

## **Scale-up and Sustain a Cohort Program for First-Year Engineering Students Who Are Placed in Algebra II**

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# Full Paper: Scale-up and Sustain a Cohort Program for First-Year Engineering Students Who Are Placed in Algebra II

## Introduction

The College of Engineering and Applied Sciences (CEAS), Western Michigan University (WMU) offers nine EAC-ABET accredited engineering programs, three ETAC-ABET accredited engineering technology programs and a CAC-ABET accredited computer science program ([www.wmich.edu/engineer](http://www.wmich.edu/engineer)). The graphics and printing science program is accredited by the Accreditation Council for Collegiate Graphic Communications (ACCGC). CEAS also offers 11 master and six doctoral programs. Fall 2017 enrollment consisted of 2,415 undergraduates, 447 master and 158 doctoral students. In 2016-17, CEAS awarded 359 bachelor's, 201 master's, and 14 doctoral degrees. WMU is categorized by the Consortium for Student Retention Data Exchange (CSRDE) at the University of Oklahoma [1] as "Moderately Selective."

To better inform students of the academic pathways, CEAS revised admissions requirement in 2012. Beginning fall 2012, students who are placed into Algebra II in their first semester at WMU by ACT or SAT math sub-scores are admitted into CEAS Exploratory (EXEP). In EXEP, students must achieve a grade of B or better in Algebra II in no more than two attempts before they can advance. When the EXEP students pass Algebra II with a grade B or higher, they are placed in Pre-Engineering, Pre-Engineering Technology, or Computer Science. The Pre-Engineering and Pre-Engineering Technology curricula consist of a set of courses in the first three semesters of a CEAS curriculum. Students who complete the pre-programs with a grade of C or higher in all the courses can apply and be admitted into the professional programs. There are no established enrollment limits for admission to the CEAS professional programs.

EXEP students who receive a grade less than B either retake Algebra II in spring semester and continue in the EXEP status, or they are advised to explore another major better aligned with their interest and math preparation. Students are dismissed from EXEP and CEAS if their grade in Algebra II is less than B in the second attempt, but they can continue in WMU.

About 75-100 students annually are placed in EXEP, forming 20-25% of new first-year students. CEAS implemented the EXEP Cohort program in 2013 to support the Algebra II students.

## Creating and Scaling-Up the CEAS-EXEP Cohort Program

EXEP Cohort is based on the very successful STEP (STEM Talent Expansion Program) program that now involves annually ~90% of first-year students -- about 350 first-time first-year students annually are placed in cohorts [2], [3]. Progressing through the entire first year as a cohort is identified as a "high impact practice" by the National Survey of Student Engagement (NSSE) [4]. *Gabelnick et al* [5] report that a cohort or learning community helps to build connection among student peers, and between students, faculty and staff. Our cohorts each has an anchor

class that serves as a focal point to direct student success services. Based on surveys conducted each fall, we learned that a significant majority of students have studied and formed study groups with other students in their cohort. Graduating seniors have often told us the study groups they formed during their first year through STEP lasted through senior capstone design project.

In EXEP Cohort, students are registered for fall semester during summer orientation into the same section of Algebra II, a First-Year CEAS Experience (ENGR 2100), and Introduction to Engineering Analysis (ENGR 1002). Depending on a student's intended CEAS major, a fourth course – Engineering Graphics – or General Education course(s) are added to the schedule to attain full-time academic status, which is at least 12 credit hours. For the spring semester, after the EXEP students passed Algebra II with a grade of B or higher and are in Pre-Engineering or Pre-Engineering Technology or Computer Science, they are registered into the same sections of Precalculus, Technical Communication, and General Chemistry I and Lab. Students add a CEAS major-specific course or General Education course to attain academic full-time status.

ENGR 2100 is a 2-credit hour first year seminar course taught by a CEAS academic advisor. The course focuses on teaching academic skills and the expectations of a student studying engineering, and serves as support for students during the transition to college and develop the habits of a successful engineering student. The course uses *Studying Engineering: A Road Map to a Rewarding Career* by Raymond Landis [6]. ENGR 2100 is the anchor class of the EXEP Cohort and it serves as a conduit for connecting students to academic and social resources provided through WMU and STEP.

ENGR 2100 is currently undergoing a significant redesign to more closely align the course with the text, and to facilitate a more active learning environment. A ENGR 2100 workbook is being created, with specific activities for students to engage in before and after class. Most of these activities are derived from the material in the course text. This change was precipitated by observations of ENGR 2100 and ENGR 1002 instructors that students were under prepared for the rigor and expectations of engineering coursework and math study, and that perhaps a more active approach than the current seminar structure would more effectively reach students.

ENGR 1002, "Introduction to Engineering Analysis," is adapted from Wright State University's Model for Engineering Mathematics Education [7], [8]. At WSU, the engineering mathematics course targets students placed into Precalculus or Calculus I; ENGR 1002 targets Algebra II students. ENGR 1002 is a one-credit hour recitation that meets once per week for 150 minutes. More details about ENGR 1002 can be found elsewhere [9], [10].

The first step in creating EXEP Cohort is to request class seats for the courses. Our practice is about 3-month before registration begins, to ensure issues are resolved and seats have been reserved for EXEP Cohort. We have scaled up to involve all CEAS Algebra II students. We created templates to facilitate course registration and placement. Institutionalization of EXEP Cohort has been accomplished through a change in summer orientation and registration practices.

Results of EXEP Student Performance in Algebra II and Precalculus

The CEAS admissions criteria were changed in 2012, and Algebra II students were admitted into EXEP. In fall 2013, CEAS implemented EXEP Cohort. We use 2012 as the baseline, and compare the results from 2013 to the present.

### 1. Student Performance in Algebra II

The performances of EXEP students in Algebra II from 2012 to 2017 are summarized in Table 1 below, which shows the number and the percent of EXEP students who achieved a grade of B or higher in Algebra II in first attempt and up-to-two attempts. Table I shows that in the baseline year 2012, 17 out of 62 EXEP students (27.4%) passed Algebra II with grades  $\geq B$  in first attempt, and 24 out of 62 (38.7%) in no-more-than 2 attempts. The percent of grades  $\geq B$  in Algebra II are all higher in subsequent years with the EXEP Cohort program.

Table 1. Performance of EXEP Students in Algebra II

Year	Total # Students	# $\geq B$ , 1 <sup>st</sup> Attempt	# $\geq B$ , 2 Attempts
2012 (baseline)	62	17 (27.4%)	24 (38.7%)
2013 Cohort	79	29 (36.7%)	41 (51.9%)
2014 Cohort	90	45 (50.0%)	55 (61.1%)
2015 Cohort	80	29 (36.3%)	46 (57.5%)
2016 Cohort	73	47 (64.4%)	50 (68.5%)
2017 Cohort	98	39 (39.8%)	51 (52.0%)

We performed Chi Square test for the hypothesis that the higher percent of EXEP students with grades  $\geq B$  in Algebra II in 2013 to 2017 is correlated with EXEP Cohort. Using  $\alpha \leq 0.05$  and a degree of freedom of 4 (5 – 1; 5 cohorts from 2013 to 2017), we validate the hypothesis that the higher percent of EXEP students who have grades  $\geq B$  in Algebra II in their first attempt is correlated with EXEP Cohort. Similarly, we validate the hypothesis that the higher percent for two attempts is also correlated with EXEP Cohort.

We compared the EXEP students' performance in Algebra II with a group consisting of all other students who are enrolled in Algebra II in the same semester as EXEP students -- Table 2.

Table 2. Performance in Algebra II of EXEP and Comparison Group

Semester	Total # EXEP Students	# $\geq B$ 1 <sup>st</sup> Attempt	Total # Comparison	# $\geq B$
2012 (baseline)	62	17 (27.4%)	389	77 (19.8%)
2013 Cohort	79	29 (36.7%)	357	70 (19.6%)
2014 Cohort	90	45 (50.0%)	337	64 (19.0%)
2015 Cohort	80	29 (36.3%)	335	77 (23.0%)
2016 Cohort	73	47 (64.4%)	282	62 (22.0%)
2017 Cohort	98	39 (39.8%)	260	93 (35.8%)

We performed Chi Square tests for the hypothesis that the greater percent of grades  $\geq B$  in Algebra II observed for EXEP students than the comparison groups is correlated with EXEP Cohort. Using  $\alpha \leq 0.05$  and a degree of freedom of 4 (5 – 1; 5 cohorts from 2013 to 2017), we

validate the hypothesis that the higher percent of EXEP students with grades  $\geq B$  in Algebra II than the comparison groups is correlated with EXEP Cohort. [There is no statistically significant difference in the baseline year (2012) between EXEP students and the comparison group.]

## 2. Performance in Precalculus in the Semester Immediately Following Algebra II

The performance of the EXEP students in Precalculus in the semester immediately following Algebra II are summarized in Table 3 below, which gives the number and percent of the EXEP students with grade  $\geq C$  in Precalculus.

Table 3. Performance of EXEP Students in Precalculus in Semester Immediately Following Algebra II

Year	Total # of EXEP students	Total # of EXEP Students in Precalculus in Semester Immediately Following Algebra II with Grades $\geq C$	#/ (%) of EXEP Students with Grade $\geq C$ in Precalculus
2012 (baseline)	62	17	17 (100%)
2013 Cohort	79	27	22 (81.5%)
2014 Cohort	90	45	42 (93.3%)
2015 Cohort	82	26	23 (88.5%)
2016 Cohort	73	44	37 (84.1%)

As shown in Table 3, 17 out of 17 EXEP students (100%) in the baseline year (2012) passed Precalculus with grades  $\geq C$ . Although in 2013 to 2016, the percent of students with grades  $\geq C$  is less than 100%, we do not think the EXEP Cohort is the cause and make no further investigation.

We compare the performance of the EXEP students with a comparison group made up of all other students taking Precalculus in the same semester as the EXEP students, and the results are summarized in Table 4 below.

Table 4. Performance in Pre-Calculus of EXEP and Comparison Group

Semester	Total # EXEP in Precalculus	# Grades $\geq C$	Total # Comparison in Precalculus	Grades # $\geq C$
2012 (baseline)	17	17 (100%)	255	149 (58.4)
2013 Cohort	27	22 (81.5%)	240	155 (64.6%)
2014 Cohort	45	42 (93.3%)	290	183 (63.1%)
2015 Cohort	26	23 (88.5%)	268	169 (63.1%)
2016 Cohort	44	37 (84.1%)	108	49 (45.4%)

Table 4 shows there are higher percent of EXEP students than the comparison groups to have grades  $\geq C$  in Precalculus. We perform Chi Square tests for the hypothesis that the higher percent is correlated to the EXEP Cohort program. Using  $\alpha \leq 0.05$  and a degree of freedom of 3 (4 – 1; 4 cohorts from 2013 to 2016), we validate the hypothesis that the higher percent of EXEP students with grades  $\geq C$  in Precalculus is correlated with the EXEP Cohort program.

## 3. Retention to CEAS and to WMU

We analyze 1<sup>st</sup>-to-2<sup>nd</sup> year retention to CEAS and to WMU of the EXEP students. In the baseline year (2012), the retention rate to CEAS is 40.3% and the retention rate to WMU is 64.5%. The number and percent of the EXEP students returning to CEAS and to WMU are summarized in Table 5 below.

Table 5. Retention to CEAS and Institution of the CEAS EXEP Students

Year	Total # EXEP Students	2 <sup>nd</sup> -Year Retention to CEAS	2 <sup>nd</sup> -Year Retention to Institution
2012 (baseline)	62	25 (40.3%)	40 (64.5%)
2013 Cohort	79	39 (49.4%)	67 (84.8%)
2014 Cohort	90	51 (56.6%)	83 (92.2%)
2015 Cohort	80	42 (52.5%)	57 (71.3%)
2016 Cohort	73	37 (50.7%)	52 (71.2%)

Table 5 shows that the retention rates to CEAS and to WMU for students in EXEP Cohort from 2013 to 2017 are higher than the baseline retention rates of 2012. We perform Chi Square test for the hypothesis that the higher retention rates are corrected to EXEP Cohort. Using  $\alpha \leq 0.05$  and a degree of freedom of 3 ( $4 - 1$ ; 4 cohorts from 2013 to 2016), we validate the hypothesis that the higher retention rate to WMU is correlated to EXEP Cohort. The retention rate to CEAS of students in EXEP Cohort is higher than the baseline (2012), but not statistically significant.

#### Sustaining CEAS-EXEP Cohort

The costs to implement EXEP Cohort include instructional costs of ENGR 2100 and ENGR 1002. ENGR 2100 enrolls 20-25 students per section, and it is taught by a CEAS academic advisor who receives a small stipend. ENGR 1002 is taught by a CEAS associate dean, and there is no instructional cost. Moving forward, a part-time instructor can be hired and trained to teach ENGR 1002, which enrolls 45-50 students per section. One section of ENGR 1002 supports two sections of ENGR 2100, so the instructional costs are not substantial. It is recommended that one student assistant be hired to work up to 15 hours per week to assist one EXEP Cohort.

The tasks of updating the course schedules and making requests for course seats for EXEP Cohort are performed by the CEAS Advising Office as part of its normal operation. Therefore, there are no additional operating costs since CEAS Advising has adopted and is institutionalizing the practice of placing students into cohorts during summer orientation and course registration in students' entire first-year at CEAS.

#### Conclusions

In fall 2013, CEAS implemented EXEP Cohort to support Algebra II students as a result of revision to admissions requirement which was implemented in fall 2012. CEAS has scaled up EXEP Cohort to involve 100% of the Algebra II students. The implementation of EXEP Cohort beginning 2013 is correlated with a statistically significant, higher percent of EXEP students above the baseline in achieving grades  $\geq B$  in Algebra II in first attempt and two attempts, and a higher percent than comparison groups of students taking Algebra II in the same semester as the EXEP students. The EXEP Cohort program is also correlated with a statistically significant, higher percent of EXEP students with grades  $\geq C$  in Precalculus than comparison groups of other

students enrolled in Precalculus in the same semester as the EXEP students, as well as a higher 2<sup>nd</sup> year retention rate of the EXEP students to WMU than the baseline year. Retention rate to CEAS of students in EXEP Cohort is higher than the baseline, but not statistically significant.

Finally, EXEP Cohort is relatively inexpensive to implement and scale up, and they should be considered when engineering schools look at programs to support Algebra II students.

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