ENGR 1002, Introduction to Engineering Analysis:

Apply Algebra II to Solve Engineering Problems

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Overview of Presentation

- ENGR 1002
- Preliminary Conclusions & Supporting Evidence
- Lessons Learned and Future Work

ENGR 1002

- 1 credit-hour, 150-min recitation, recommended for CEAS Algebra II students
- Does not add to student's tuition cost because of WMU flat tuition plan of 12-15 credit hours (ENGR 1002 + FYE 2100 = 3 cr.)
- Implemented fall 2014; earlier effort didn't get traction

ENGR 1002 Topics & Schedule

Week	Topics	Comment	Week	Topics	Comment
1	Intro of Units & Unit Convection	$(ab)^n=a^nb^n\neq ab^n$	2	Algebraic Expressions (Definitions --Density, Mole, Mass, Volume & Molar Fractions)	Write algebraic expressions of the definitions, manipulate & solve x=y/z & x=(a/b)/(y/z)
3	Algebraic relations of mass, volume & molar fractions; converting mass fraction to volume fraction, etc.	More practice of algebraic fractionss, equation derivation	5	Algebraic Functions: Coefficient of linear thermal expansion	Input/output; depend/ independent variable
6	Algebraic Functions: Ohm's Law and Hooke's Law	Series and parallel circuits algebra	8	Linear Equation (linear Interpolation/ Extrapolation); Steam Tables	y = b + ax; slope, intercept
9	Equation of Straight Line (position, speed, acceleration)	Slope, intercept; initial/final values	10	Quadratic Equations & Projectiles	Standard solutions; meaning of negative solution
12	Exponential & Logarithm Equations (PV^n=constant; Present/Future Value)	Convert to linear equation and solve for unknown	13	Natural Exponential & Logarithm Equations (Diffusion, Light Absorption)	Convert to linear equation and solve for unknown

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ENGR 1002-Class Format

- Hybrid format: students view video of lectures & problem-solving created in a think-aloud format prior to recitation
- Videos of lectures, problem-solving, solutions to homework and hour exams produced using Microsoft PowerPoint/ TechSmith; Intuit Tablet/SmoothDraw/ Microsoft OneNote
- Videos, homework, lecture notes on WMU *eLearning* platform
- In Class: quiz + problem solving

ENGR 1002: Students

- 20-25% of new CEAS beginners in Algebra II based on ACT-MATH sub-score

Percent of First-Year CEAS Students and First-Semester Mathematics Enrollment

	2010	**2011**	**2012**	**2013**	**2014**	**2015**
Calculus II or higher	7.5	3.4	4.5	8.0	7.0	13.8
Calculus I	40.7	38.0	37.2	35.1	35.0	38.1
Precalculus	25.2	34.0	31.7	33.4	31.9	27.5
Algebra II	19.1	16.8	24.2	20.8	25.6	19.7
Algebra I	6.8	8.4	--	--	--	--
No Math Data	0.7	0	2.4	2.6	0.4	0.9

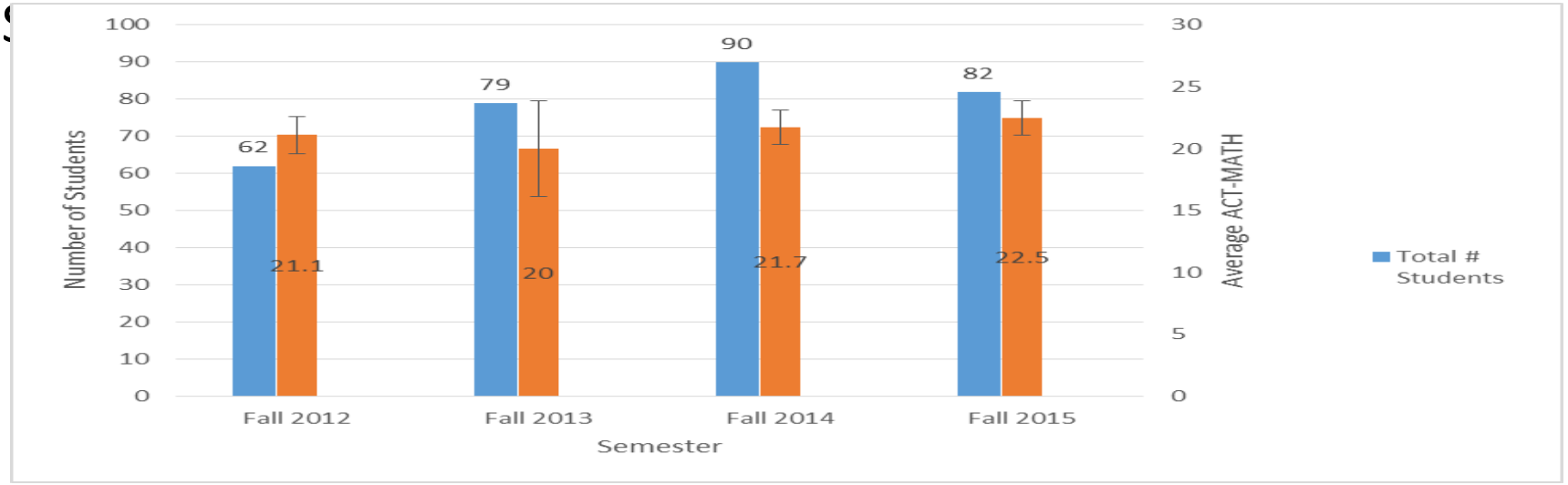
- A response to Algebra II students being a significant percent of student population

Project Background

- CEAS revised admissions criteria in fall 2012 to better inform students about academic pathways and created CEAS Exploratory (CEAS-EXEP)
  - Consisted of new beginners placed in Algebra II by ACT-MATH sub-scores
  - Must pass Algebra II ≥ B in no more than 2 attempts to continue in CEAS
- Implemented CEAS-EXEP Cohorts Program in fall 2013
  - Students in a cohort enrolled in same sections of 2-3 courses together
  - Algebra II, FYE 2100, Engineering Graphics (if required)
  - CEAS academic advisors serve as instructor of FYE 2100 and mentor of cohort assisted by CEAS students
- Added ENGR 1002 to CEAS-EXEP cohort schedule in fall 2014

Background: CEAS-EXEP Students

Number of ENGR 1002/CEAS-EXEP Students & ACT-MATH Sub-



- There is no statistical difference in math preparation between baseline (fall 2012) and ENGR 1002/CEAS-EXEP Cohorts

Preliminary Conclusions & Supporting Evidence

- C#1: Students who passed ENGR 1002 (grade ≥C) have a higher chance of passing Algebra II with a grade ≥B (confidence level ≥ 95%)

Chi-Square Test of Fall 2013 (Without ENGR 1002) *vs* Fall 2014 (With ENGR 1002)

Fall 2013		**Fall 2014**			**Fall 2013**	**Fall 2014**	
Total # Students	# Alg II ≥B, 1st attempt	Total # Students Passed ENGR 1002 (≥C)	# Alg II ≥B 1st Attempt	α Value	# Alg II ≥B, 1st + 2nd attempts	Total # Alg II ≥B With ENGR 1002	α Value
79	29 (36.7%)	51	42 (82.4%)	≤0.05	41 (51.9%)	49 (96.1%)	0≤0.05
Fall 2013		Fall 2015			Fall 2013	Fall 2015	
Total # Students	# Alg II ≥B, 1st attempt	Total # Students Passed ENGR 1002 (≥C)	# Alg II ≥B 1st Attempt	α Value	# Alg II ≥B, 1st + 2nd attempts	Total # Alg II ≥B With ENGR 1002	α Value
79	29 (36.7%)	41	25 (61.0%)	≤0.05	41 (51.9%)	34 (85.0%)	≤0.05

Preliminary Conclusions

- C#2: CEAS-EXEP Cohorts program has resulted in improving 2nd-year retention to WMU (confidence level ≥ 95%)

Chi-Square Test - CEAS-EXEP Cohorts Retention to WMU versus Baseline

Fall 2012		**Fall 2013**		
Total # EXEP	2nd Year Return to WMU	Total # EXEP	2nd Year Return to WMU	α value
62	40 (64.5%)	79	67 (84.8%)	≤0.05
Fall 2012		**Fall 2014**		
Total # EXEP	2nd Year Return to WMU	Total # EXEP	2nd Year Return to WMU	α value
62	40 (64.5%)	90	83 (92.2%)	≤0.05

Preliminary Conclusions & Supporting Evidence

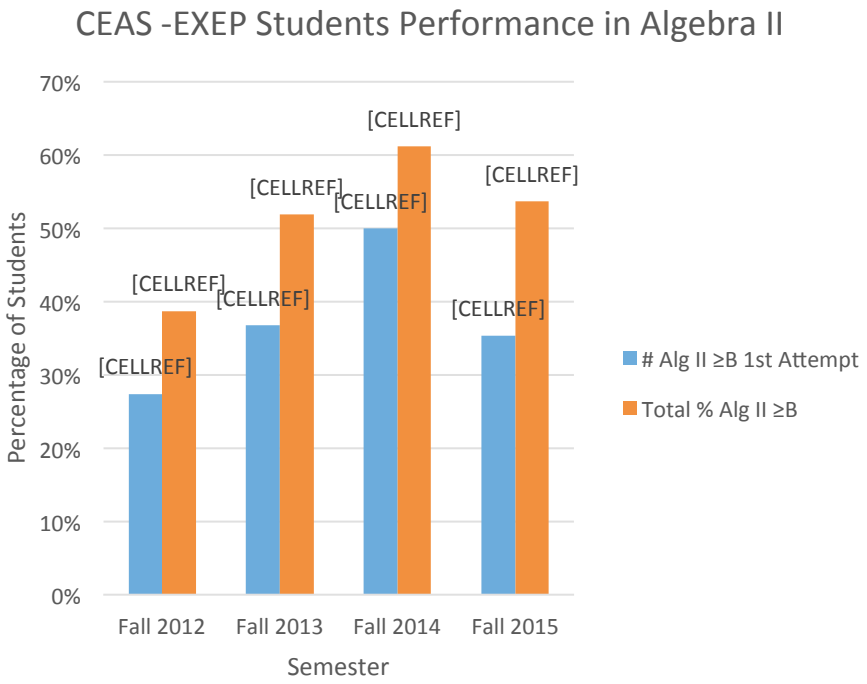
- C#3: ENGR 1002 & CEAS-EXEP Cohorts Program's effects on performance in Algebra II & Precalculus, and retention to CEAS are mixed, some statistically significant and some not statistically significant, but never negative.

Some Examples of Inconclusive Results

- Effect on performance in Algebra II

Fall 2012 (baseline)		**Fall 2013**			**Fall 2012 (baseline)**	**Fall 2013**	
Total # Students	#≥B, 1st Attempt	Total # Students	#≥B, 1st Attempt	a value	#≥B, 1st+2nd Attempts	≥B, 1st + 2nd Attempts	a value
62	17 (27.4%)	79	29 (36.7%)	0.07	24 (38.7%)	41 (51.9%)	≤0.05
Fall 2012 (baseline		**Fall 2014**			**Fall 2012 (baseline)**	**Fall 2014**	
Total # Students	#≥B, 1st Attempt	Total # Students	#≥B, 1st Attempt	α value	#≥B, 1st + 2nd Attempts	≥B, 1st + 2nd Attempts	α value
62	17 (27.4%)	90	45 (50.0%)	≤0.05	24 (38.7%)	55 (61.1%)	≤0.05
Fall 2012 (baseline)		**Fall 2015**			Fall 2012	Falll 2015	
Total # Students	#≥B, 1st Attempt	Total # Students	#≥B, 1st Attempt	α value	#≥B, 1st + 2nd Attempts	≥B, 1st + 2nd Attempts	α value
62	17 (27.4%)	82	27 (32.9%)	0.11	24 (38.7%)	44 (53.7%)	0.06

Chi-Square Test of Baseline *vs. 2013-15* Cohorts



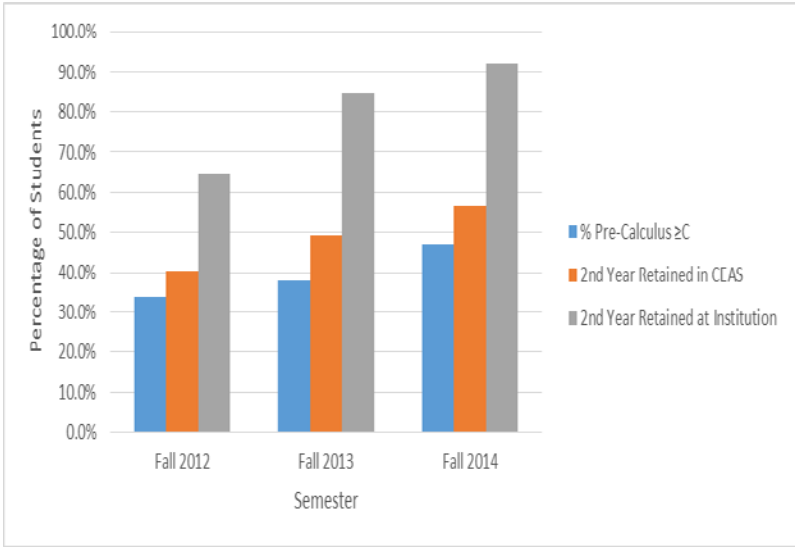
Percent (and Number) of CEAS-EXEP Cohort Students with Grade ≥B in Algebra II and Baseline

One More Example of Inconclusive Results

- 2nd-Year Retention to CEAS and Performance in Precalculus of CEAS-EXEP Cohorts vs Baseline

Fall 2012		**Fall 2013**		
Total # EXEP	2nd Year Return to CEAS	Total # EXEP	2nd Year Return to CEAS	α value
62	25 (40.3%)	79	39 (49.4%)	0.06
Fall 2012		**Fall 2014**		
Total # EXEP	2nd Year Return to CEAS	Total # EXEP	2nd Year Return to CEAS	α value
62	25 (40.3%)	90	51 (56.6%)	≤0.05

Chi-Square Test of Retention to CEAS of CEAS-EXEP Cohorts *versus* Baseline



Performance in Pre-Calculus (the Following Spring Semester) of CEAS-EXEP Cohorts and Baseline

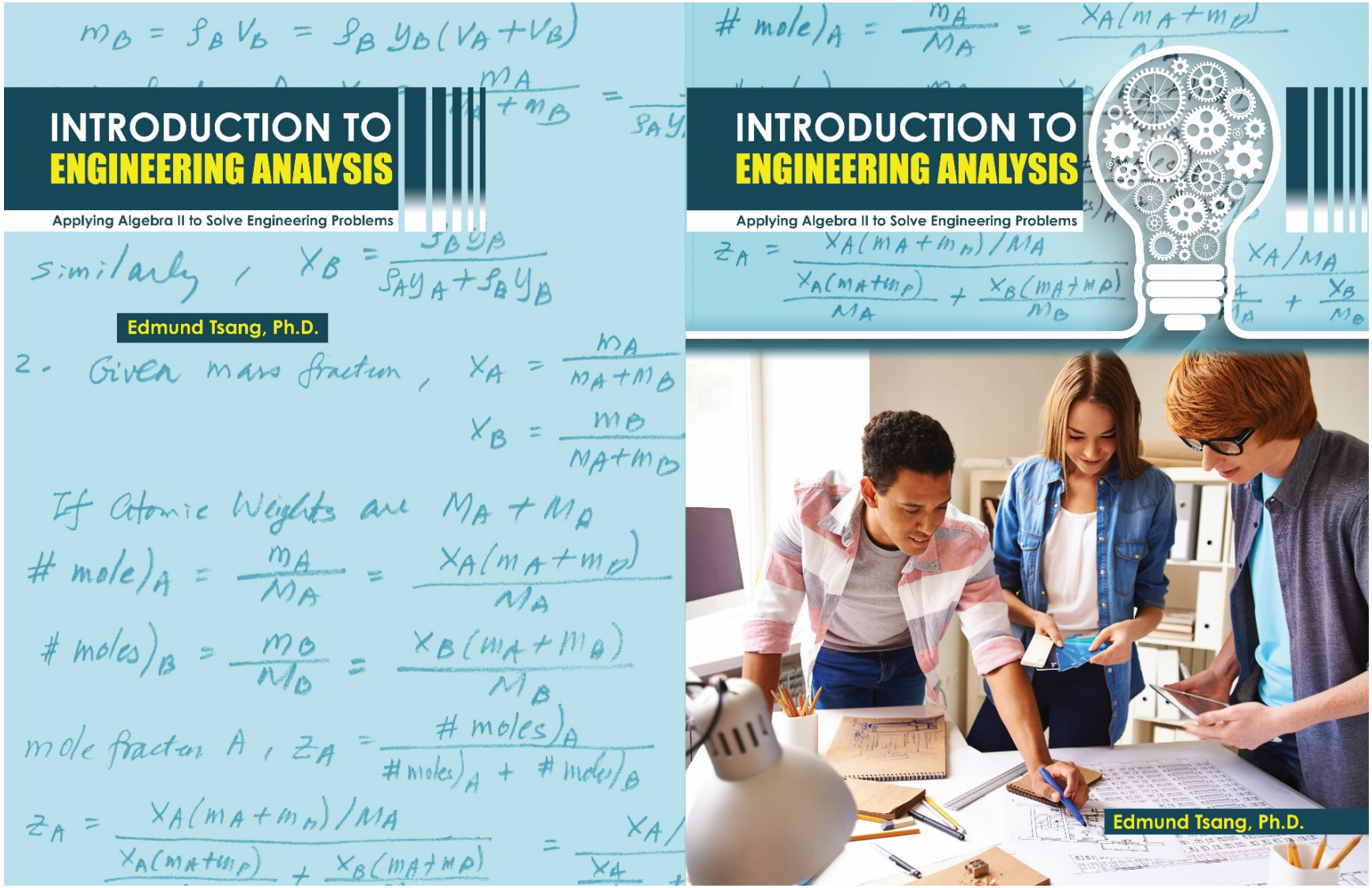
Lessons Learned

- Sending letters to admitted Algebra II students, identifying a math course at community college near students' hometown, is an effective strategy to move more Algebraic II students to Precalculus
  - ➢ resulted in moving ~29% of enrolled Algebra II students to Precalculus in fall 2014 and fall 2015.
- Creating the video lectures, problem solving, and solutions to homework and hour exam are relatively effortless using TechSmith and an Intuit tablet.
- Student attendance in the Friday afternoon section of ENGR 1002 was lower than another section held on a weekday. Will move the Friday section to Monday in Fall 2016.

Future Work

- Continue to track ENGR 1002/CEAS-EXEP Cohorts students
- Add more Algebra II examples of engineering
- Create videos addressing ENGR 1002 students about the affective aspects of learning
  - ➢ Attitudes/mindset
  - ➢ Appreciating value of learning through practice/repetition
  - ➢ Respond to a grade ≤C in hour exams

A few examination copies of textbook available to interested audience members



Questions/Comments

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