University of San Diego
Rick Olson & Susan Lord



University of San Diego
ENGINEERING PROGRAMS

Who Are We?

USD

- Private, Independent, Catholic, Liberal Arts University
- ~ 5000 Undergraduate Students
- Small Classes
- Ethical Conduct & Compassionate Service are Core Values

Engineering at USD

- Undergraduate Programs in EE, ISyE, and ME
- ~147 Semester Units with 40+ Units of Liberal Arts Classes
- Dual BS/BA degree
- Common First Two Years
- ~240 students, 15 faculty
- Ranked 21st by US News and World Report
- You don't declare majors when entering USD

First Year Sequence

Engineering 101 – Introduction to Engineering

- 110 Students in Fall 2010 (~ 70% Incoming Freshmen)
- Lecture/Lab
- Survey of Engineering and Disciplines
- Problem Solving w/Excel
- Introductory Graphics
- Weekly LEGO NXT-based Design Lab

Engineering 102 – Introduction to Design and Practice

- Biweekly 2 hour labs
- Topics in EE, ISyE, ME
- Semester-long NXT Design Project w/Documentation

Our Variation of Engr. Math

- Supplemental math refresher
- One hour/week
- Very hands-on
- "Weekly" HW and Quizzes

- Students thought the class helped their E-math abilities.
- HW was harder than they were prepared for.

	Cohort 1 Fall 2009	Cohort 2 Spring 2010	Cohort 3 Fall 2010	Cohort 4 Spring 2011	Cohort 5 Fall 2011
Linear & Quadratic Equations	X				
One Link Robot	X		X	X	X
Two Link Robot	X		X	X	X
Laws of Sines and Cosines	X		X	X	X
Vectors	X		X	X	X
Complex Numbers	X		X	X	X
Simultaneous Equations	X		X	X	X
Sinusoids	X		X	X	X
Derivatives		X	X	X	X
Integration		X			
Differential Equations		X			

Summary of Engr 294 Offerings

	# Students	Avg SAT-M	How Identified
FA09 Freshmen			
Fall Cohort	9	642	Self-Selection
Spring Cohort	3	647	Self-Selection
No Engr Math	64	673	
FA10 Freshmen			
Fall Cohort	10	604	SAT Scores
Spring Cohort	5	666	Self-Selection
No Engr Math	61	649	
FA11 Freshmen			
Fall Cohort	9	616	SAT Scores
No Engr Math	70	655	

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Math Background

	SAT-M					
	<=550	560-600	610-650	660-700	>700	
ENGR Math	3	5	17	7	3	35
No ENGR Math	15	17	58	61	44	195
	18	22	75	68	47	

	First Math				
	Coll. Alg.	Calc I	Calc 2	Calc 3	
ENGR Math	1	24	8	3	36
No ENGR Math	11	81	71	36	199
	12	105	79	39	

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How you think this class helped your ability to solve problems related to each course topic on...

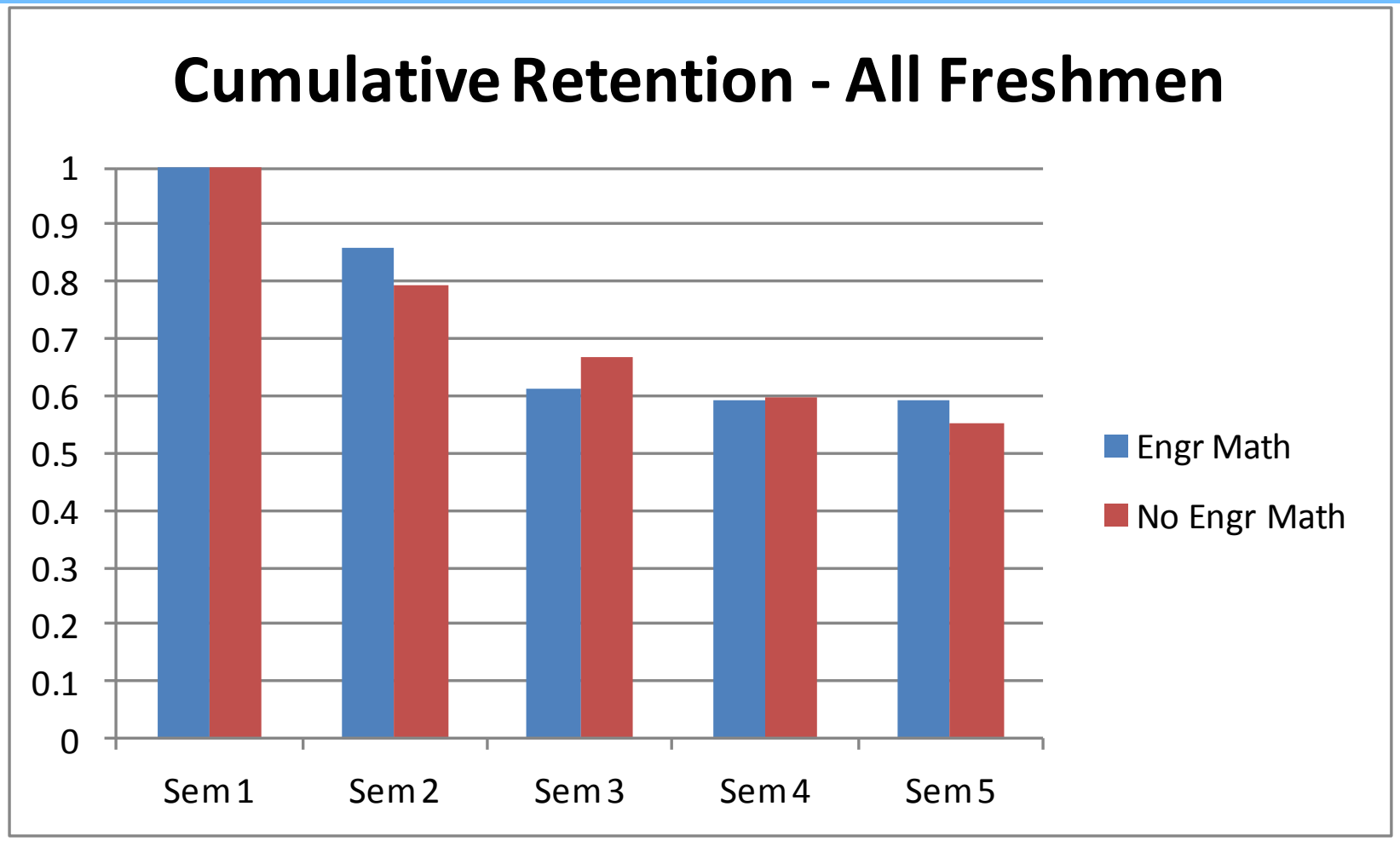
Statistic	One Link Robot	Two Link Robot	Laws of Sines and Cosines	Vectors	Complex Numbers	Sim. Equations	Sinusoids	Derivs
Min Value	1	1	1	1	1	2	2	1
Max Value	5	5	5	5	5	5	5	5
Mean	3.00	3.09	3.36	3.36	3.55	3.82	3.91	3.55
Variance	2.40	1.69	2.25	1.85	1.47	0.96	0.89	1.67
Standard Deviation	1.55	1.30	1.50	1.36	1.21	0.98	0.94	1.29

1 - Class had little impact
5 - I am now much more proficient

Data through SP 2011

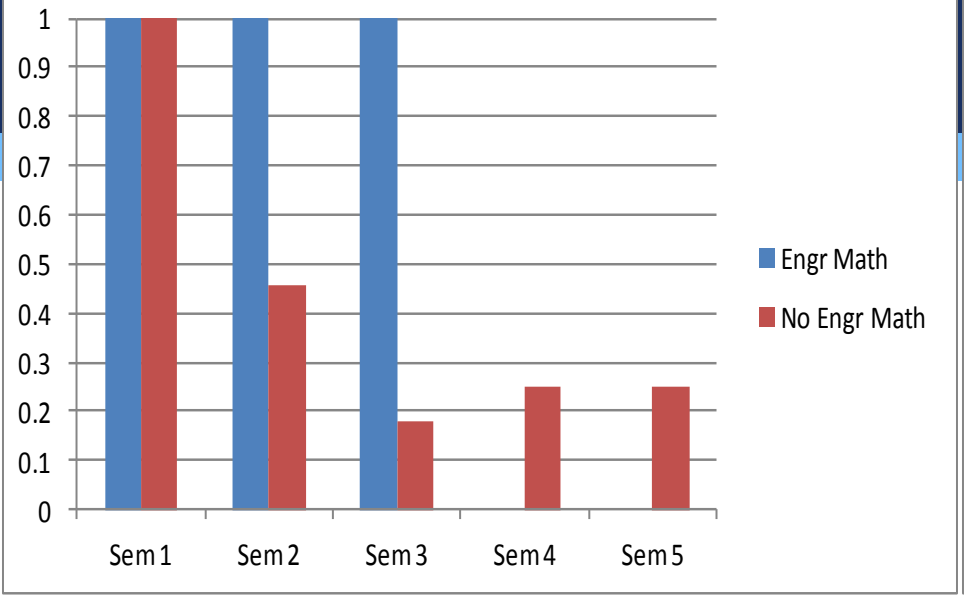
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Retention Summary

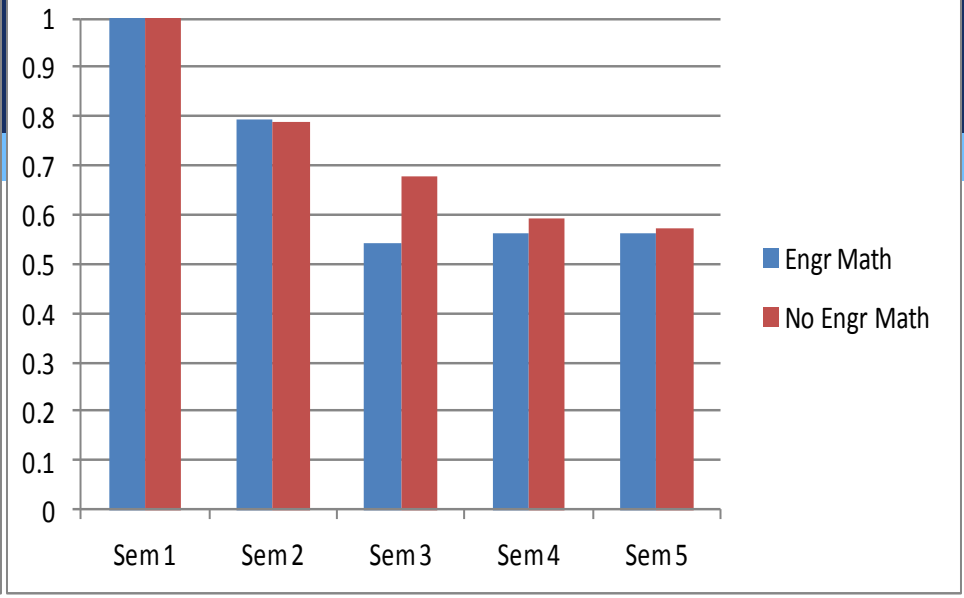


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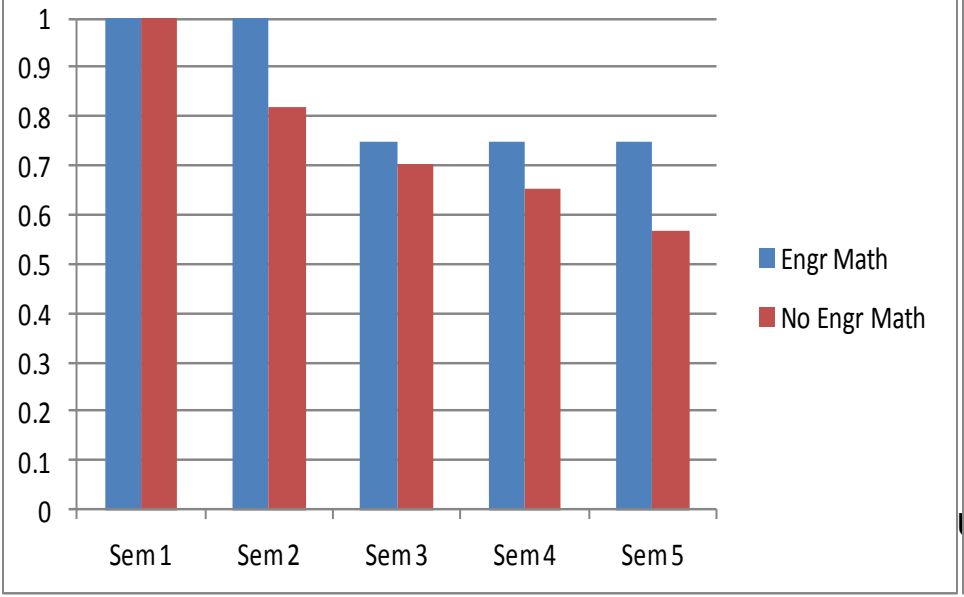
Cumulative Retention - Coll. Alg.



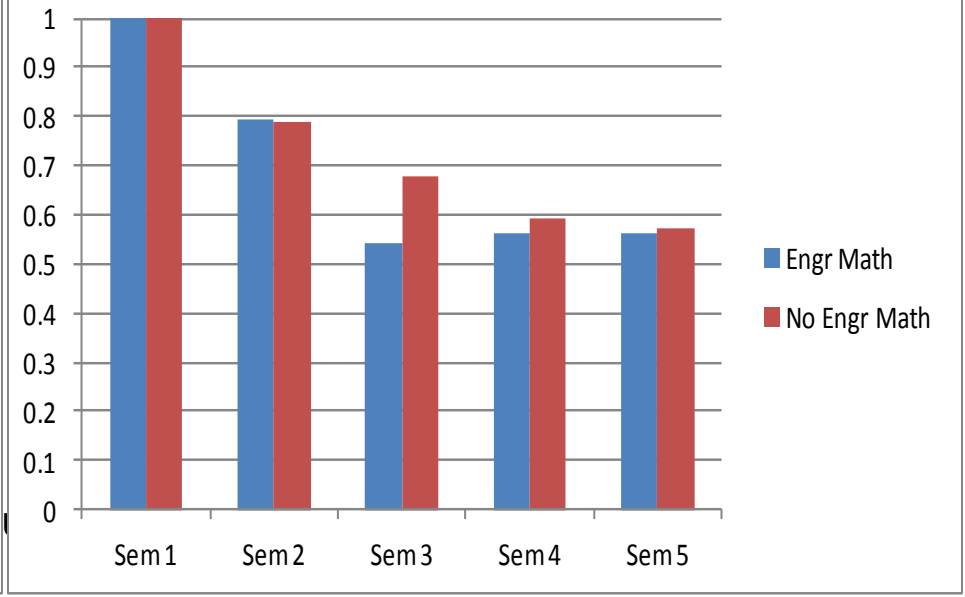
Cumulative Retention - Calc 1



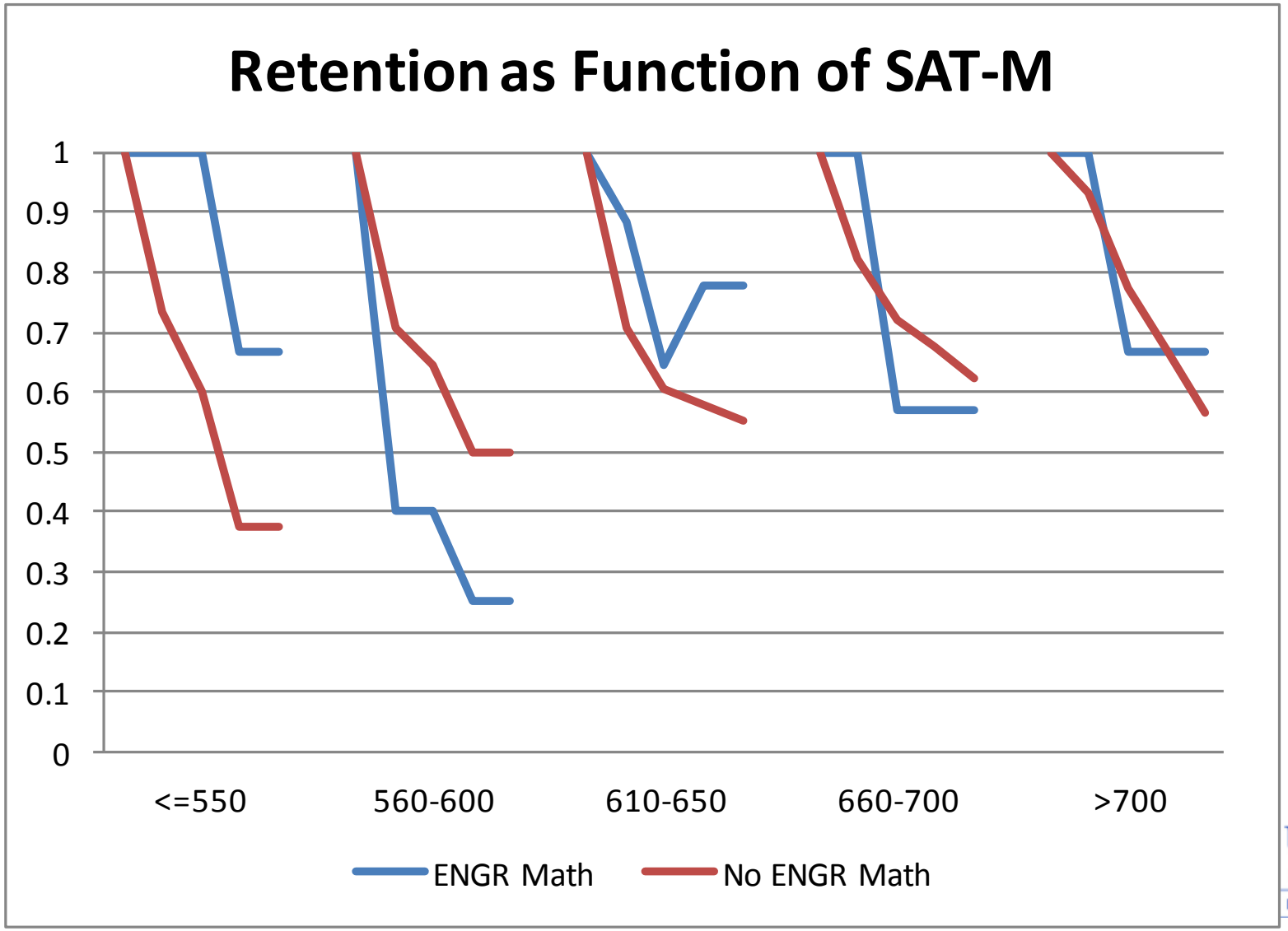
Cumulative Retention - Calc 2



Cumulative Retention - Calc 3



No Clear Interaction of SAT-M and E-Math



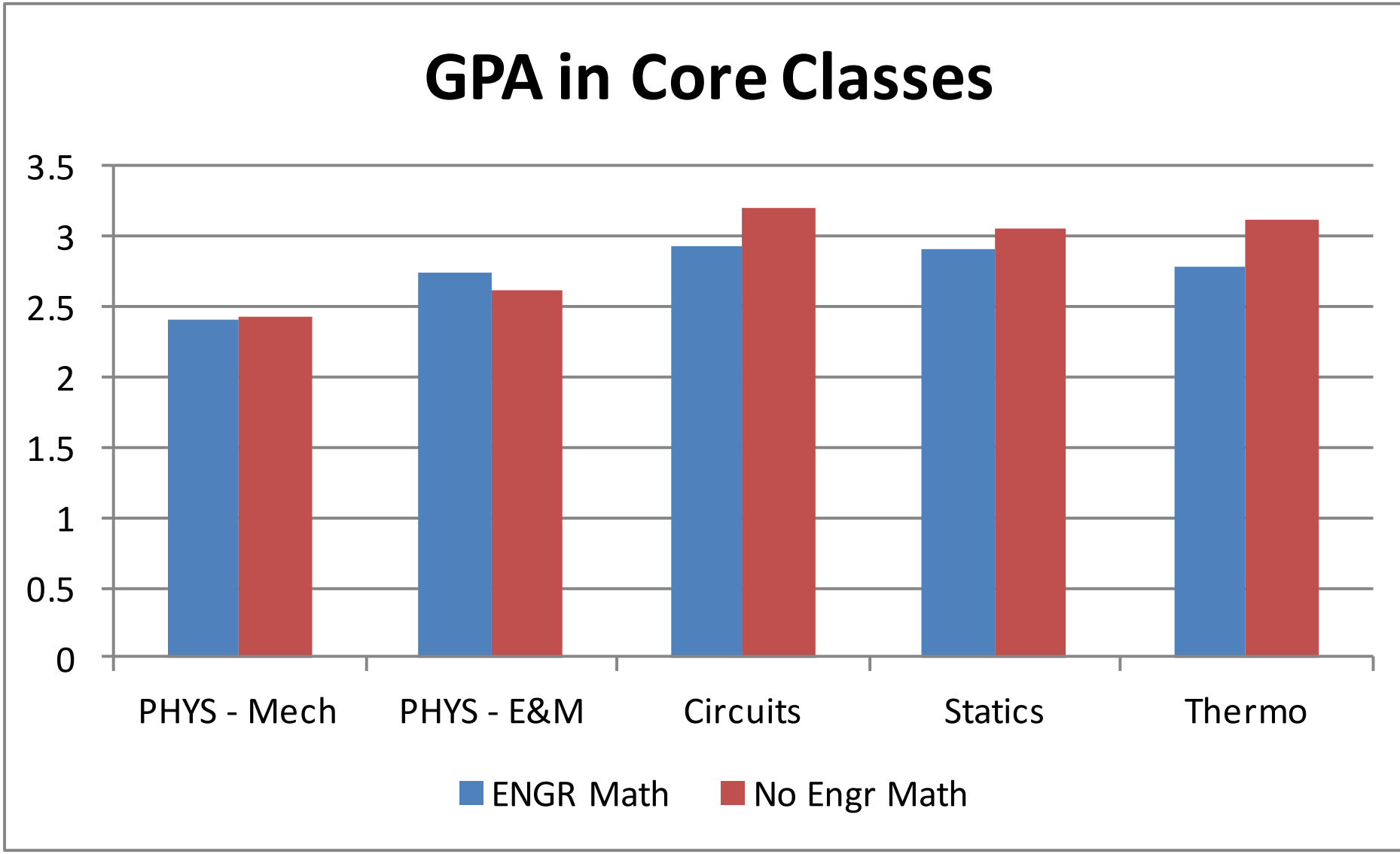
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GPA in Core Classes - Detailed

		PHYS - Mech	PHYS - E&M	Circuits	Statics	Thermo
Calc 1	ENGR Math	2.27	2.87	3.00	3.07	3.00
	No Engr Math	2.27	2.65	3.26	2.97	3.10
Calc 2	ENGR Math	2.90	2.67	2.94	2.72	2.42
	No Engr Math	2.48	2.53	3.03	3.19	3.17
Calc 3	ENGR Math	2.00	2.67	2.67	3.33	3.33
	No Engr Math	2.67	2.78	3.38	2.96	3.14

		PHYS - Mech	PHYS - E&M	Circuits	Statics	Thermo
<=550	ENGR Math	0.67	2.83	3.00	3.00	3.00
	No Engr Math	2.67	2.33	3.33	3.33	3.33
560-600	ENGR Math	2.33	2.67	3.67	2.67	3.33
	No Engr Math	1.67	2.40	3.08	2.40	3.13
610-650	ENGR Math	2.40	2.67	2.53	2.73	2.42
	No Engr Math	2.38	2.71	3.24	3.10	3.21
660-700	ENGR Math	3.78	3.00	3.17	3.00	2.33
	No Engr Math	2.64	2.53	3.07	3.07	2.97
>700	ENGR Math	2.22	2.50	3.33	3.33	3.33
	No Engr Math	2.60	2.73	3.38	3.14	3.31

No Clear Benefit in Core Classes



Engineering Math Videos

Self-Paced modules based on ENGR Math materials developed as part of a project to help veterans prepare to transition into engineering careers.

Linear Equations
Quadratic Equations
Trigonometry 1, 2, 3
Vectors
Complex Numbers
Sinusoidal Functions

Example 1 – Sequential Movements

A ship travels 200 miles at 45° North of East, then 300 miles due East. State the resulting position of the ship in polar coordinates.

Show Hint

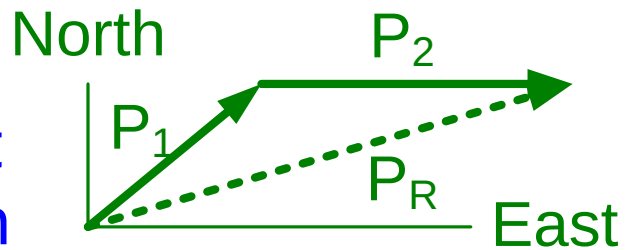
Show Solution

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Example 1 – Sequential Movements

A ship travels 200 miles at 45° North of East, then 300 miles due East. State the resulting position of the ship in polar coordinates.

Find the resultant vector that summarizes the movement in rectilinear coordinates.



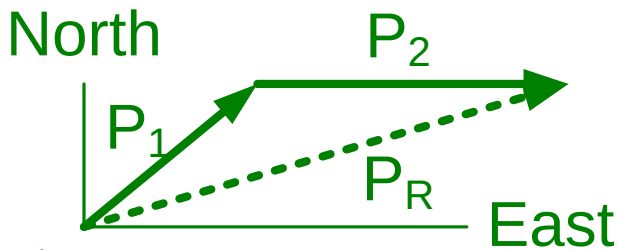
Show Hint

Show Solution

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Example 1 – Sequential Movements

A ship travels 200 miles at 45° North of East, then 300 miles due East. State the resulting position of the ship in polar coordinates.



Show Solution

$$\vec{P}_R = \vec{P}_1 + \vec{P}_2$$

$$\vec{P}_1 = 200\cos 45\,\vec{i} + 200\sin 45\,\vec{j}$$

$$= 141.4\,\vec{i} + 141.4\,\vec{j}$$

$$\vec{P}_2 = 300\,\vec{i}$$

$$\vec{P}_R = \left(141.4\,\vec{i} + 141.4\,\vec{j}\right) + \left(300\,\vec{i}\right)$$

$$= 441.4\,\vec{i} + 141.4\,\vec{j} \text{ miles}$$

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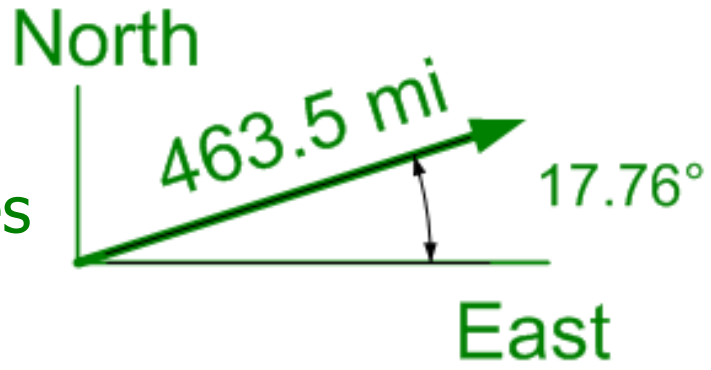
Example 1 – Sequential Movements

A ship travels 200 miles at 45° North of East, then 300 miles due East. State the resulting position of the ship in polar coordinates.

$$\vec{P}_R = 441.4\vec{i} + 141.4\vec{j}$$

$$\left|\vec{P}_R\right| = \sqrt{441.4^2 + 141.4^2} = 463.5 \text{ miles}$$

$$\theta = \tan^{-1}\left(141.4 / 441.4\right) = 17.76°$$



$$\vec{P}_R = 463.5 \angle 17.76° \text{ miles}$$

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What's Next

1. Flip the class
   Rework videos to provide lecture on content a la Khan Academy, with walk through of "simpler" problems
2. In-class group work on current HW

Perhaps replace formal course with JIT targeted tutorials

- Basic Trig/Sines just before used in Calc
- Vectors and more trig at start of Physics
- Could be led by Tau Beta Pi members

- National Science Foundation Grant No. DUE-0817332: National Model for Engineering Mathematics Education
- National Science Foundation Grant No. EEC-0948070: Connecting Veterans to Customized Engineering Education at the University of San Diego

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