



CARNEGIE MATH
PATHWAYS

Getting Ideas into Action Statway and Quantway Networked Improvement Communities

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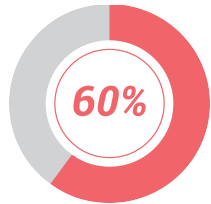
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Faculty, Capital Community College



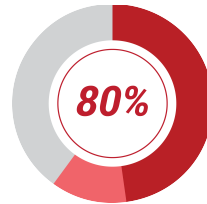
Carnegie Foundation
for the Advancement of Teaching

The Problem in the U.S.



60-70%

of community college students need at least one developmental math course before enrolling in college-credit courses



80%

of those students never get out of the developmental math pathway



500,000

students

in every cohort will never complete the math requirement

We cannot continue to use the same approach and expect different results.

WHAT DO STUDENTS DO?

53% correct

Very few could explain why

Which is
greater:

$$\frac{a}{5} \text{ or } \frac{a}{8}$$

WHAT DO STUDENTS
DO?

Which is
greater:

$$\frac{a}{5} \text{ or } \frac{a}{8}$$

$$\cancel{8a} = \cancel{5a}$$

WHAT DO STUDENTS DO?

$$\frac{5}{9} + \frac{7}{9} = \frac{12}{18} = \frac{2}{3}$$

$$\frac{a}{5} = \frac{a}{8}$$

$$~~8a = 5a~~$$

$$\frac{5}{9} + \frac{7}{9} = \frac{12}{18} = \frac{3}{4}$$

WHAT DO STUDENTS DO?

Compulsion to calculate

Try to remember

Adapt procedures

$$\frac{a}{5} = \frac{a}{8}$$

$$\cancel{8a} = \cancel{5a}$$

$$\frac{5}{9} + \frac{7}{9} = \frac{12}{18} = \frac{2}{3}$$

WHY DO THEY DO THIS?

Compulsion to calculate
Try to remember
Adapt procedures

They can't remember correctly.

They didn't try hard enough to learn.

We didn't say it slowly enough.

Not enough examples/practice.

They don't understand.

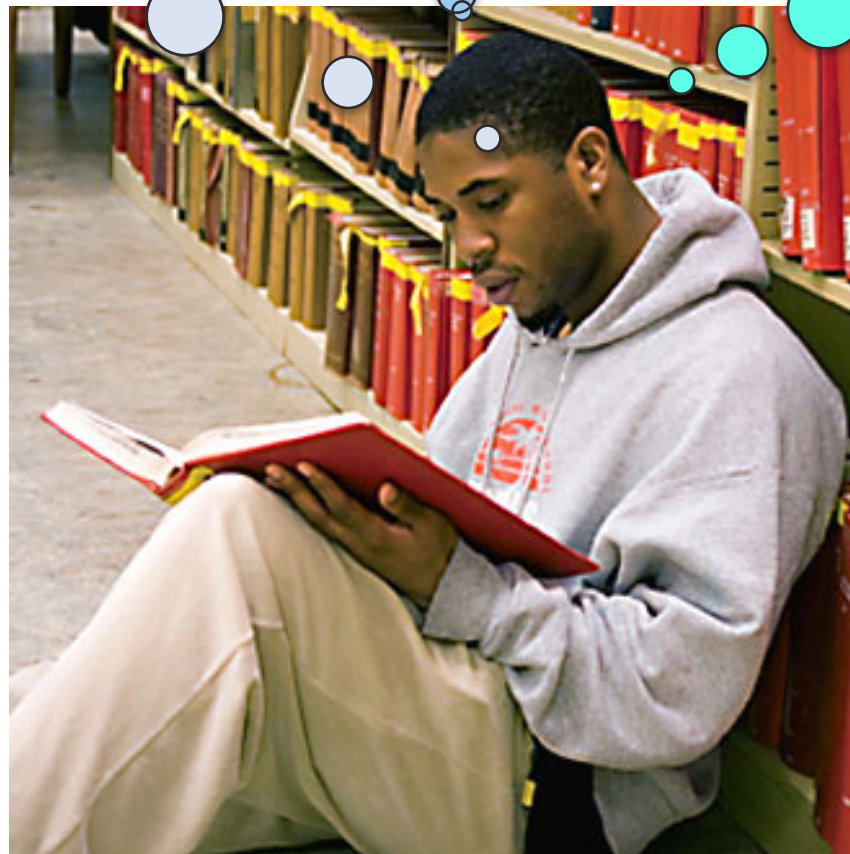
A student, upon completing a diagnostic assessment in a developmental math course:

“I am embarrassed by how stupid I am and suddenly feeling very discouraged ... I can't even tell which fraction is bigger than another, or where they should fall on the number line. I feel like crying.”

Maybe I
don't have
what it
takes

What's
the
point?

Maybe I
don't
belong
here



We need a solution that...

- Understands why students are not learning
- **Accelerates** mathematics completion
- Significantly **increases outcomes**
- Equips students with **rigorous learning and transferable knowledge**
- **Closes the gap**, works for ALL students
- **Increases college completion**

Math Pathways was our answer



STATWAY

Statistical Reasoning Pathway

QUANTWAY

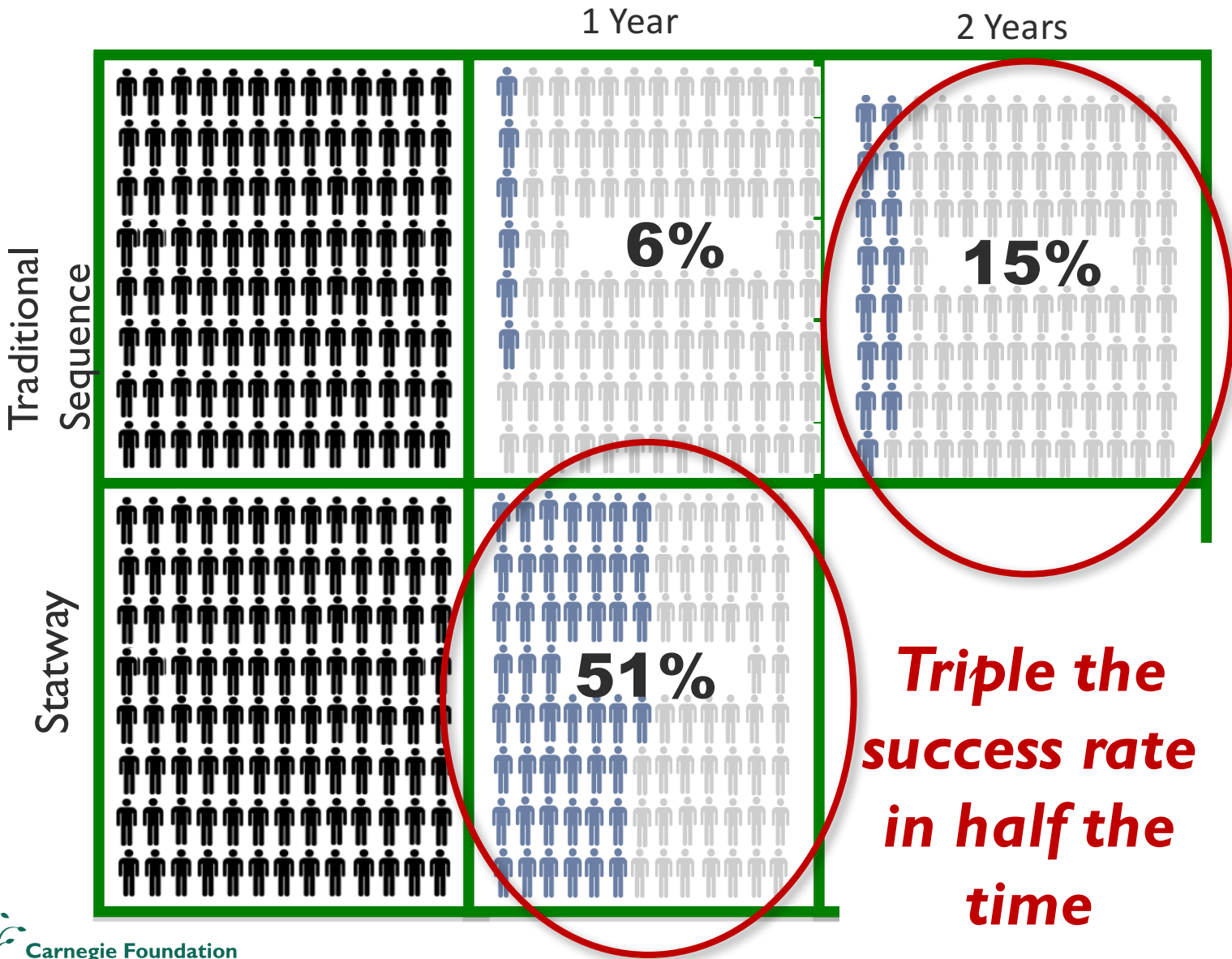
Quantitative Reasoning Pathway



Learning Outcomes

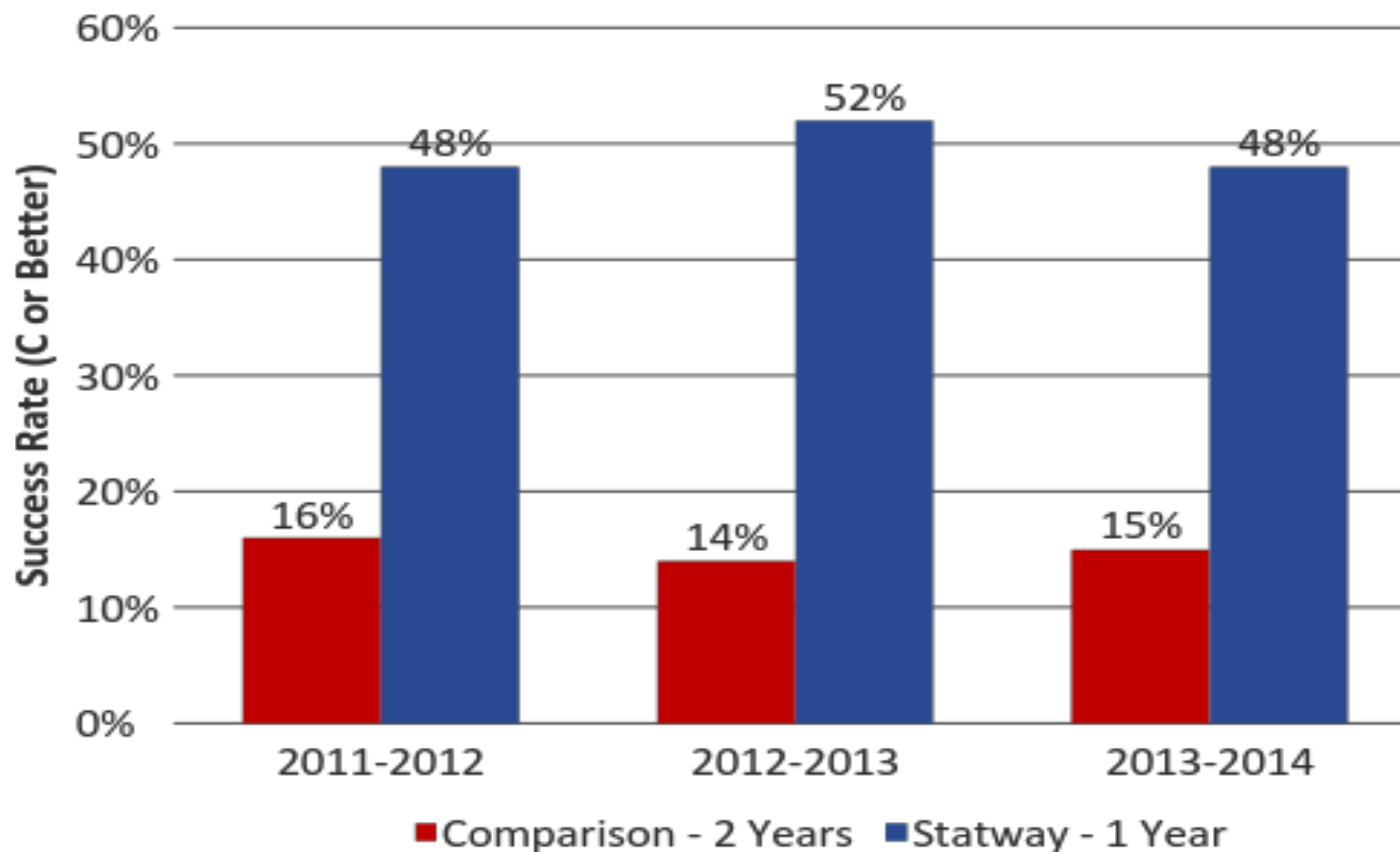
Endorsed by Math/Stat Professional Societies

Statway: Time to Complete a College Level Math Course

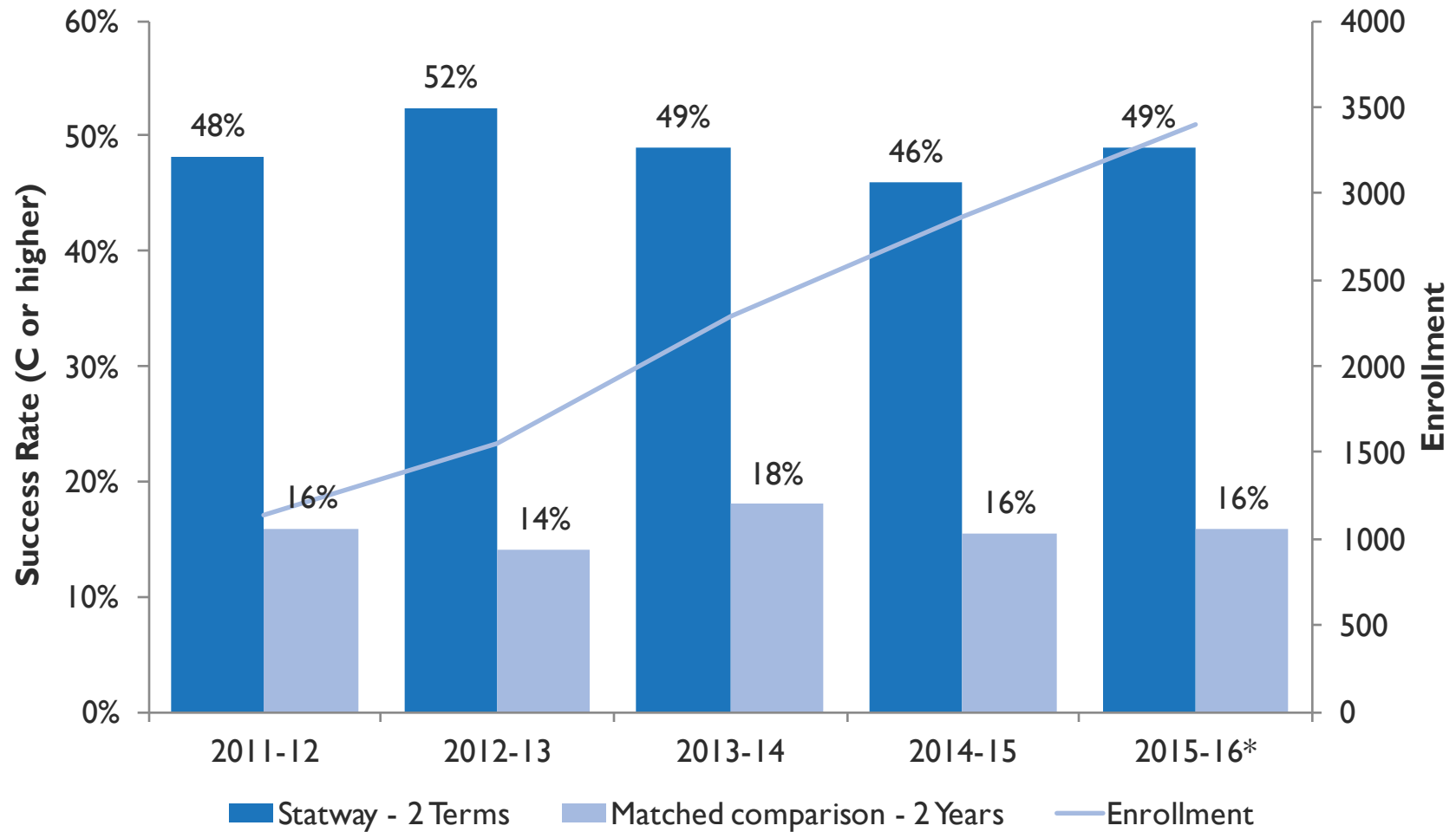


***Triple the
success rate
in half the
time***

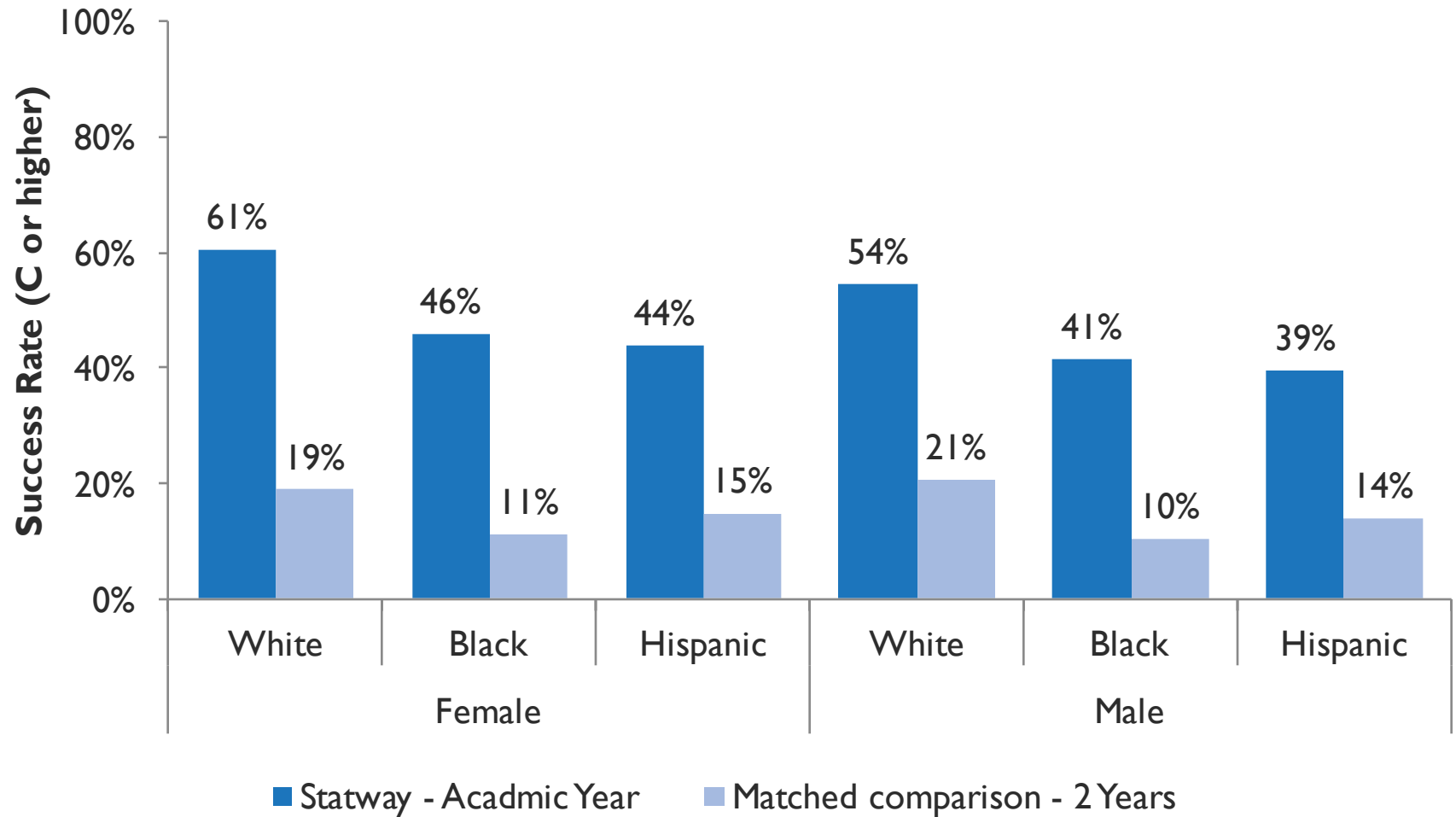
Our first year we learned that Statway Triples the Success in Half the Time



Statway: Triple Success in Half the Time

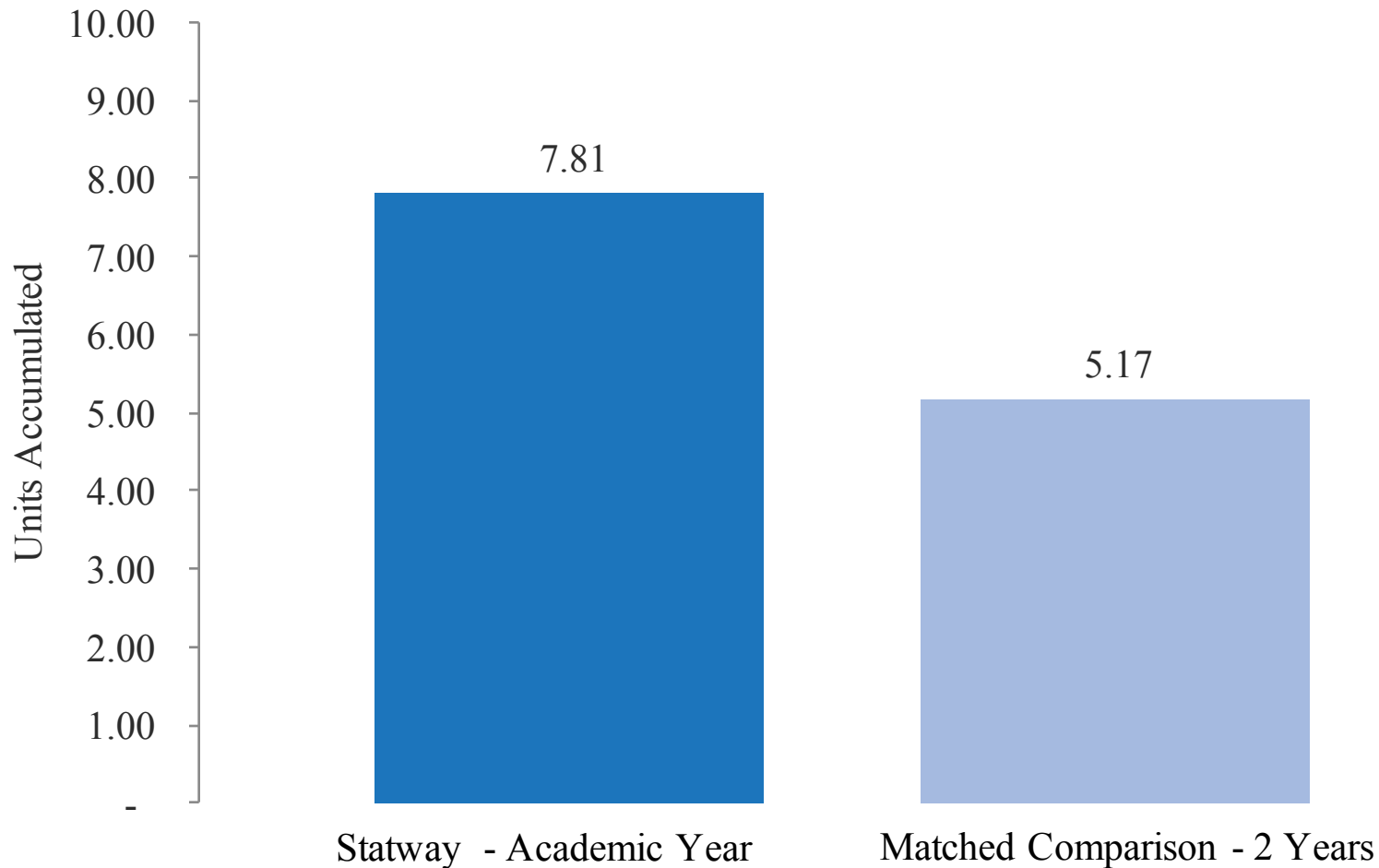


Statway: Advancing Equity – Improving Outcomes For Diverse Subgroups

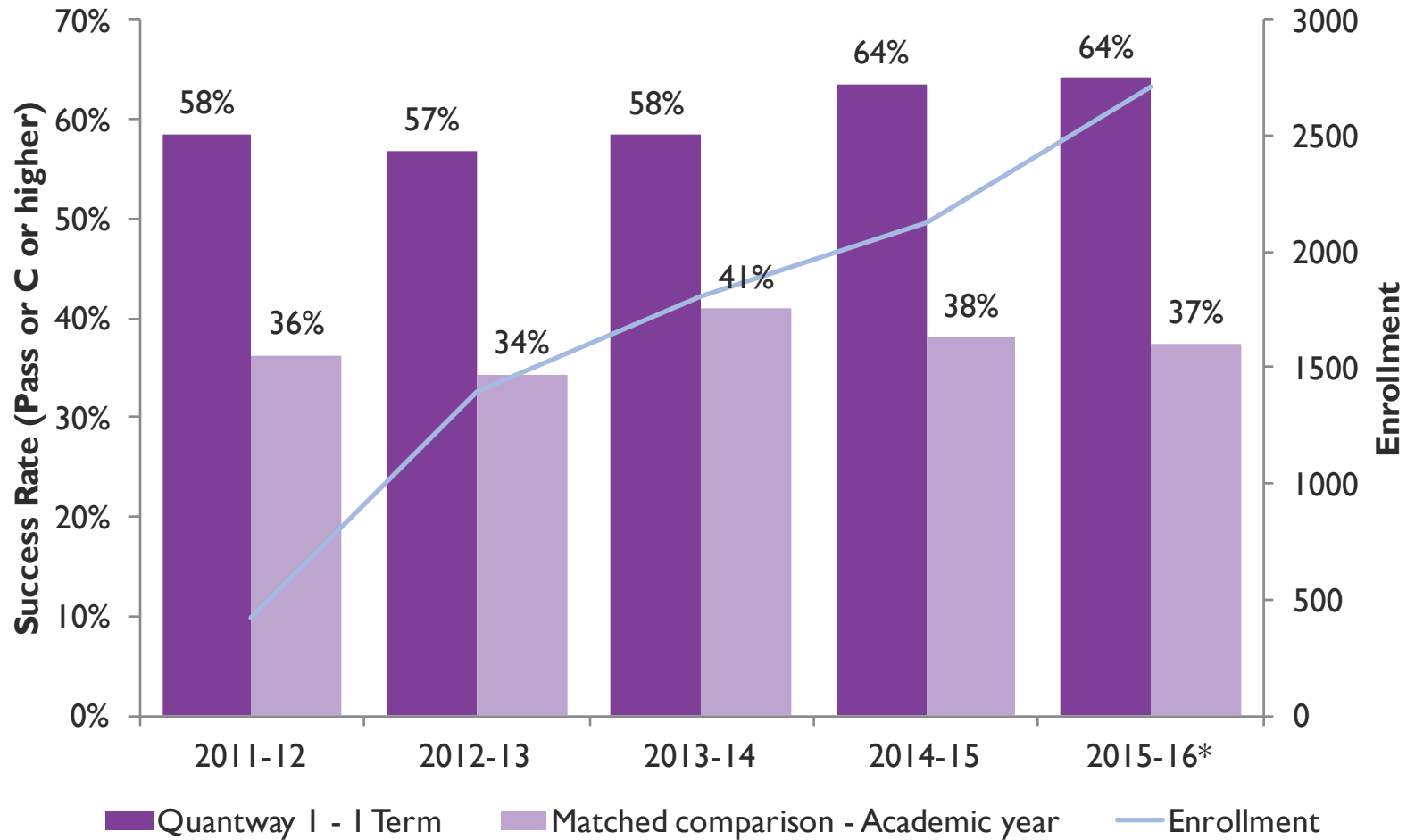


College credit accumulation and post-participation outcomes for Statway students

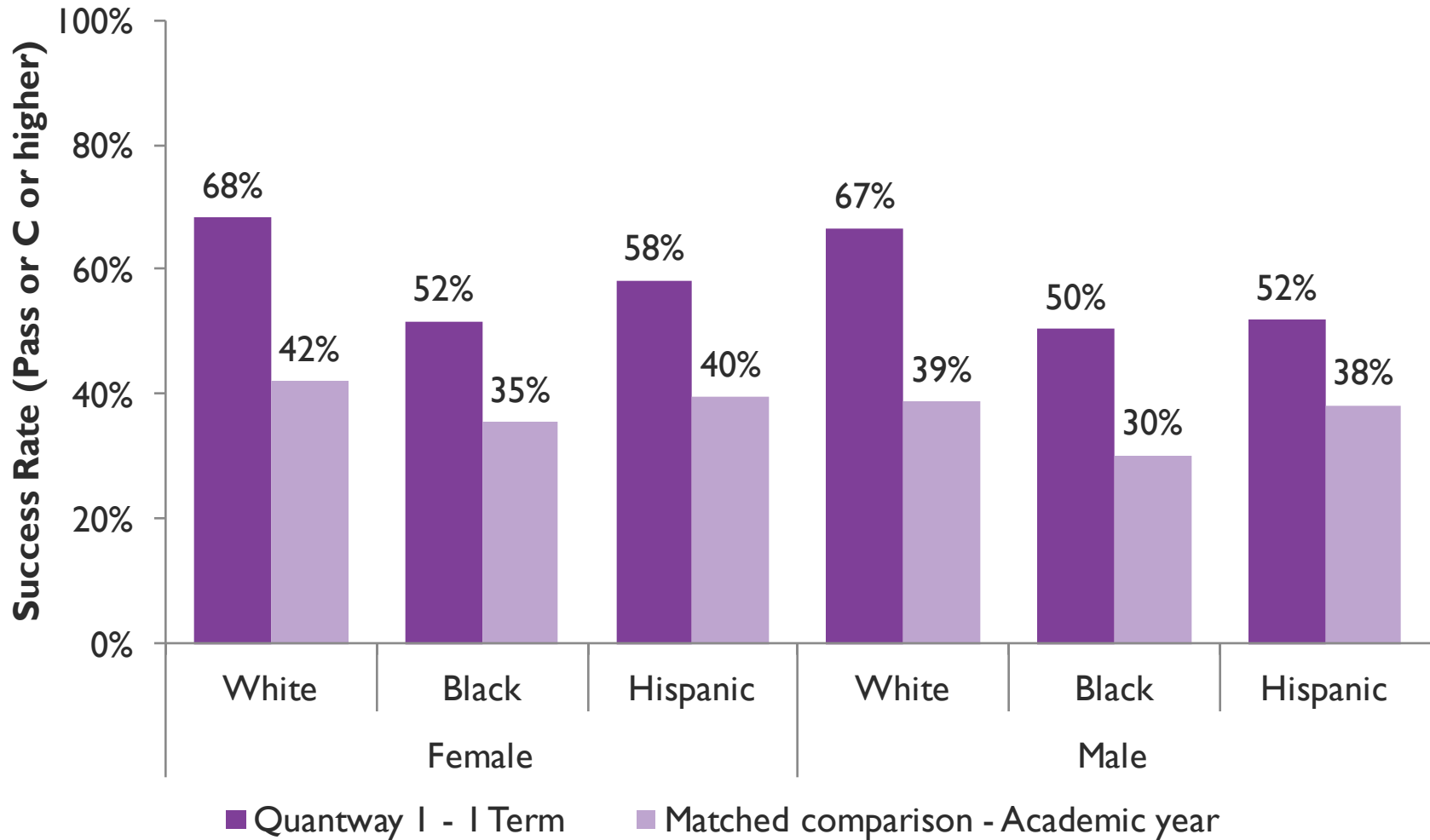
On average, Statway students accumulate comparable college level units in the subsequent calendar year – based on first three Statway cohorts



Quantway 1: Nearly Twice the Success in Half the Time

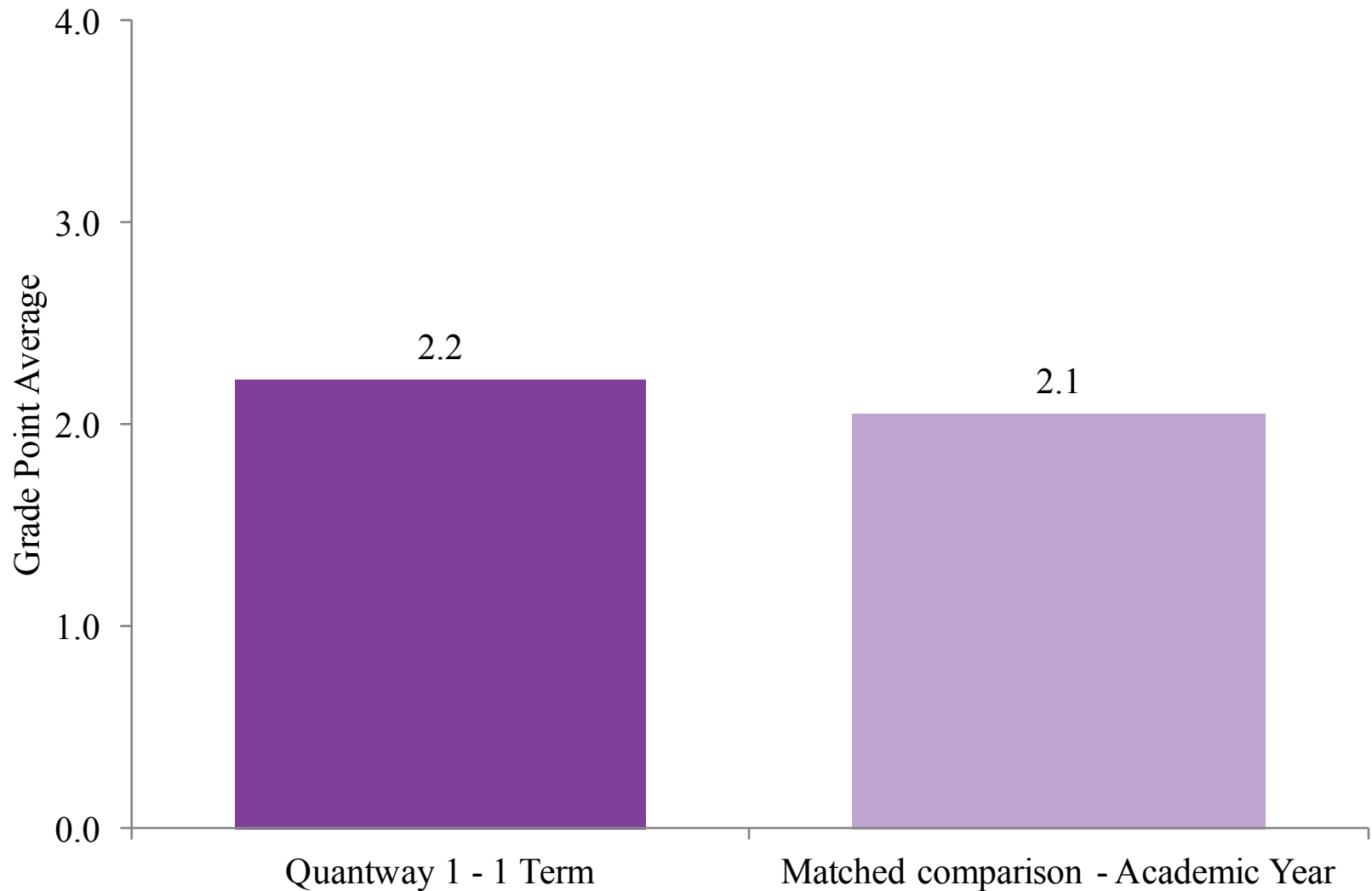


Quantway 1: Advancing Equity - Improving Outcomes For Diverse Subgroups



College-level math course grades and post-participation outcomes for Quantway students

Quantway 1: Students demonstrate a comparable GPA on college math



The Back Story: Four Areas of Concentration

CURRICULUM - What do students really need to know in math?

Re-conceptualized the curriculum content

PEDAGOGY - Do we know how or what students learn?

*Learning Opportunities: Teach for **understanding** NOT procedural learning*

PSYCHOSOCIAL FACTORS - Do we understand the barriers students have to their learning?

Productive Persistence: Mindset and stereotype threats

NETWORKED IMPROVEMENT COMMUNITY (NIC) - How do we convince faculty to do what they have been doing, differently?

*Develop a **NIC** and **data analytics** for continuous improvement*

*We cannot continue to use the same approach
and expect different results.*

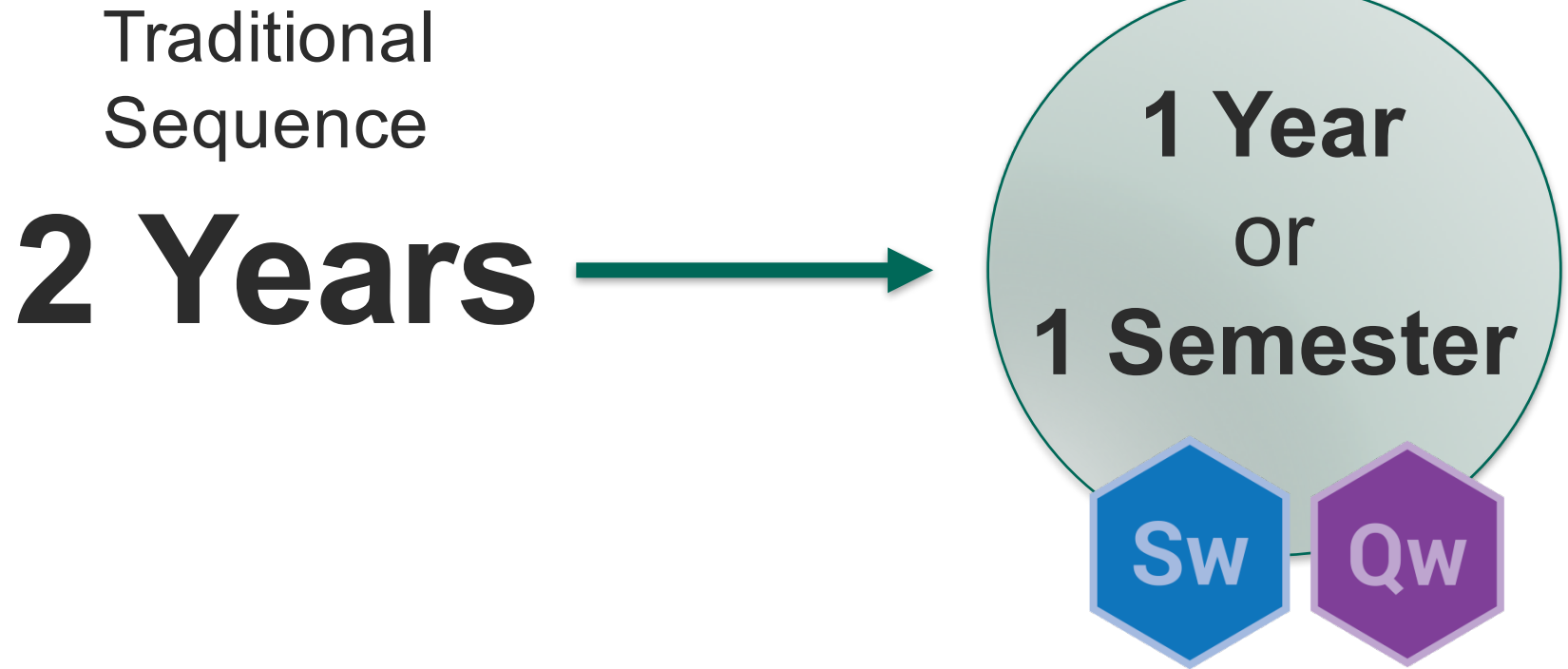
The Back Story: curriculum

What do students really need to know in math?
Re-conceptualized the curriculum content

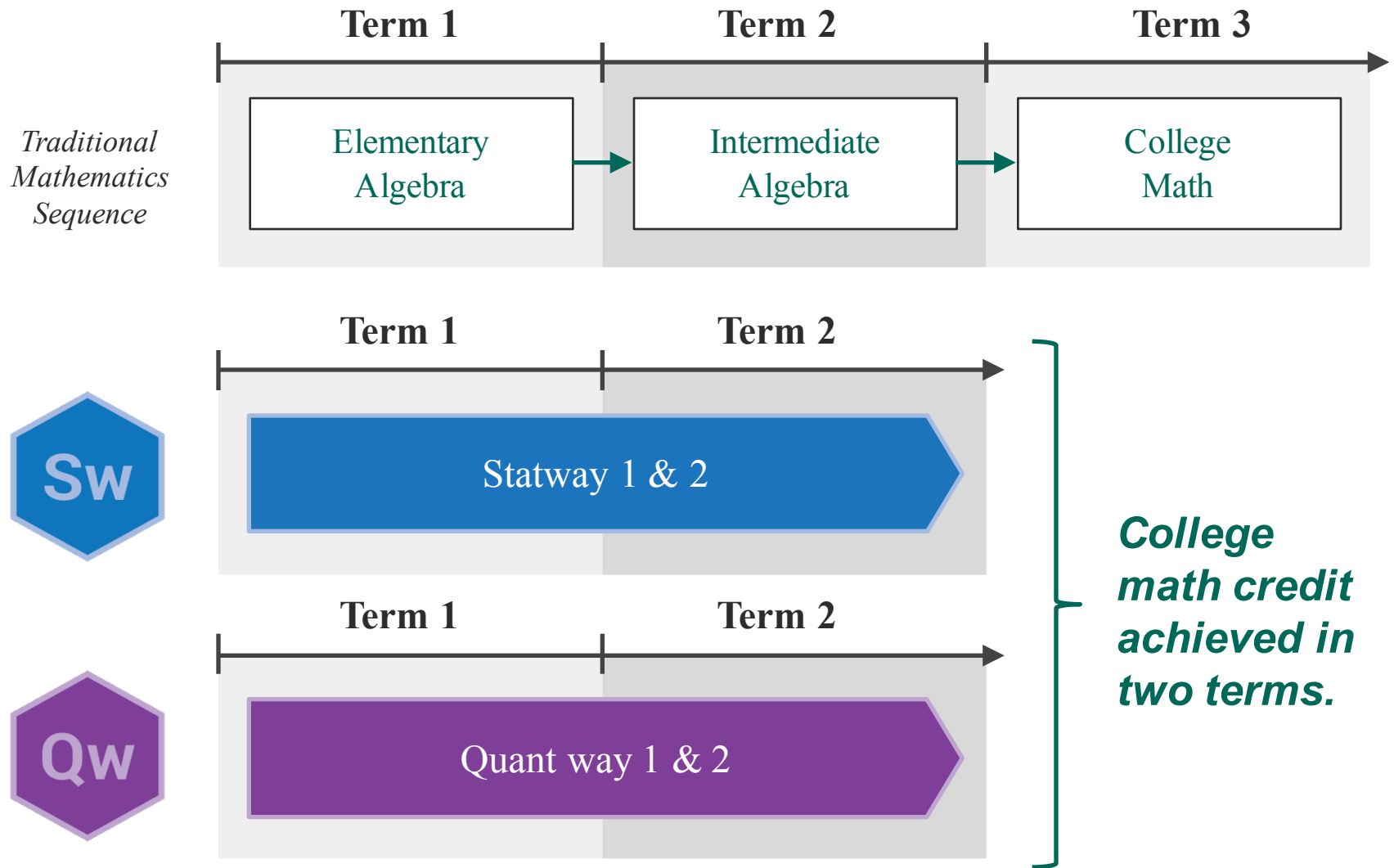
*We cannot continue to use the same approach
and expect different results.*

ACCELERATED: *RECONCEPTUALIZED*

Earn college level math credit in one year or less



Accelerated and Restructured Cohort Design



The Back Story: pedagogy

What do students really need to know in math?

Re-conceptualized the curriculum content

Do we know how or what students learn?

***Learning Opportunities: Teach for understanding
NOT procedural learning***

***We cannot continue to use the same approach
and expect different results.***

Use of neuroscience and cognitive psychology

- It is less about race, ethnicity or gender
- It is about neural connectivity and opportunities for the brain to develop
- It is about *teaching as a cultural routine*
 - *That needs to change*
- It is about *implicit biases and stereotype threat*



Learning Opportunities: disruptive pedagogy

- **Productive struggle** – with important mathematics; increased neural activity
- **Explicit connections** – between concepts, procedures, problems, situations
- **Deliberate practice** – increasing variation and complexity over time

The Back Story: psychosocial factors

What do students really need to know in math?

Re-conceptualized the curriculum content

Do we know how or what students learn?

*Teach for **understanding** NOT procedural learning*

Do we understand the barriers students have to their learning?

Productive persistence: Mindset and stereotype threats

*We cannot continue to use the same approach
and expect different results.*

Productive Persistence

Tenacity + Good Strategies

Aim:

Students continue to put forth effort during challenges and when they do so they use effective strategies.

Students believe they are capable of learning math.

Students feel socially tied to peers, faculty, and the course.

Students believe the course has value.

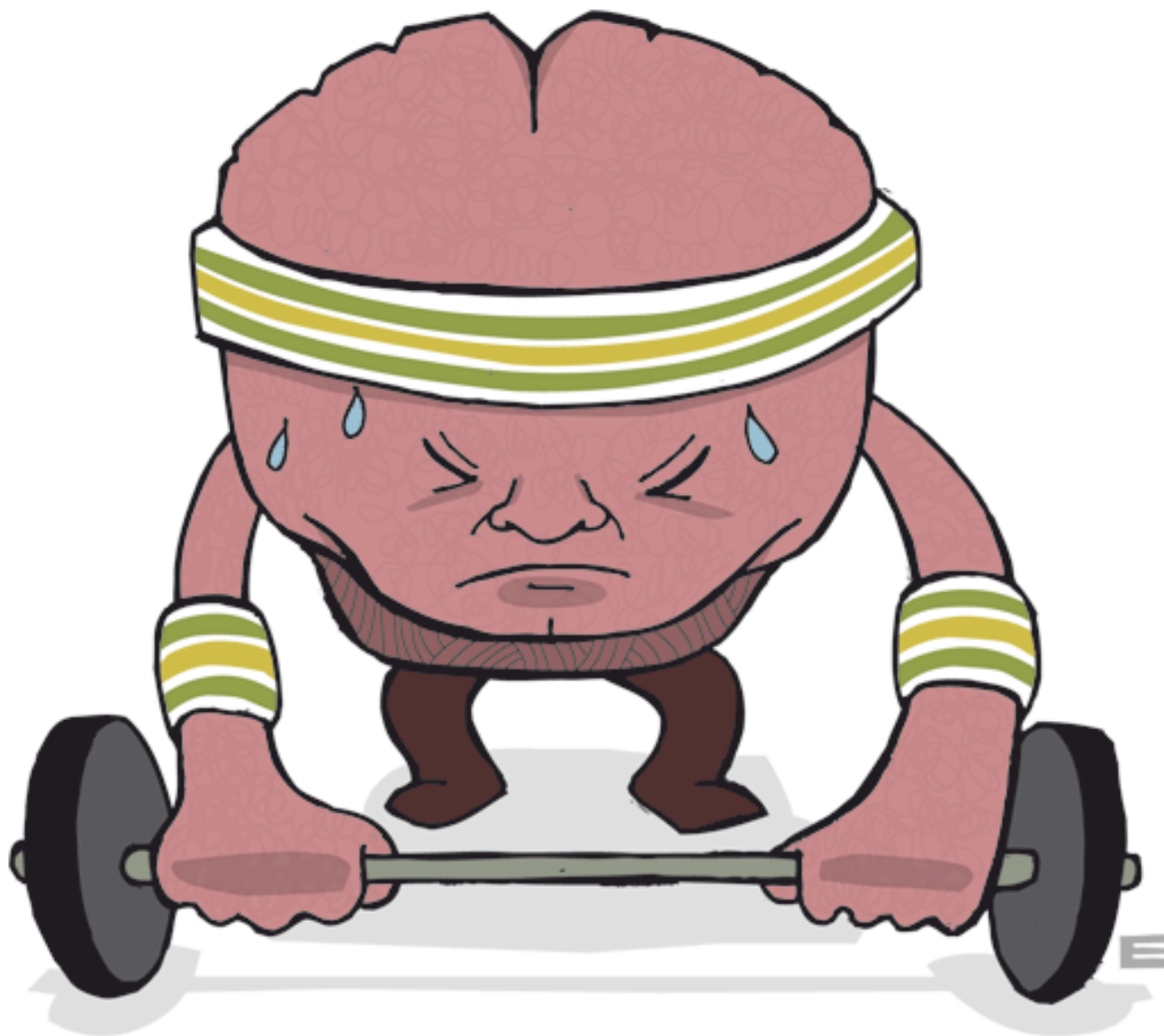
Students have skills, habits and know-how to succeed in college setting.

Faculty and college support students' skills and mindsets.



Mindsets About Ability

	Fixed mindset	Growth mindset
Goals	Look smart	Learn
Values effort, help & strategy?	No	Yes
Response to challenge	Give up	Work harder and smarter
Changes in grades	Decrease	Increase



You Can Grow Your Brain

New Research Shows the Brain Can Be Developed Like a Muscle

By: Lisa S. Blackwell and David S. Yeager

Many people think of the brain as a mystery. We don't often think about what intelligence is or how it works. And when you do think about what intelligence is, you might think that a person is born either smart, average, or dumb—either a “math person” or not—and stays that way for life.

But new research shows that the brain is more like a muscle—it changes and gets stronger when you use it. Scientists have been able to show just how the brain grows and gets stronger when you learn.

Everyone knows that when you lift weights, your muscles get bigger and you get stronger. A person who can't lift 20 pounds when they start exercising can get strong enough to lift 100 pounds after working out for a long time. That's because muscles become larger and stronger with exercise. And when you stop exercising, the muscles shrink and you get weaker. That's why people say “Use it or lose it!”

But most people don't know that when they practice and learn new things, parts of their brain change and get larger, a lot like the muscles do. This is true even for adults. So it's not true that some people are stuck being “not smart” or “not math people.” You can improve your abilities a lot, as long as you practice and use good strategies.

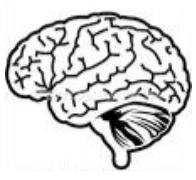


A Section of the Cerebrum nerve fibers (white matter)

Inside the outside layer of the brain—called the cortex—are billions of tiny nerve cells, called neurons. The nerve cells have branches connecting them to other cells in a complicated network. Communication between these brain cells is what allows us to think and solve problems.

Mindsets about academic potential

“Most people don't know that when they practice and learn new things, parts of ***their brain change*** and get larger, a lot like the ***muscles*** do. This is true even for adults. So it's not true that some people are stuck being “not smart” or “not math people.” ***You can improve*** your abilities a lot, as long as you ***practice*** and ***use good strategies.***”

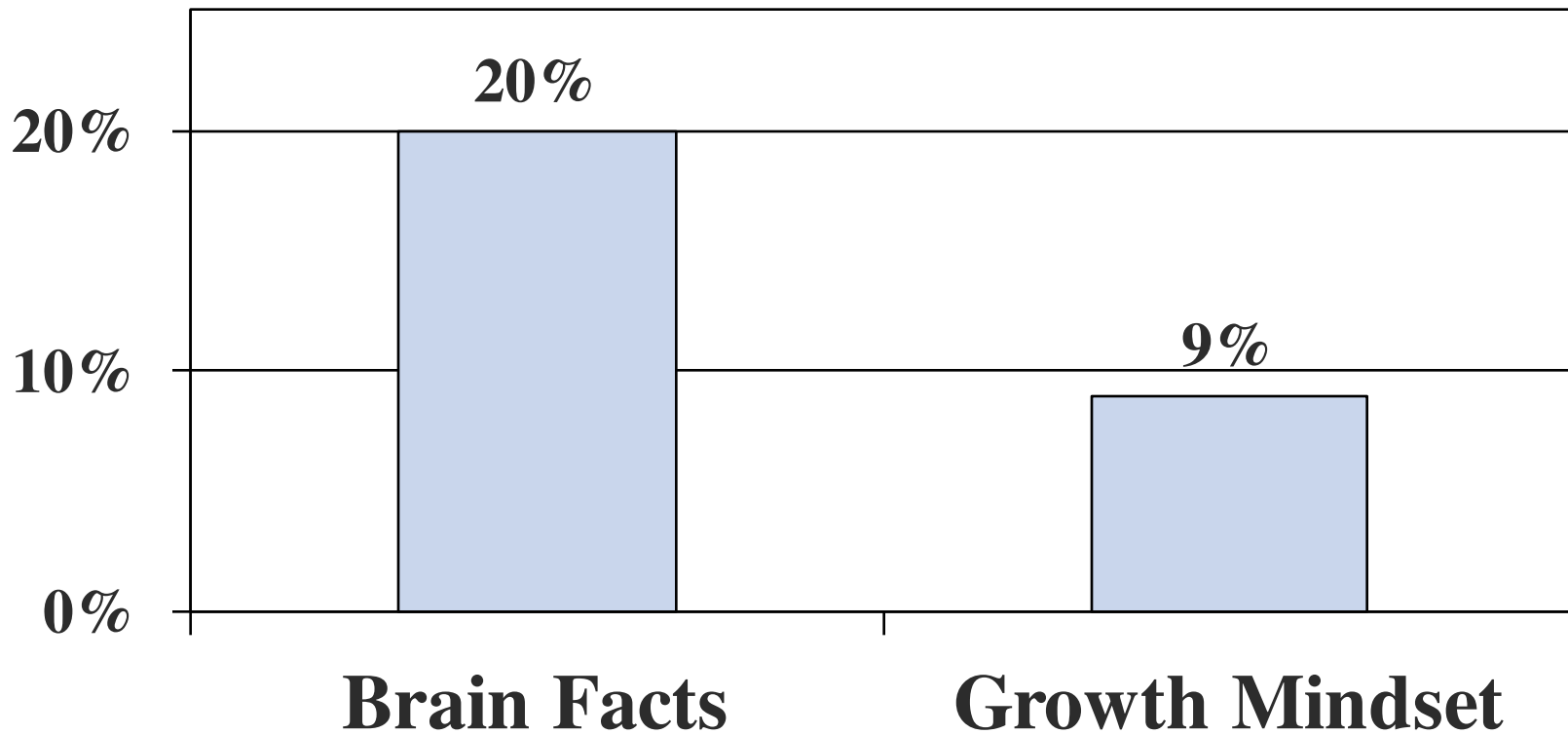


Mindsets about academic potential

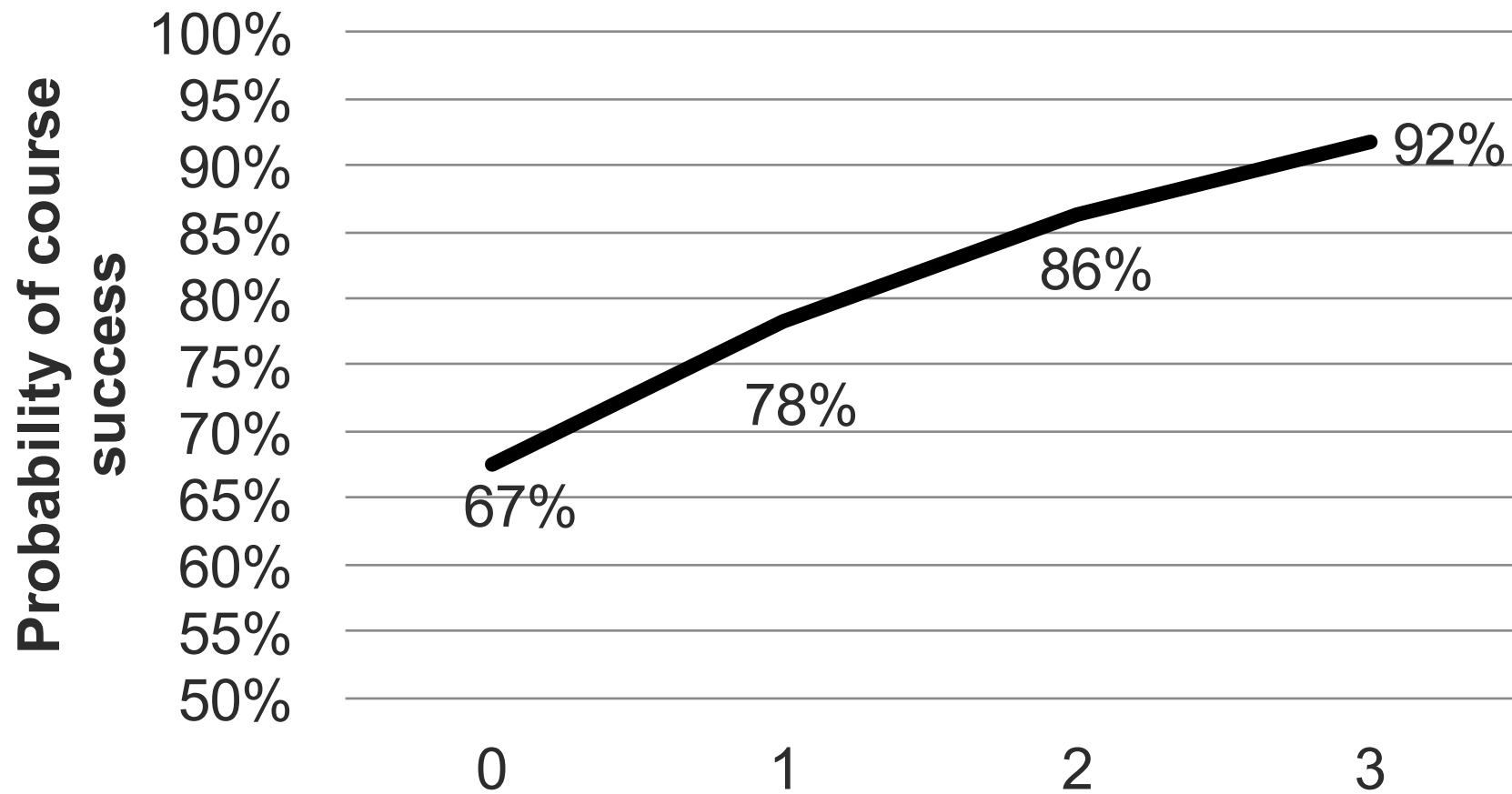
- **Fixed mindset (intelligence is fixed)**
 - *“If I have to try hard, I’m clearly not smart.”*
 - No point in trying if one is not a “natural”
- **Growth mindset (intelligence is malleable)**
 - *“Trying harder makes you smarter.”*
 - Obstacles can be overcome through effort, help from others, and use of improved strategy
 - Note: It’s **NOT** just about “trying harder.”

Course Dropout

Students Who Withdrew From Developmental Math



Students Who Develop a Growth Mindset Are More Likely to Pass With C- or Better



The Back Story: Networked Improvement Community

What do students really need to know in math?

***Re-conceptualized** the curriculum content*

Do we know how or what students learn?

*Teach for **understanding** NOT procedural learning*

Do we understand the barriers students have to their learning?

Mindset and stereotype threats

How do we convince faculty to do what they have been doing, differently?

*Develop a **Networked Improvement Community (NIC)** for **data analytics and continuous improvement***

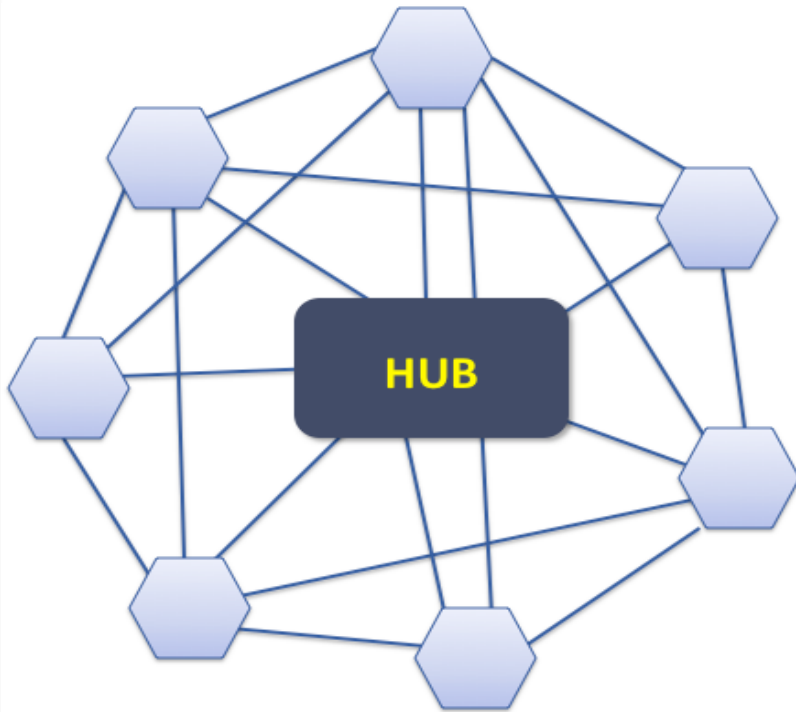
We cannot continue to use the same approach and expect different results.

How We Created a Network for Faculty

- **RESEARCH AND PRACTICE** joined to address the problem
- **RE-CONCEPTUALIZED** the approach
- **BOLD INSTRUCTIONAL DESIGN** including curriculum, pedagogy and productive persistence
- **EVIDENCE-BASED** networked improvement community

What is a Networked Improvement Community?

Networked Improvement Communities



The rudiments of
Improvement Science

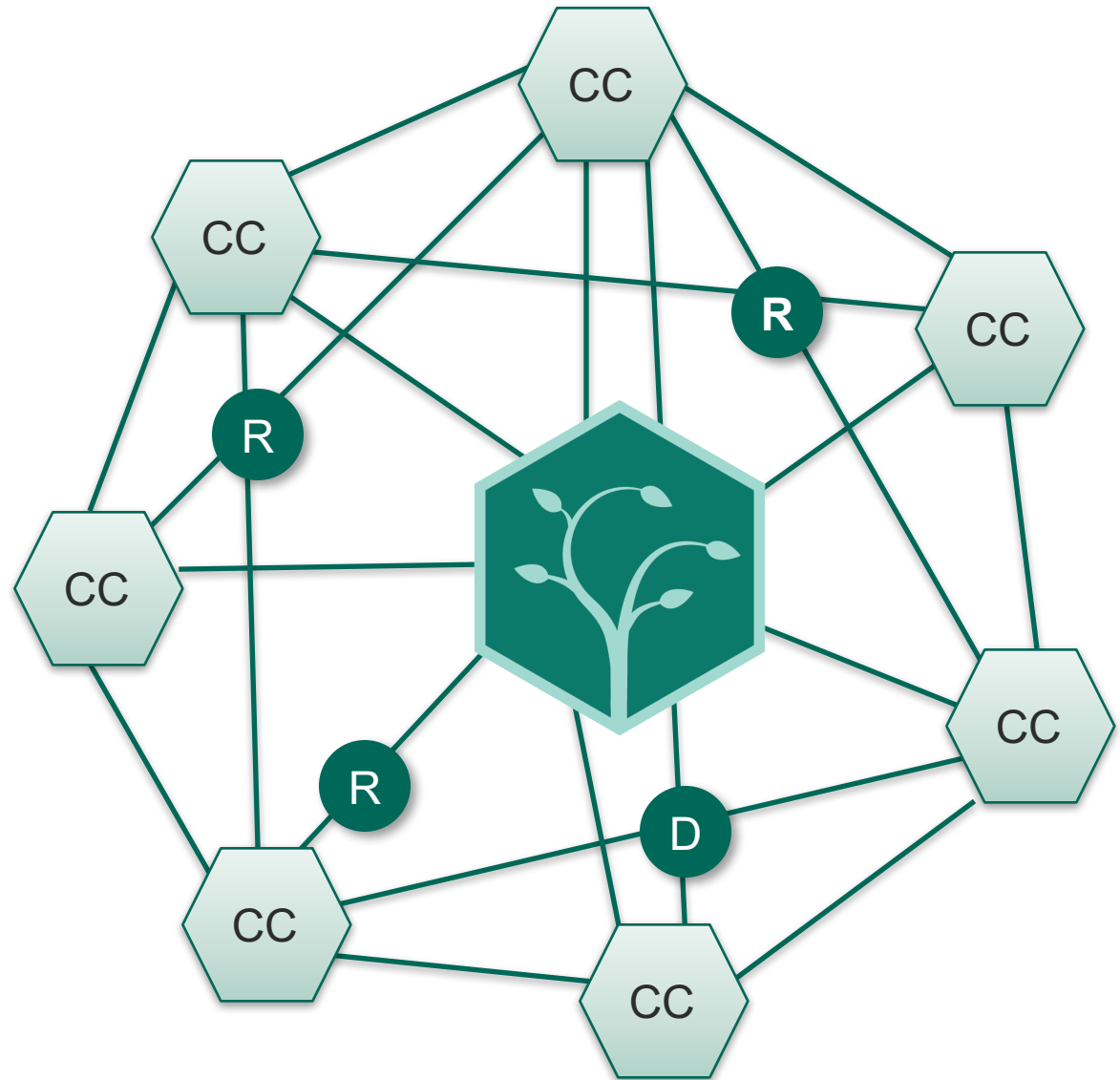
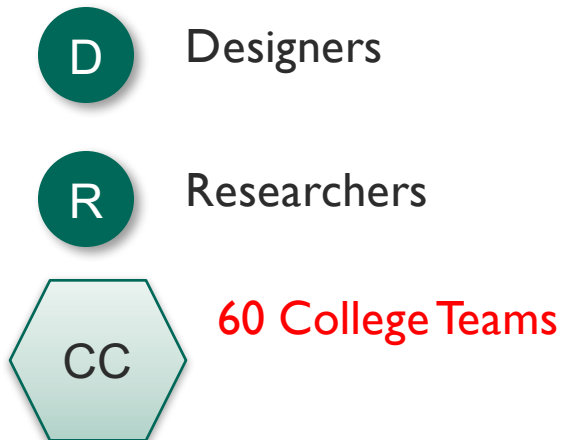


The Power of
Networks

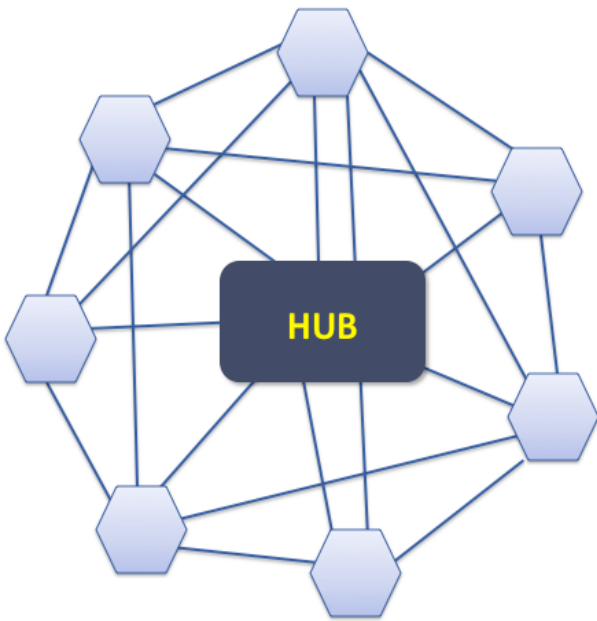


Accelerating learning
in and through practice
to improve

Networked Improvement Community



Core Elements of a NIC



Common problem

Shared aim

Common theory of practice improvement

Common measurement system

Common methodology for disciplined inquiry

Defined mechanisms for spreading learning across the network

Data analytics for feedback and improvement

An Organizing Principle for a NIC?

Creating an AIM Statement!

Purpose of an Aim Statement

Clearly *defines* success for an improvement effort

Scopes the effort: defines the population and intervention that you will improve

Focuses and *motivates* towards an important *accomplishment*. “This is what we are doing together.”

Serves as a ‘*North Star*’ to guide our efforts

Supports *iterative improvement*, don’t be worry about being wrong

Some is not a number, soon is not a time

Our Original Carnegie Math Pathways Aim

Double the number of
developmental students who
complete college level math
within a year

Our Revised Aim

Increase from **5%** to **50%** the
percent of developmental students
who earn
college credit
in a single year

Our New Aim

By June 2018,
reclaim the mathematical lives of
30,000 students



CARNEGIE MATH
PATHWAYS

Began Network July 2010
First Implementation Fall 2011

*Currently in over 60 institutions in 15 states and
have reached over 20,000 students*



Carnegie Foundation
for the Advancement of Teaching

Building an Internal Network

- First Year – the beginning
 - Faculty commitment
 - Reaching out to others
 - Mathematics Department
 - Student advising
 - Students, pilots and information dissemination

Connecting with the NIC

- Second Year
 - Success! Launching the first course
 - High enrollment
 - Student learning and completion success
 - More Integration with the National Network
 - Reinforce and map outcomes
 - Improve the curriculum

SUCCESSFUL COLLEGES

know their data...

reduce options, align with major...

*have leadership who **demands and empowers** change...*

*support **professional learning** and leadership development...*

Your Aim

By July 20____,
reclaim the
mathematical
lives of ____
students.

Institutional Structures & Leadership

Instructional System

Productive Persistence

Language and Literacy

Advancing Quality Teaching

What Students are Saying



“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!”

What 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 a lot of us, not only to pursue higher education but to learn something that would really apply to our everyday life. ”





CARNEGIE MATH
PATHWAYS

<https://www.carnegiefoundation.org/in-action/carnegie-math-pathways/>

Pathways Institutional Systems Map

What are the **POLICIES** that support or hinder Pathways implementation?

What is the Institutional **AIM**?

What is the **TARGET STUDENT POPULATION**?

Who are the **EXTERNAL STAKEHOLDERS**?

Who are the **INTERNAL STAKEHOLDERS** that need to be involved?

What are the **MEASURES OF SUCCESS**?

What are the **PROCESSES** (sequences of actions) that enable the institution to achieve its aim?

What are the **EXTERNAL RESOURCES** required for implementation?

What are the **CRITICAL SUCCESS FACTORS** (things the institution must get right for success)?

What are the potential **BARRIERS TO IMPLEMENTATION**?