Engineering Math Development at CBU Utilizing the WSU Model

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Chair of ME

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Overall Context for this work is somewhat unique

- CBU is a Private University (5400+ students in Riverside California – 32% minority, semester based) Over 6000 for this fall (2x the start).
- College of Engineering Started in 2006 (first classes Fall 2007)
  - 5 Degrees offered: CE, CM, ECE, ME and Engineering (pre law, pre med, bioengineering, business and global applications) Adding CHE next year.
  - Incoming class size (55, 67, 81, 111, 130?(est)) Total over 280 total last fall. Over 330 anticipated this fall.
    - 35% ethnic minority,
    - 20% female
    - 22% international
    - 30+% of incoming students involved in athletics
  - Cohorts of students on presidential scholarship from Rwanda (11/12, 16/19, 14/16, 7/2)
  - Full time Faculty (1,2,5,8,13,18,?) Currently 2 of 18 faculty are women
  - One year retention 82% (2nd highest school at the university),

Our NSF team has diverse and complimentary backgrounds

- Dr. Elizabeth Morris – PhD Mathematics Education (School of Education) – mentored Dr. Jung for EGR “100”
- Dr. Xuping Xu -Masters in Applied Math and PhD in EE from Notre Dame (School of Engineering) (taught 2 sections of EGR “101” including follow on to EGR “100”.
- Dr. Anthony Donaldson – PhD in EE, innovative curriculum work at TTU, SPU and CBU (School of Engineering)… intuitive lab for calculus.
- *Dr. Helen Jung* – PhD in CE, involved in K-12 outreach (*new faculty* (taught EGR “100” and developed new labs.
- *Dr. Ziliang Zhou* – PhD in ME, MBA, *(taught multiple sections* of EGR “101”.
- *Dr. Rod Foist – PhD in CpE, new faculty, taught EGR 101 in fall and spring, teaching labs only next year…. FPGA expert, will introduce them in the lab for the course.*
- Dr. Alex Chediak – PhD Material science Cal Berkeley – responsible for teaching and implementing a new inquiry based physics curriculum for our engineering program (joint appointment SOE and College of NMS)

Outstanding undergraduate curriculum is a focus and thus a fit for this model

- One of four articulated areas of focus for the school's activities
- One of ten distinctives desired for our programs
- Faithfulness in using vocational gifts for service is seen as a primary way we worship God and thus curriculum development is seen as directly tied to our school of engineering mission statement and its guiding verse ("For we are Christ's workmanship created in Christ Jesus for good works that God prepared in advance for us to do."Ephesians 2:10)

Course structure was changed to fully implement Wright State model

- 2007-2008 – algebra, precal or calculus entry points (WSU 100 1.0 introduced in fall, WSU 101 1.0 introduced for first two groups in spring 2008.)
- 2008-2009 – WSU 100 2.0 (labs added), WSU 101 2.0, Math anxiety assessment begun for 100.
- 2009-2010 – WSU 100 3.0 (EGR faculty and vertical integration "VI") WSU 101 3.0 (required course, VI and customized text started) Assessment using WSU questions was conducted.
- 2010-2011 – WSU 100 & 101 4.0 (Recitation sections and new labs-closing feedback loop. Adding additional VI feedback from Mathematics dept.), Optional labs for those placing out of Calc I and II. Math anxiety assessment for 101 started.
- 2011-2012 – WSU 100 and 101 continued to be refined and assessed.

NSF WSU curriculum implementation

Example: BS Electrical and Computer Engineering
We also have BS CE, ME and general Engineering degrees

	Fall			Spring			Summer	
	Course #	CR	Description					
Year 1								
	EGR 182	4	Engineering Math II	MAT 245	4	Calc I		
	EGR 101	3	Engineering from a Ch	EGR 102	4	Intro to Engineering Design		
	EGR 121	3	Problem Solving and F	PHY 201	4	Mechanics/Waves		
	ENG 113	3	Composition I	EGR 122	3	Visualization Languages I		
	EGR 103	1	Engineering Service I	EGR 192	1	Freshman Seminar		
	GST 100	1	Focus					
		15			16			
Alternative	EGR 181	4	Intro to Egr Math I	EGR 182	4		MAT 245	Calc I
Year 2								
	PHY 203	4	E/M Optics	EGR 202	0	Worldview Reflection		
	EGR 231	4	Circuit Theory I	EGR 232	4	Circuit Theory II +Design		
	MAT 255	4	Calculus II	EGR 234	4	Digital Logic Design		
	ENG 123	3	Composition II		4	Science Elective*		
		3	GE#3		3	Upper Division Math**		
				EGR 221	3	Data Structures		
		18			18			

* BIO 146 or 153 or CHE 115
** preferred MAT 403, 413

Note: EGR 181 is similar to WSU 100 but with a lab. EGR 182 is Wright State's 101
3 hours lecture, 1.5 hours lab 15 weeks.

Vertical and horizontal integration “VI and HI” has been implemented

- New labs developed for ‘100’ and ‘101’, were used in 2011 and 2012 more planned for this summer (details to follow at end).
- Input from Physics (mechanics), circuits, statics, strength of materials and additionally Calculus I (taken after 101). Papers at FIE and ASEE on this.
- Next fall 2 lab sections of 100 and 6 lab sections of 101 will all be taught by engineering faculty with integrated (VI and HI)labs. (Expecting 120 students in 100 and 101)

Results from assessment are encouraging!

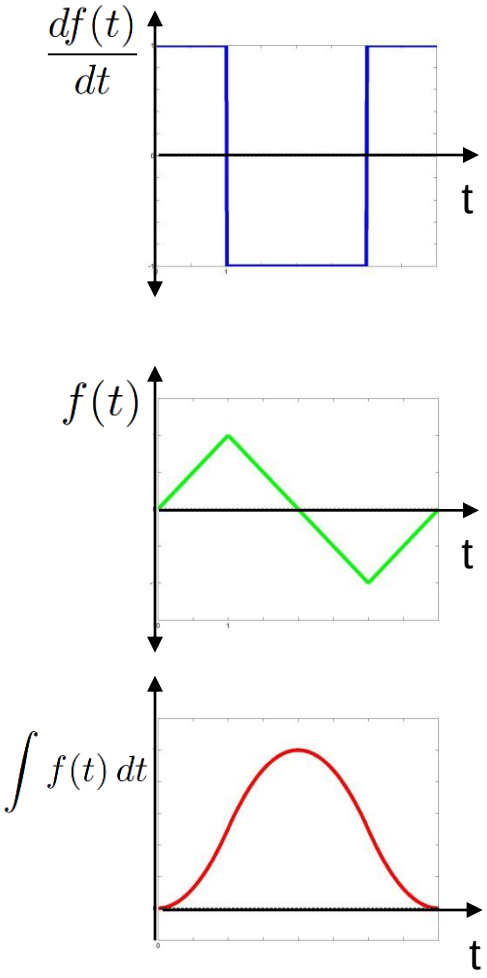
- 65% of ‘at risk’ students entering 100 in Fall of 2011 still in program after 1 year (WSU (MPL3) went from 26 to 48 %),
- Student perception of benefit was highest for courses where we have begun to vertically integrate.
- Overall student perception of benefit was good but needs improvement. (see details on next slides)

Changes coming for next year!

- Additional innovative labs.
- A lab notebook , with Matlab included.
- Will start using the WSU textbook.
- Exploring discussions with institutions abroad.
- Looking for next grant opportunities (with partners!)

Calculus Made Fun With EE Hardware

or, "Intuitive Integrals & Derivatives"



Math Operation, $\int$

8th-grade language

"smoother"

Engineering language

"Low-pass filter"

Math Operation, $\frac{d}{dt}$

8th-grade language

"rougher"

Engineering language

"High-pass filter"

Applications: Audio and video signal processing!! – Cool stuff!!!

New “WSU EGR 101” Lab

(Analog & Digital Implementations of Calculus)

Math Operations

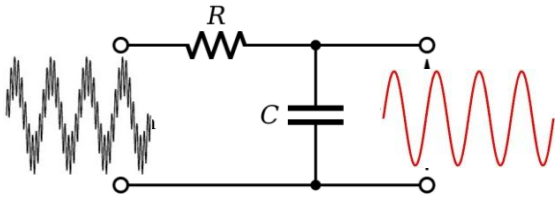
“Signal” Operations

Analog

Digital

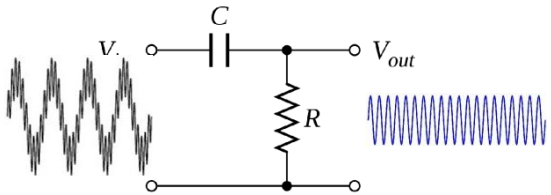
$\int$

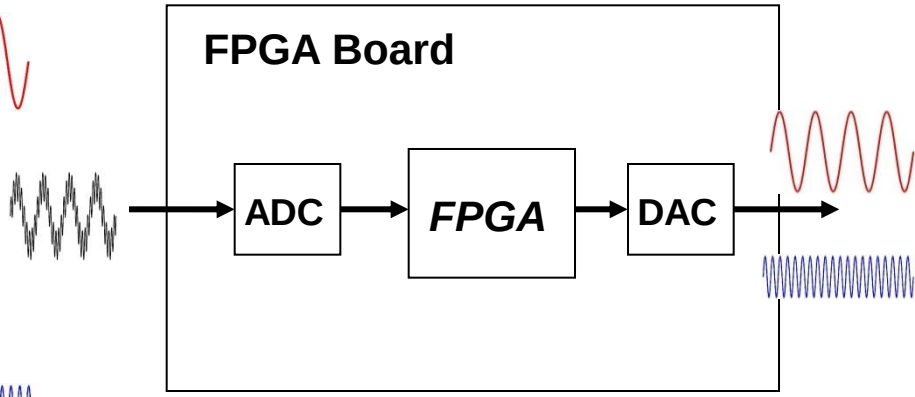
Low-pass Filter



$\frac{d}{dt}$

High-pass Filter





(Low-pass & High-pass Filters)

FPGA = Field Programmable Gate Array

ADC = Analog-to-Digital Converter

DAC = Digital-to-Analog Converter

WSU Model based Publication

Paper published at FIE 2011

total	grade		algebra	trig	vector analysis	complex analysis	derivative	integral
70.1%	C-	student 6	60%	46%	80%	90%	21%	19%
79.3%	C+	student 13	65%	55%	75%	100%	100%	25%
76.8%	C+	student 20	72%	40%	66%	89%	67%	35%
72.9%	C	student 22	60%	50%	88%	90%	63%	43%
75.8%	C	student 27	53%	67%	80%	88%	71%	82%
71.8%	C-	student 29	78%	35%	90%	95%	21%	52%
79.1%	C+	student 30	70%	62%	84%	88%	21%	45%
		average	84%	72%	91%	92%	74%	62%

WSU Model based Publication

grade	algebra	trig	vector analysis	complex analysis	derivative	integral
C	63%	58%	100%	70%	25%	38%
A-	89%	88%	88%	70%	95%	80%
B	61%	85%	91%	80%	100%	50%
A	94%	92%	84%	90%	100%	100%
A-	72%	92%	85%	90%	75%	63%
B+	84%	90%	66%	90%	95%	63%
A	89%	92%	100%	90%	100%	100%
B	75%	67%	63%	60%	100%	63%
A	86%	79%	78%	80%	75%	80%
B-	73%	85%	72%	90%	95%	30%
B	69%	79%	100%	70%	75%	63%
A	91%	88%	66%	90%	100%	68%
A-	88%	96%	88%	80%	25%	95%
B+	91%	65%	72%	60%	75%	80%
A	100%	100%	84%	80%	15%	80%
B-	70%	94%	59%	70%	95%	63%
A-	89%	96%	88%	90%	100%	63%
A-	95%	73%	94%	50%	95%	68%
B	94%	77%	50%	70%	100%	50%
A-	81%	96%	72%	90%	100%	63%
A	78%	92%	72%	90%	100%	100%
A	97%	92%	100%	90%	90%	80%
B+	52%	96%	94%	80%	100%	25%
average	82%	86%	81%	79%	84%	68%

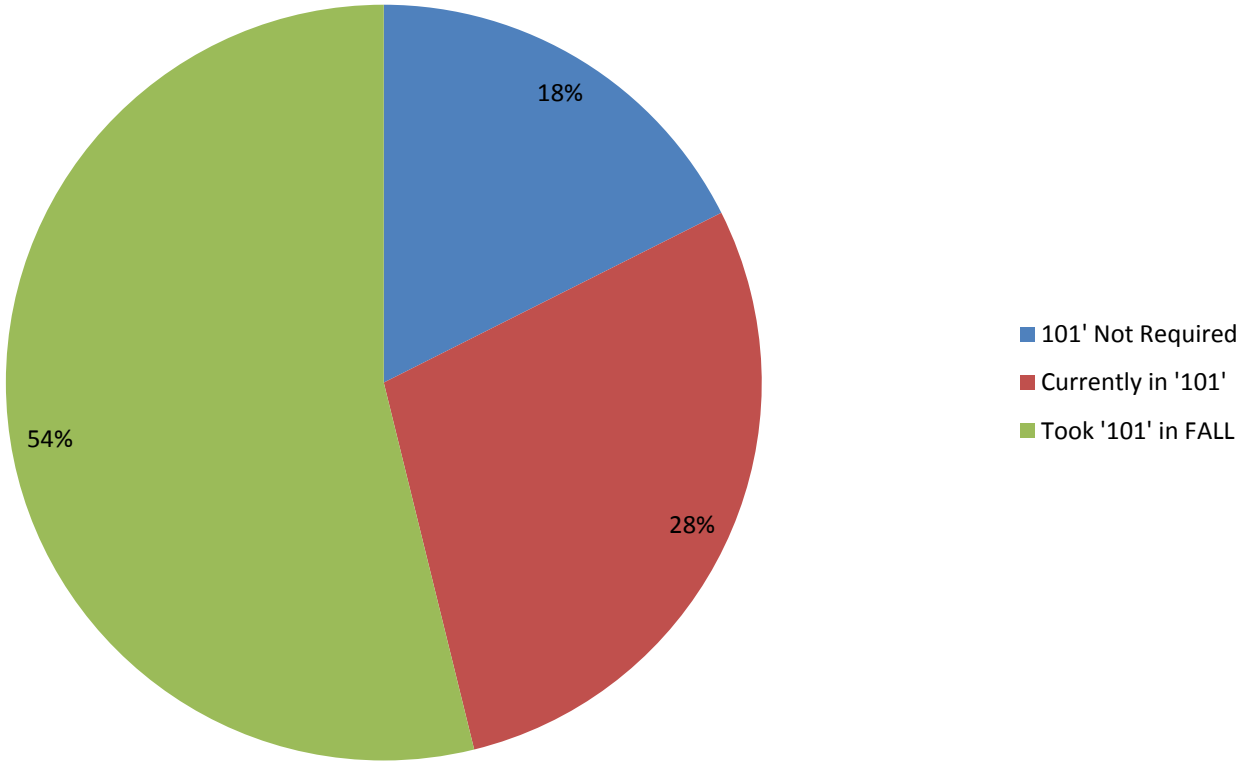
Improved results on class average

FIE 2012 paper accepted, under final revision

Special Thanks

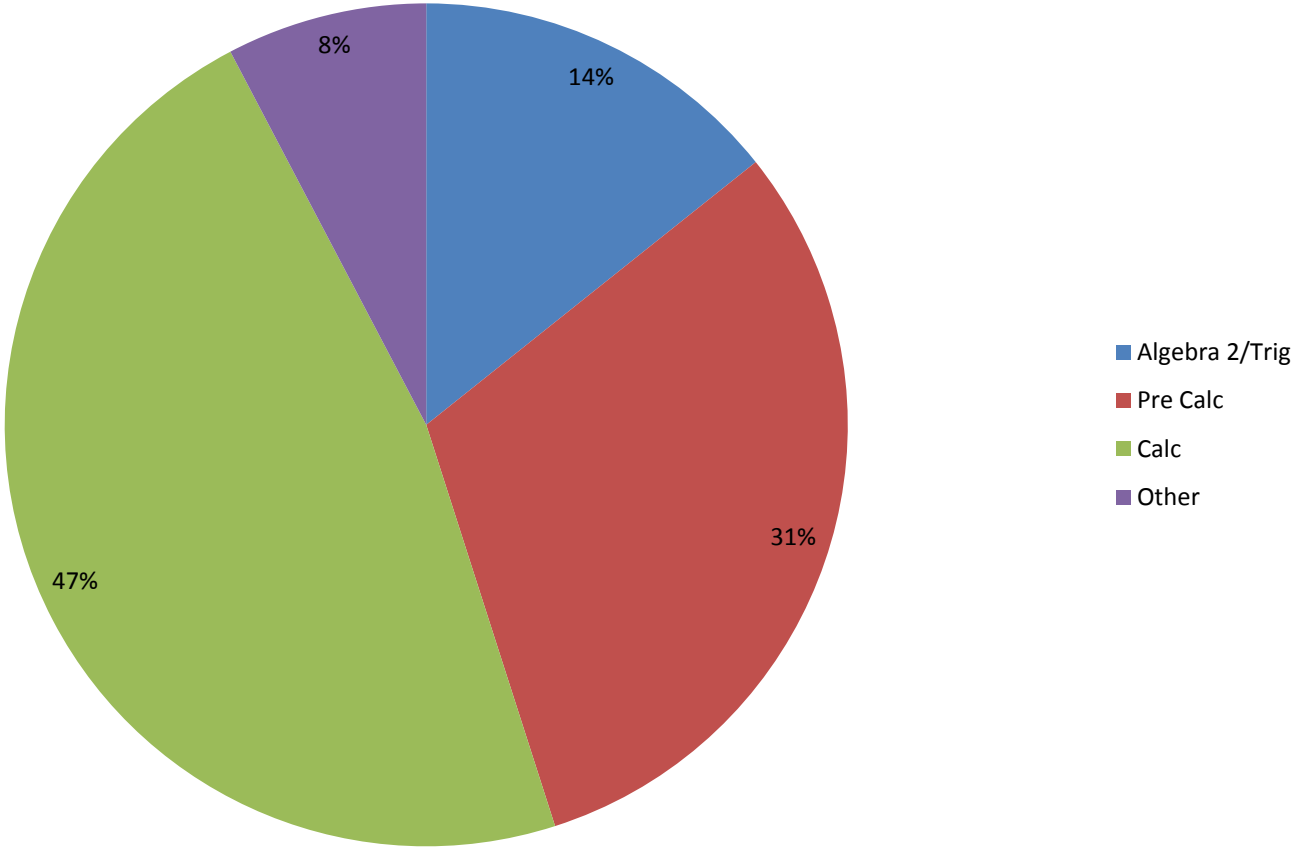
- Jeff Froyd (Head of Faculty development at Texas A&M)
- Nate Klingbeil at Wright State University
- The National Science Foundation

Spring 2012 Engineering Survey Demographics



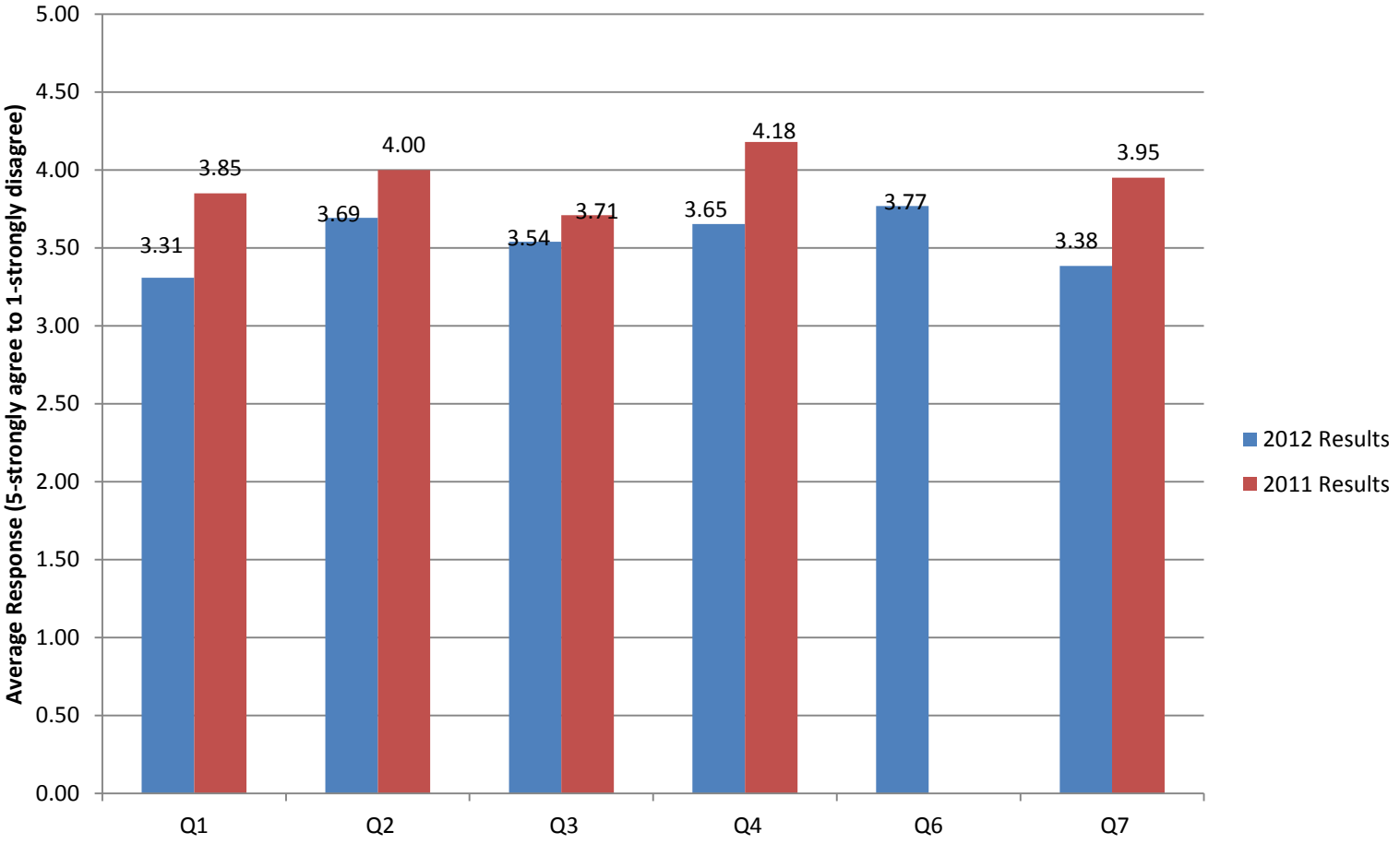
Highest High School Math

(all 1st year EGR students for 2011-2012)

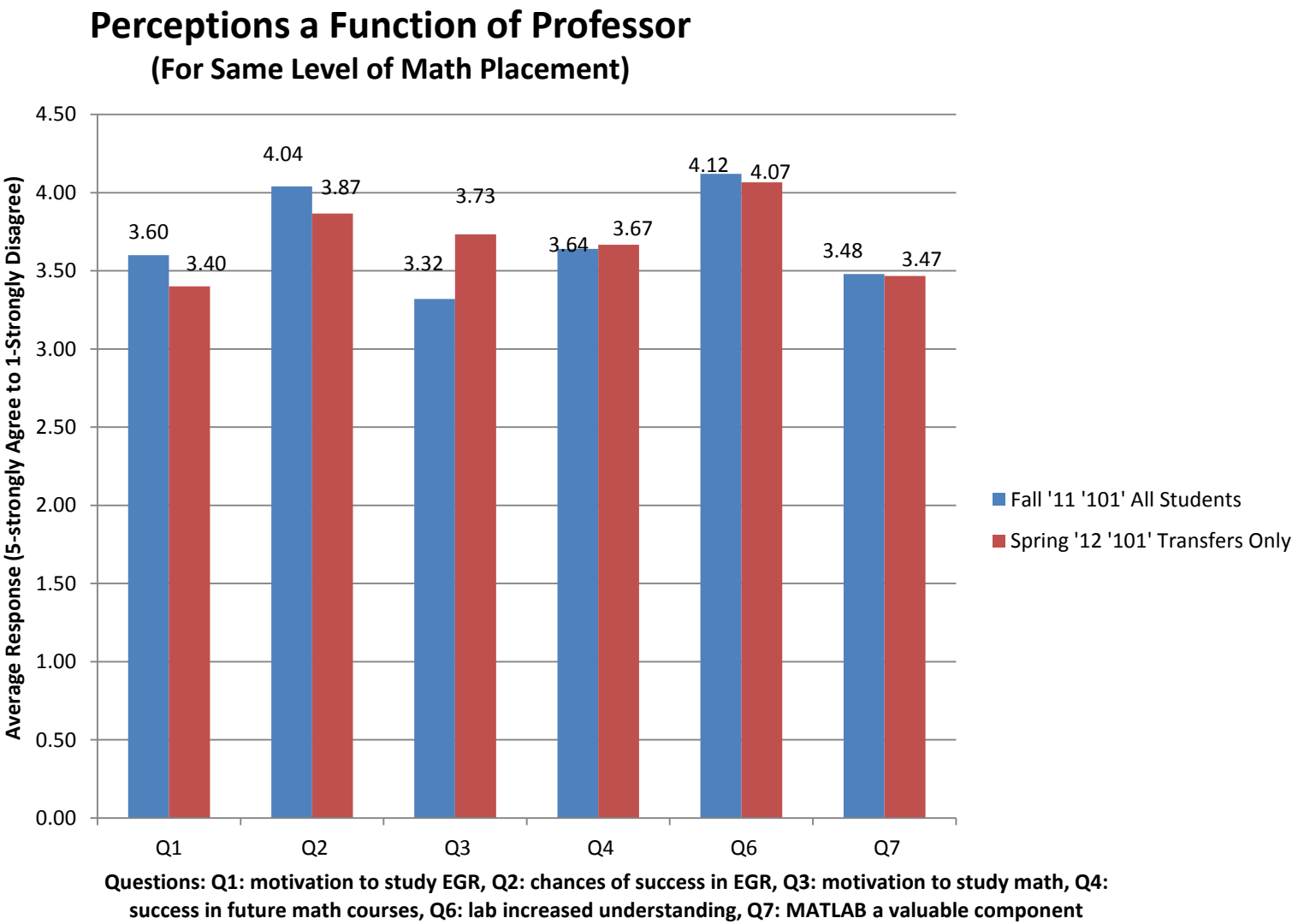


CBU '101' Had a Positive Impact

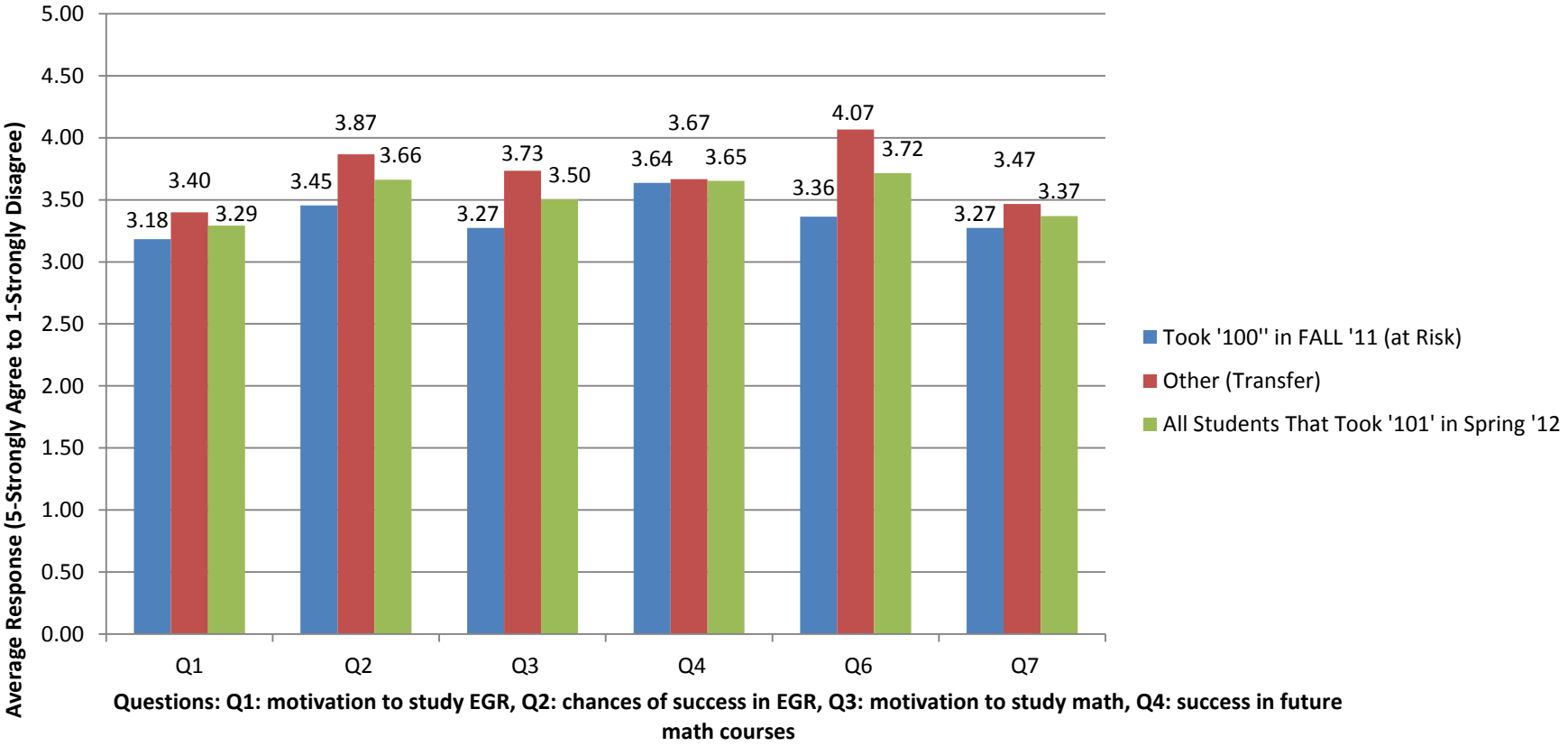
(But not as high as previous years-why?!)



Questions: Q1: motivation to study EGR, Q2: chances of success in EGR, Q3: motivation to study math, Q4: success in future math course, Q6: lab increased understanding, Q7: MATLAB a valuable component


Perceptions a Function of Professor
(For Same Level of Math Placement)
Average Response (5-strongly Agree to 1-Strongly Disagree)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
3.60
3.40
4.04
3.87
3.32
3.73
3.64
3.67
4.12
4.07
3.48
3.47
Q1
Q2
Q3
Q4
Q6
Q7
Fall '11 '101' All Students
Spring '12 '101' Transfers Only
Questions: Q1: motivation to study EGR, Q2: chances of success in EGR, Q3: motivation to study math, Q4: success in future math courses, Q6: lab increased understanding, Q7: MATLAB a valuable component

Transfer Students More Positive Than At Risk Students



Additional assessment is being implemented

- Math anxiety (pre and post for 101 as well)
- Correlation for student performance in Calculus (w and w/o 101) is planned
- Correlation for student performance on National FCI for Physics is planned
- Specific new lab modules for intuitive learning of calculus.