Piloting Next Generation Learning Strategies To Increase Inclusive Excellence and Persistence In Math And Science

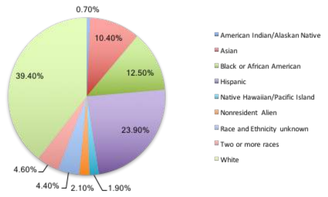
Huda A. Makhluf

National University, 11255 North Torrey Pines Road, La Jolla, California 92037-1011

INTRODUCTION

"For we know that the nation that out-educates us today will out-compete us tomorrow."

Based on a recent survey by the National Assessment of Educational Progress, minority students have a performance gap in math and sciences as early as elementary school, with more students struggling to complete a high school degree and enroll in college as they progress. Additionally, a growing body of evidence indicates that these students are even less likely to major in STEM fields. According to the US Department of Education, only 35.1% of students who enrolled in STEM fields graduated with a STEM degree. Our nation's demographics are changing, California's in particular. We are becoming more and more a diverse nation and a diverse state. Given the academic achievement lag in minority, low-income and first-generation students, a true crisis may be developing. With a vision to close this gap, tremendous effort is required to shepherd these students from the start line to the finish line. Given NU's large presence in CA, we see this as a call and an opportunity to positively impact people's lives, improving the communities we live in, the economy, and our nation's global competitiveness at large.



Goal 1: Pilot and adopt personalized and adaptive learning technologies

Launch an experiment using adaptive learning platforms to increase math and science literacy (Key partners: Faculty in the Dept. of M&S, Student Services, CIL and IR)

Goal 2: Research experiences for undergraduates site program

Engage students in research early in college

(Key partners: NU Director for Outreach-Corporate Partnerships and Community Colleges)

Goal 3: Inspire and support K-12 math and science teachers

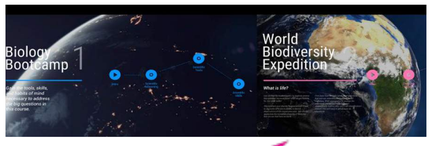
(Key partners: Reuben H. Fleet Science Center, BIOCOM, and the Sanford College of Education at NU)

METHODS

We designed an experimental group and a control group to monitor and track the learning success of all students. Assessments of the pilots included the following measurements:

1) The impact on student learning,
2) Student perceptions of science, pre/post CURE surveys,
3) Persistence data and student pass rates.

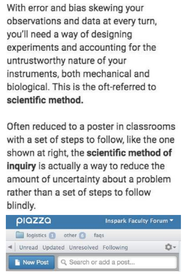
Biology in the 21st century requires that undergraduates learn how to integrate concepts across levels of organization and complexity and to synthesize and analyze information that connects conceptual domains.



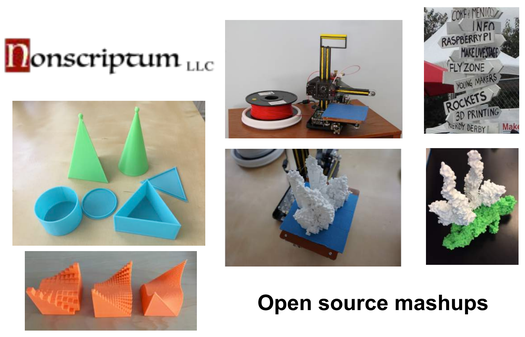
Experimental Design

With error and bias skewing your observations and data at every turn, you'll need a way of designing experiments and accounting for the untrustworthy nature of your instruments, both mechanical and biological. This is the oft-referred to **scientific method.**

Often reduced to a poster in classrooms with a set of steps to follow, like the one shown at right, the **scientific method of inquiry** is actually a way to reduce the amount of uncertainty about a problem rather than a set of steps to follow blindly.



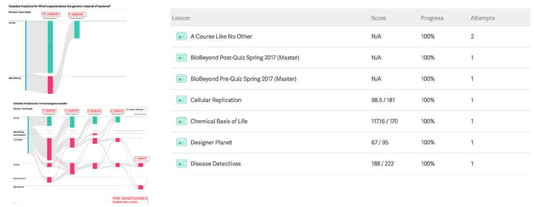
We offered three 3D Printing Workshops for K-12 STEM Teachers in LA and SD



Open source mashups

RESULTS

Biobeyond demands rigor and has been perceived as hard and difficult by our students (productive struggle). It presents them with game-like challenges, interactive exercises, and simulations and requires them to think critically and engage "earnestly" with the material.



Grades by gender by treatment indicated that female students showed grade improvements in Biobeyond. A mean grade increase from 2.77 to 3.07 was observed

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Student age:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  15.00   26.00   31.00   32.75   37.75   56.00

Gender:
Gender BAU Treatment
     F  35        33
     M  39        35
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Grades by Gender by Treatment:
Gender Student.Research.Condition  mean grade (0-4)
     F                Treatment         3.068750
     M                Treatment         3.060000
     F                      BAU         2.779412
     M                      BAU         3.218421
```

Grades by age quartile by treatment indicated that students who were 26 years and younger benefited the most form this innovative platform. The mean grade increase for this group jumped from 2.83 to 3.57. This finding was not surprising given tech savviness in this age group as well as digital expectations.

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Grades by Age Quartile by Treatment:
Ages Student.Research.Condition  mean grade (0-4)
> 38                Treatment         3.256250
31-38               Treatment         2.964706
26-31               Treatment         2.235714
< 26                Treatment         3.575000
> 38                      BAU         3.428571
31-38                     BAU         2.990476
26-31                     BAU         2.900000
< 26                      BAU         2.831579
```

Institution	Estimated impact on grade	p-value	Median hours by student	# lessons assigned	# lessons completed by student (median)	% lessons completed by student (median)
ASU	+ 0.42	< .001	44	54	45	83%
Miami Dade College	+ 0.46	< .05	16	16–48	14	55%
Mohave Community College	+ 0.26	< .05	23	36–47	25	56%
National University	+ 0.22	n.s.	31	35–39	31	85%

DISCUSSION and CONCLUSION

Personalized and adaptive learning strategies and technologies can increase student motivations and learner engagement.

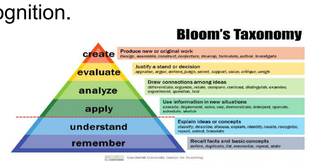
We have identified the following powerful practices and takeaway messages:

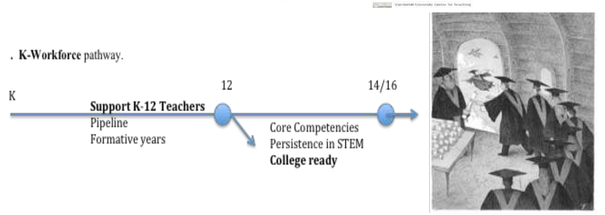
- Students own their learning, study at their own pace
- Students chart their success and are engaged
- Students embrace difficult tasks as an opportunity for deeper learning rather than an obstacle!
- Students experience great learning opportunities with formative and summative assessments
- Faculty and students feel empowered by tracking and monitoring their progress in real time through powerful analytics,
- The impact on student success is high and represents a forward thinking view on ROI.
- 3 D Printing: *"You had quality professionals that knew the background in the field of study and were able to support the material they presented."*

FUTURE DIRECTIONS

1. Make the majority of courses active and adaptive in order to educate every student in a unique way, and teach him/her effective "habits of the mind".
2. Implement teaching as research in every course.
3. Promote student metacognition.

Promoting **Metacognition**
Intellectual skills
Broad and integrative knowledge
Specialized Knowledge
Applied learning





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Department of Mathematics and Natural Sciences, National University,
11255 North Torrey Pines Road, La Jolla, CA 92037
www.nu.edu • 858-642-8488