

Infusion of WebAssign, iPads, JuliaBox and Peer-Led Team Learning to Enhance Minority STEM Majors' Mathematics Performance

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Northeastern State University in Tahlequah, Oklahoma

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Introduction: Problems and Math Class

- ▶ Rising concern about America's ability to maintain its competitive position in the global economy due to lack of graduates with training and expertise in STEM fields
- ▶ Minority STEM workforce is well below their expected percentage in the total STEM workforce



Introduction: Problems and Math Class



One of the primary reasons students switch or drop out of STEM disciplines is **Mathematics** instruction

Introduction: Problems and Math Class

Lecture-based learning is predominant mode of instruction at UAPB and other institutions.

Lecture-based learning is a one-way communication, which treats students as **passive participants** who are to take notes while sitting quietly and who may ask questions only if time permits.

Research has shown that this **rigid learning method is not helpful** for most students in acquiring new knowledge

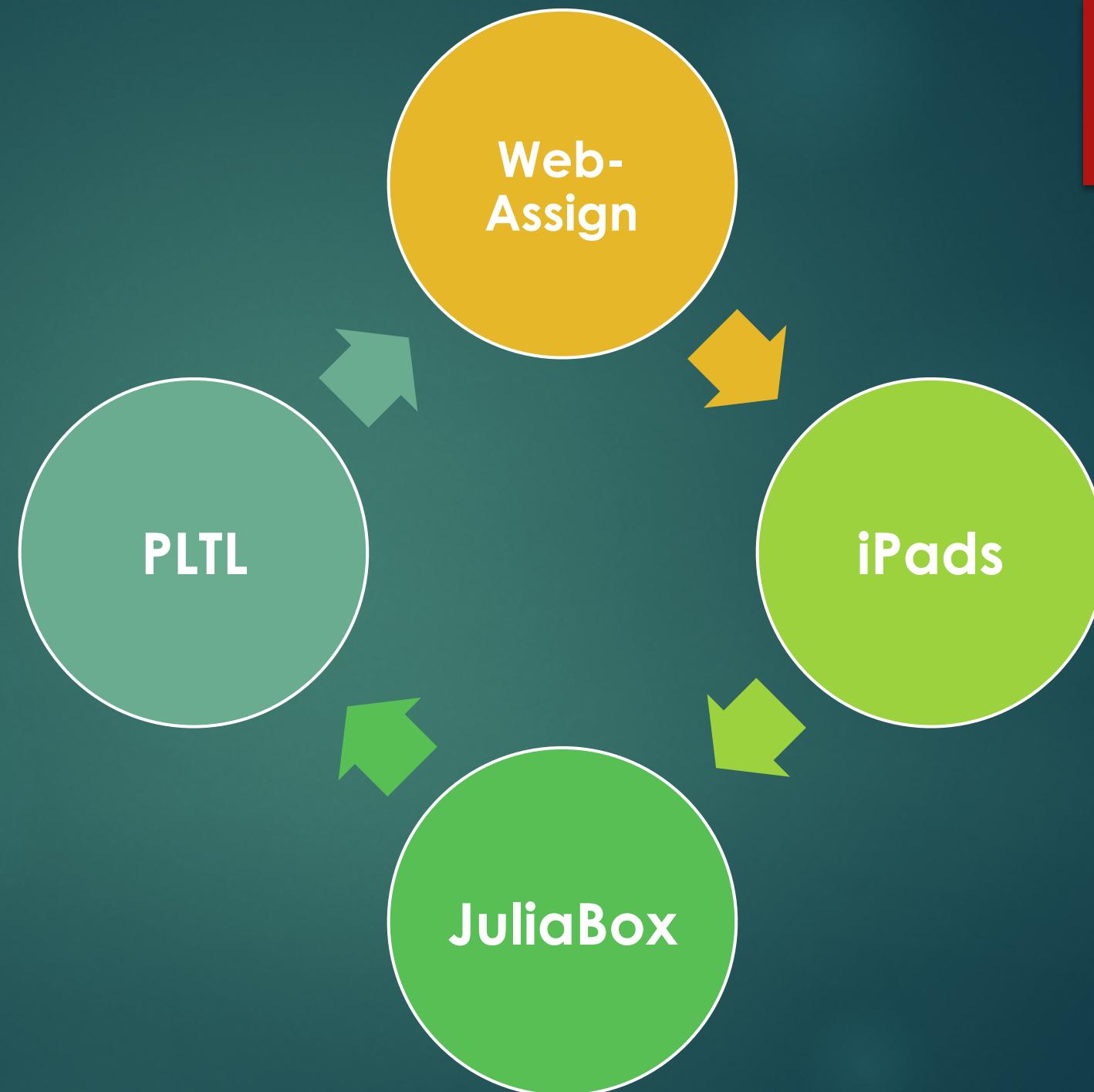


Hypothesis: Evidence-Based Learning and Math Class



Goal:

Enhance
minority
STEM majors
Math
performance



Methods:

In-house faculty-development workshop regarding WebAssign and Julia coding

Develop a co-requisite College Algebra class

Pilot evidence-based instructions in College Algebra and co-requisite College Algebra classes

Utilize iPads for evidence-based learning

Trained and mentored peer-lead-team-learning (PLTL) leaders and weekly meetings

Why WebAssign?

- Pay \$119 per semester for all classes in UAPB
- Pay one time \$119 for three Algebra courses in UAPB
- Web-based, no installation required.
- Detailed online documentation, randomized questions
- Homework graded instantly and automatically



Example of WebAssign

14. +1 points LarColAlg9 3.1.075.MI.

 My Notes  Ask Your Teacher

The path of a diver is given by the function

$$f(x) = -\frac{4}{9}x^2 + \frac{24}{9}x + 11$$

where $f(x)$ is the height (in feet) and x is the horizontal distance from the end of the diving board (in feet). What is the maximum height of the diver?

 ft

Need Help?

Read It

Watch It

Master It

Talk to a Tutor

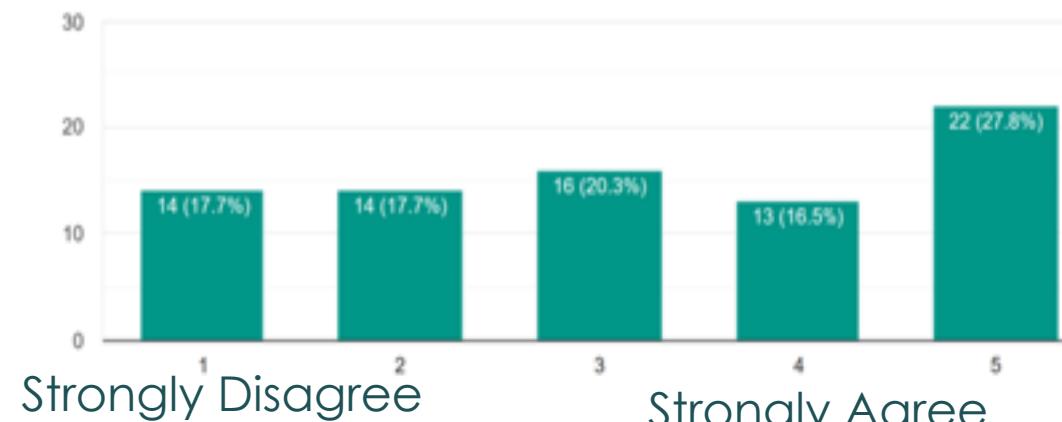
Students Survey Results

College Algebra Class

Strongly Disagree

I like web-based learning (WebAssign) in my College Algebra class

79 responses



45% Agreed

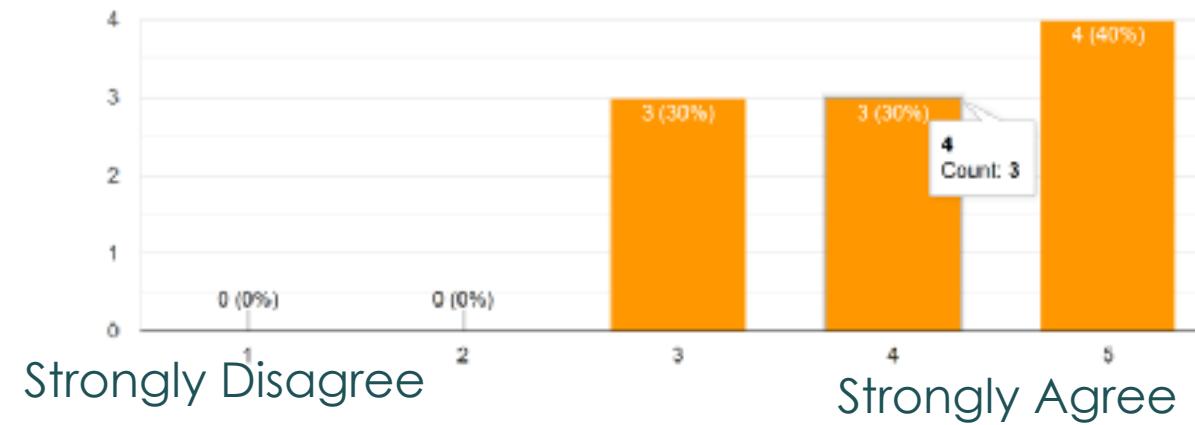
44.3% agreed; 35.4 disagreed

Co-Req College Algebra Class

Strongly Disagree

I like a web-based learning (WebAssign) in my Co-Req College Algebra class

10 responses



70% Agree

70% agreed

What is Julia?

- Julia is a functional programming language released in 2012.
- Its creators wanted to combine the readability and simplicity of Python with the speed of statically-typed, compiled languages like C



Who is Julia For?

- Julia is popular among data scientists and mathematicians.
- It shares features with mathematical and data software like Mathematica
- Its syntax is closer to the way mathematicians are used to writing formulas.



Why Did I Choose Julia?

- Free
- Web-based (JuliaBox - No installation)
- Fast
- Ease to use
- Suitability for big-data applications



How to Get Julia?



Julia: [https://julialang.org/
downloads/index.html](https://julialang.org/downloads/index.html)



JuliaBox: [https://
juliabox.com](https://juliabox.com)

How did I use the JuliaBox in my Co-Req College Algebra class?

First, used the JuliaBox like a calculator

Then wrote functions to automatize the calculation process

Benefits writing Julia coding:

- Helped students to memorize formula
- Helped students to understand the concepts better
- Students felt accomplished
- Students are able to add a new skill to their resume



Julia Code Example

The screenshot shows a Jupyter Notebook interface with the title "jupyter Co-Req College Algebra" and a status bar indicating "Last Checkpoint: Last Saturday at 2:45 PM (autosaved)". The toolbar includes File, Edit, View, Insert, Cell, Kernel, Widgets, Help, and various execution and validation buttons. The notebook cells show the following code and output:

```
In [3]: a = abs(40-20)
Out[3]: 20

In [4]: b = abs(28-5)
Out[4]: 23

In [5]: c2 = a^2 + b^2
Out[5]: 929

In [6]: c = sqrt(c2)
Out[6]: 30.479501308256342
```

Find a distance using Pythagorean Theorem ($c^2 = a^2 + b^2$)

Julia Code Example

jupyter Co-Req College Algebra Last Checkpoint: Last Saturday at 2:45 PM (unsaved changes)  

File Edit View Insert Cell Kernel Widgets Help Not Trusted Julia 1.0.3

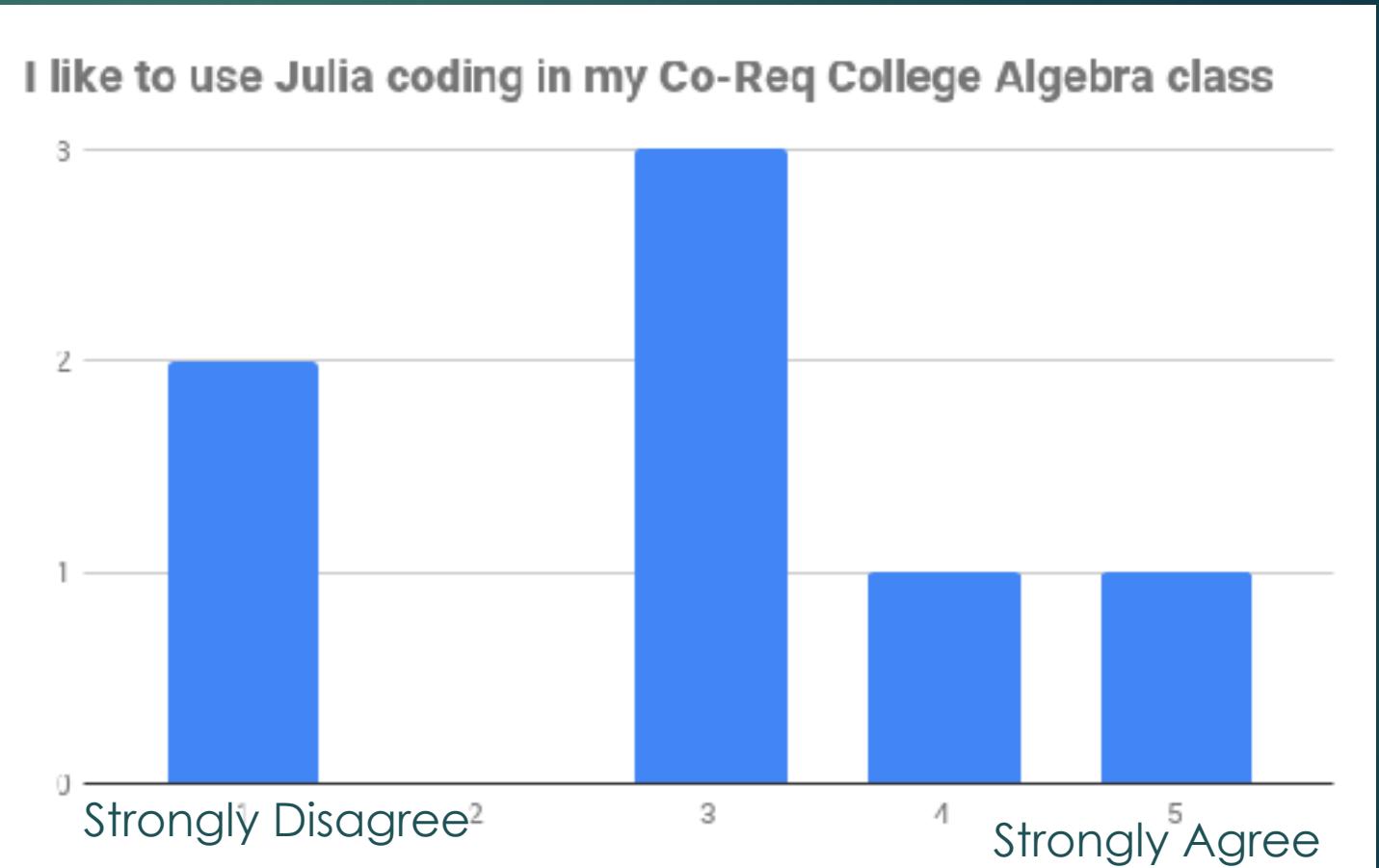
In [5]: `function CircleWithTwoPoints(x1,y1,x2,y2)`
 `x_center = (x1 + x2)/2`
 `y_center = (y1 + y2)/2`
 `squared_radius = (x_center - x1)^2 + (y_center - y1)^2`
 `println("center is: ", "(", x_center, ", ", y_center, ")")`
 `println("radius^2 is: ", squared_radius)`
end

Out[5]: CircleWithTwoPoints (generic function with 1 method)

In [6]: `CircleWithTwoPoints(-3,0,3,0) # two points are: (-3,0) and (3,0)`
center is: (0.0, 0.0)
radius^2 is: 9.0

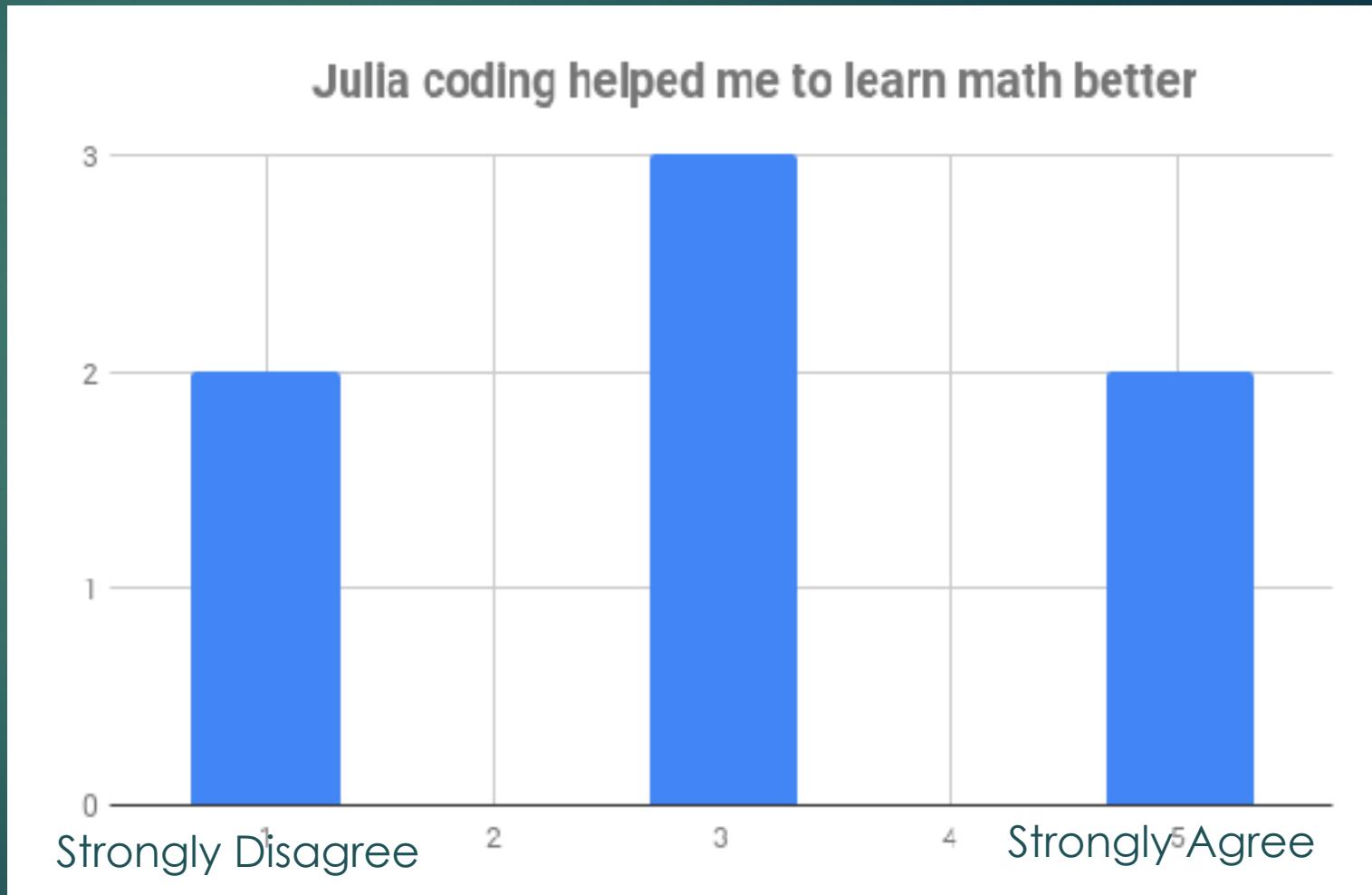
Students Survey Results

- Students are still new to Julia coding.
- Students are open to a new approach of learning.



Students Survey Results

- Students are still hesitant to learn and use
- STEM majors usually more open to Julia coding than non-STEM majors
- Plan to use more in class and during the lab



What is PLTL workshop?

- Small groups of students get together under a PLTL leader
- A workshop is not another lecture (i.e PLTL leaders are not expected to repeat the exact subject matter)
- A workshop is not a question and answer session (i.e PLTL leaders are not to “fill in the blanks” for students)
- The group may work on their homework assignments or worksheet that their instructor provide

How many, how often?

21

- The class is divided into small sets of students usually six to eight per group
- The group is expected to meet weekly for the duration of the semester for between 1 ½ to 2 hours a session allowing them to rely on these sessions for help.

What is a PLTL leader?

- Coach
- Encourager
- Communicator
- A good role model
- Helper
- Mentor
- Tutor



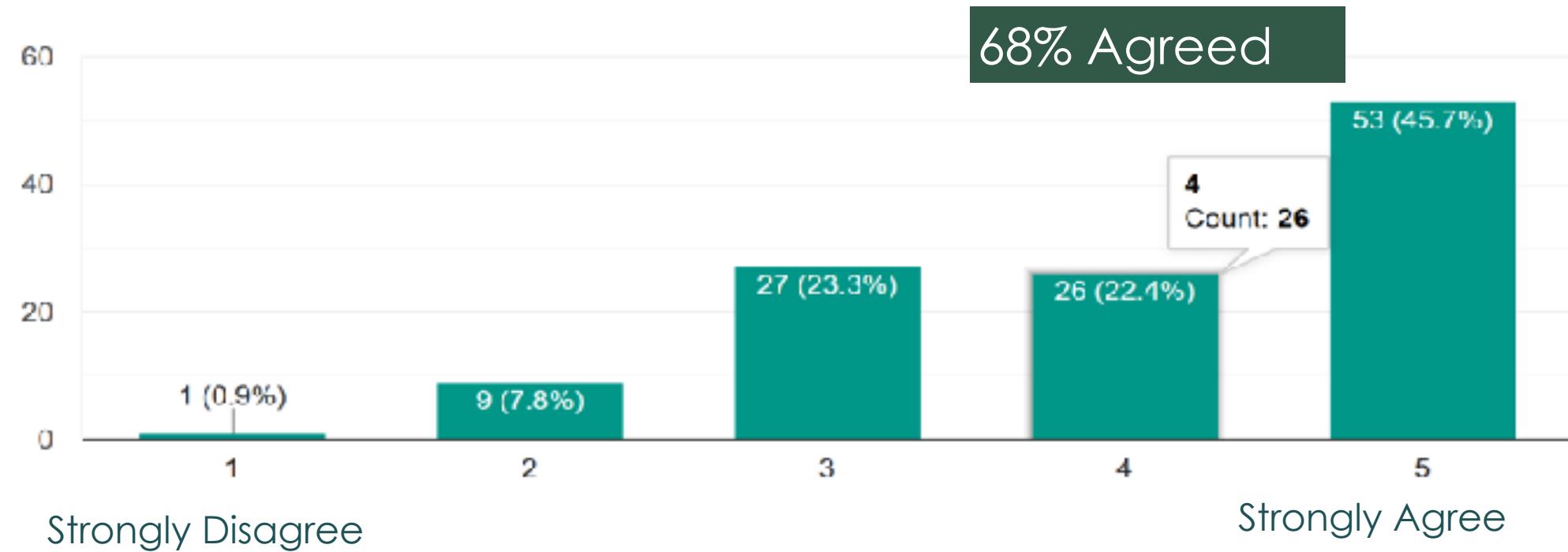
PLTL Student Survey Data

23

PLTL workshop helped me to learn math better



116 responses



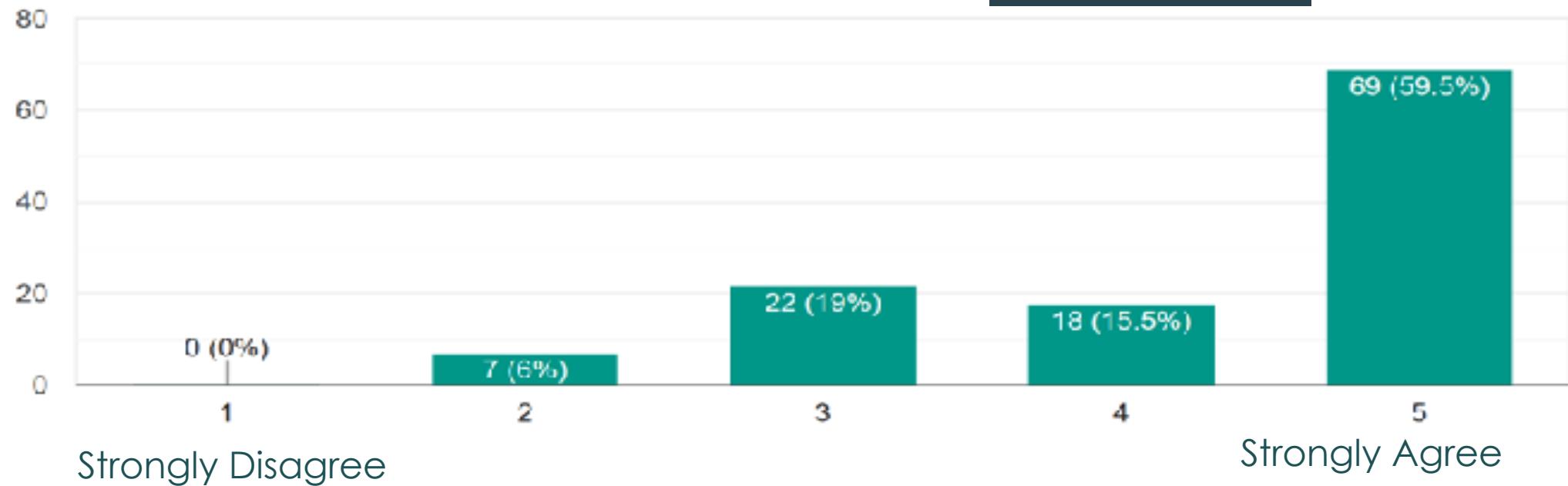
PLTL Student Survey Data

24

I like my PLTL leader in my College Algebra class

116 responses

75% Agreed



Preliminary Results

Evidence based learning helped most of students

Some students do not have much opinions about the new approach of learning

Evidence-based learning helped me to like math more because ...

11 responses

I be coolng

I have to actually do the work and think through the problem.

I learn better

I seen it written out

I Can See What's Going On

It tells you where the answers come from

N/a

Nothing

I understand better

Yes

i don't know

Preliminary Results

Students liked

- hands-on learning
- Utilizing iPads
- PowerPoint lessons
- Co-Req College Algebra lab for one-on-one time

Describe how specific course components helped improve your learning in math.

12 responses

The PowerPoints for each lesson.

The power point actually shows you how to do the problem

I'm not sure , everything is helpful

Because my educator doesn't move onto another lesson unless we all understand

The ipad

N/A

I learn something everyday

The access to the PowerPoints

The technology helps you go back to previous lessons or PowerPoints quickly

the factoring and combining like terms has improved my learning

Helped by being one on one

Not sure

Preliminary Results

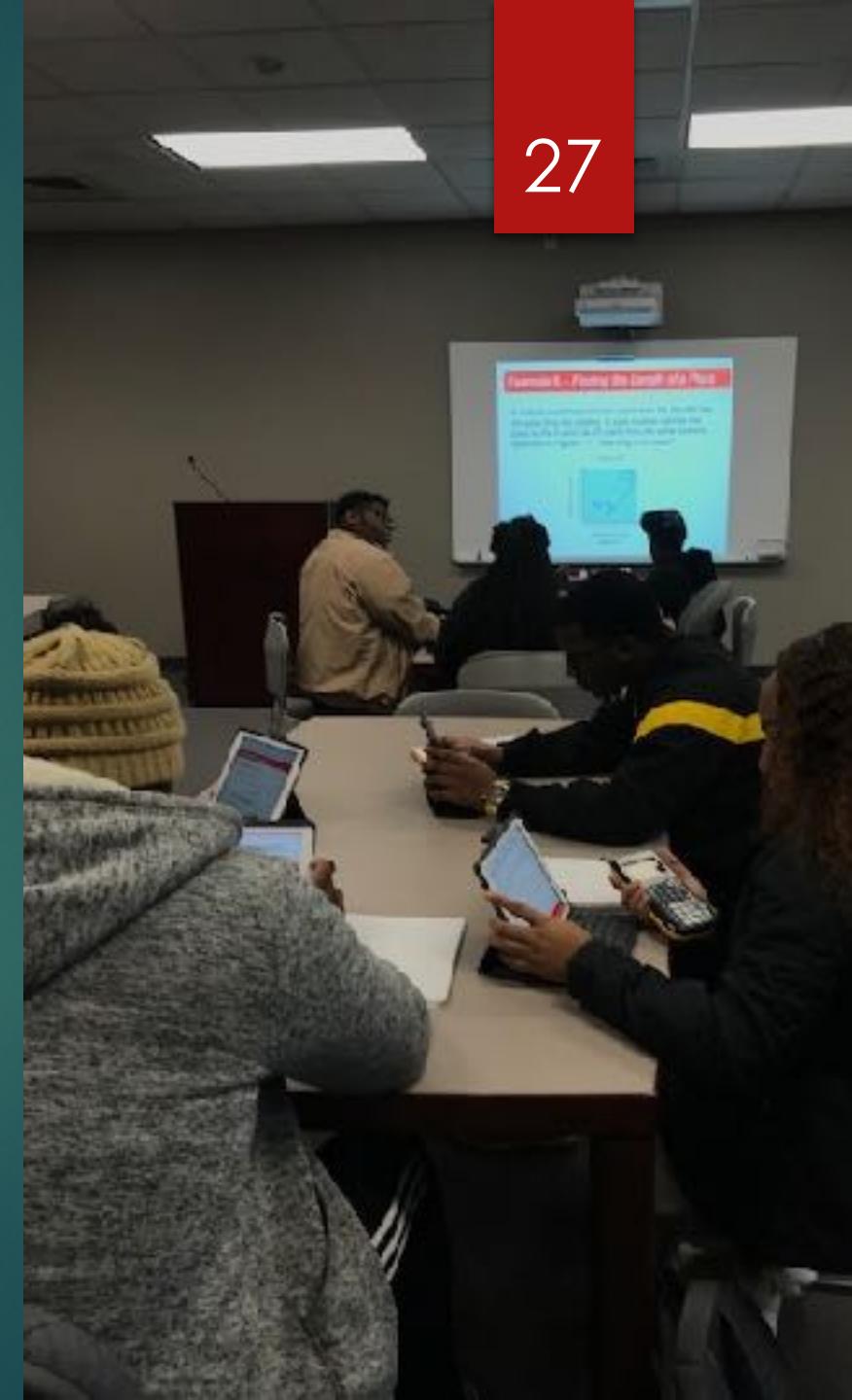
Web-based learning (WebAssign) shows a great promise if students have an access code (← UAPB plans to purchase a code as a built-in lab fee so every students will have an access code).

JuliaBox is still going through a learning curve since it is a very new approach of learning. However, STEM majors welcome this new coding approach and try to enhance computer programming skill

iPad has been utilizing positively among students with WebAssign work and JuliaBox computer coding

PLTL has been very successful. Students have been receiving extra help they need.

Piloting faculty have been active and applying evidence-based instructions.



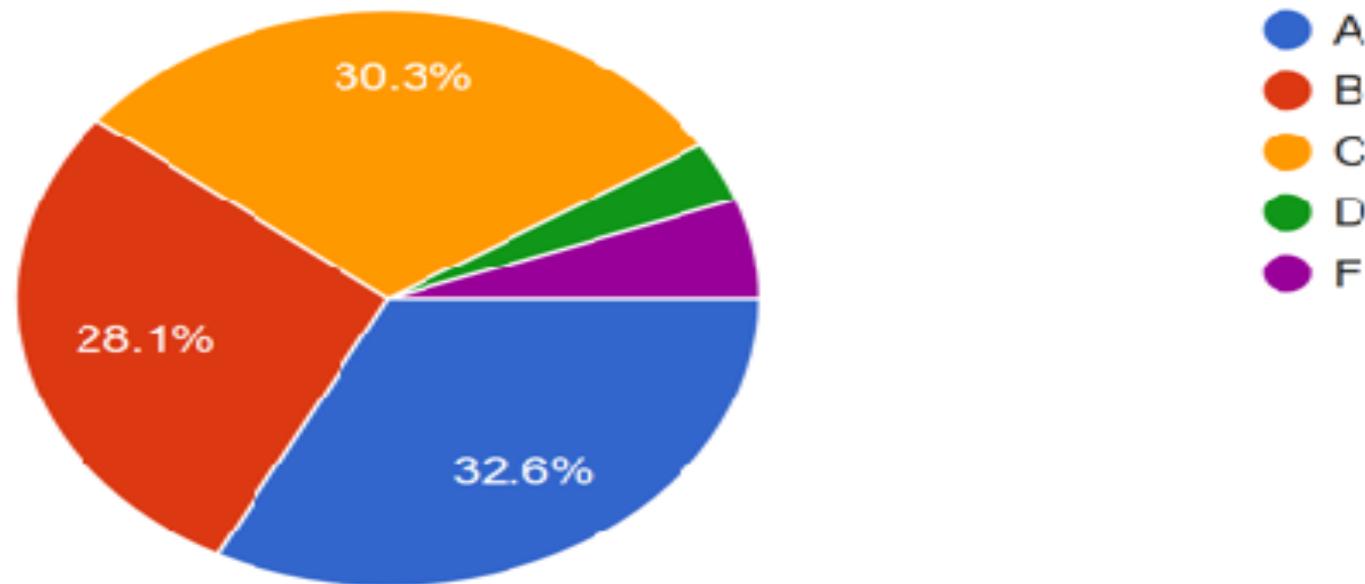
Students Current Grades

28

My current grade is

89 responses

91% passing rate



Future Research

- Collect data by STEM and non-STEM majors regarding Julia coding
- Use more Julia coding in class and lab
- Pilot Co-Req College Algebra class with 25+ students in class (currently, we have 7 students)
- Train more PLTL leaders and utilize seasoned PLTL leaders to mentor new PLTL leaders
- Provide more in-house Julia coding faculty-development workshop
- Apply evidence-based learning to different math classes such as Pre-Calculus, Calculus I and Calculus II

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Any Questions?

Thank You!