



Scaling-Up, Institutionalizing, and Sustaining a STEM Talent Expansion Program Program at University XX

Dr. Edmund Tsang, Western Michigan University

Edmund Tsang received a B.S. with distinction in Mechanical Engineering from University of Nebraska and a Ph.D. in Metallurgy from Iowa State University. Dr. Tsang's current professional interests include integrating service-learning into engineering, social entrepreneurship, and student success and retention. Dr. Tsang retired in December 2017 as Emeritus Associate Dean and Emeritus Professor of Mechanical Engineering, Western Michigan University

Ms. Anetra J. Grice, Western Michigan University

Anetra Grice has served as the STEP Program Director for Western Michigan University's College of Engineering and Applied Sciences since 2010.

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Abstract

A STEM Talent Expansion Program (STEP IB) has been scaled up and it now places ~90% of all first-time first-year summer orientation participants into cohorts. Students in a cohort take the same 3-to-5 courses together in fall semester and 2-to-4 courses together in spring semester. Progressing the entire first year as a cohort builds connection between students and among students, faculty and staff. A cohort also serves as a focal point to direct information about student support services created as a result of the STEP award. Factors impacting institutionalization of STEP at Western Michigan University and sustainability of the program when NSF funding ends will be described in this paper. The second-year retention rate and 6-year graduation rate are also discussed.

Introduction

The College of Engineering and Applied Sciences (CEAS), Western Michigan University (WMU), offers nine EAC-ABET accredited undergraduate engineering programs, three ETAC-ABET accredited undergraduate engineering technology programs, an undergraduate computer science program that is accredited by CAC-ABET, and an undergraduate graphics and printing science program that is accredited by the Accreditation Council for Collegiate Graphic Communications (ACCGC). In addition, CEAS offers 11 master's programs and seven doctoral programs. Fall 2017 enrollment consisted of 2,415 undergraduates, 447 master's students and 158 doctoral students.

In 2005, WMU was awarded a STEM Talent Expansion Program (STEP) from the National Science Foundation to improve second-year retention by adapting the strategy of placing students into cohorts. Placing first-year students in cohorts or learning communities is recognized by the National Survey of Student Engagement (NSSE) of Indiana University as one of six high-impact practices positively affecting student success and retention [1]. Placing first-year students in cohorts or learning communities is also cited by Gabelnick et al. as a means to promote connection among students, faculty and staff, and with the students' majors [2]. In 2010, WMU received a second STEP award (STEP IB) to scale up the number of students impacted and to improve 6-year graduation rates. We use the cohorts as focal points to channel information about the student support services developed in STEP IB, including Student Success Centers and Engineering House. This paper will describe how the STEP project has been scaled up and institutionalized, and how it will be sustained at WMU, together with second-year retention and six-year graduation rates. WMU is categorized a "Moderately Selective" institution by the Consortium for Student Data Exchange at the University of Oklahoma (<https://csrde.ou.edu/>). Other engineering programs with similar student demographics as WMU may find the strategies and methods described in this paper useful.

Scaling Up STEP Cohorts

Although CEAS does not have a common first-year engineering curriculum for its 14 engineering and applied sciences programs, we are successful in placing 90% of all first-year summer orientation participants in STEP cohorts. We have seen an increase from 75% to 90% over the past eight years. The STEP IB project involves, on average, 343 first-time first-year students annually who are placed into 18-19 cohorts. Figure 1 below shows the total number of students who participated in summer orientation from 2010 to 2017, and the number of students and percent of students placed in STEP cohorts. The other 10% of students who participated in summer orientation and are not placed in a cohort are usually students with many Advanced Placement (AP) credits; student athletes; or students who opt out of the STEP Cohorts.

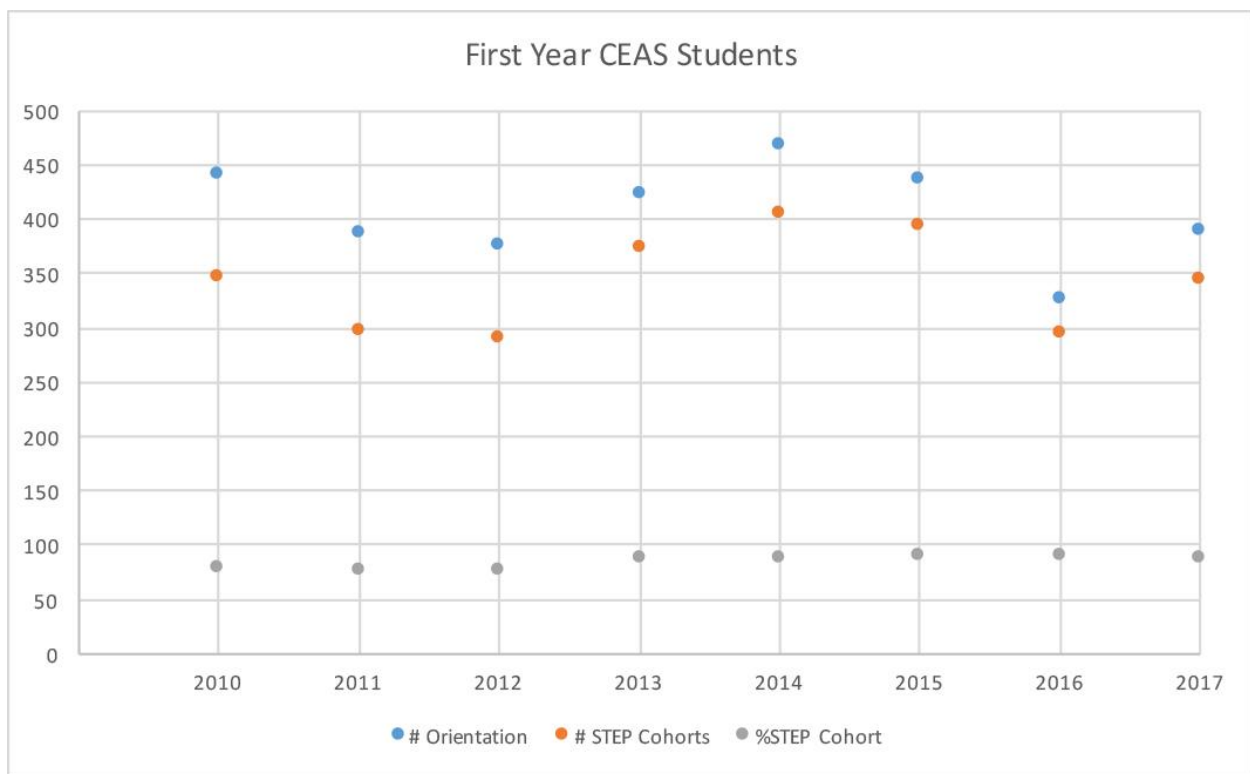


Figure 1. The Number and Percent of CEAS Students Placed in STEP Cohorts during Summer Orientation from 2010 to 2017

Two examples of the templates used during summer orientation to place students into STEP cohorts for Chemical Engineering and Aerospace Engineering students are shown in Figure 2. CHEG 1010, Introduction to Chemical Engineering, is the anchor class for the Chemical Engineering Cohort, and students in this cohort are also enrolled in the same section of three other courses together: General Chemistry I and Lab, and Technical Communication. In addition, Calculus I-ready Chemical-Engineering students are enrolled in the same section of Calculus I, while the Precalculus students are enrolled in the same section of Precalculus. The CHEG 1010 instructor serves as the STEP Mentor. For the following spring semester, the Chemical Engineering students are enrolled in the same section of General Chemistry II and Lab, and

CHEG 1810, Chemical Engineering Computation. The Calculus I students are enrolled in the same section of Calculus II, and University Physics I and Lab while the Precalculus students are enrolled in the same section of Calculus I.

Advisor Initials _____

FALL 2017 STEP LEARNING COMMUNITY CLASS SCHEDULE
WESTERN MICHIGAN UNIVERSITY • COLLEGE OF ENGINEERING AND APPLIED SCIENCES

NAME: _____ WIN#: _____
EMAIL: _____
MAJOR: Pre-Chemical Engineering

Learning Community: **CHEG** FACULTY MENTOR: **TBD**

Y/N/C	Course	CRN	Cr.	Day/Time	Location
	CHEG 1010	Lecture - 40253 Lab - 40254	3	MW 8-8:50 W 2:30-5:20	1710 Sangren D-115 Floyd
	CHEM 1100	40612	3	MWF 12:00-12:50	1720 Chemistry
	CHEM 1110	44543	1	F 2-4:50	2851 Chemistry
	IEE 1020	44292	3	TR 11:30-12:45	E-121 Floyd
	MATH 1180	Lecture- 44474 (14) Lab-44475		TR 9:30-10:45 W 9-9:50	1910 Sangren 3393 Rood
		OR	4		
	MATH 1220	40665 (14)		MTRF 10-10:50	3391 Rood
		Total	14		

IF NO, WHY: _____

	M	T	W	R	F
8	CHEG 1010		CHEG 1010		
9		MATH 1180	MATH 1180R	MATH 1180	
10	MATH 1220	MATH 1180/ MATH 1220		MATH 1180/ MATH 1220	MATH 1220
11		IEE 1020		IEE 1020	
12	CHEM 1100	IEE 1020	CHEM 1100	IEE 1020	CHEM 1100
1					
2			CHEG 1010 L		CHEM 1110
3			CHEG 1010 L		CHEM 1110
4			CHEG 1010 L		CHEM 1110
5			CHEG 1010 L		
6					
7					
8					
9					

CHEG
2017April5

AP/IB/DE | Yes/No

Advisor Initials _____

FALL 2017 STEP LEARNING COMMUNITY CLASS SCHEDULE
WESTERN MICHIGAN UNIVERSITY • COLLEGE OF ENGINEERING AND APPLIED SCIENCES

NAME: _____ WIN#: _____
EMAIL: _____
MAJOR: Pre-Aerospace Engineering

Learning Community: **AERO** FACULTY MENTOR: **TBD**

Y/N/C	Course	CRN	Cr.	Day/Time	Location
	IEE 1020	44289	3	MWF 10:30-11:20	C-122 Floyd
	CHEM 1100	40609	3	TR 11-12:15	1720 Chemistry
	CHEM 1110 LAB	40795	1	T 2:00-4:50	2271 Chemistry
	EDMM 1420	Lecture-44277 Lab-44296	3	MW 3:30-4:20 W 12:30-3:20	D-109 Floyd C-226 Floyd
	MATH 1700	41467	4	MTRF 9:00-9:50	3393 Rood
		Total	14		

IF NO, WHY: _____

	M	T	W	R	F
8					
9	MATH 1700	MATH 1700		MATH 1700	MATH 1700
10	IEE 1020		IEE 1020		IEE 1020
11	IEE 1020	CHEM 1100	IEE 1020	CHEM 1100	IEE 1020
12		CHEM 1100	EDMM 1420 Lab	CHEM 1100	
1			EDMM 1420 Lab		
2		CHEM 1110	EDMM 1420 Lab		
3	EDMM 1420	CHEM 1110	EDMM 1420 Lab/ EDMM 1420		
4	EDMM 1420	CHEM 1110	EDMM 1420		
5					
6					
7					
8					
9					

2017April7

AP/IB/DE | Yes/No

Figure 2. Templates Used during Summer Orientation to Place Chemical Engineering and Aerospace Engineering Students into STEP Cohorts

For the Aerospace Engineering (AE) Cohort, IEE 1020, Technical Communication, is the anchor class, and an Aerospace Engineering faculty interacts with the AE students through IEE 1020 and serves as the STEP Mentor. The Aerospace Engineering students are also enrolled in the same section of Engineering Graphics, Calculus I and General Chemistry I and Lab. For the following spring semester, the Aerospace Engineering students are enrolled in the same section of Introduction to Aerospace Engineering, Calculus II, and University Physics I and Lab, and Computer Programming. Some Aerospace Engineering students may take a General Education course to fill out their class schedules in fall and spring semesters. More details on creating the STEP Cohorts can be found elsewhere [3].

We survey students placed in cohorts at the end of each fall semester. A significant majority of the students reports in the survey that they have studied with other students in their cohorts outside the classroom. Our graduating seniors have told us that the relationship they developed

with others students in the study groups which they formed during the first-year, carry over to senior capstone design project.

Factors Supporting Institutionalizing STEP at Western Michigan University

In order to make lasting impacts to support student success in engineering, the best practices identified by projects supported by the National Science Foundation need to be institutionalized [4, 5]. This is to ensure that the innovation and institutional reforms are not lost when funding ends or when principal personnel move to another institution or retire. The following factors supporting institutionalizing the STEP program at WMU have been identified:

- A. Form an Advisory Board with Key Institutional Decision-Makers – At WMU, the Provost and Vice President of Academic Affairs chairs the STEP Advisory Board. Advisory Board members include the Vice President of Student Affairs (replaced by the Dean of Students in 2015) as well as the Dean of Arts and Sciences, the Dean of Engineering and Applied Sciences, the Dean of Lee Honors College, and the chairs of departments that provide seats for the STEP cohorts (e.g., Mathematics, Chemistry). There are also two external board members consisting of engineering educators – one in our state and one in a neighboring state -- such that travel time and cost for the external board members to attend meetings are not hurdles. The STEP Advisory Board meets two times a year -- once in fall and another time in spring – and the meeting format consists of a reporting component and a planning component. In the reporting component, the Advisory Board reviews project progress and provides feedback; in the planning component, the Advisory Board assists the Project Team to set priorities and provides suggestions for strategies. More importantly, the Advisory Board can influence institutional practices that could mitigate barriers to student success. For example, based on reporting by the Project Team, the number of days between “mid-term grade report” and “last day to withdraw from a course” has been changed from one week to two weeks, giving academic advisors more time to work with students with poor mid-term grades. Also, as a result of discussions at a STEP Advisory Board meeting, faculty have now been able to “Report Student Academic Concern” from a link on the faculty portal to the university webpage.
- B. Partner with the Office of Institutional Research – As early as possible, we recommend you to meet with the Office of Institutional Research (IR) regarding the data needs of the project. For the partnership to be successful, it is important to identify an IR liaison and to avoid making data requests at IR’s busiest times. For our STEP project, the IR liaison is its Assistant Director, and we make two data requests a year – one time in fall semester to determine retention and graduation rates, and one time in spring to fulfill the STEP survey and other reporting requirements to NSF. We have always made requests for data about a month before the data are needed.
- C. Align the Program with the College Strategic Plan – Institutionalizing and sustaining STEP was adopted by CEAS when it revised its Strategic Plan in January 2013. One of the strategies for achieving Objective #2, “Increase the retention rate of students within CEAS,” was to “Provide sustainable funding for our Science Technology Engineering and Mathematics Talent Expansion Program (STEP).”

- D. Create and Use Operations Calendar and Manuals – As the STEP activities were being implemented, key tasks and critical dates have been identified, and they were used to create an Operations Calendar, which is reviewed and updated annually. Operations and training manuals have also been created, and they are reviewed and updated annually and used to guide tutoring training; student success centers operations; and communication with students [Algebra II students, transfer students, students who underperformed in a STEM (science, technology, engineering, mathematics) course, etc.], and with parents of first-year students,
- E. Gain Buy-In from Faculty and Staff – Prior to 2005, summer orientation activities were focused primarily on registering students for fall classes and little attention was paid to student development and successful transition from high school to college. Usually after the first or second week of summer orientation, it was often quite chaotic to help students build their schedules as classes in “popular” time slots of degree-required courses were filled up. The faculty and staff who were involved in summer orientation have since embraced the cohort strategy because seats in classes have been reserved and they can now focus attention on the program requirements and successful transition from high school to college during summer orientation. As a result of the buy-in, the tasks of creating the cohort schedule templates for summer orientation and identifying the course seats that need to be reserved have been assumed by the Advising Office instead of the STEP Principal Investigator. There is also now a pool of ~30 CEAS faculty and staff who have served as STEP mentors to draw from.
- F. Share Resources with Other Student Success Units on Campus – Some of the tools created by the STEP Project have been shared with other student success units on campus, these included a computer program and tracking website that uses swipe card readers to log students attending tutoring centers, and an IR report that takes the attendance data and reports student academic performance. This IR report has been renamed from “Student Success Engineering” to “Students Attending Success Center Sites” to reflect adaption by other academic units on campus, including the tutoring centers of Mathematics, Physics and Statistics; and the Bronco Study Zone. Our STEP project has benefited from this collaboration because we can now see if CEAS students use any of the student success sites across campus, not just those offered by CEAS-STEP. Our academic advisors and faculty mentors can also view data via the tracking website, which helps when meeting with students who may be struggling academically.
- G. Maintain Regular Communication with Campus Collaborators – It is sometimes easy to stay out of contact with collaborators on campus, especially when those interactions occur only once or twice a year. Maintaining regular communication is crucial to active collaboration. For example, our Residence Life collaborator alerted the STEP Project Team last year to an opportunity of collaboration on the WMU campus. STEP is now represented on a campus-wide committee on student success, because we maintain regular communication with the Resident Life Assistant Director. Regular communication is also key to ensuring shared resources are working as intended and for continuous improvement. For example, a collaborator recently suggested a change to the Student Success Centers’ tracking system that would show students’ majors on the tracking website. This helps all units gain an

understanding of which student populations are using the success services. Regular communication could also reduce duplication of efforts and resources.

- H. Focus on Delivering the Best Customer-Service -- STEP project staff embrace the ethos of “servant leaders” and aim to deliver the best customer-service to CEAS faculty and staff so they can succeed as STEP Mentors. STEP project staff also aim to deliver the best customer-service to support other collaborators on campus so they can succeed in their job of providing student success services. Our focus is always on student success.

Sustaining STEP beyond NSF Funding

When CEAS was reviewing and updating its strategic plan in 2012, sustaining STEP was identified by its faculty, staff and administration as a strategy to improve student retention and graduation. In fall 2012, the Board of Trustees approved Differential Tuition (DT) for CEAS, and the DT budget proposal approved by the Board of Trustees include a line for STEP when NSF funding ends. In January 2013 CEAS students started paying an additional \$40 per credit hour in differential tuition, and the income generated by DT is used for infrastructure and laboratory enhancement; faculty and staff professional development in teaching, learning, and advising; student scholarships, in addition to sustaining STEP activities.

The DT-STEP budget pays the salary for a full-time STEP program manager, and stipends for a graduate assistant, 2 senior tutors and 18 tutors servicing the Student Success Centers. The DT-STEP budget also includes STEP Mentors support, and programming and marketing expenses.

Retention and Graduation Rates and Comparison with Baseline

During summer orientation, when students are placed in STEP cohorts, their university-assigned identification numbers are entered into a database, which is identified by the academic year. For example, students placed into STEP cohorts during 2017 summer orientation are tagged as 2017 STEP. Each fall, an IR report is run on the data base to determine if the student is enrolled in or graduated from CEAS, is enrolled in or graduated from the institution but with a non-CEAS major, or not enrolled due to attrition. From the IR reports, the rates of retention to and graduation in CEAS are calculated.

The comparison of the retention and graduation rates of the first STEP award from 2005 to 2009 with baseline rates and with rates maintained by the Consortium for Student Retention Data Exchange (CSDRE) is shown in Table 1.

Table 1. Comparison of Retention and Graduation Rates in CEAS of STEP I with Historical Baseline and CSRDE

CSRDE ¹	WMU Baseline ²	Retention to CEAS	STEP I (2005-09) (Average 306 students)
69%	57.4%	2 nd Year	67.6%
53%	42.3%	3 rd Year	52.2%
NA	32.7%	4 th Year	46.0%
NA	32.8% ⁴	5 th Year	42.6%

40.7% ³	32.3% ⁴	6 th Year	42.4%
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¹ Data is for all institutions (Highly Selective, Selective, Moderately Selective, Less Selective) as reported in the 2005-06 Consortium for Student Retention Data Exchange (CSRDE). WMU is a “Moderately Selective” institution.

² CSRDE STEM Retention Survey, WMU Office of Student Academic & Institutional Research, data averaged over 2000-05.

³37.4% graduated in a STEM field in 6 years with another 3.3% returned the 7th year for a combined 40.7%.

⁴ WMU Office of Student Academic & Institutional Research, data averaged 2000-03.

Based on the results, we concluded that the cohort strategy of STEP I is correlated with an improvement in the 1st-to-2nd-year retention in CEAS from a baseline rate 57.4% to 67.6%, and the 6-year graduation rate in CEAS from a baseline rate of 32.3% to 42.4%. Furthermore, the retention and graduation rates in CEAS as a result of the STEP cohort project compare well with the CSRDE rates, which are the average rates of “highly selective,” “selective,” “moderately selective” and “less selective” institutions.

In STEP IB from 2010 to the present, we increased the number of students placed in cohorts from 304 first-year students annually (averaged over 2005-2009) to 343 first-year students (averaged over 2010-2017), representing an increase of placing from 75% to 90% of all first-year students who participated in summer orientation over the last eight years. Based on the recommendation of the STEP Advisory Board, we have chosen CSRDE peers for comparisons with STEP IB results.

Table 2. Comparison of Retention and Graduation Rates in CEAS of STEP IB Cohorts with CSRDE

CSRDE	Retention to CEAS	2010 Cohort (347 students)	2011 Cohort (296 students)	2012 Cohort (291 students)	2013 Cohort (373 students)	2014 Cohort (405 students)	2015 Cohort (394 students)	2016 Cohort (295 students)
63.9% ¹	2 nd Year	62.2%	60.1%	65.9%	67.4%	66.9%	66.2%	70.8%
NA	3 rd Year	49.0%	53.6%	56.7%	53.4%	50.9%	55.1%	
NA	4 th Year	45.0%	48.1%	49.5%	49.3%	45.6%		
NA	5 th Year	42.1%	44.3%	48.1%	49.1%			
27.9% ²	6 th Year	38.9%	41.9%	45.8%				

¹Data is for Moderately Selective institutions, averaged 2010-2014

²Data is for Moderately Selective institutions, averaged 2005-2009

The 2010 and 2011 Cohorts performed worse than STEP I and might be an anomaly, because the 2012 and later cohorts have similar rates of 1st-to-2nd-year retention to CEAS as STEP I. The 2016 Cohort with a 1st-to-2nd-year retention rate to CEAS of 70.8%, is higher than STEP I’s rate.

There are notable results of STEP IB: The gap between underrepresented minority (URM) students and majority Caucasian students in the 2nd year and 3rd year retention rates to CEAS began to narrow starting in 2013. Figure 3 below shows a gap of more than 10% between URM and majority students in the 2nd year retention rate to CEAS and to WMU in 2010 and 2011. The gap has narrowed to less than 5% in 2013, 2014, 2015 and 2016 between these two student populations.

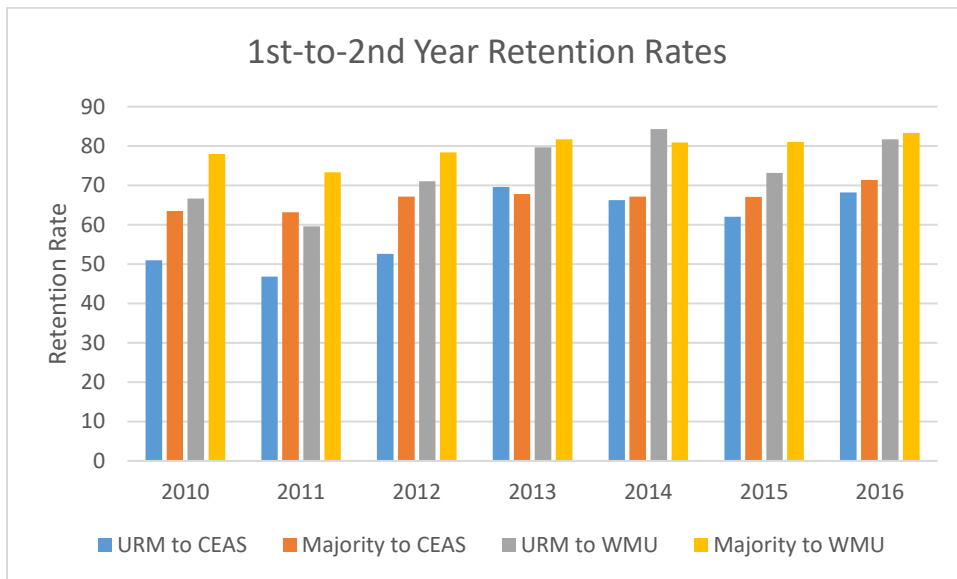


Figure 3. 2nd Year Retention Rates to CEAS and to WMU of URM and Caucasian Students

Figure 4 below shows the 3rd year retention to CEAS and to WMU for URM students and majority Caucasian students. Again, the gap between the two groups in 3rd year retention rates narrowed in 2013 and 2014 from 2010 and 2011, although the gap reappeared for the 2015 Cohort.

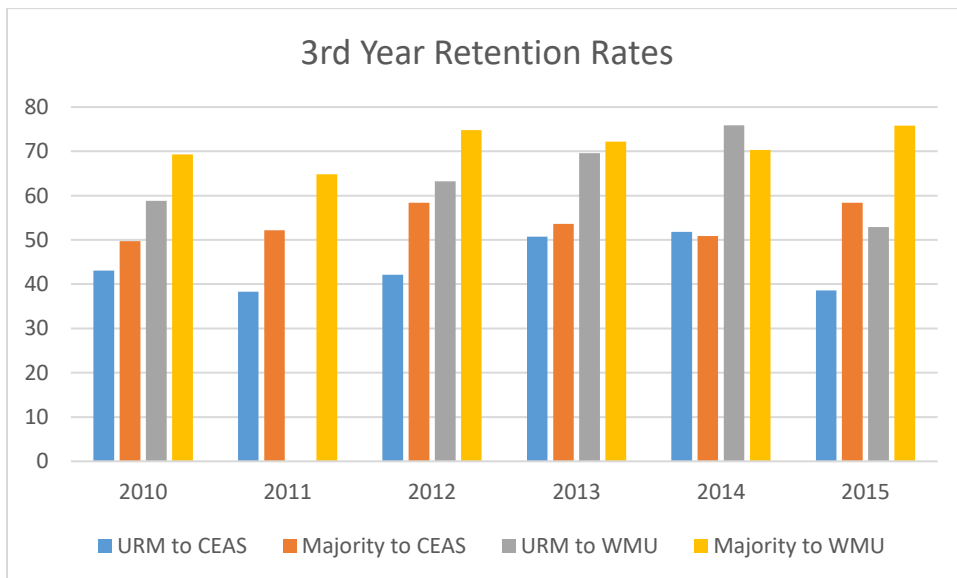


Figure 4. 3rd Year Retention to CEAS and to Institution of URM and Caucasian Students

Conclusion

This paper has described a methodology to scale up the strategy of placing first-year students into cohorts, and the factors that positively affect the institutionalization and sustaining the practice when external funding ends. Data show that the cohort strategy has led to improvement above the baseline in retention and graduation rates in CEAS, and these rates compare favorably with peer institutions.

References

1. The National Survey of Student Engagement (NSSE) at Indiana University, <http://nsse.indiana.edu/html/>.
2. Gabelnick, F., MacGregor, J., Matthews, R.S., and Smith, B.L. (1990). *Learning Communities: Creating Connections Among Students, Faculty, and Disciplines*, Jossey-Bass, San Francisco: CA.
3. Kline, A., Aller, B., and Tsang, E (2011), "Improving Student Retention in STEM Disciplines: A Model That Has Worked," Proceedings of the American Society for Engineering Education Annual Conference, Vancouver, B.C., Canada, June 26-29, 2011.
4. Stanford, C., Cole, R. S., Froyd, J., Henderson, C., Friedrichsen, D., Khatri, R. (2017). "Analysis of Propagation Plans in NSF-Funded Education Development Projects," *Journal of Science Education and Technology*, 26 (4), pp.418-437.
5. Foote, K., Knaub, A., Henderson, C., Dancy, M., & Beichner, R. J. (2016). Enabling and challenging factors in institutional reform: The case of SCALE-UP. *Physical Review Physics Education Research*, 12(1), 010103. <http://doi.org/10.1103/PhysRevPhysEducRes.12.010103>.