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Recruiting Undecided Admits to Pursue a STEM Degree

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Recruiting Undecided Admits to Pursue a STEM Degree

Abstract

This paper details the use of evidence based practices in a strategic effort to recruit, and then retain, undecided admits into a science, technology, engineering and mathematics (STEM) learning community designed to increase student success in STEM and, ultimately, the number of STEM degrees awarded. The primary goal of the National Science Foundation funded learning community (LC), COMPASS, focuses on tapping into the pool of students who have good math potential, but are undecided in a career path, to increase the number of students entering the STEM pipeline. To accomplish this goal COMPASS must first increase the number of undecided non-STEM students converting to STEM disciplines and then increase the STEM retention rate of this group.

The primary intervention is a two-year learning community model enhanced by other evidence based practices including mentoring, curricular cohorts, tutoring and undergraduate research. To foster a unique learning environment where students are comfortable exploring the STEM disciplines, COMPASS places undecided, non-STEM students into one of two tracks during the first-semester in college where they complete a Career Planning: STEM Explorations or STEM Seminar course. In addition to the Career Planning and STEM Seminar courses, students also enroll in cohort math courses throughout the first year, are assigned a STEM program advisor, have the opportunity to live in block housing, receive an upper-division STEM peer mentor, interact in a designated STEM Center with program peers and STEM graduate tutors and participate in an early undergraduate research experience.

This paper discusses COMPASS' infrastructure, the evidence based practices implemented to achieve its objectives, the results from these activities and the career readiness research as well as lessons learned in the first three years of the LC's operation. Early results show positive steps in recruitment of undecided students and first-year STEM retention while the Career Planning course participants show a significant decrease in their decision making confusion and look more like their STEM counterparts with less commitment anxiety. This project fills a gap in research on successful STEM recruitment and retention strategies as well as the integration of career readiness assessments and career development interventions in determining early indicators and long-term success of potential STEM recruits. Communities impacted include students displaying confusion regarding career decisions who benefit from early intervention and education on STEM opportunities; education disciplines with a focus on career planning and student development programs; and graduate students whose tutoring of students will eventually help them to be better teachers in their academic careers.

Introduction

Responding to the national emphasis on the need to increase the number and diversity of well-prepared students entering the STEM (science, technology, engineering, and mathematics) workforce[1], the goal of the National Science Foundation funded learning community (LC) COMPASS (Convincing Outstanding Math-Potential-Admits to Succeed in STEM) focuses on tapping into the pool of students who have good math potential[2], but are undecided in a career path, to increase the number of students entering the STEM pipeline and ultimately earning STEM degrees. To accomplish this goal COMPASS must first increase the number of undecided non-STEM students converting to STEM disciplines and then increase the retention rate of this group in STEM. By creating a two-year learning community model with educational enhancements based on evidence based practices including career planning, mentoring, curricular cohorts, tutoring and undergraduate research, COMPASS has been aggressively pursuing these goals.

Though some estimate more, approximately 25% of the entering undergraduate population begin as an undeclared major, of which about 16% switch into a STEM discipline.[3] Another seven percent move into STEM from non-STEM majors. Though these students move into the STEM disciplines, many leave STEM prior to degree completion. Beggs, Bantham, and Taylor[4] suggested that there are basically four categories of factors that influence the career decision making process. Included in these are the (a) influences of other individuals (family, friends, teachers) or media, (b) rewards of the job (extrinsic and intrinsic), (c) fit and interest in the field and (d) characteristics of the major/degree (ease of coursework, faculty reputation, exposure to introductory material). The researchers implied that students made career decisions based not on education about the options and assessment of their personal values, interests and beliefs, but on influence and assumption. Research shows that participation in a career planning course can assist students in making an educated decision regarding their future while increasing retention[5, 6] and academic performance (GPA), decreasing negative thoughts about career choices[7] and increasing student confidence about career plans.[8]

Not all undecided students will have the interest, skills or abilities for declaring a major in a STEM discipline. For STEM recruitment from the undecided population to be successful additional criteria should be identified. Nicholls et al.[2], while investigating variables for predicting STEM enrollment, concluded that two factors, advanced high school math and science courses and the Math SAT, ranked as the highest predictors of students selecting STEM. This lends support for targeting undecided students with higher Math SAT scores and high school math grades for participation in the career planning and learning community experience.

Once recruited into STEM, research suggests that a holistic, multi-pronged approach[9, 10, 11], rather than a single intervention, may be necessary to solve retention issues and the nation’s STEM crisis. Seymour and Hewitt[12] identified several reasons students leave the STEM disciplines including difficulty with required math courses, poor teaching by STEM faculty, loss of confidence due to low grades in the early years and losing interest in STEM. No one intervention can address all of these factors. This paper details the COMPASS Program’s use of evidence based practices in a strategic effort to recruit, and then retain, undecided admits into a STEM learning community designed to increase student success in STEM and, ultimately, the number of STEM degrees awarded.

The Learning Community

The University of Central Florida (UCF) is a growing metropolitan university in Orlando, FL and the second largest university in the nation, serving a student population with high percentages of STEM underrepresented groups. Of UCF's undergraduate STEM majors, 32% are underrepresented minorities and 37% are females (2015 UCF data).

To foster a unique learning environment, the COMPASS learning community utilizes a number of educational interventions where students are comfortable exploring the STEM disciplines, become confident in the career decision-making process and are more likely to retain to graduation in the STEM discipline. These interventions are evidence based with strong support in the literature.

The **goal of the COMPASS learning community** *is to increase the number of students entering the STEM pipeline and ultimately earning STEM degrees*. The project has **four objectives**. The first objective (Recruit) is to attract 400 students per year *listed as undeclared (or non-STEM) majors with math SAT scores greater than 550* into COMPASS (LC participants). The second objective (Capture) is to increase the number of the COMPASS students declaring a STEM major at the university. Institutional data shows that this group of students typically experiences the same, if not greater, attrition after declaring a STEM major as students who start in a STEM major. The third objective (Retain) is to increase the number of COMPASS students remaining in STEM majors by increasing their retention rates compared to the University's STEM population. This will result in more STEM degrees at the institution, throughout and after the grants funding period. The fourth objective (Research) is to determine how Career Readiness and Career Interest assessment results correlate to students selecting STEM and being successful in STEM.

To achieve the first objective (Recruit), an aggressive marketing campaign is conducted to inform the community of the opportunities available to STEM students at the University, primarily freshmen, through the COMPASS program. In particular, students and parents of admitted undecided and non-STEM students are informed of the program's benefits (i.e., career exploration, block housing, cohort math courses, mentoring, tutoring). Details of the COMPASS recruitment activities are discussed in the Overview of Objectives. Through year four of the grant, 795 students have participated in COMPASS.

To achieve the second objective (Capture), the undecided, non-STEM students are placed into one of two tracks during their first-semester in college where they complete a Career Planning: STEM Explorations or STEM Seminar course. These courses assist students with the decision making process or in confirming the declaration of a STEM major. Capture is determined by students declaring a STEM major by the beginning of their second term, after the Career Planning or STEM Seminar interventions. The STEM majors, grouped by college, included for this study are: (a) College of Engineering and Computer Science (Aerospace, Civil, Construction, Computer, Electrical, Environmental, Industrial, Photonics and Mechanical Engineering, Computer Science), (b) College of Medicine (Biomedical Sciences, Biotechnology) and (c) College of Sciences (Biology, Chemistry, Forensic Science, Mathematics, Physics and Statistics). Table 1 outlines the breakdown of those who started in COMPASS by college (declared major beginning of second term), gender and ethnicity and the total university STEM population for each cohort year. Gender and ethnicity data are calculated as a percentage of the individual college's population. Additionally in the first term, participants are enrolled in the COMPASS math cohorts which are taught by hand-picked Mathematics faculty and graduate mentors. These same graduate mentors joined by a group of science graduate students serve as tutors in the COMPASS Center. Upper-division STEM peer mentors are assigned to work with the students during the first term answering questions about the STEM experience, coursework and general transition issues.

Table 1. Demographic data by college, gender and ethnicity for the COMPASS *captured* and UCF populations for cohort years 2012-2015

		Cohort Year											
		2012			2013			2014			2015		
		Total	#	%	Total	#	%	Total	#	%	Total	#	%
UCF STEM	Total		2376	39%		2236	37%		2461	38%		2650	41%
	Male		1509	64%		1369	61%		1605	65%		1679	63%
	Female	6065	867	36%	6051	867	39%	6456	856	35%	6456	971	37%
	Black		217	9%		219	10%		238	10%		246	9%
	Hispanic		483	20%		524	23%		610	25%		612	23%
CECS (STEM LC)	Total		7	19%		31	36%		168	62%		259	65%
	Male		4	57%		18	58%		134	80%		222	86%
	Female	37	3	43%	87	13	42%	272	34	20%	400	37	14%
	Black		0	0%		4	13%		7	4%		20	8%
	Hispanic		2	29%		6	19%		46	27%		46	18%
COM (STEM LC)	Total		1	3%		13	15%		26	10%		52	13%
	Male		0	0%		6	46%		13	50%		20	38%
	Female	37	1	100%	87	7	54%	272	13	50%	400	32	62%
	Black		0	0%		2	15%		2	8%		6	12%
	Hispanic		1	100%		3	23%		9	35%		7	13%
COS (STEM LC)	Total		10	27%		13	15%		35	13%		42	11%
	Male		3	30%		5	38%		15	43%		16	38%
	Female	37	7	70%	87	8	62%	272	20	57%	400	26	62%
	Black		2	20%		2	15%		8	23%		3	7%
	Hispanic		1	10%		3	23%		8	23%		13	31%
Non-STEM (LC)	Total		19	51%		33	38%		43	16%		33	8%
	Male		2	11%		13	39%		26	60%		16	48%
	Female	37	12	63%	87	20	61%	272	17	40%	400	17	52%
	Black		3	16%		2	6%		7	16%		0	0%
	Hispanic		4	21%		8	24%		4	9%		10	30%

To achieve the third objective (Retain), the project faculty designed a carefully thought out set of evidence based practices proven to increase the retention of students once declared in a STEM discipline. The most significant of these to increase retention[13, 14] is the development of a learning community within the group. The first four strategies (advising, cohort STEM courses, graduate and peer mentors) are actually implemented during the "capture" phase of encouraging students to declare STEM, but are well known retention practices. The retention process begins as early as the designated COMPASS orientation sessions where participants meet their First Year advisor. A housing block is offered to those interested in the living-learning community experience. The COMPASS cohort math courses are offered each semester and though participants are required to enroll in these courses during their first year in COMPASS, they can continue with the courses until completing the math sequence for their major. The COMPASS Tutoring Center, called the "Center", serves as a support for students while taking early math and science courses required for the STEM disciplines. Though students continue to identify as members until graduation, the formal portion of the program culminates with an undergraduate research experience in the spring of their second year. A full list of the retention strategies can be found in Table 2.

Table 2. COMPASS interventions to increase retention in STEM

COMPASS Retention Activities
Designated academic advisor (First-Year, College)
Cohort STEM courses (Math, Career Planning, STEM Seminar)*
Graduate mentors/tutors*
Peer mentor*
Designated orientation sessions
Welcome and kick-off programs
COMPASS Tutoring Center*
Living-learning community (block housing)*
Undergraduate research experience*

*evidence based practices identified in the literature review

To meet the fourth objective (Research) of determining how Career Readiness and Career Development assessment results correlate to students selecting STEM and being successful in STEM, instruments designed to register increases or decreases in career readiness factors are implemented in a pre/post format for all participants and a control group.

The remainder of this paper will detail the support, development and implementation of the COMPASS LC. Specifically, (a) a comprehensive literature review supporting the evidence based practices implemented by COMPASS to increase recruitment and retention in the STEM disciplines; (b) a discussion of the COMPASS management structure; (c) a detail of the educational plan; (d) an overview of the implementation of activities related to each objective; (e) an overview of program assessment to date; and culminating with (f) a discussion of lessons learned and future plans for COMPASS.

Literature Review

As mentioned, COMPASS relies on a number of evidence based practices to increase the recruitment of students into the STEM disciplines and, further, their continued retention to graduation with a STEM degree. These practices, which include learning communities, academic support centers, tutoring, mentoring and undergraduate research, are supported by the literature and were well documented by the project PI[15] as summarized in this section.

Learning communities. There are many classifications of learning communities identified in the literature. Only those relevant to the COMPASS LC are addressed in this review. Curricular learning communities enroll a cohort of students in intentionally linked courses around a theme, in this case science and math[16]. These courses are typically offered in the first year of study. This type of LC provides intentional interaction among students and with faculty around specific discipline courses in order to build a community.[16, 17] Student-type learning communities bring students of a particular population together, in this instance STEM. The final type of learning community exhibited in COMPASS is the residential learning community, often referred to as living-learning communities. In general, students who live in residence halls have been shown to have higher levels of (a) social interaction with faculty and peers, (b) persistence, (c) satisfaction with the institution, and (d) commitment to the institution.[17] Pascarella, Terenzini and Blimling[18] found that these benefits increase when intentional learning communities are introduced into the residence hall environment. Expanding living-learning communities to be used in conjunction with curricular learning communities provides students the opportunity to carry academic conversations outside the classroom into their living environment which allows for an overlap between students' social and academic activities.[19, 20] COMPASS creates a learning community based on cohort participation in STEM based classes with other students like themselves with an opportunity for a residential component based on the students' specific academic interests, a combination of the types of learning communities mentioned above.

To increase the chances of retention, students must be involved early with both faculty and peers in the academic and social systems of the institution.[13, 21-25] Learning communities assist in this process.[26] Institutions implement learning communities as a way to increase student involvement, build community, create a connection to the curriculum, enhance student-student and student-faculty interaction, and ultimately retain students.[19, 27, 28] With recruitment being a primary goal, COMPASS embeds undecided students in a cohort around a particular academic interest.[29, 30] The negative effects of STEM disciplines on persistence in the major and timely graduation, especially engineering[31, 32], make this type of a learning community important. Students grouped with like-minded peers are more likely to emulate the characteristics of that group.[18, 33] These peer groups are a known positive influence on retention and are more likely to form around a common purpose.[34, 35]

Academic support center. An academic support center is one example of safe, shared spaces[16, 19, 13] where students and faculty can informally come together outside of class to enhance learning. COMPASS provides such a space for its students, referred to in this paper, as the COMPASS Tutoring Center. Creating environments that encourage study groups[36] lends to the success of learning communities. Peer and academic involvement, both accomplished through students studying together, are two of the most potent types of involvement[33] in which students can participate.

Tutoring. The academic support center created for COMPASS provides math and science tutoring, a service that plays a role in the retention of students.[37] Research shows that tutoring is overwhelmingly the most used service[38] by students and those who participate in tutoring experience an improved transition to and increased sense of belonging within the institution[39], both important outcomes of a first-year learning community. Providing academic support for students in their discipline has always been a key retention strategy, especially in the areas of science and mathematics. A 2005 survey of American Society for Engineering Education member institutions[40] found tutoring at the top of the list of retention program options offered to undergraduate students. COMPASS offers tutoring for the participants at the designated COMPASS Tutoring Center and block housing facility.

Mentoring. Student mentorship works in improving student learning[41] and engagement in one's chosen field. Despite the absence of a comprehensive theory of what mentorship is, there are four major domains comprising the mentoring concept, as identified by Nora and Crisp.[42] The four latent constructs include: (1) *psychological and emotional support,* (2) *support for setting goals and choosing a career path,* (3) *academic subject knowledge support aimed at advancing a student's knowledge relevant to their chosen field* and (4) *specification of a role model.* In this STEM LC, student participants are provided mentors throughout the first two-years of the college experience: peer mentors and graduate assistants in the freshman year and faculty and graduate students in the sophomore year research experiences. Haring[43, 44] refers to this as a networking mentorship model. Others involved in the COMPASS mentoring process include program advisors assigned to students and industry professionals introduced to students through networking sessions and the Career Planning and STEM Seminar courses.

Undergraduate research. Over two decades ago, the National Research Council[45, 46] encouraged the use of undergraduate research to transform the approach to training future STEM professionals. These opportunities allowed students to prepare for the more flexible future workforce and taught the skills necessary for lifelong learning. More recently, others[47, 48, 49] repeated the importance of continuing research and involving undergraduate STEM students in the process. Furthering the relevance of how these experiences influenced students, Hunter, Laursen and Seymour[50] found students who did not initially view themselves as a "scientist" did so after an undergraduate research experience (URE) while others have shown that early exposure to UREs show positive effects on students including increases in retention rates[51, 52] and gains in critical-thinking skills.[53] Students in COMPASS receive exposure to the research environment and introduction to the research experience during the first-year Career Planning and STEM Seminar courses with a semester long URE opportunity in the second-year of their STEM academic career.

Management Structure

The COMPASS PIs established a management structure for the program. Four committees were envisioned: The *Internal, External, Project* and *Assessment* committees. The *Internal Committee* consisted of the University Provost (chair), the dean of Undergraduate Studies (US), the project PI and the deans of the Colleges involved (Engineering and Computer Science (CECS), Sciences (COS) and Medicine (COM)). Due to the departure of the Provost, a college dean vacancy and an interim Dean of US, it was decided that the best way to communicate challenges and accomplishments of the project was through smaller group meetings with the Internal Advisory Board (IAB). For this reason the COMPASS Project Committee appointed the Dean of COS as the chair of the Project's IAB. This appointment provided stability at the helm of Project IAB until the new Provost had the chance to acclimate himself with the institution. Therefore, since the grant's inception, the Project Director has met regularly with all members of the board, apprising them of the challenges and accomplishments of the grant effort. The *External* chair, also a project Co-PI, connected with an extended group of industry stakeholders through his Dean's Advisory Board and through his many one-to-one interactions with several other university stakeholders interested in the success of students pursuing a degree in a STEM discipline. So, instead of an External Advisory Board that meets periodically and discusses challenges and accomplishments of the grant effort, the COMPASS project committee chose to inform industry stakeholders through: (a) Dean's Advisory Board meetings and (b) face-to-face interactions of the dean with individual industry stakeholders. The Dean of Sciences follows a similar approach in informing his external stakeholders of the successes of these programs. It is notable that CECS and COS represent 84% of the students involved in the COMPASS program. The *Project Committee* has as its members the Grants Specialist hired by COMPASS, an Undergraduate Program coordinator, the Career Planning course instructor, the First Year COMPASS advisors and the Co-PIs in this grant effort. The role of the committee is to oversee all of the student support services planned for the program, address the day-to-day needs and to act as an advocate for the students. This committee meets monthly to provide guidance to the project and information to the Internal and External committees. The *Assessment Committee* has as its members the Assistant Director of the Faculty Center for Teaching and Learning (for the training of faculty and graduate students), the Director of Office of Excellence and Operational Assessment (for assessment and evaluation), the Director of Institutional Knowledge Management (for the collection of needed data), the project PI, and the STEM Explorations course coordinator. It is expected that COMPASS will continually improve throughout the period of the grant as a result of formative assessment and feedback from the Internal, External, Project and Assessment Committees. In addition to those listed, the College of Education and Human performance and the Offices of Housing and Residence Life and Undergraduate Admissions work closely with the Project Committee to support project efforts.

Educational Plan

Through year four of the grant, 795 students were recruited to participate in the STEM LC. These students follow block scheduling within COMPASS for the first year with a continuation of offerings in mathematics in the second year, depending on the need of their intended major. Figure 1 illustrates the schedule students follow. Bold classes are blocked for project participants and are taught by project faculty. In the first semester all students participate in a math cohort relative to their math placement. Students are required to complete a math placement test or provide proof of college level math credit prior to admission into COMPASS. The program offers cohorts in College Algebra, Pre-Calculus and Calculus I, II and III. Students placing at a lower level (Intermediate Algebra) than what is offered by COMPASS can participate in the program, but only in the Career Planning or STEM Seminar cohorts and subsequently, join the math cohorts in year two.

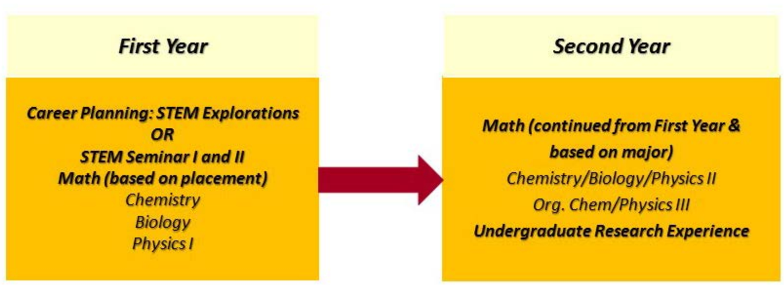

Figure 1. Pictorial of block scheduling for STEM LC students in years 1 and 2

As COMPASS is first and foremost a STEM recruitment program, the project team initiated two interventions to support students in selection of a STEM major. During the first semester of enrollment, the Career Planning: STEM Explorations course is required of all undecided or non-

STEM declared students participating in COMPASS. This course is a modified version of the Career Planning course offered at the institution structured to include STEM career exploration as a major part of the class. This class is designed to introduce students to career and life planning theories and concepts and to help students apply these to their own lives with emphasis on STEM careers. Research[54, 55] advocates the importance of learning about oneself, the world-of-work and the importance of cognitive decisions to identify the best career fit which supports the course division into three parts: Who am I?, Where am I going? and How do I get there?. "Who am I", addresses the self- assessment portion of the course and includes the Choices career interest profiler, Holland's RIASEC, Myers Briggs and the integration of each of these into a STEM career plan. This segment addresses competency. "Where am I going" incorporates guest speakers from the STEM consortium (faculty and STEM professionals participating in COMPASS) on careers which address relatedness. "How do I get there" provides onsite (faculty lab) experiences where students observe scientists and engineers in their work environment which addresses autonomy. The work for each of the phases culminates in a Career Action Plan, STEM major selection and a Major research paper. Table 3 provides course content details.

Table 3. Career Planning: STEM Explorations course plan

WHO AM I? Personal Assessment	
Weeks 1-5	• Career Thoughts Inventory; Career Development Inventory; MyPlan Career Assessments (personality/interest inventory, values assessment, skills profiler) • Exploration of values associated with STEM career: STEM-related values Card Sort activity • Personality type and STEM Careers: synthesizing personal assessments
WHERE AM I GOING? The World of Work in STEM	
Weeks 6-10	• Guest Lectures: Life Sciences (Biology, Chemistry, Forensic Sciences); Engineering (Civil, Construction, Environmental, Industrial, Electrical, Computer, Photonics, Mechanical, Aerospace); Physical and Natural Sciences (Mathematics, Physics, Statistics, and Computer Science) • Synthesizing the STEM World of Work • O*Net (Occupational Network Database Online) summary • Expectations and deliverables discussed for experiential learning component
HOW DO I GET THERE? Experiential Learning and STEM Major Identification	
Weeks 11-16	• Ethics in STEM professions • Experiential Learning Labs (Options of UCF or Industry Labs) • Synthesizing and integrating experiential learning lab experiences • STEM comparison and Fit Chart (personality, interests, values, social, cultural and numerical fit score) • Major Selection and Career and Major Action Planning

The STEM Seminar is required of all participants who were undecided or non-STEM, but declared a STEM major directly before the first semester of enrollment. The importance here is to embed these new recruits into a community of STEM learners, seeing others with similar goals and aspirations, to help clarify and confirm their STEM decision. The STEM Seminar incorporates math reviews, STEM faculty and industry professional lectures, lab visits and, of course, embedding COMPASS students with other STEM students. In addition to the specific purpose of each class, another benefit is the creation of a cohort where a learning community continues to form.

Overview of Objectives

The first objective (Recruit) involves an aggressive marketing campaign to inform the community of the COMPASS Program available to first-time-in-college (FTIC) STEM students at the University. A student brochure and accompanying parent postcard were created to recruit participants from the University's admitted pool of non-STEM and undeclared students. The parent postcard invites parents to review the program website and encourage students to apply. The brochure outlines the benefits of being in COMPASS (i.e., career exploration, block housing, cohort math courses, mentoring, tutoring), and invites University admitted students to apply to COMPASS. A series of email messages developed for recruitment are sent as follow up to the direct mailings approximately two and four weeks after receipt of the student brochure. A program web-site (URL here) highlights benefits as well as program components for both current and prospective students. The site provides an introduction to COMPASS faculty, staff, students and support offices in addition to an explanation of the program benefits and details of the Career Planning: STEM Explorations course. An on-line application allows interested admits to apply to COMPASS. Current students access the site for information regarding news and events, program activities and the COMPASS Center schedule. An admissions committee, consisting of the COMPASS director (PI), Grant Specialist and the Director of Undergraduate Admissions, assesses and decides on the status of each COMPASS applicant. As Math SAT scores are one of the highest predictors of selecting STEM[2], participants are chosen from applicants with a minimum 560 Math SAT score or an ACT math quartile equivalent. The committee considers a number of factors in addition to the Math SAT/ACT scores before a positive admission decision can be made: major declared at application to the university and at subsequent intervals and courses completed by the student during high-school, amongst others. Factors such as gender and ethnic diversity are taken into account. Review of these applications begins in late December and continues through mid-August, if necessary. In year two of the grant, the decision was made to divide the COMPASS students into two groups upon acceptance into the program. Pathway one consists of those students who apply to the university and enroll in their first term as undeclared or non-STEM majors. Pathway two consists of students who apply to the university as undeclared or non-STEM, but by the time of enrollment in their first term have declared a STEM major. This retention intervention is warranted because these students are as likely, if not more so, to leave the STEM disciplines prior to graduation.

The second objective (Capture) is determined by students declaring a STEM major by the beginning of their second term, after the Career Planning or STEM Seminar interventions. The originally undecided, non-STEM students are placed into either Pathway one (Career Planning: STEM Explorations) or Pathway two (STEM Seminar). The Career Planning: STEM Explorations course is required of all COMPASS Pathway one students and is offered each summer and fall term. Spring was excluded due to a lower student recruitment cycle for the university during this term. Faculty from the STEM areas deliver discipline specific lectures and lab visits to develop and encourage student interest in the various fields. Twelve faculty from the natural, physical and life sciences, engineering, biomedical science and computer science disciplines are involved in the course. The STEM Seminar I and II are required of all COMPASS

Pathway two students. All COMPASS students are enrolled in an appropriate cohort math course each semester. Math graduate mentors are assigned as teaching assistants in the COMPASS cohort sections of the math courses attaching the mentoring process to a more formal classroom setting. The Science and Engineering graduate mentors are assigned to the Career Planning and STEM Seminar classes to participate in the classroom discussions, allowing these graduate students to get to know COMPASS participants outside the math and science course realm. Additionally, all of the graduate students serve as tutors in the COMPASS Center. Peer mentoring, based on a well-established and successful existing program Girls EXCELling in Math and Science (GEMS)[56], is offered in the first term of enrollment in association with the Career Planning course to aid undecided students in the transition into the STEM disciplines. Upper-division STEM peer mentors are assigned to work with the students answering questions about the STEM experience, coursework and general transition issues. Mentors are paired, one science and one engineering, in an effort to (a) provide expertise across disciplines in case students have questions and (b) ease the load of a large mentoring group on an individual mentor (each mentor was assigned approximately six mentees). The mentor is available during the *capture* phase of the student's participation when he/she would be available to answer questions mentees may have about the different majors.

The third objective (Retain), is accomplished through a carefully thought out set of evidence based practices proven to increase the retention of students once declared in a STEM discipline. As previously indicated, the most significant of these interventions is the development of a learning community. A full list of the COMPASS activities are included in Table 2. A few of the retention strategies (advising, cohort STEM courses, graduate and peer mentors) are implemented as part of the *capture* phase.

As creating community early within the group is critical, COMPASS participants are encouraged to register for one of two designated COMPASS orientation sessions. On these dates, students and parents participate in a two hour COMPASS overview then the students join the programs First Year Advisor for a special advising and registration session. Block housing, the living portion of the LC, is strongly encouraged, but remains optional in an attempt to not restrict student participation in the program. The COMPASS staff partner with the Office of Housing and Residence Life to bolster the number of participants in the optional block housing. The same academic advisor introduced to the participants at orientation is assigned to work with COMPASS participants throughout the first year of the program. The advisor assists with course planning for the subsequent terms and offers encouragement and additional education on the STEM major selection. Once declared in STEM, the advisor assists the participants in scheduling the appropriate math and science courses to help them *stay* or *get* on track in the STEM major. An additional advisor from the student's college is assigned after declaration of the STEM major. COMPASS participants are embedded in cohort math classes and the Career Planning or STEM Seminar with other STEM students. These courses are described in detail in the Educational Plan section of this paper. Students are required to take these courses as part of the cohort along with the COMPASS cohort math courses. Though participants are required to enroll in the math cohort courses during their first year in COMPASS, they can choose to continue with the courses until completing the math sequence for their major, sometimes running well into the second year. The cohort courses provide additional support and facilitate easy development of study groups. Once on campus, the COMPASS Center, used for group study and tutoring, is available to all first and second year participants enrolled in math or science courses. The Center, which is available 65 hours a week, is staffed by the COMPASS graduate teaching assistants (GTA). The Math GTAs participate in the cohort math lectures and lead math recitation sessions in addition to providing tutoring in the Center as a service to the participants. In year two of participation, participants who remain academically eligible (3.0 GPA) participate in a paid undergraduate research experience. Students are paired with one of the 135 committed COMPASS faculty mentors to participate in a one semester funded research experience as part of the faculty's research team. Though students continue to identify as members until graduation, the formal portion of the program culminates with the undergraduate research experience.

The fourth objective (Research) focuses on determining how Career Readiness and Career Development assessment results correlate to students selecting and being successful in STEM. This research occurs as a study comparing those students participating in the Career Planning: STEM Explorations course (experimental group) to those already decided on their STEM major in the STEM Seminar course (control group). The Career Development Inventory (CDI)[57, 58, 59] and Career Thoughts Inventory (CTI)[60, 61, 62] were identified as the appropriate instruments for measurement. The instruments are designed to register increases or decreases in career readiness factors and are implemented during the first semester of enrollment, in class, in a pre/post format for all participants and the control group. The CDI can be used *before* administering an interest inventory to measure an individual's readiness to make vocational choices, or with an interest inventory to determine how best to interpret the interest inventory results. The CTI measures negative career thoughts. Negative thinking can make it more difficult to make career decisions. Though it is normal for everyone to think negatively from time to time, too much negative thinking causes problems and can lead one to avoid decisions that need to be made.

Assessment of Objectives

This section of the paper will be split into two parts: (1) cohort coding details and (2) details of the assessment of each objective.

The decision was made to divide the COMPASS students into two groups, each with a unique code. Pathway one consisted of those students who applied to the university and enrolled in their first term as undeclared or non-STEM majors. Each participant in Pathway one was coded CE## (i.e., CE15 = Program Experimental 2015). Pathway two consisted of students who applied to the university as undeclared or non-STEM, but by the time of enrollment in their first term had declared a STEM major. Each participant in Pathway two was coded CS## (i.e., CS15 = Program STEM recent 2015) or CX## (i.e., CX15 = Program STEM declared 2015). Control groups developed are coded using CC## (i.e., CC15 = Program Control 2015). Codes are updated annually with the specific start date of the academic year (i.e., CE12, CE13, CE14, CE15, CS13, CS14, CS15, CX14, CX15, CC13, CC14, CC15, etc.).

Assessment of Recruitment: The first objective (Recruit) is to attract 400 students per year *listed as undeclared (or non-STEM) majors with math SAT scores greater than 550* into the program (COMPASS participants). Recruitment for years one and two was difficult. Receiving the award late in the recruitment cycle and then having a slower start than planned in year two, meant not meeting the recruitment goals. However, using direct mailing materials to parents and students and University Open House programs have proven to be a long term success. The strategies implemented for end of year two and three led to an increase in recruitment. The development of two pathways (started in year two) including one for those who applied to the university as non-STEM, but declare STEM prior to the start of the first term, is a more attractive option for students. As undeclared numbers continue to decline at the university, the Pathway two group continues to grow. The designated COMPASS orientations (started in year three) allowed for a more structured approach for pre-enrollment advisement and registration. Students saw themselves as a member of COMPASS before registration commenced, allowed them to attend orientation as a cohort and receive a special project information session informing them of program details. For years three and four recruitment, students were coded as COMPASS in the orientation system and identifiable at other non- COMPASS orientations to the COMPASS advisor. With these minor adjustments and continued marketing **402 students were chosen to participate in summer and fall 2015**. Table 4 depicts recruitment of the project cohorts by pathway (CE = Pathway one, CS and CX = Pathway two). One can observe that females make up a large percentage of those cohorts (CE, CS) who are in the early decision making or confirming process indicating that COMPASS is being successful in attracting more females to investigate the STEM career path. A side effect of striving to meet the overall recruitment goal for COMPASS has been a decrease in the percentage of underrepresented students participating in the program. Now that overall recruitment goals have been met, attention will refocus on increasing the diversity in the pool to minimally mirror the diversity percentages of the University's STEM population (see Table 1). Researchers will continue to fine tune the recruitment process in order to (a) increase the number of students participating in Pathway one (CE) and (b) increase the number of underrepresented students. Efforts towards recruitment of the undeclared population will be intensified by using multiple sequential contacts as follow-up to the direct mailings.

Table 4. COMPASS recruitment breakdown by number in each cohort year (N) and percentage of under-represented groups gender (F=Female) and ethnicity (AA=African American, H=Hispanic) in each group

Cohort	**CE**				**CS**				**CX**			
Year	**(N)**	**F**	**AA**	**H**	**(N)**	**F**	**AA**	**H**	**(N)**	**F**	**AA**	**H**
2012	37	65%	11%	22%	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2013	82	52%	12%	22%	5	60%	0%	40%	n/a	n/a	n/a	n/a
2014	72	44%	13%	15%	88	39%	10%	27%	112	16%	5%	29%
2015	67	53%	3%	18%	90	31%	10%	21%	245	22%	7%	18%

Assessment of Capture: The second objective (Capture) is to increase the number of the COMPASS students declaring a STEM major at the university. An important component of bringing students into the STEM disciplines is to create a community of STEM learners. To be more intentional and implement community building efforts, project staff continue to move interventions earlier (i.e., orientations, housing, advisors, mentoring, welcome events) into the capture process.

The primary intervention for undecided, non-STEM students within COMPASS is the Career Planning: STEM Explorations course. The course structure was divided between a weekly lecture (Monday) and a weekly discussion (Wednesday) section (alternative schedule for summer term). The lecture was content heavy and explained overall concepts to students whereas the discussion sessions were broken into smaller groups for addressing items on a more one-to-one basis. The offering of the Career Planning course over the summer term allowed more schedule flexibility for students leading to earlier declaration of a STEM major and allowing students more options for getting on-track in the intended major. The faculty STEM field lectures and related lab visits were implemented as part of the course with minimal problems. The integration of STEM industry professionals into the “Where am I going?” presentations was suggested after year one and have been a great success. Most students could not visualize themselves as faculty and could not see past the career choice of these individuals to hear what could be done in the disciplines. Industry professionals provide an immediate pathway perspective for college students (work in the industry or academia) and can articulate an attractive professional setting that the students can see themselves at upon graduation (e.g., Disney, Lockheed Martin are examples of industry professionals that have presented in the Career Planning class). To measure the effectiveness of the faculty and industry participation as guest lecturers and through lab visits, project staff created two feedback instruments which were administered after each lecture and visit. The Likert scaled instruments cover satisfaction with the sessions as well as the contribution of the speaker or lab visit to the students understanding of a particular career option. Debriefing session were conducted with faculty to discuss the evaluations, receive their feedback on the course and keep them informed of any changes. Feedback was solicited from the industry professionals as well. The overall course evaluation allowed students to convey the importance of individual inventory results, class projects and assignments to their decision making process. Table 5 depicts the capture and retention of the COMPASS cohorts. Though the project has been close to the capture (declaration of a STEM major) goal of 75%, it was not until the 2014 cohort (year three) that the project surpassed the goal.

Table 5. COMPASS recruitment, capture and retention in STEM data, 2012-2015

Cohort	**Recruit**	**Capture**	**Retention**		
			One Year	**Two Year**	**Three Year**
Target Goal	**400**	**75%**	**65%**	**65%**	**65%**
2012 (Pilot)	37	24 (65%)	17 (71%)	9 (38%)	10 (42%)
2013	87	63 (72%)	53 (84%)	36 (57%)	n/a
2014	272	241 (89%)	205 (85%)	n/a	n/a
2015	400*	352 (88%)	n/a	n/a	n/a

*Though 402 students were recruited in 2015, 2 students removed themselves from the program during the first week of class

Assessment of Retention: The third objective (Retain) is to increase the number of COMPASS students remaining in STEM majors by increasing their retention rates compared to the University’s STEM population. The results for retention are shown in Table 4. Year one students have been retained in STEM at 42% three years after declaration of a STEM major, year two students have been retained in STEM at 57% two years after declaration of a STEM major and year three students have been retained in STEM at 89% one year after declaration of a STEM major. While close to the baseline goal of 45% retained four years after declaration in a STEM major (University data) with cohort years two and three, only year three students are on target to meet the proposed 65% retention to graduation goal set forth by the project. When reviewing student records of those who attritted from cohort years one and two, one explanation for lower retention rates could be that many of those who left the university or STEM majors failed to follow the suggested path of COMPASS math cohort interventions leading to less successful completion of the gateway math courses. This observation strengthens the Program's leadership decision to require the math cohort participation of all COMPASS students beginning in year three. A study is ongoing to determine which of the retention interventions most greatly influence retention and sense of community within COMPASS. The final retention activity, undergraduate research experiences, has only begun to be explored by COMPASS students in cohort year three (Spring 2016).

Assessment of Research: The fourth objective (Research) is to determine how Career Readiness and Career Interest assessment results correlate to students selecting STEM and being successful in STEM. Data from the career readiness and development instruments (CTI and CDI) have been collected annually for COMPASS participants. In a review of the CTI results, researchers[63] found that COMPASS participants showed:

- a significant decrease in their decision making confusion by the end of the Career Planning class
- a significant decrease for participants in scores for commitment anxiety and external conflict
- significant increases in career planning, career exploration, career decision attitude and career orientation (meaning that the class helped the students make more of an effort to plan their careers and explore their options using many resources)
- significant gains in career orientation (meaning that their career decision attitudes showed significant improvement)

In general, COMPASS women had more negative career thoughts than men though these negative thoughts decreased from the pre to post-test. By the end of the Career Planning course, 138 of 191 (72%) participants were choosing STEM, compared to the 57% expected proportion nationally, indicating that the course had an influence on STEM major selection. There were no significant differences found in SAT scores between those choosing STEM or not choosing STEM, but all STEM students had higher SAT and university math placement scores. When comparing CTI scores of Pathway two (CS14) participants to the STEM control, there was no statistically significant difference between the two groups meaning that those with a recent declaration in STEM mirrored STEM declared students with low decision making confusion and commitment anxiety. The STEM Control had significantly lower scores on the CTI (indicating less confusion, commitment anxiety, and external conflict) than Pathway one (CE14) participants however, COMPASS students' post test scores were much closer to the STEM control's level indicating the career planning course assisted them in lessening the conflicts related to major selection[63].

Discussion

At the start of the project's fourth year goals for recruitment, capture and retention of COMPASS participants are being met. Researchers continue to fine tune the recruitment process in order to (a) increase the number of students participating in Pathway one and (b) increase the number of underrepresented students, both initial objectives of the project. As efforts have increased to meet the overall recruitment goal for COMPASS, there has been a decrease in the percentage of underrepresented students participating. Now that annual recruitment goals are being met, attention will refocus on increasing the diversity in the pool.

Strategies implemented for year three of the project have been successful in affecting recruitment: (a) two pathways for students (Career Planning or STEM Seminar) based on where the student was in the STEM major decision making process at the time they started matriculation at the university, (b) two COMPASS orientations designated throughout the summer and students informed to choose this option and (c) the COMPASS advisor assigned prior to summer term and available at each orientation. Students needed more options with the Career Planning course. Adding the course for summer admits was a logical adjustment and helped recruiting efforts for summer admitted students who may not desire to wait to take the course in an already academically challenging fall term. The summer course offering also allowed more schedule flexibility for students, led to an earlier declaration of the STEM major and allowed students more options for getting on-track in the intended major. These strategies will continue.

An important component of bringing students into the STEM disciplines is to create a community of STEM learners. Though the students were in the Career Planning course together, offered the opportunity to live together and encouraged to use the COMPASS Center, the connection to the learning community appeared limited. Evidence based practices used to build the community have been more intentional and implemented earlier during the *capture* phase. The COMPASS block housing opportunity for first-year students was a much more successful effort in year three and the 2015-2016 cohort reached capacity at 160 participants in the living learning community. The decision to embed COMPASS students in cohorts in the math courses and housing to further encourage the integration with the learning community helped. Since that time, COMPASS students are notified upon acceptance that participation in the cohort math class as well as Career Planning or STEM Seminar were required components. Peer mentoring was being used only on a limited basis by students. When analyzing the data, Pathway two mentees were the ones least likely to avail themselves of the mentor. This may be because they already feel a connection to the STEM discipline and do not see the need to participate. For 2015-2016, only Pathway one participants received the full mentoring experience during their first term of enrollment. Additionally, all COMPASS female participants were invited to participate in the Girls EXCELling in Math and Science (GEMS) networking sessions which brings in STEM industry professionals to network with the mentors and mentees.

Ultimately, this project will increase the number of potential STEM graduates by recruiting more students into the STEM degree programs, but it has shown to be beneficial in other ways. Studies have shown students who complete a career planning course take fewer excess hours due to declaration of a major based on appropriate decision making. As universities commit to access and affordability, extra classes result in extra costs which are especially hard for low income students. At the University 38% of students are on Pell Grants regardless of STEM or non-STEM major. The COMPASS students participating in the Career Planning course will have the same benefits of major exploration with fewer excess hours and a shorter time to major declaration. As there are non-STEM students completing the Career Planning course with the participants, converters and non-converters have an enhanced understanding that mathematics, science and technology have a beneficial effect in all aspects of one's life. Furthermore, by including STEM professionals in the program, COMPASS strengthens the ties to local industry and contributes to a better alignment with workforce needs.

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