Documenting the True Extent of Attrition in STEM: The value of IR-Academic Collaboration
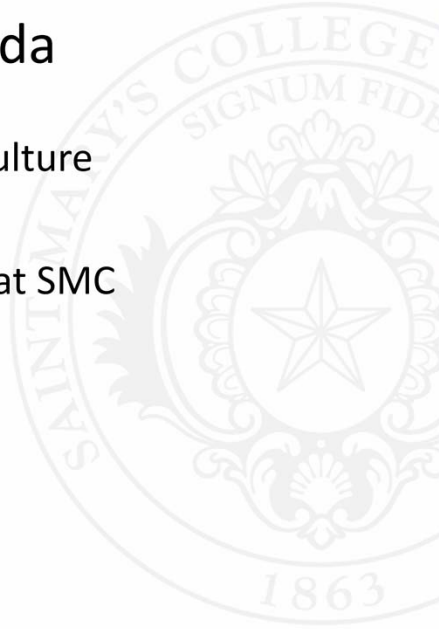
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CAIR Conference 2016

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Agenda

- National Concern and Culture

- STEM data for students at SMC

- What have we learned?

National Concern
STEM Degree Production

- Extensive literature about **STEM Degree Production**

- ***National Academies of Science, Engineering, and Medicine (2016).*** Barriers and Opportunities for 2-year and 4-year STEM Degrees: Systematic Change to support Diverse Student Pathways.

National Concern
STEM Degree Production

- STEM 'aspirants', STEM majors, STEM degree completion
- Differences by institution and student characteristics
  - Underrepresented minority
  - low-income
  - first generation
  - Disproportionately in community college and four year public
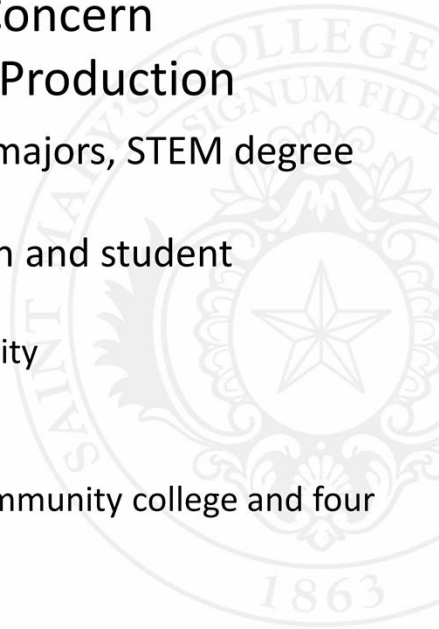
Culture of UG STEM Education

"Explicit and implicit customs and behaviors, norms, and values that are normative within STEM education"

- Inherent or natural ability determines capacity for STEM learning
- Introductory math and science courses as gatekeepers (or "weeders")

Culture of UG STEM Education

- The liberal arts college responsibility (Severinghaus, 1953)

  "The liberal arts college, therefore, has the important responsibility of trying to prevent students from cherishing inappropriate professional ambitions too long ... Effort should be made as early in the student's college career as possible to determine whether, on the basis of personality, character, motivation, and academic performance, he is qualified to go into medicine. If it is decided that he is not qualified, then every intelligent device ... should be used to persuade him to reevaluate his professional objective."

Culture of UG STEM Education

- Grading practices and instructional practices
- Racial and gender stereotypes
- Stereotype threat
- Stigma
- Mentor's dilemma
- Mathematics, low grades and loss of confidence

Liberal Arts   Science
Economics & Business Administration
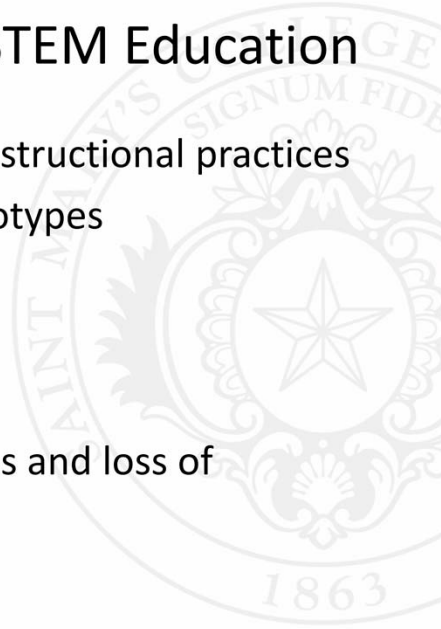
Saint Mary's is nestled in the hillside of a valley just east of San Francisco Bay. We have three UG schools within the college, Liberal Arts, Science, and Economics and Business Administration. Two graduate schools, School of Education and Economics and Business Administration.

Fall 2016
2,654 TUG
59% Female
26% Hispanic
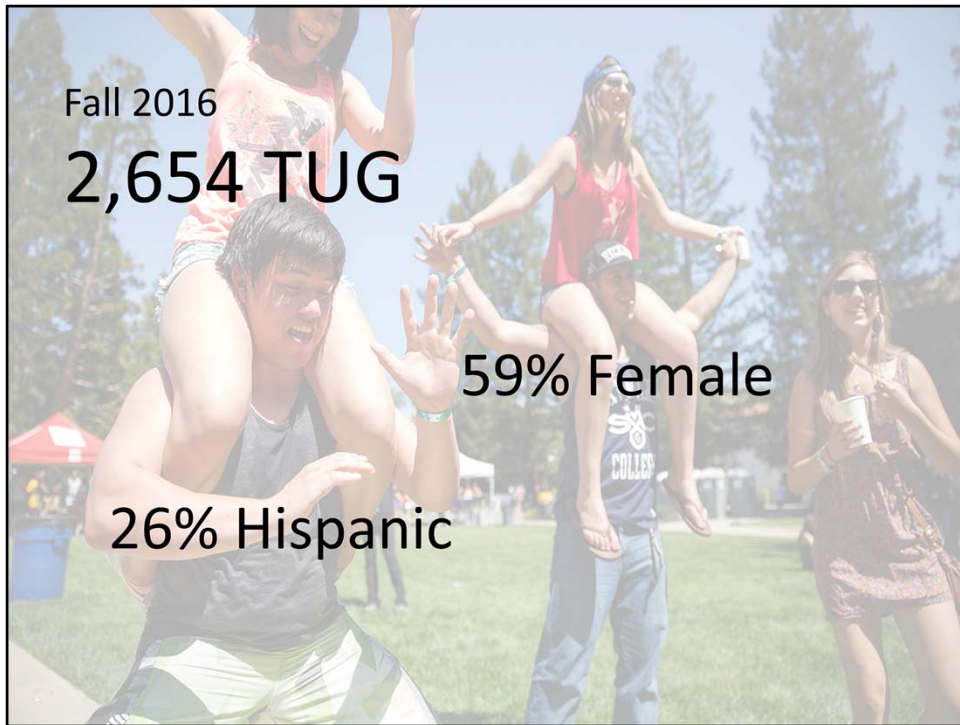
Our 2,654 TUG students and 1,262 GPS enjoy a 13-1 faculty to student ratio. We are 59% Female and 26 % Latino. SMC is a Hispanic Serving Institution and this year applied for a Dept. of ED Title III grant for STEM and Articulation Program.
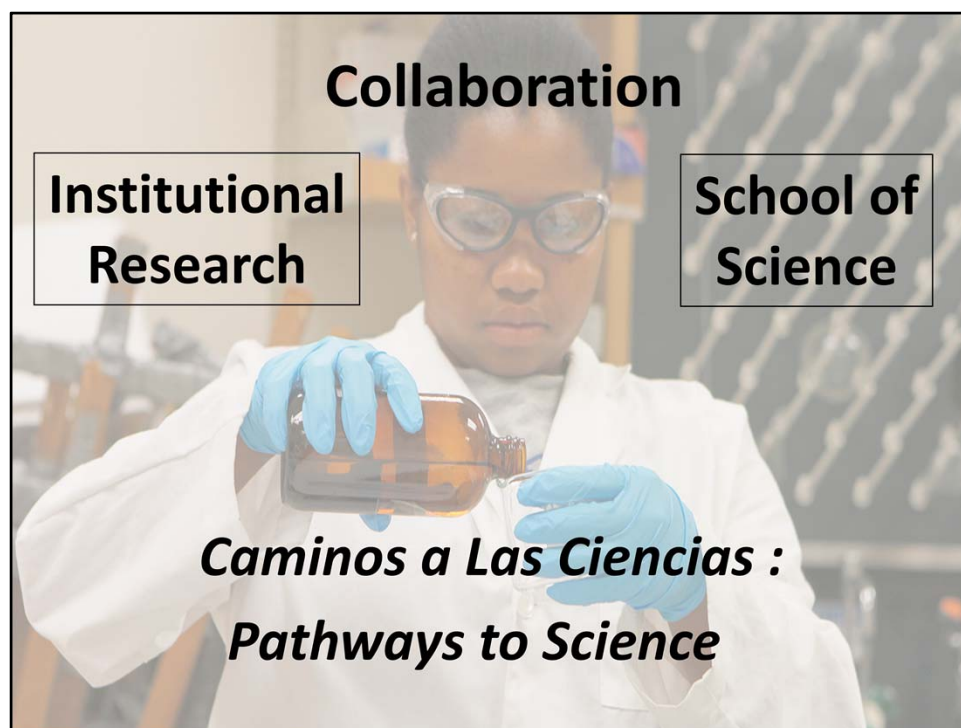
The title of their proposal is Caminos a Las Ciencias: Pathways to Science. The purpose of the grant is find supportive ways to increase the number of Hispanic and / or low-income undergraduates completing a degree in a STEM major.
This presentation is the product of the collaboration between the School of Science and Institutional Research in preparing this grant proposal. The data shown here were used to craft the proposal to attain the grant.
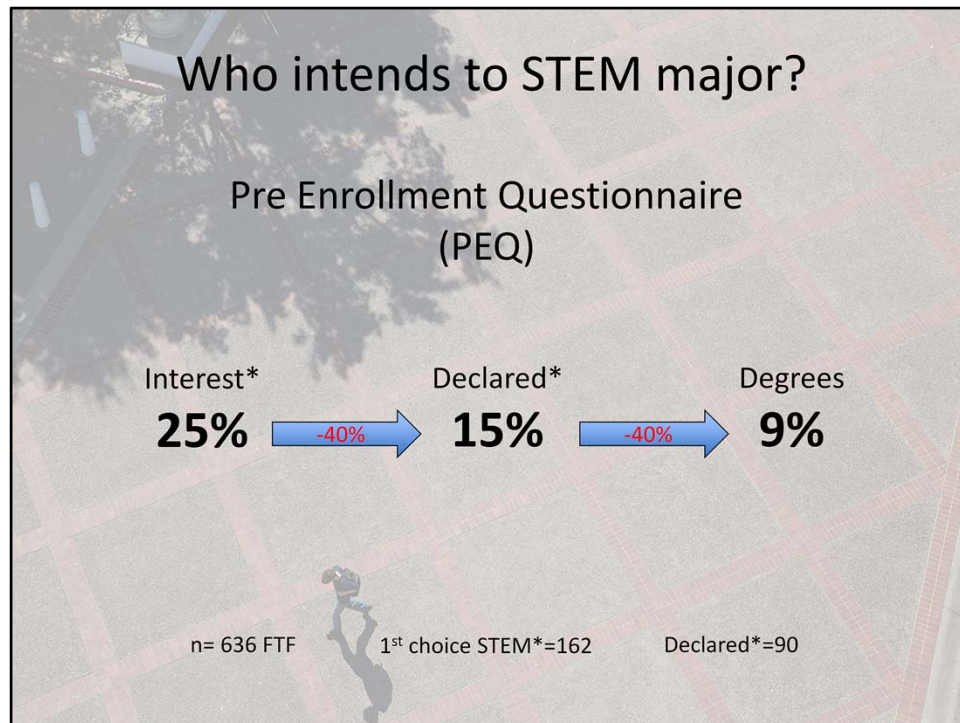
School of Science at Saint Mary's

1. Biology
2. Biochemistry
3. Chemistry
4. Earth & Environmental Science
5. Math
6. Physics
7. *Allied Health*
8. *Psychology*

Which majors are we considering for STEM in the SOS: These first six would be considered as traditional STEM, our SOS also has an Allied Health degree which is included in STEM because it was part of the majors for this grant, Psychology is excluded and is placed in the 'other than STEM' degree for outcome.

Graduation Rates

STEM

First Time Freshman

82%
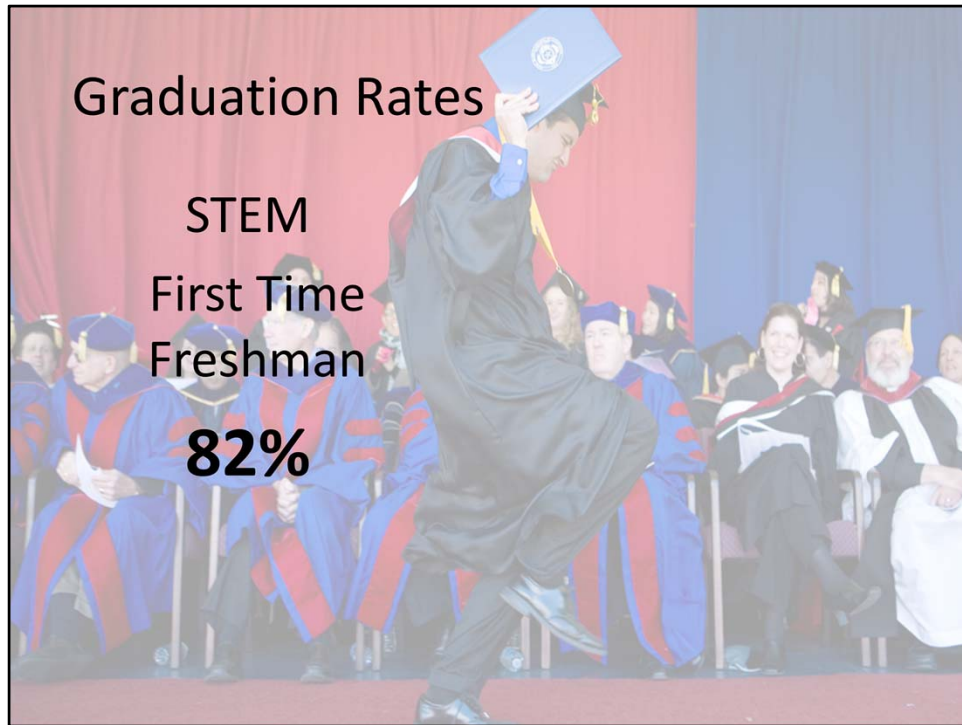
Using these degree programs, for all First Time Freshman from 2008-2011, the average graduation rate for these cohorts who declared in a STEM major is 82%. Wow! However, in using this graduation rate, we had to consider that before 2012, students at SMC didn't have to declare a major until degree verification; the average time for major declaration was at the end of the second year with most declaring well into their 4th year. Needless to say, prior to 2012, the graduation rates for STEM were most likely a bit misleading. So, how could we find the data for students who started with the intent of a STEM major?

Who intends to STEM major?

Pre Enrollment Questionnaire
(PEQ)

| Interest* | | Declared* | | Degrees |
| 25% | -40% | 15% | -40% | 9% |

n= 636 FTF   1st choice STEM*=162   Declared*=90

A Pre Enrollment questionnaire could help us. In the past, Pre Enrollment questionnaires, administered through admissions, were to establish advising and course selection for incoming students. If we had these we could compare them to our STEM graduates. Unfortunately, all of these informal paper questionnaires were discarded or unavailable. Luckily, in 2014, IR began sending PEQ surveys to admitted students requiring a response for registration. Now, these PEQ surveys are housed and distributed, through IR in collaboration with admissions. Using the Fall 2015 PEQ responses we found that 220 had a STEM as first or second choice, we felt having only the a 'first' choice as STEM to a better indicator of the 'aspirant' STEM students, 162 (25%) had a 1st choice as STEM. In spring, we found that 90 of these students declared in STEM by the end of their freshman year, a 40% decline from interest. Historically, using our 2008-2011 cohorts, the average cohort graduation rate in STEM is a whopping 9%; another 40% decline from declared; for a total of 64% overall reduction from interest to degree. What's happening in the pathway to science with these students who show a strong 'interest" in STEM at the start?
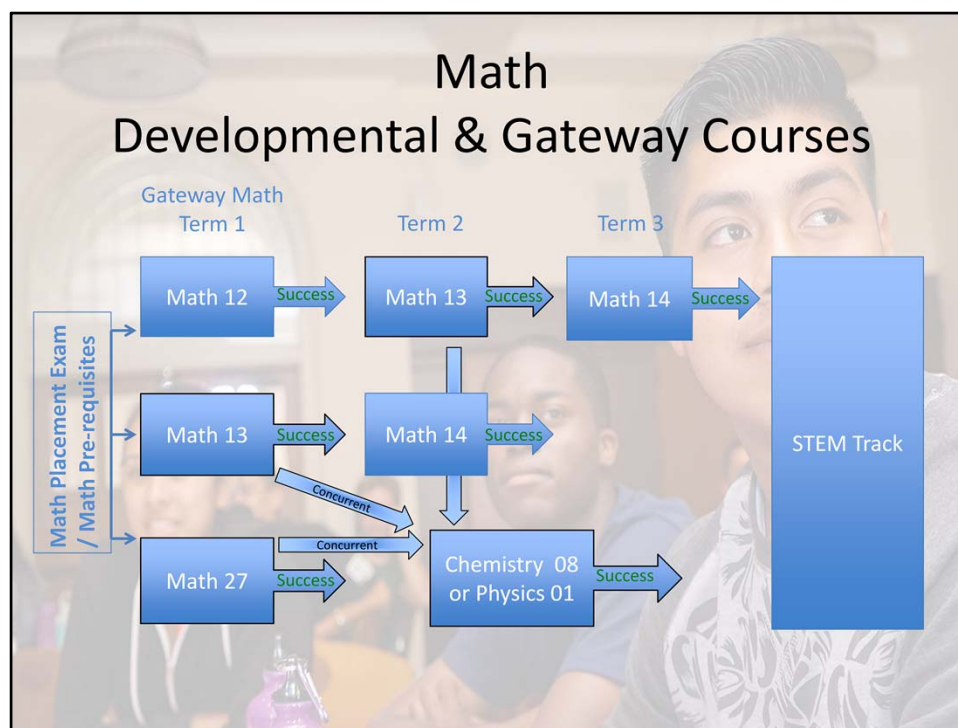
As with most institutions, the 'Pathway to Science' is through a group of gateway courses. The Dean suspected that the 'weeding' may be occurring in the Developmental and Gateway Math courses.

STEM 'aspirant' students are placed in one of three Math courses and must successfully complete the courses or course to move on in a STEM curriculum. Success is defined as a C- or better to advance. Students are placed in a Developmental or Gateway Math course based on the Pre-requisite Math and their Math Placement test scores. Developmental Math 12, 13, 14 – Readiness for Calculus; Math 13, 14 both series equivalent to Math 27, Calculus with Elementary Functions.

If a student is placed in Math 12, he/she must complete two more semesters of Math and cannot start into a core science course until the second semester. If placed into Math 13 or Math 27 a student can take Chemistry or Physics concurrently. Success in these courses, allows a student to move forward.

This presentation focuses on the analysis of student preparation, placement, and performance in these developmental and gateway math courses to determine a baseline for the grant submission.

Preparation & Placement

2008-2015 FTF student data for all gateway math courses
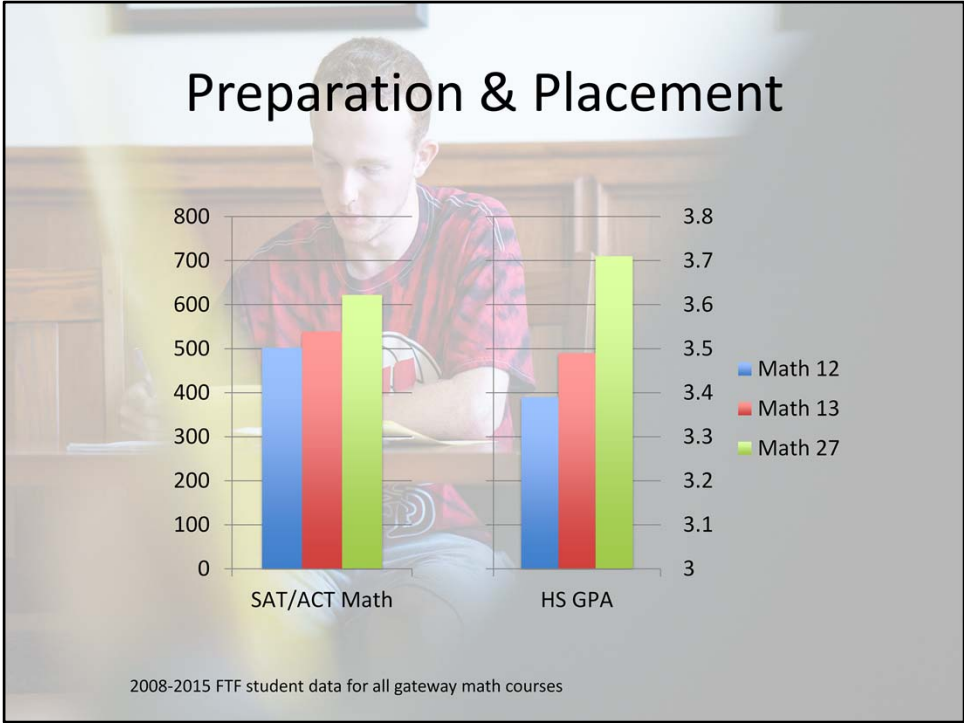
We first looked at entering student's preparation and placement into the courses. This data uses all 2008-200-15 FTF students taking these courses in their first semester. Looking at high school GPA and SAT/ACT Math scores to summarize preparation, given that they also took a placement test for these courses, there is an obvious positive relationship between both test scores and high school GPA with Math course assignment. There is a 0.32 difference in HS GPA and a 120 point difference in test scores between Math 12 and Math 27 students.

What does this mean for the demographics of the courses?

Placement Demographics

Gender

2008-2015 FTF student data for all gateway math courses
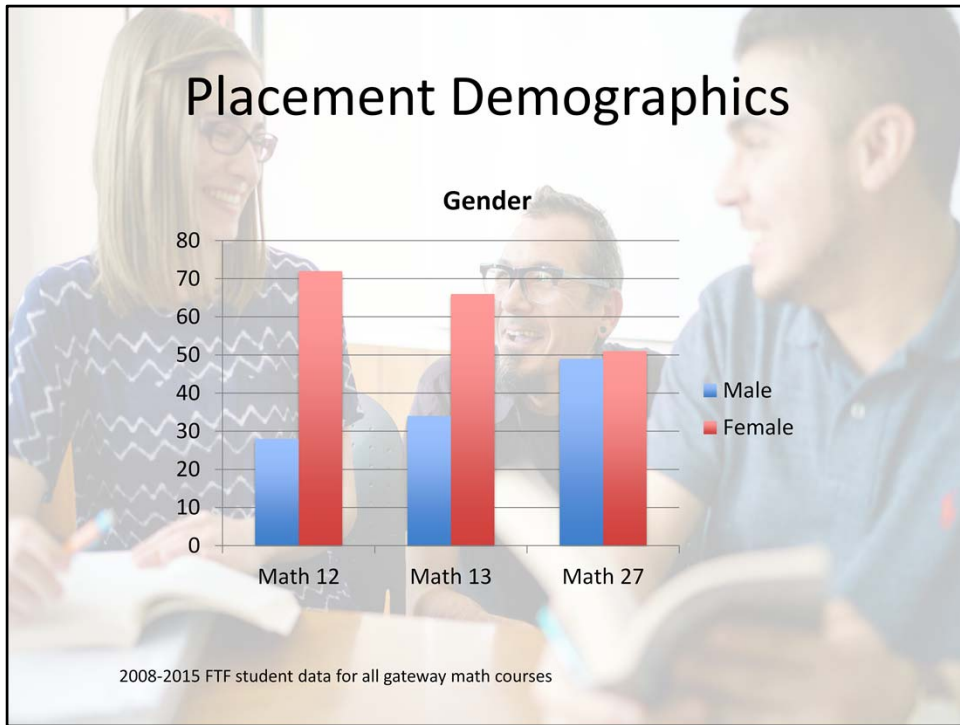
Moving on to the gender distributions in this courses, we find that females are over represented in both Math 12 and Math 13, and though equally represented in Math 27, under represented by SMC standards for women. There is a opposite trend for the distribution of gender between courses females in decline and males increasing from Math 12 to Math 27. Is this reflective of female preparation (high school courses) for STEM degrees? Or are there other reasons for these distribution differences.
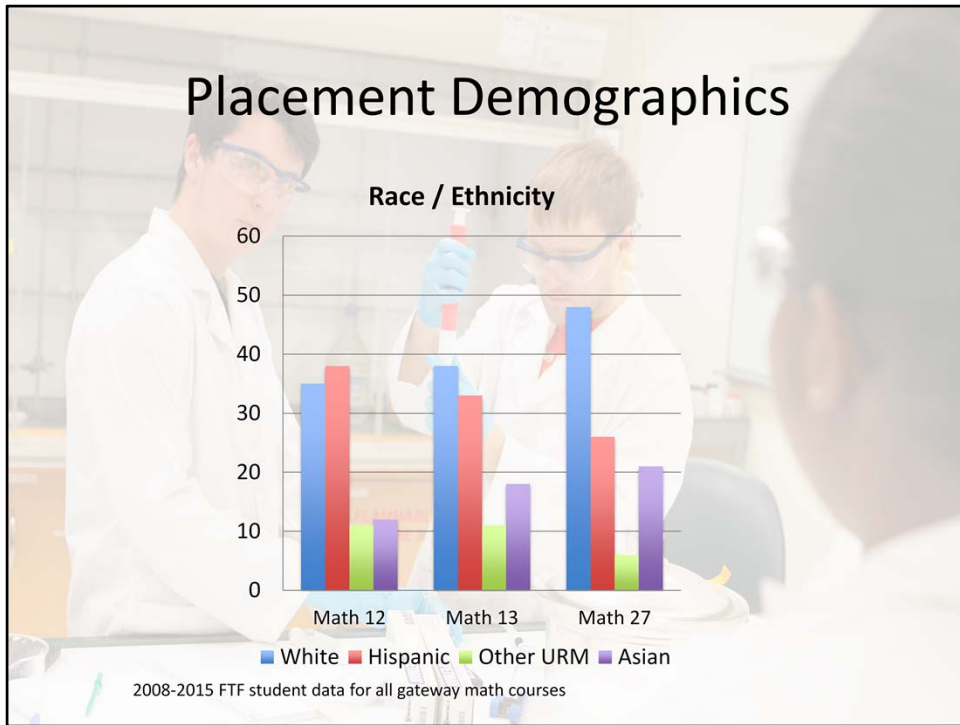
Placement of students based on their ethnicity and race shows us that the Hispanic students are over represented in both Math 12 and 13 and under represented in Math 27.   We also notice an opposite trend for enrollment/placement in Math 12 to Math 27 for white and Hispanic students.

Placement Demographics

% First Generation | % Low Income

2008-2015 FTF student data for all gateway math courses
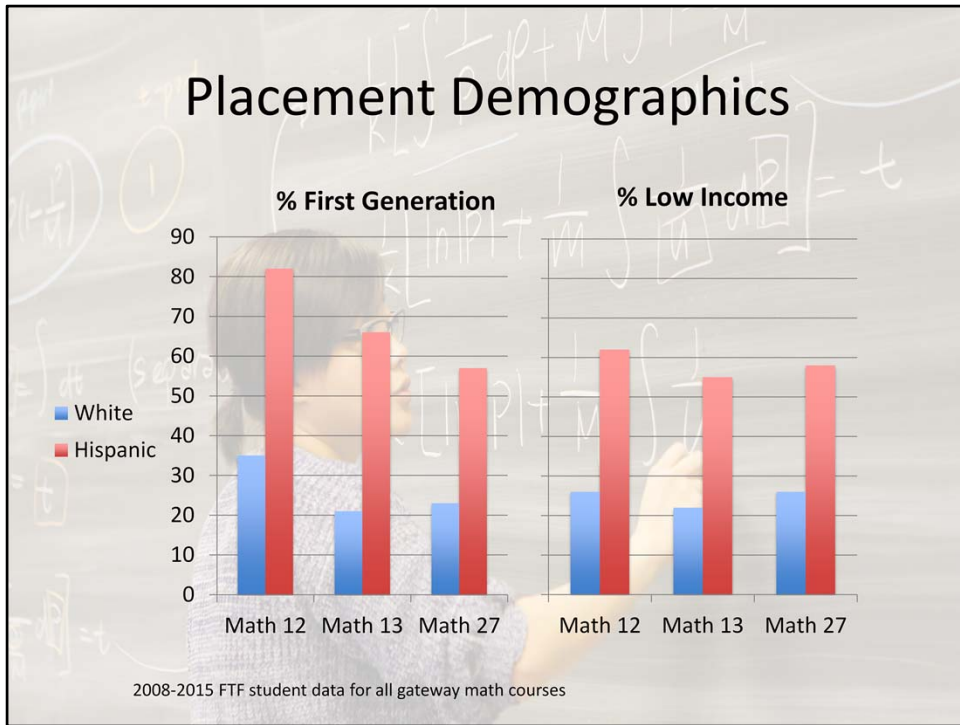
For the sake of this grant, the decision was made to use the white students as a comparison group for our Hispanic population.

We know that Hispanic students are more likely to be first generation and/or also low income, so we looked at the comparison of these groups within the courses. We find that the Hispanic FG students were over represented in all Math courses with over 80% of the Hispanic students FG in Math 12. We also notice a decrease for Hispanic FG students from Math 12 to Math 27. Using Pell eligibility as an indicator of low income, the Hispanic students are also over represented, though not to the extent as FG, and we don't see a trend between the math courses.

Math Gateway Course Outcome
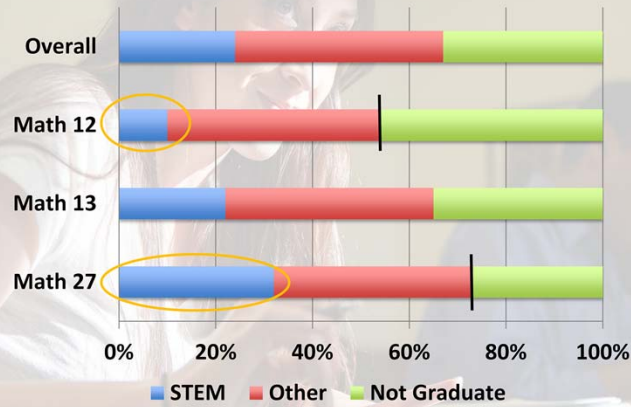
With the demographic of the courses well described, we turned to outcomes for students who take these courses. Again making the assumption FTF student's who take these Math courses in their first term make them 'aspirant' STEM students, they had graduation rate of 67%, with 24% of those in STEM. However, when you break out the specific courses, remarkably there is an almost a 20% difference in overall graduation rates between Math 12 and Math 27 (54%-73%). What is also striking, is that the STEM graduation rate from Math 12 is only 10%, and also startling to us and to the Dean of the school of Science, only one third of the students who are in the higher-level STEM gateway Math course graduate with a STEM degree.

Math Course Performance and Graduation

| Program		A	B	C	D,F
STEM	-12	**23**	15	10	0
	-13	44	24	16	4
	-27	**53**	41	31	5
Other	-12	63	56	42	22
	-13	31	42	49	43
	-27	25	30	42	53
No Grad	-12	14	29	48	**78**
	-13	25	34	35	**53**
	-27	22	29	27	**42**

*2008-2011 First Time Freshmen. Math course in first term.

How does performance in these courses influence attaining graduation.

We didn't see any difference in the overall grade distributions between these Math courses. Analyzing what effect grades had on outcome in these courses; outcome, being measured by graduating with either STEM or an 'other than STEM' degree or not graduating; we found that 23% of the Math 12 students who get an A graduate with a STEM degree graduate in STEM, where as 53% of Math 27 A students graduate in STEM. Clearly, if a student succeed with a B or better in Math 27, they graduate in stem more than 40% of the time. However a majority of students who get an A or B in Math 12 graduate in an 'other than STEM' discipline, but if they fail Math 12, they are more likely to not graduate. Notably, Math 13 and 27 also are about 50/50 to graduate in 'an other than STEM' or not graduate.
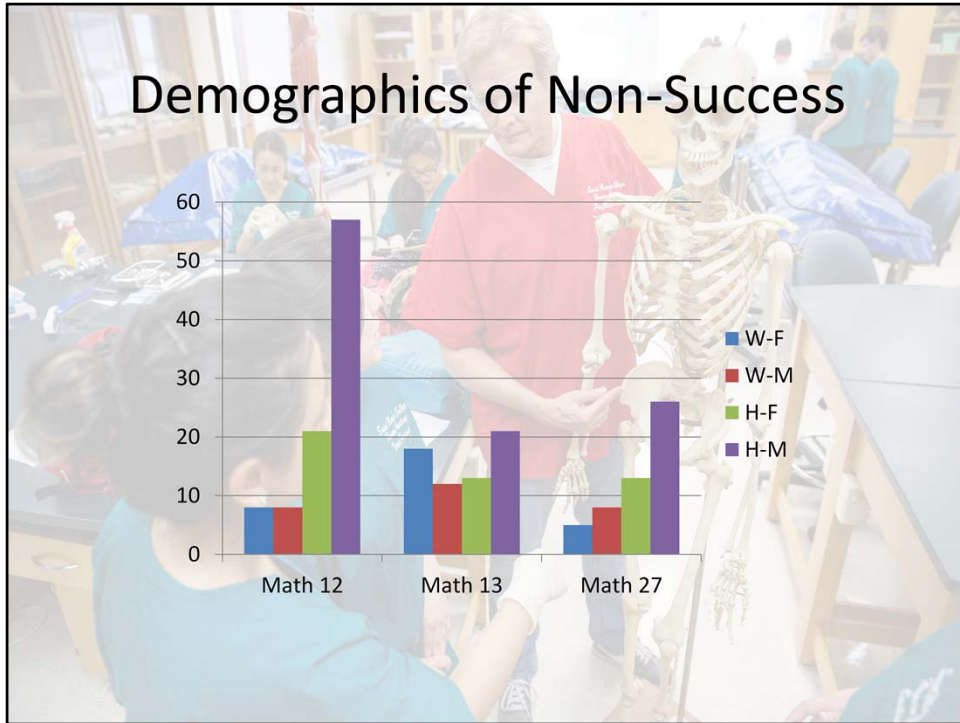
Going one step further into the data, we look at the Demographics of failure in these Math courses by looking at the % of only the students receiving D's & F's within their population, we find over 50% of Hispanic Male students failing in Math 12 in contrast to 8% of white male students. There is also a contrast in Math 27, with 20% difference in failure rate between white male and Hispanic male students. In addition to the male students, there is a 13% difference in non-success for the female white and Hispanic student's in Math 12. There are little differences with within all of the gender comparisons in Math 13.

Gender Effect on STEM Graduation*

*2008-2011 First Time Freshmen. Math course in first term.
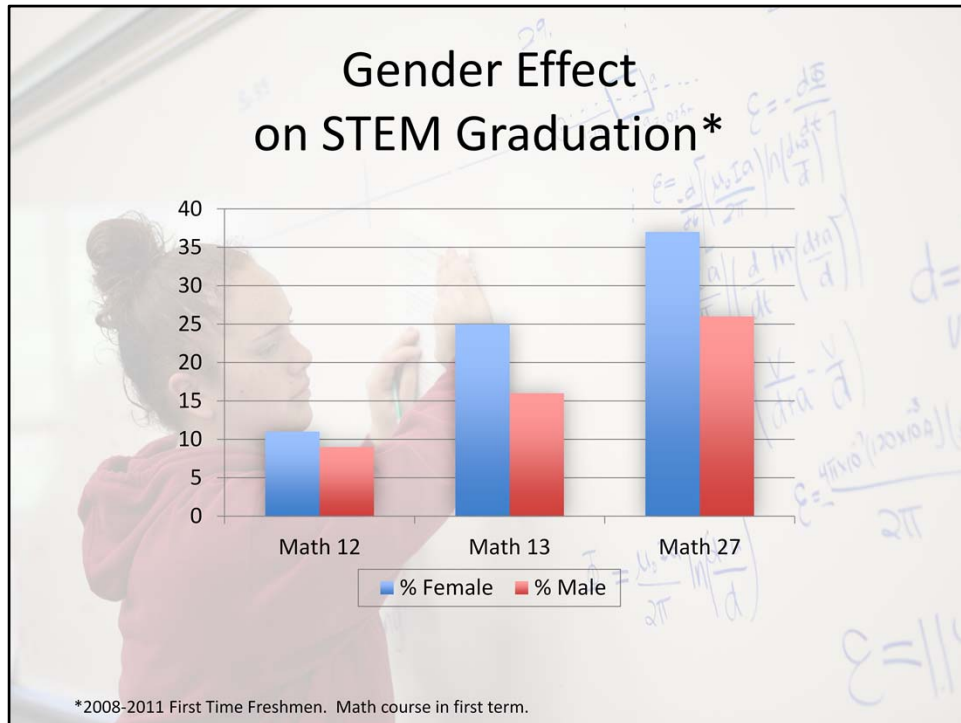
So what else may be happening within our population to influence these outcomes? We can turn to the demographics of the outcomes in these courses to find some answers.

We know that female students are over represented in Math 12, however, they graduate in STEM at about the same rate as male students. It is also notable in Math 27, that female students, which are in roughly the same numbers as male students, but under represented at SMC, graduate at a higher rate in STEM. Traditionally, we would expect to find males dominating the STEM disciplines in composition and outcome. However, we find that females graduated in STEM more than males in all of these Math courses at SMC.

First Generation Effect on Graduation
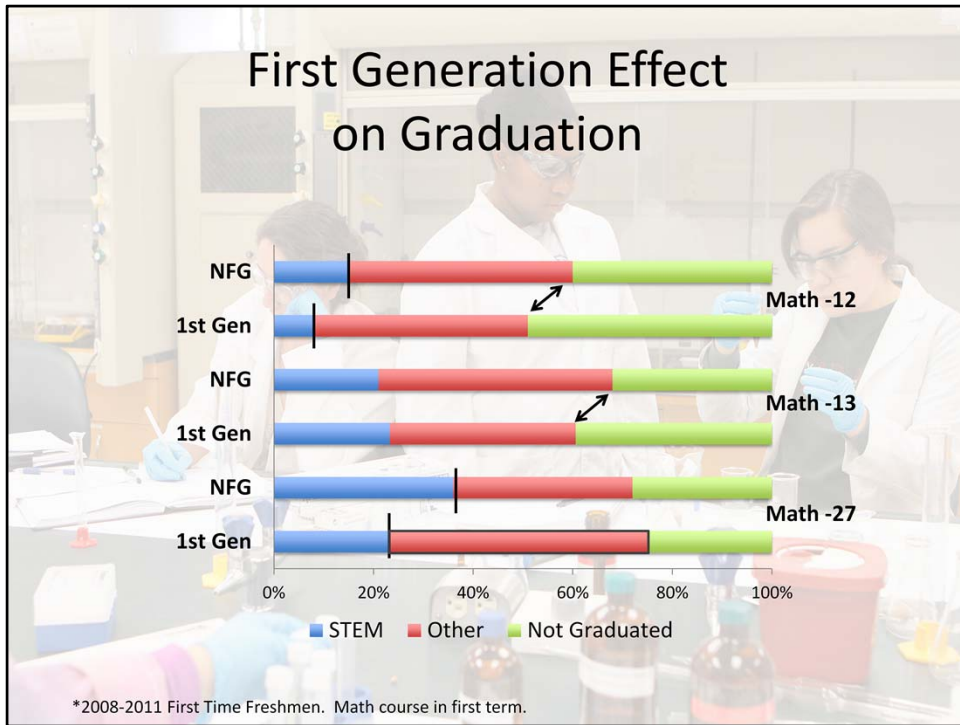
Even though we saw that the Hispanic low income, student population was higher in Math 12 and 13, we didn't find any effect of low income on the graduation rate of these students in the math courses.

However, we do see an effect of First Generation students in these courses on graduating in STEM. FG students in Math 12 and 27 graduate in STEM less than Non FG, with Math 12 FG graduating in STEM at only 8% about half of NFG. FG graduate less overall than NFG when in Math 12 & 13. And lastly, in Math 27, while the number of students not graduating is about the same for FG and NFG students, over half of the FG students graduate in an other than STEM degree program, while NFG graduate equally in both STEM and other programs.
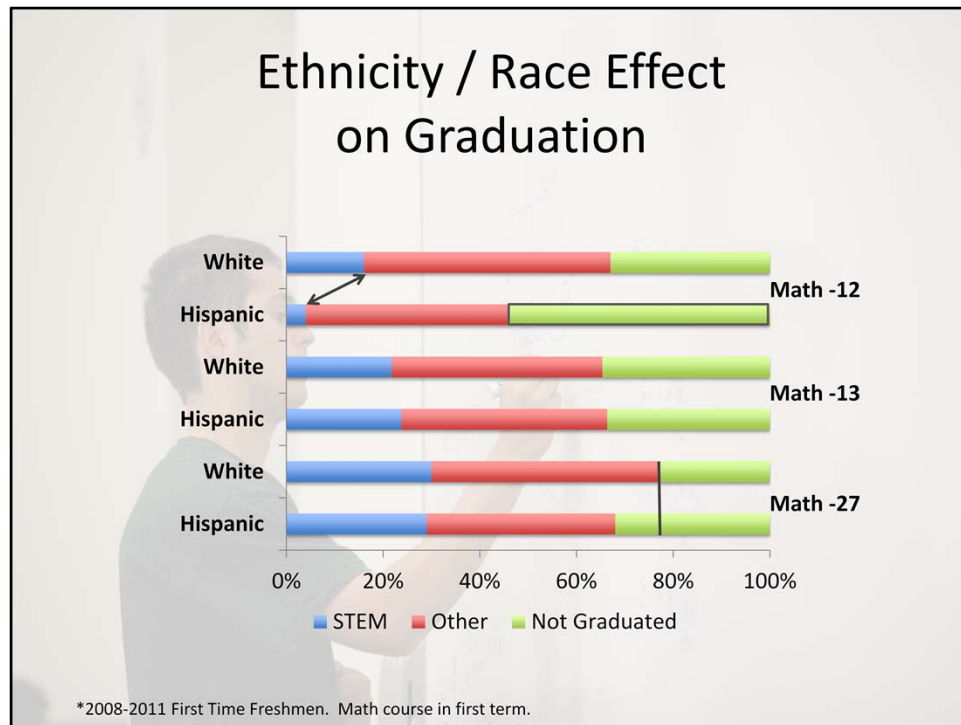
Remembering that the White and Hispanic composition of the Math 12 & 13 courses was about the same, but the Hispanic students were over represented in FG in both these courses, we find that the difference in graduation between the Hispanic and White students is most evident in the Math 12 course. Only 4% of the Hispanic students who took Math 12 graduating in STEM compared to 16% of White students. In addition, 54% of Hispanics did not graduate, compared to 33% of white students. The differences between these populations are not in evidence in Math 13. But in Math 27, where the Hispanic students ARE under represented, it isn't in STEM graduation where we see a difference; it is in graduating at all. Instead of graduating in another program, like their white peers, 10% more of Hispanic student do not graduate.

Success in Math Pathway

			% Total	% Other	% Not Grad
Math 12-13-14	Hispanic	Pass	21	80	0
		Not Pass	79	32	68
	White	Pass	31	50	25
		Not Pass	69	52	37
Math 13-14	Hispanic	Pass	65	40	31
		Not Pass	35	50	47
	White	Pass	64	48	29
		Not Pass	36	40	53
Math 27	Hispanic	Pass	64	29	26
		Not Pass	36	58	42
	White	Pass	80	44	19
		Not Pass	20	55	41

Lastly, we looked at the success of Hispanic and White students in the pathway to science.

In the Math 12-13-14 series 79% of Hispanic students did not pass through the first two courses. While this number is high, we also find that 69% of white students did not pass through this series of courses. Although, 63% of those non-passing white students graduated while only 32% of the Hispanic non-passing students did. In the Math 13-14 series there was little difference in the pass-not pass numbers, although of note, for Hispanic students, the same numbers pass in this series as the Math 27 series. However, the white student-passing rate was 80% in Math 27.

We know from the previous analysis that Hispanic students graduate less overall in Math 27, but these differences are not attributable to not passing. Not passing Hispanic students behave the same as not passing white students in their graduation pattern. It is Hispanic students that pass Math 27 who contribute to the graduation loss from Math 27 with 26% of those passing not graduating, however, passing Hispanic students do have a higher STEM graduation rate than passing white students (45%-37%).

Simple Summary

- Placement and performance determine outcome in STEM
- Overall graduation rate in an other than STEM is about 43%

  - **Math 12:** most difficult path to STEM degree, only 1 out of 10 students graduate in STEM and only 54% graduate overall

  - **Math 13:** most even playing field; 2 out of 10 students graduate in STEM 65% graduate overall

  - **Math 27:** most likely will graduate (72%), but surprisingly only 3 out of 10 graduate in STEM

- Effects on outcome
  - **Gender**: males less likely to graduate than females
  - **Ethnicity / Race**: Hispanic students have a more difficult path
  - **First Generation**: greatest effect across all courses
    - most evident in Math 12

Recapping all of this in a simple way.

Placed in Math 12 – overall very little chance of graduating in STEM (10%) and only 54% will graduate at all.
Placed in Math 13 – most even playing field for placement. Over 20% graduate in STEM and 67% overall.
Placed in Math 27 – most likely to graduate (72%) but surprisingly only 30% graduate in STEM.
These outcome are effected by Gender: Males are less likely to graduate than females. Hispanic males have a high rate of failure in Math 12.
Ethnicity: Hispanic students have a more difficult path.
First Generation has the greatest effect across all courses, but is most evident in Math 12

This data was used in one form or another, by the grant writing team, to construct an effect support mechanism for all 'aspirant' students with a focus on Hispanic / low income for the purposes of grant submission.

What have we learned?

- STEM majors: Our results

- Our experience working with the School of Science on the grant proposal
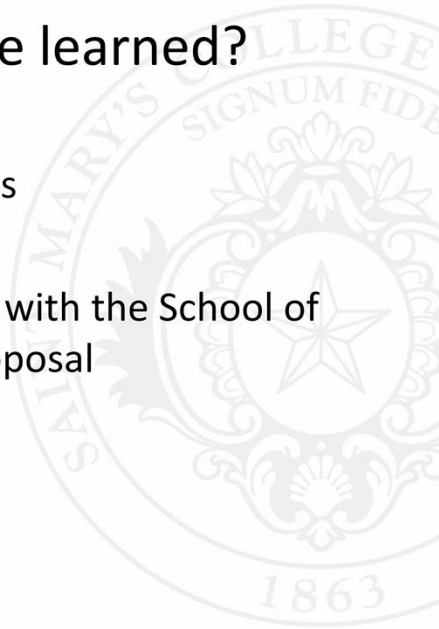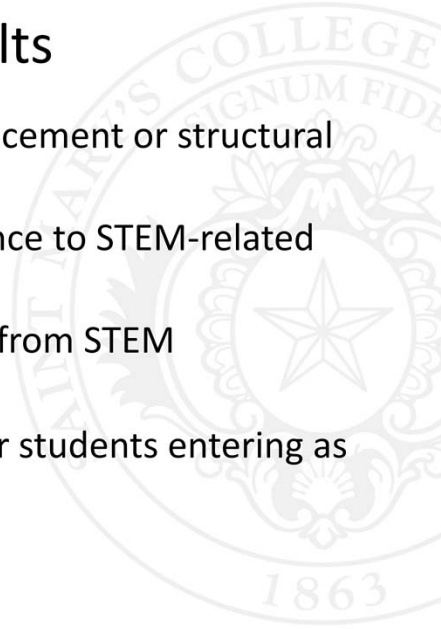
Results

- Initial concern: Perceived difficulty of Hispanic and low-income students to navigate math 'gateway' courses to STEM

- Our analysis of preparation, placement and performance in 'gateway' math courses and the relationship to four year graduation in STEM major
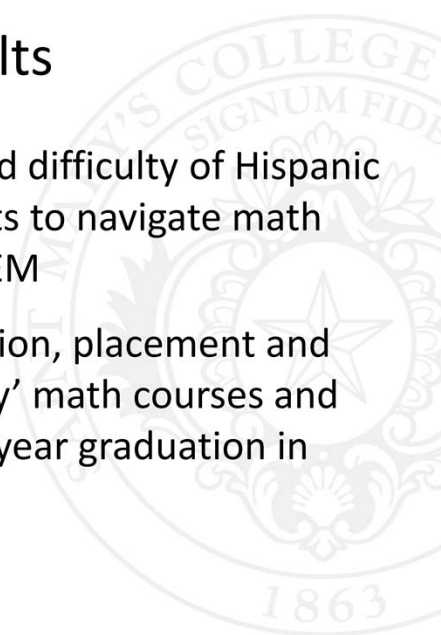
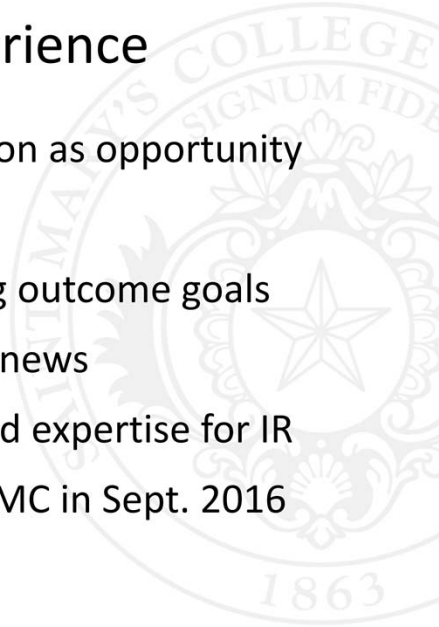# Our Experience

- IR-Academic Collaboration as opportunity

- The value of our data

- Our expertise in defining outcome goals

- Being the bearer of bad news

- Increased knowledge and expertise for IR

- Grant was awarded to SMC in Sept. 2016 (5 year $2.7 million)

Questions?