Carnegie Foundation
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Part I

Dramatic Success for Students in Developmental Mathematics

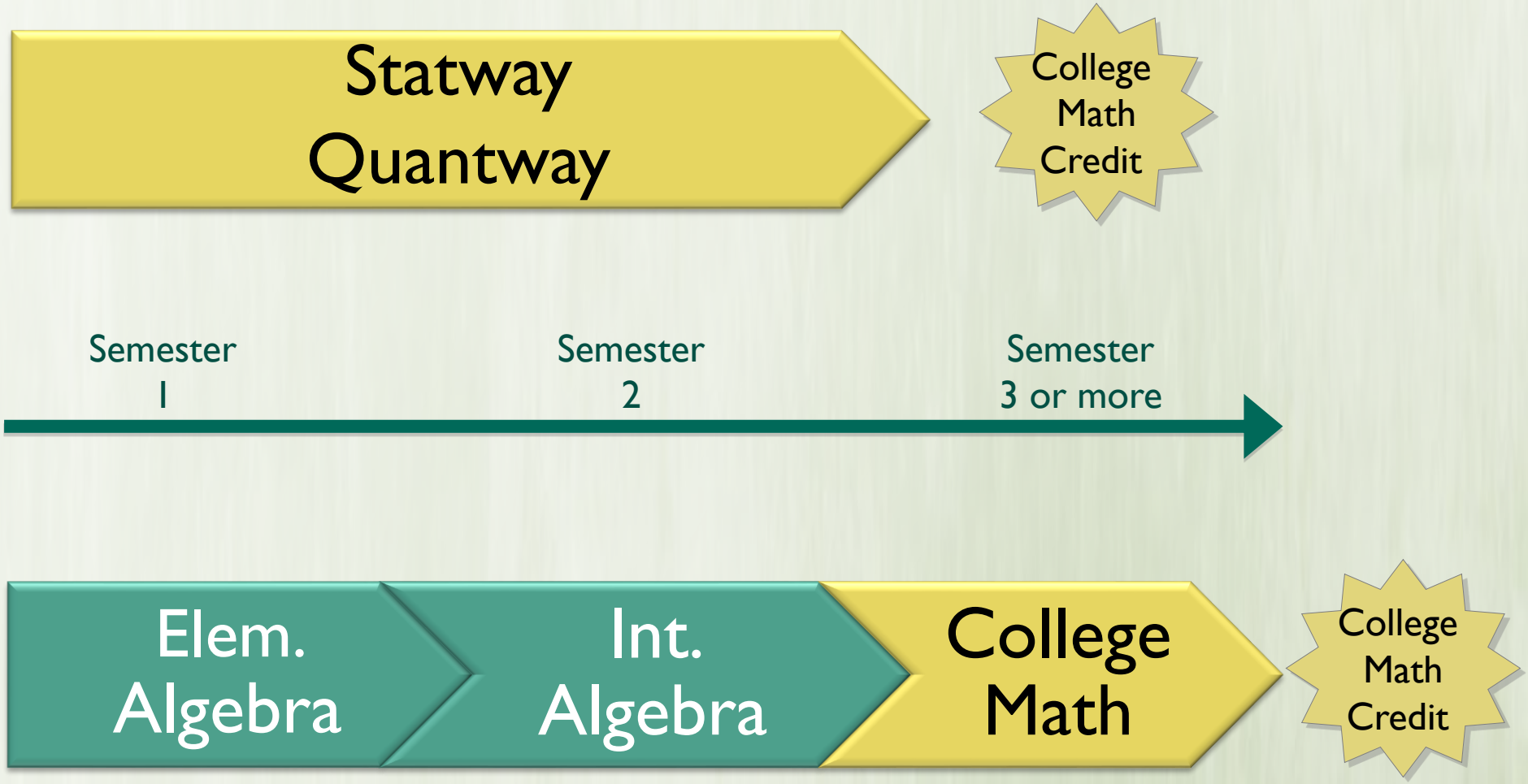
First Year Results from Carnegie's Pathways Programs

The Problem

- Nationally, two-thirds of incoming community college students must take at least one developmental math course before they can enroll in college-credit courses.
- Up to 80 percent of these students never get out.
- As a consequence, millions of people each year are not able to progress toward their career and life goals.

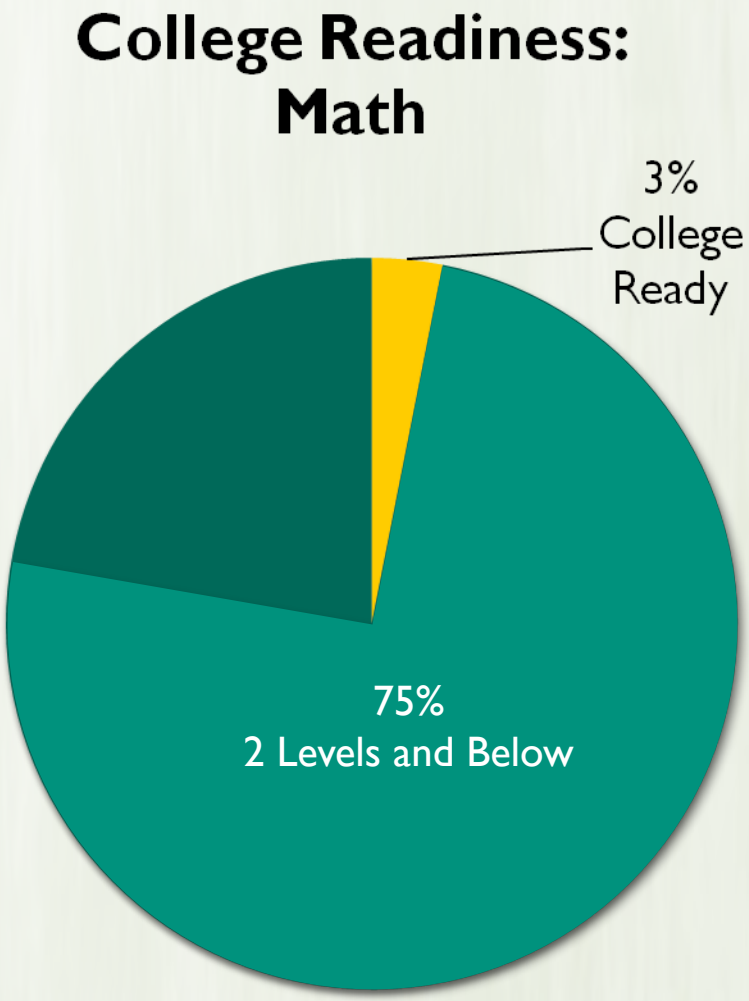
We cannot continue using the same approach and expect different results.

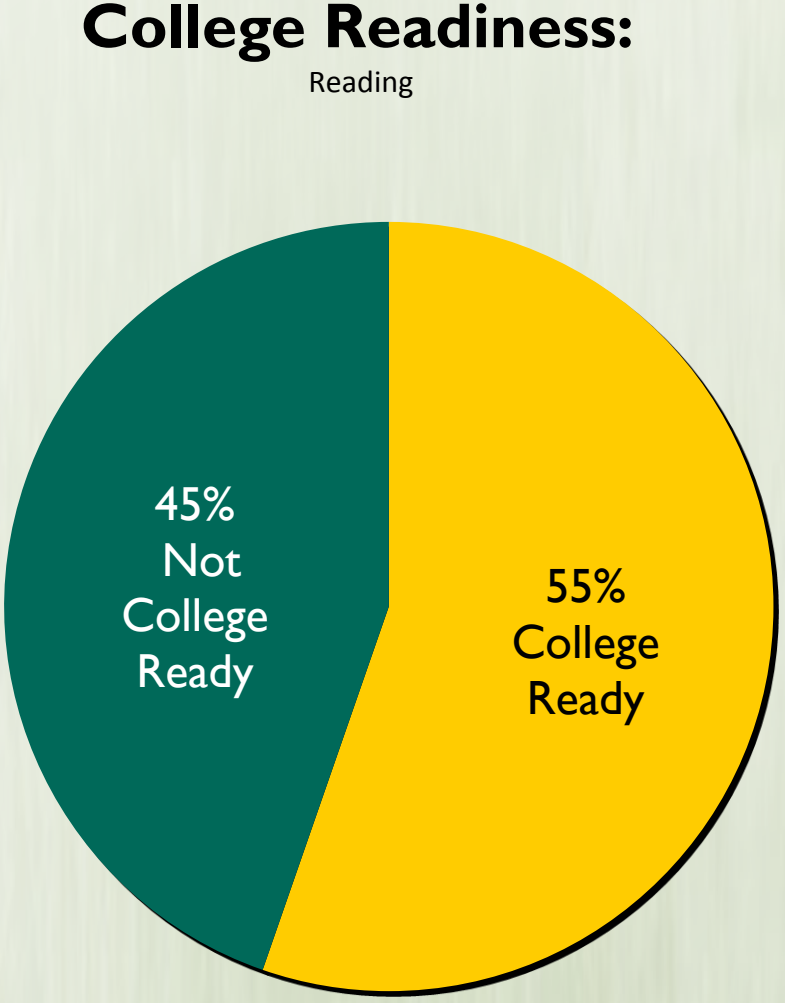
A New Way: Coherent, Intensive, Accelerated Learning



What Colleges Traditionally Have Done

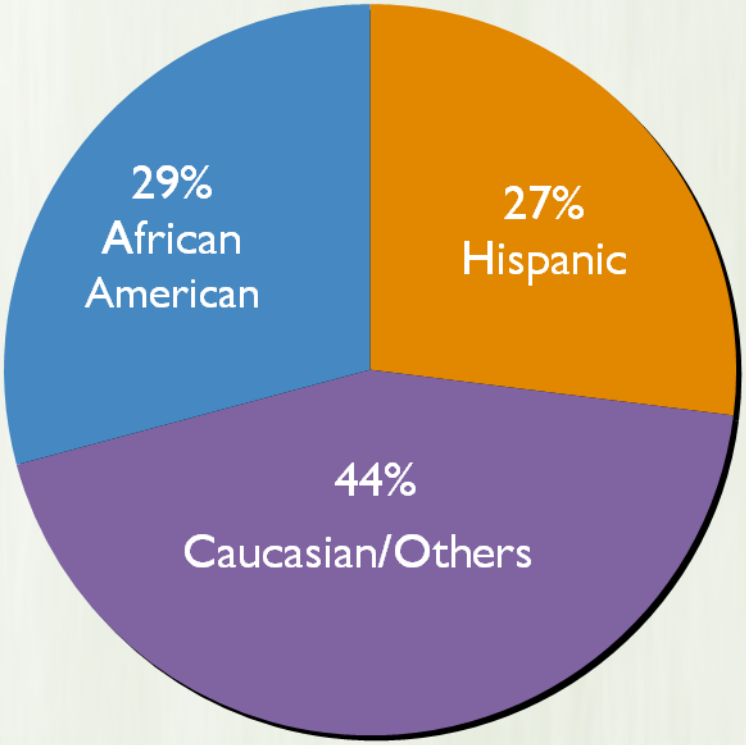
Who Are Our Pathways Students?



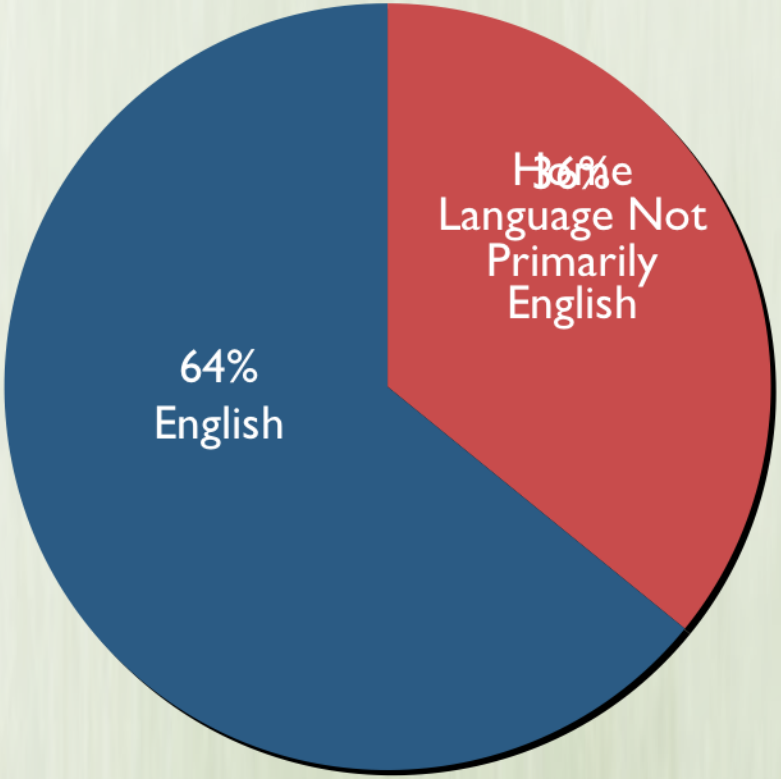


Who Are Our Pathways Students?

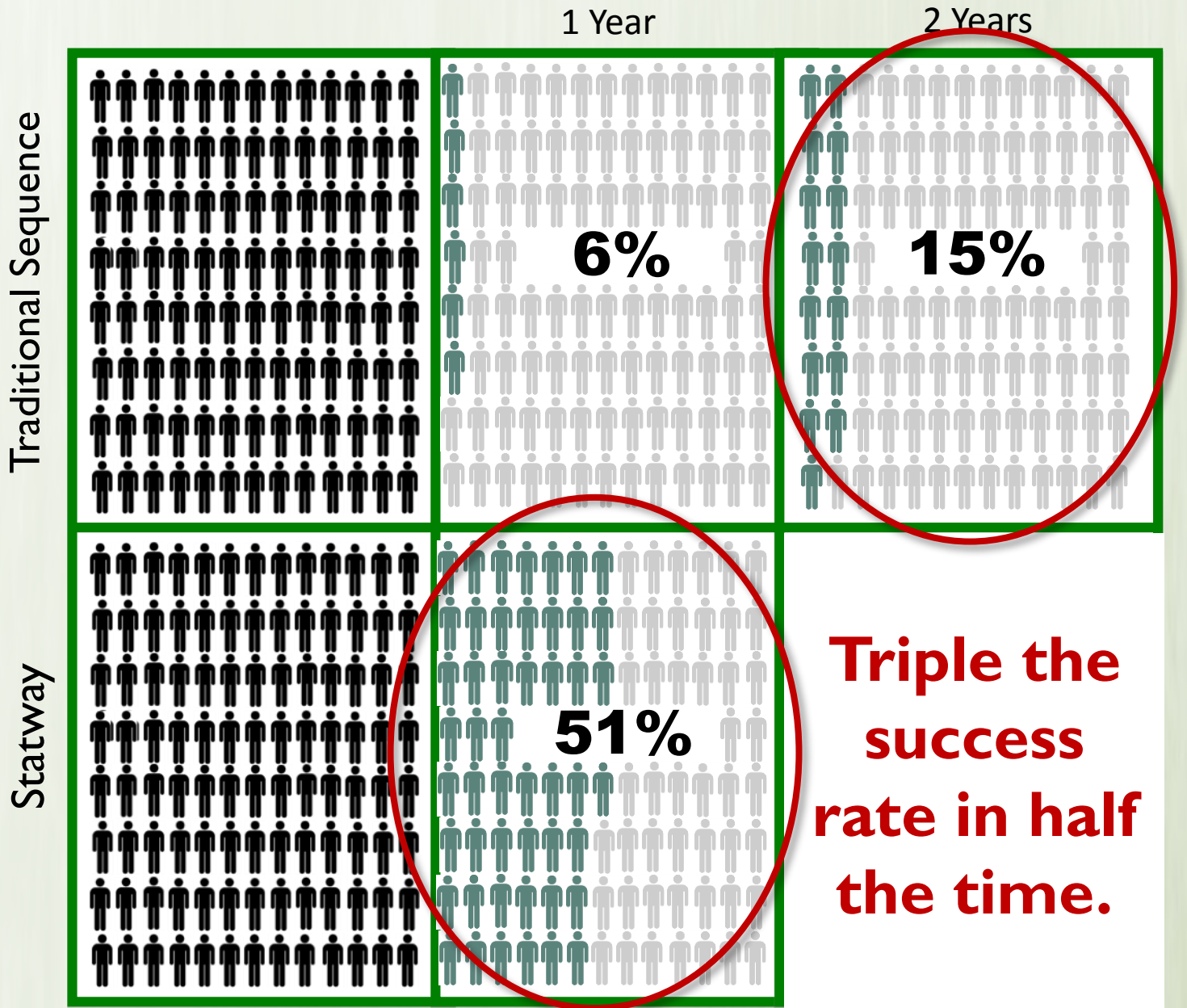
Race / Ethnicity



Home Language



Time to Complete College Level Math Course: Statway vs. Traditional Sequence



It starts with…

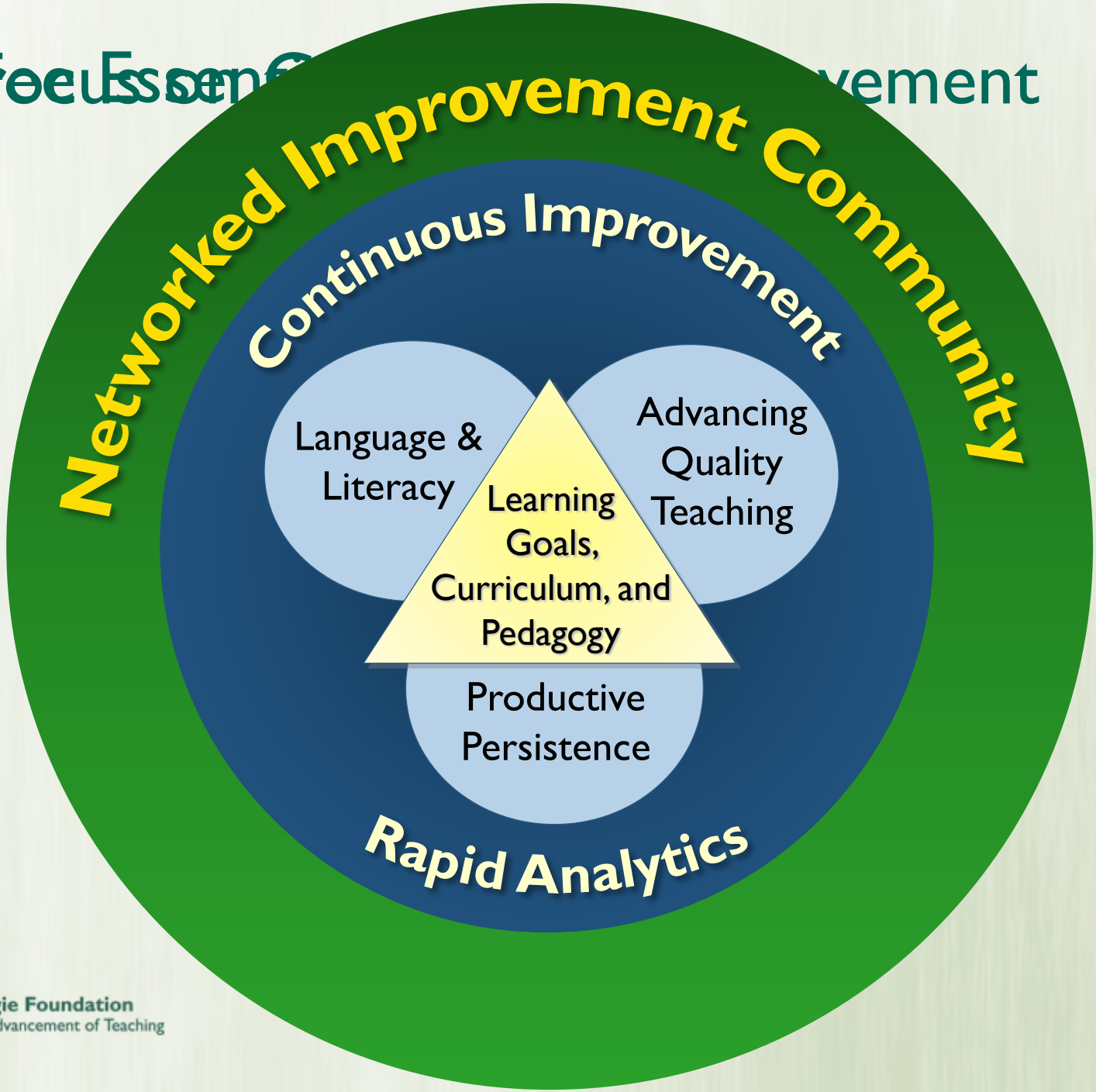
Professional organizations established learning goals

Critical Thinking

Math that Matters

Lessons, Assessments, Online

Benchmarking performance against college and university courses



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New Roles for Faculty

Faculty Voices

"Teaching is a lonely job, and it is really great to have others watch and experience what is going on in my classroom to help inform all of us on how to improve our methods to have better student engagement."

- Julie Phelps, Valencia Community College

Faculty Voices

"I thought I was a pretty good teacher, but being involved in lesson study forced me to ask the harder questions about how what I did in class impacted student learning."

- Michelle Brock, American River College

Student Voices

"It's very refreshing to be not only grasping it, but actually interested in math…. It's nice to wake up and be excited for my first class of the day."

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Student Voices

"It gave me hope at the beginning of this quarter. And so now it's kind of like 'I can [do this]' but I'm also doing something that I think is very useful. …The stereotypes [that minorities and females can't do math] aren't true!"

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Student Voices

"This class has helped me in my other classes. This has…exercised my mind enough for me to become a better writer, believe it or not."

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Part II

How do we do it: Curriculum and Pedagogy

Curriculum and Pedagogy

- Ambitious learning outcomes
- Authentic contexts
- Use of technology
- Communication
- Learning opportunities
  - productive struggle
  - explicit connections
  - deliberate practice

Productive Struggle

Can a person's birthday determine his or her personality traits, like being kind or jealous?

Dates of Zodiac Sign	Choice 1		Choice 2		Choice 3	
	Strengths	Weaknesses	Strengths	Weaknesses	Strengths	Weaknesses
3/21 to 4/20	Adventurous Energetic Pioneering Courageous Enthusiastic Confident Dynamic Quick-witted	Selfish Quick-tempered Impulsive Impatient Foolhardy Daredevil	Adaptable Versatile Communicative Witty Intellectual Eloquent Youthful Lively	Nervous Tense Superficial Inconsistent Cunning Inquisitive	Optimistic Freedom-loving Jovial Good-humored Honest Straightforward Intellectual Philosophical	Blindly optimistic Careless Irresponsible Superficial Tactless Restless
4/21 to 5/21	Modest Shy Meticulous Reliable Practical Diligent Intelligent Analytical	Fussy A worrier Overcritical Harsh Perfectionist Conservative	Patient Reliable Warmhearted Loving Persistent Determined Placid Security-loving	Jealous Possessive Resentful Inflexible Self-indulgent Greedy	Adventurous Energetic Pioneering Courageous Enthusiastic Confident Dynamic Quick-witted	Selfish Quick-tempered Impulsive Impatient Foolhardy Daredevil

Authentic Contexts

Algebraic Evaluation

Evaluate:

3x -5 when x=4

Quantway™ Evaluation

The formula for the braking distance of a car is

$$d = \frac{V_0^2}{2g(f + G)}$$

1. Let $f = 0.8$ and $G = 0.05$. Write a simplified form of the formula using these values for the two variables.
2. How can you verify your predictions about the relationship between velocity and braking distance?

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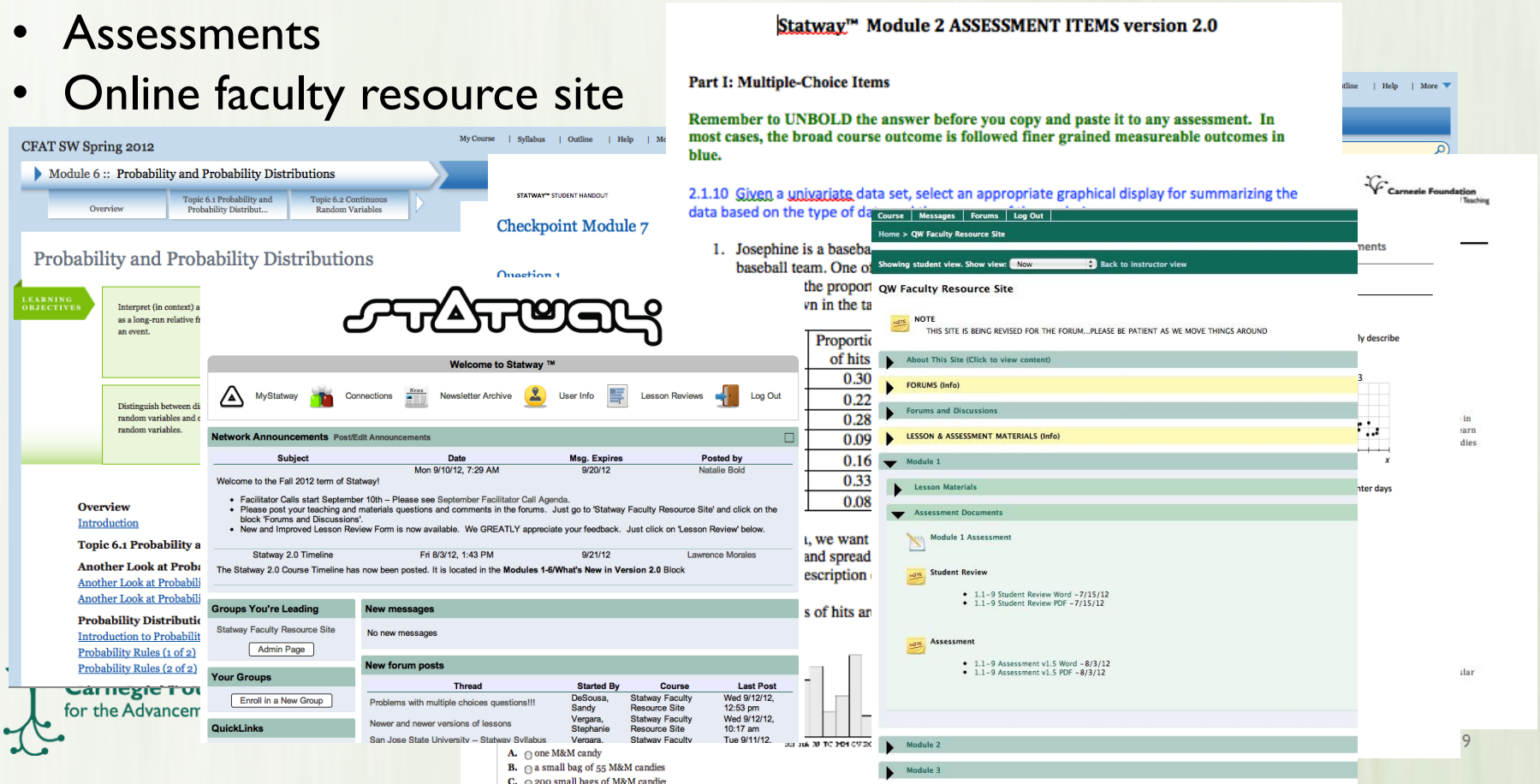
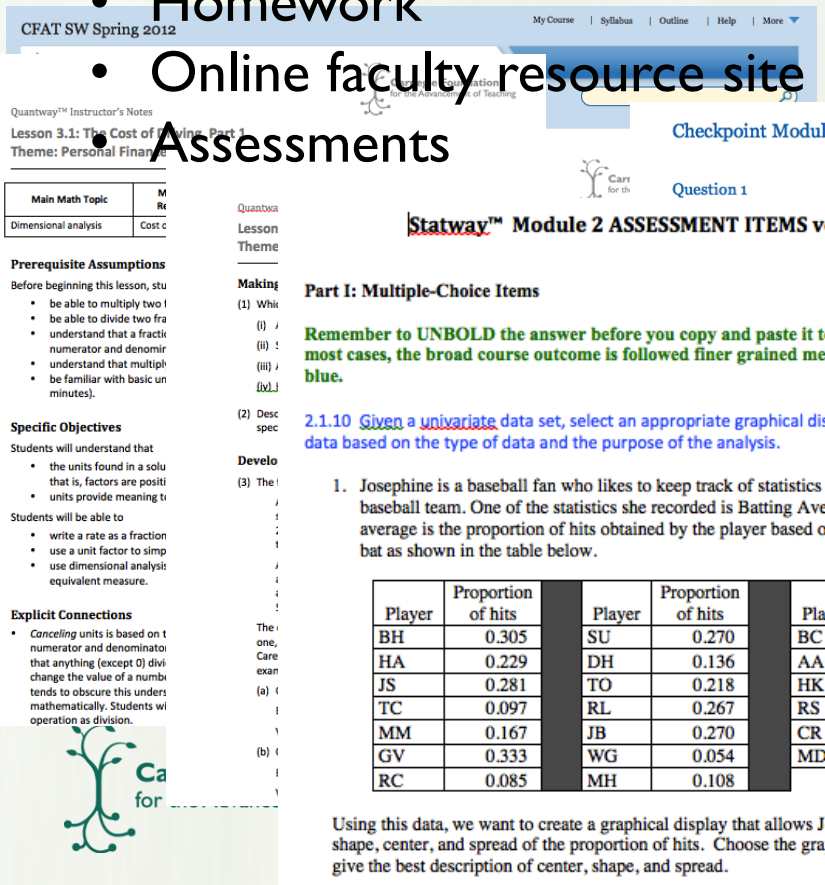
Curriculum

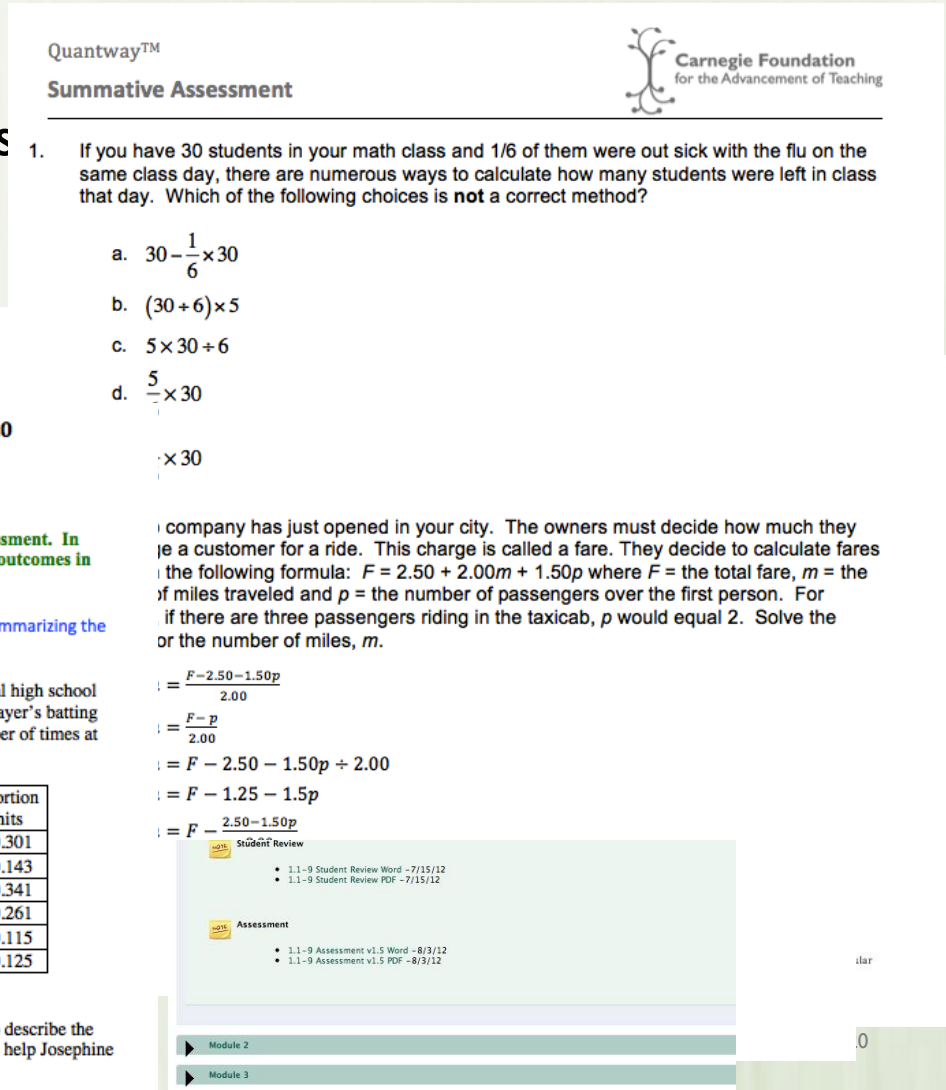
- Online component
- Instructor & student in class lesson materials
- Homework
- Assessments
- Online faculty resource site



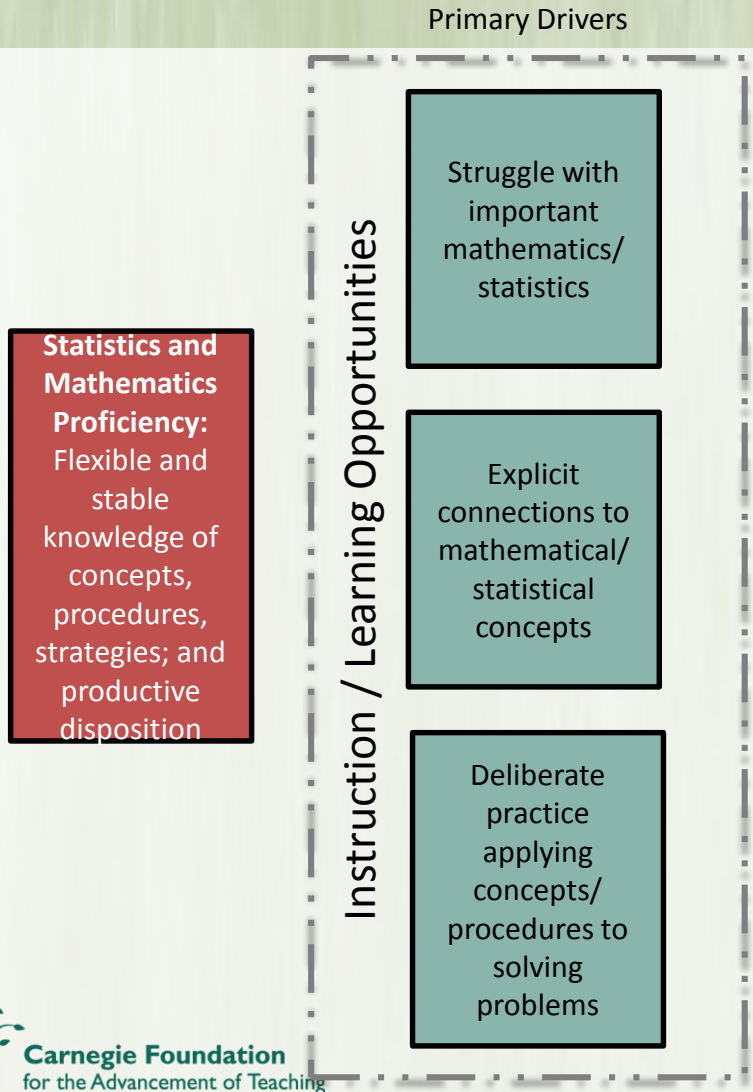
Course components

- Online component
- Instructor & student in-class less
- Homework
- Online faculty resource site
- Assessments





Learning Opportunities Stigler, Givvin UCLA



Secondary Drivers: How do these teachers use these Instructional resources to create learning opportunities for these students

Students engage productively with learning opportunities:

- Believe they are capable of learning math, gradually over time
- See math as something that makes sense, that one can "figure out"
- Willing to invest persistent effort

Teachers effectively implement curriculum with students to create learning opportunities:

- Belief that these students are capable of learning math and statistics
- See math as something that makes sense, that one can "figure out"
- Skills and knowledge to implement instructional system: engage students in problems; make concepts explicit in ways students can understand; provide emotional support

Instructional resources that afford creation of learning opportunities:

- Relevant to students interests
- Statistics (as distinct from math, to allay anxiety)
- Focus on understanding/thinking with concepts
- Clear learning goals (concepts & skills) aligned with formative and summative assessments
- Lesson structure: struggle, then instruction
- Conceptual flows to structure instruction

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Productive Persistence
Tenacity + Good Strategies

Practical Theory

- Centered on a problem of practice
- Co-developed with practitioners and students
- Tested with academic experts

Practical Measures

- Brief and practical
- Face-valid for practitioners
- Recognizable to researchers
- Designed to inform improvements
- "Can't improve what you can't measure"

Improvable "Starter Package"

- Initial set of activities
- Systems for collecting data
- Strategies for improvement
- Field tests that inform practice and theories

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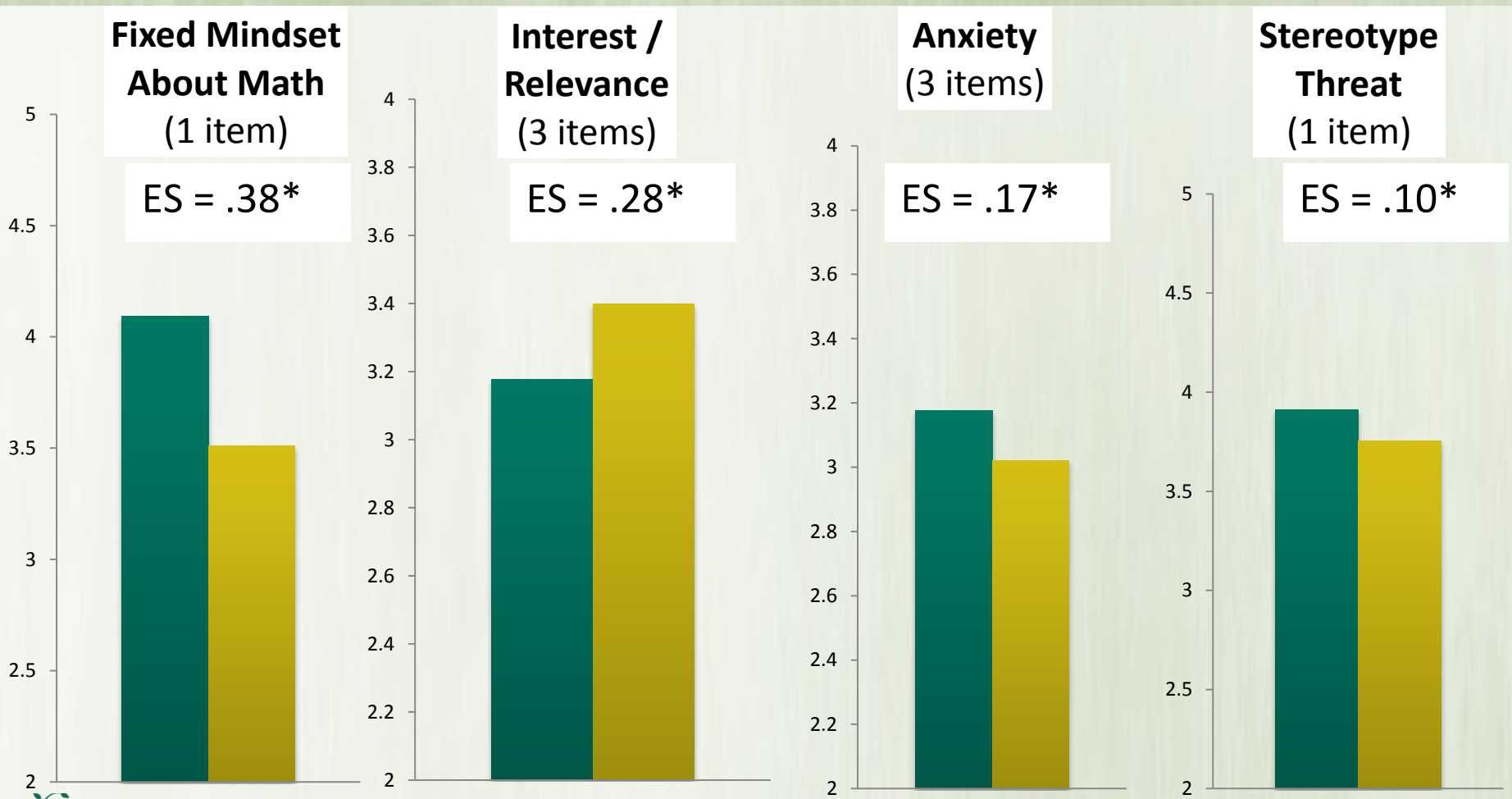
Student Background & Follow-Up



ES = Effect size in SD units

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* P < .001

Students Informing Improvement

Lesson	Understanding	Language	Interest	Relevance	Feeling
1.1.1 - The Statistical Analysis Process (1)	3.09 (119)	3.30 (106)	2.88 (128)	2.88 (112)	3.33 (233)
1.1.2 - Mindset Activity and Populations and Samples (2)	3.14 (59)	3.36 (66)	2.96 (56)	2.72 (60)	3.39 (118)
1.1.3- Research Questions and Types of Statistical Studies (3)	3.17 (107)	3.31 (97)	2.96 (95)	2.64 (99)	3.40 (198)
1.2.1 - Random Sampling (4)	3.13 (67)	3.24 (62)	2.94 (49)	2.89 (55)	3.34 (114)
1.2.2 - Other Sampling Strategies (5)	3.08 (26)	3.12 (34)	3.03 (29)	2.54 (26)	3.38 (58)
1.2.3 - Sources of Bias in Sampling (6)	3.00 (32)	3.25 (20)	2.91 (23)	2.64 (25)	3.41 (49)
1.3.1 - Collecting Data by Conducting an Experiment (7)	3.16 (70)	3.23 (69)	2.96 (49)	2.93 (74)	**3.53 (132)**
1.3.2 - Random Assignment in Experiments (8)	3.07 (68)	3.10 (61)	2.82 (68)	2.79 (63)	3.32 (129)
2.1.1 - Dotplots, Histograms, and Distributions for Quantitative Data (9)	2.95 (97)	3.11 (75)	2.77 (90)	2.68 (90)	3.23 (175)
2.1.2 - Constructing Histograms for Quantitative Data (10)	2.85 (33)	3.35 (37)	3.00 (32)	2.64 (44)	3.21 (72)
2.2.1 - Quantifying the Center of a Distribution (11)	3.07 (59)	3.11 (61)	2.80 (54)	2.95 (56)	3.30 (115)
2.3.1 - Quantifying Variability Relative to the Median (12)	2.78 (82)	3.16 (64)	2.73 (74)	2.68 (78)	3.21 (149)
2.4.1 - Quantifying Variability Relative to the Mean (13)	2.86 (131)	3.01 (125)	2.76 (109)	2.59 (136)	3.20 (250)
3.1.1 - Introduction to Scatterplots and Bivariate Relationships (14)	2.74 (73)	3.16 (77)	2.79 (85)	2.69 (74)	3.18 (156)
3.1.2 - Form, Direction, and Strength of the Relationship Between Two Measurements (15)	3.03 (35)	3.06 (33)	2.86 (35)	2.70 (33)	3.22 (68)
3.1.3 - Introduction to the Correlation Coefficient and Its Properties (16)	2.94 (36)	2.83 (29)	2.79 (28)	2.67 (24)	3.19 (58)
3.2.1 - Using Lines to Make Prediction (17)	2.95 (40)	2.97 (32)	2.52 (44)	2.71 (31)	3.19 (73)
3.2.2 - Least Squares Regression Line as Line of Best Fit (18)	2.71 (31)	2.81 (36)	2.68 (28)	2.71 (42)	3.06 (69)
3.2.3 - Investigating the Meaning of Numbers in the Equation of a Line (19)	2.67 (15)	3.11 (18)	2.65 (17)	2.08 (12)	3.06 (31)
3.2.4 - Special Properties of the Least Squares Regression Line (20)	2.50 (6)	3.00 (4)	2.50 (2)	2.00 (4)	3.00 (8)
3.3.1 - Using Residuals to Determine If a Line is a Good Fit (21)	2.08 (13)	2.63 (16)	2.00 (15)	2.58 (12)	3.32 (28)
3.3.2 - Using Residuals to Determine if a Line is an Appropriate Model (22)	2.70 (20)	2.67 (18)	2.71 (17)	2.68 (19)	2.92 (37)

Legend

- 3.501-4.000
- 3.001-3.500
- 2.501-3.000
- 2.001-2.500
- 1.501-2.000
- 1.000-1.500

Questions

Understanding: Overall, how well did you understand the material from the last class you attended?
Language: Overall, how difficult was it to read and understand the language in the assignments in this lesson?
Interest: How interesting was the lesson material and problems you worked on?
Relevance: How relevant to your goals or interests were the assignments you worked on in this lesson?
Feeling: Overall, how do you feel about the Statway course RIGHT NOW?

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Networked Improvement Community

- Changed role for faculty
- A community tackling on a high leverage problem – dev math
- Combining the worlds of research and practice
- Focused on continuous improvement

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What Statway Students Are Saying

" I praise the fact that someone finally had enough sense to realize that a great deal of students have been kept from furthering their education due to this overpowering wall, and now there is hope for alot of us, not only to pursue higher education but to learn something that would really apply to our everyday life. "

Course relevance

"I panic alot when I hear anything to do with testing"

Math and test anxiety

"I feel that if one person put in the work to really understand the concepts they can pass. I was never a "math person" but coming into Statway has completely made a 360 degree turn about how i feel about math. It is great!"

A growth mindset

What Students are Saying

" It really makes you think critically for math instead of just getting answers."

"This class was really interesting and even though I hate math, I started to like it."

" This course actually relates to the real world and made math more easy."

"…less calculation, fewer formulas, greater thinking….It will help you in everyday life."

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Part III

Course materials: What do the teachers and students use?