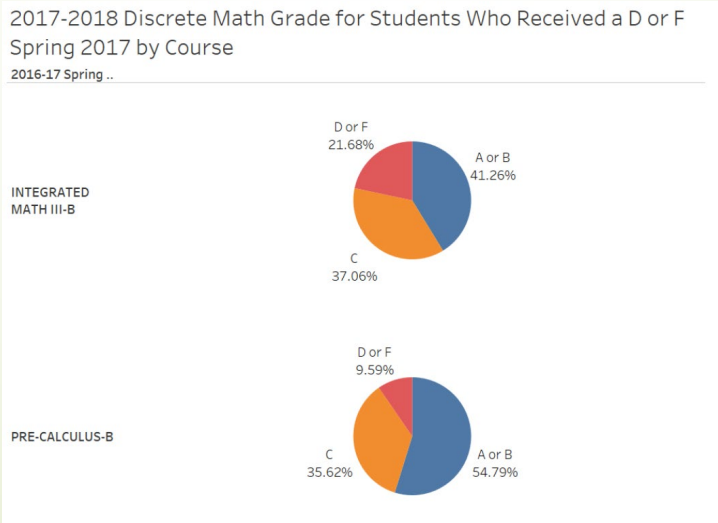
Early Outcomes

- Survey results indicated that students' dispositions towards mathematics were positively influenced by taking the course.

Affective

		Mean	N	Std. Deviation	Std. Error Mean
If I can't solve a problem in five minutes, I usually give up.*	Before	2.87	340	1.173	0.064
	Now	2.28	340	1.120	0.061
I feel that struggling with a math problem is an important part of learning math.*	Before	3.55	337	1.048	0.057
	Now	3.89	337	1.029	0.056
When another student or the teacher challenges my solution, I feel uncomfortable.*	Before	2.96	339	1.069	0.058
	Now	2.60	339	1.034	0.056
I feel comfortable sharing my mathematical ideas or asking questions about another person's ideas in a whole class discussion.*	Before	3.31	340	1.142	0.062
	Now	3.71	340	1.104	0.060
In mathematics, you can be creative and discover things by yourself.*	Before	3.32	339	1.124	0.061
	Now	3.80	339	1.026	0.056
I like solving math problems.*	Before	2.84	337	1.171	0.064
	Now	3.27	337	1.147	0.063

Achievement: Grades



SDSU Course-taking & Achievement

In Process: Next Slide

Number of records - each student may be counted more than once if they took more than one math class freshman year

		HS Senior Math Class				
Grade Fall & Spring		**Discrete Mathematics**	**AP Calc and/or Stats**	**Pre-Calc**	**Other**	**No Math**
A, B, and C	**Number of Records**	31.0	108.0	18.0	23.0	4.0
	Student Count	29.0	104.0	18.0	20.0	4.0
CR	**Number of Records**	10.0	21.0	4.0	2.0	
	Student Count	10.0	21.0	4.0	2.0	
DFW	**Number of Records**	36.0	56.0	22.0	8.0	1.0
	Student Count	27.0	45.0	15.0	7.0	1.0
		66.0	170.0	37.0	29.0	5.0

Using the number of records - students counted more than once

	HS Senior Math Class				
Grade Fall & Spring	**Discrete Mathematics**	**AP Calc and/or Stats**	**Pre-Calc**	**Other**	**No Math**
A, B, and C	40.26%	58.38%	40.91%	69.70%	80.00%
CR	12.99%	11.35%	9.09%	6.06%	
DFW	46.75%	30.27%	50.00%	24.24%	20.00%

Using student count - %will add to more than 100 because individual student may have received passing grade and n

	HS Senior Math Class				
Grade Fall & Spring	**Discrete Mathematics**	**AP Calc and/or Stats**	**Pre-Calc**	**Other**	**No Math**
A, B, and C	55.77%	80.62%	58.06%	80.00%	100.00%
CR	19.23%	16.28%	12.90%	8.00%	
DFW	51.92%	34.88%	48.39%	28.00%	25.00%

DMPC's Early Outcomes: A DMPC Teacher's Perspective

- "I didn't know this was math" – Anonymous Student
- Students who may not have taken a fourth year are taking and succeeding at a fourth year (!)
- Groups of students building agency in mathematics
- Students growing in their identity as doers of mathematics

Challenges

Continue refining:

- Curriculum & assessments
- PD for principals and counselors, new (and veteran) teachers to sustain the program at SUHSD

Evaluation:

- Do changes in students' affects and dispositions lead to higher levels of mathematical content knowledge?
- Are students who took Discrete Mathematics successful in their college mathematics courses?
- What college math courses do they take? (Course-taking pathways/obstacles)
- What are their grades in college mathematics?

Dana Center Launch Years Initiative

Streamlining the Transition from High School to College Math

The University of Texas at Austin
Charles A. Dana Center

What is Launch Years?

- Launch Years focuses on addressing systemic barriers that prevent students from succeeding in mathematics and progressing to higher education and career success.

- Led by the Charles A. Dana Center at The University of Texas at Austin, the Launch Years initiative is backed by a $6.68 million grant from the Bill & Melinda Gates Foundation.

- Leveraging work in states, the initiative seeks to modernize math in high school through relevant and rigorous math courses as well as policies and practices leading to more equitable outcomes for all students.

Launch Years Collaborators

- Achieve
- Education Strategy Group
- Association of Public & Land-Grant Universities
- Community College Research Center

Why Is This Necessary?

The Academic Imperative

- Many students today dream of graduating high school and going on to earn a two- or four-year degree that will open doors for them throughout their lives. Eight out of ten parents also expect their children to attend and complete college. But too few students achieve this goal.
- Misaligned and outdated math requirements and policies—such as varying math requirements across states and misuse of math in college admissions criteria—block too many students from advancing.

The Economic Imperative

- Jobs today—especially well-paying jobs in areas ranging from business to healthcare that will set students on a path to success—require a range of math skills, including analyzing data, interpreting statistics, and making predictions based on mathematical models.
- There is an economic imperative to ensure that our country has a diverse workforce equipped with the specific math skills that the 21st century economy demands.

The Moral Imperative

- A college degree or postsecondary certificate of value is increasingly seen as a key that can unlock opportunities and level the playing field for low-income students and students of color—too many of whom face systemic barriers on their paths to success.
- There is a moral imperative to ensure that all students, regardless of their circumstances, background, or zip code, have access to the high-quality, relevant math education they need for any future they choose to pursue—whether it's a STEM or non-STEM career.

Why Now?

The Opportunity

- We are at a pivotal moment in history: a changing economy and evolving technology have created new jobs that require math skills.
- At the same time, higher education is increasingly modernizing math pathways to better prepare every student to gain the math skills they need to thrive in their chosen careers and to strengthen our nation's workforce.
- We must give high school students access to a broader range of rigorous and relevant math courses aligned to their needs, aspirations, and postsecondary paths.
- We also must ensure that math policies and practices across K-12 and higher education address structural factors that prevent students from progressing.

The Launch Years Approach

Multi-Year Strategy

This multi-year strategy focuses on the ground in several states to assess the high school mathematics students can access every day in the classroom. It also seeks to bring K-12 and higher education institutions together at a regional level to ensure students have clear paths for success. From these learnings, open access resources will be developed and made available to schools and districts in all states to better support students.

STRATEGY 1: AGREEMENT
Create consensus around a common understanding of mathematics pathways that extend from high school into post-secondary education and prepare students for success.

STRATEGY 2: OUTREACH
Mobilize a wide range of constituencies to advance the new paradigm for college and career readiness in mathematics and reduce persistent equity gaps.

STRATEGY 3: TOOLS
Create new pathways for math instruction in the third and fourth years of high school and initiate the implementation of transition math courses.

Statewide Implementation

Inaugural States

- Texas
- Georgia
- Washington

National Trends

- **Widespread Demand**: Recognition of transition work as opportunity to overhaul K12 mathematics education to address learning gaps, placement practices, narrow focus/relevance of mathematics content/courses
- **Algebra 2 challenges**: Recognition of need for an alternative course/pathway for those not pursing algebraically intensive mathematics, as well as need to improve existing Algebra 2 courses to improve outcomes for those who are
- **Threats to equity**: Recognition of potential for racial and economic disparities being perpetuated in both design and implementation of pathways in the transition years
- **Teacher Workforce**: Recognition of need to address teacher capacity, quality, supply, and diversity to ensure that schools and districts are equipped to support changes transition year pathways

State Trends

- **Cross Sector Teams**: Recognition that transition work crosses K12, HE and workforce and preparation and implementation requires leadership and action from each
- **Focus on Graduation**: Recognition that improvements to the transition year experiences are another lever to pull in comprehensive efforts to improve high school graduation and college-going rates
- **Optics of Alternatives**: Recognition that for new pathways to work they must gain acceptance and recognition by diverse groups; and systems must have capacity to deliver with quality
- **Expand Innovation**: Recognition that connecting transitions years to existing priority innovations and high profile initiatives can provide momentum, support, and resources
- **Alignment Opportunities and Tensions**: Recognition that to make significant change at the high school transition will require new and deeper collaboration with higher education

Interested in Learning More?

To learn more about Launch Years' goals and the challenges the multi-year initiative aims to address, visit www.utdanacenter.org/launch-years

Thank You!

Questions?