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STEM Center for Student Retention and Success: A Proposal

Madhu Dhar Ph.D

Merrimack College, dharm@merrimack.edu

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STEM CENTER FOR STUDENT RETENTION AND SUCCESS: A PROPOSAL

MADHU DHAR, PH.D, M.ED

SCHOOL OF SCIENCE AND ENGINEERING
MERRIMACK COLLEGE



Capstone

Merrimack College STEM Center Proposal
for
Student Retention and Success

By

Madhu Dhar. Ph. D

Submitted to

Dr. Elaine Ward

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Abstract

The STEM pipeline, a commonly used analogy (Kuh, 2006; Tierney, 2000), has been shrinking. Furthermore, degree attainment for women and underrepresented minority students in STEM are even lower than for undergraduates as a whole (National Science Foundation, 2007). With low numbers of students enrolling in STEM fields and even smaller numbers of women and minorities in the STEM pipeline, colleges and universities need to pay particular attention to retaining the students they have. This capstone proposes a STEM Center that provides an infrastructural support for undergraduate students in the School of Science and Engineering at Merrimack College. The Center will consolidate programs under a single entity and create a continuum of resources designed to support students at every stage of their education. Specifically, using George Kuh's high impact practices (Kuh, 2012) faculty and staff will plan and implement retention initiatives including experiential learning opportunities, undergraduate research, STEM-focused clubs and a Living Learning Community (LLC) for female students. There is also increased coordination between faculty and staff to provide targeted advising during critical points in the semester. Tinto's Interactionalist Theory of individual student departure (2012) and Bolman and Deal's Organizational Theory (2013) are used to guide the organization of the infrastructure for student support services within the school.

Keywords: STEM (Science Technology Engineering and Mathematics), HIPs (High Impact Practices), Retention.

Introduction

This capstone is an initial proposal to establish STEM Student Center for student services in the School of Science and Engineering at Merrimack College. While the faculty advising model at Merrimack is central (Evans et al., 2016) the STEM Student Center would act as supplemental resource center specifically designed for STEM students at Merrimack College, that will provide students with additional student resources and services. The center will provide, assistance for the students seeking academic support, additional coaching and support during registration, experiential learning opportunities, connections to STEM-focused clubs and Living Learning Communities (LLCs), and other administrative and student supports. The center will coordinate with faculty advisors, the Center for Student Success, the O'Brien Center for Career Development, and other offices throughout the school year and over the summer months to utilize best practices in STEM recruitment and retention strategies. Improving student support, especially in the first two years of STEM education in college can be provided by a centralized resource for drop-in advising and assistance, and by connecting students to the various referrals and resources to succeed. The STEM Center would expand and connect students with opportunities for internships and co-ops, student research, access to alumni and industry speakers/mentors, and preparation for graduate school or employment pathways after college. The center can help diversify pathways to STEM degrees – assist/facilitate the change of Majors process, work with transfer students and academic departments to create pathways to Merrimack STEM majors/programs.

Guiding Questions:

What are the factors influencing STEM students' intention to drop out of college? What the potential institutional interventions that may help improve the persistence of STEM majors?

Looking at the U.S. competitiveness in the global economy and its staggering contribution to technological success, the Committee on Science, Engineering and Public Policy (2007), past U.S. President Barack Obama, and many others called for new investments in higher and postsecondary education to create a significantly larger, more diverse talent pool of individuals interested in engineering and technical careers. The STEM pipeline, a commonly used analogy (Kuh, 2006; Tierney, 2000), has been shrinking. Research suggests a decline in the percentage of bachelor's degrees awarded in the STEM disciplines as compared to the overall number of degrees awarded. The late 1960s holds the all-time high for the percentage of bachelor's degrees awarded in STEM disciplines at 36 percent. After a drop in the 1970s, this same statistic hit a high in 1985 and 1986 with 34 percent of all bachelor's degrees awarded in the U.S. Since that time, the percentage dropped to a low of 30 percent in 1991 and rebounded slightly to 32 percent in 2006 (National Science Foundation, 2008). In his book, *The World is Flat*, Thomas Friedman asserted, "The shrinking of the pool of young people with the knowledge skills to innovate won't shrink our standard of living overnight. It will be felt only in fifteen to twenty years when we discover we have a critical shortage of scientists and engineers capable of doing innovation..." (2005, p. 253). Thus, it is critical that institutions of higher learning understand the path to success for students interested in pursuing degrees in any STEM discipline.

There are multiple reasons for the comparatively low percentage of STEM undergraduate degrees in the U.S., including well-documented declining student interest in these fields. The

most prevalent reasons cited for the lack of STEM educated graduates are the lack of K-12 preparation for the rigor of STEM education and the failure of universities to plan appropriate social and academic transitions for the new students (National Research Council, 2012). With a lower percentage of students showing interest and a lower percentage of those declaring STEM disciplines completing a degree in their intended field, the outlook for increased percentages of STEM students entering the workforce is not promising. Also, high school STEM curriculum and preparation greatly influences first-year undergraduate student decision to choose STEM majors. According to American Institutes for Research (AIR Report, 2016) at the high school level, both in the rural communities and across the nation in more urban and suburban centers, many students are not even provided with the courses they need to develop and deepen their mathematics and science interests, skills, and knowledge. The problem of STEM attrition appears to be more vexing for specific student populations. Degree attainment for women and underrepresented minority students in STEM are even lower than for undergraduates as a whole (National Science Foundation, 2007). The study also indicated that the first-year women continue to be less likely than their male counterparts to express an interest in choosing STEM majors, resulting in generalized underrepresentation. The role of an institution is crucial in predicting bachelor's degree completion typically relying on more traditional institutional characteristics, including control, size, selectivity, and institutional type (Braxton & McClendon, 2001).

This capstone that proposes a STEM Center at School of Science and Engineering, Merrimack College addresses the above-mentioned concerns of retaining students in STEM fields guided by well-established theories on student retention and organizational frameworks.

Tinto's integration model is the most known theoretical framework on college student retention (Tinto, 1993). From a sociological aspect, Tinto (1993) emphasizes students' integration with the academic and social dimensions of the college or university. Studies by Bolman and Deal (Bolman & Deal, 2013) demonstrate that leaders tend to focus on or approach change from a single vantage point such as navigating politics or setting up new organizational structures and restructuring. For the successful creation of STEM Center, change processes at the institutional level need some level of structural support over time to be fully institutionalized. On-going funding and operational support are needed, appropriate staffing, access to information, and other forms of support are necessary for a change to be sustained. Using Bolman and Deal framework (Bolman & Deal, 2013) will strengthen the support for STEM retention at School of Science and Engineering, Merrimack College.

The STEM Center will put students in a position of receiving constant academic and advising support through their undergraduate years and graduate studies in STEM majors. Students with undeclared majors will be directed and encouraged to stay in STEM disciplines. The Center will ensure right circumstances, opportunities, and incentives for first-year students to invoke students' an early interest in STEM. Programs like early introduction to research, internships, STEM service learning programs, peer mentoring and offering widespread support for women in STEM, underrepresented minorities and at-risk, students will be treated with a sense of urgency. Faculty will be encouraged to help facilitate the STEM retention by buffering with their academic advising, pedagogical teaching and helping students decide their majors. The STEM Center will function as a 'One Stop Shop' for School of Science and Engineering at Merrimack College.

Literature Review

There is a great deal of literature surrounding STEM education graduation and persistence rates of college students in America. Undergraduate STEM retention is a great concern in US higher education today and the call to increase STEM graduates in the United States has been a topic of much discussion in recent years (Beasley & Fischer, 2012). During President Obama's presidency, its urgency was underscored in 2012 when the President's Council of Advisors on Science and Technology (PCAST) called for an increase of one million graduates with STEM degrees within the next decade to address industry demands (PCAST, 2012). Positive engagement of students in STEM cannot be an individual task of a faculty or advisor alone. It is the responsibility of the institution to create the right infrastructure, programs and environment to encourage young people to be prepared to think deeply so that they have the chance to become the innovators, educators, researchers, and leaders who can solve the most pressing challenges facing our nation and our world, both today and tomorrow. But, right now, not enough of our youth have access to quality STEM learning opportunities and too few students see these disciplines as springboards for their careers.

There is little research on predictability of graduation in comprehensive, STEM-focused, private liberal arts colleges. While many universities and research institutions have made significant progress in stepping up their STEM initiatives, small private liberal arts colleges are also ramping up their STEM leadership programs (Breau, 2014). This literature review is divided into six major sections: i) in the first section we look at the historical work on studies of persistence, retention, and graduation rates ii) the second section examines the retention issues of first-year STEM students iii) the third section addresses the retention of Women in STEM pipeline iv) undergraduate STEM research and internships v) STEM outreach initiatives and vi)

High Impact Practices in STEM retention.

Retention, Attrition and Persistence of College Students in STEM

In his research, Xu (2016), finds that addressing the needs of college students in STEM fields is key to retention, emphasizing that student retention has been one of the most widely studied areas in higher education in the last four decades. Despite the strong scholarly attention, college attrition rate has remained strikingly constant at around 45 percent over the past 100 years (NCES Digest of Educational Statistics, 2014; Tinto, 2006). The author (Xu, 2016) while trying to gain a deeper understanding of what factors function beneficially or detrimentally to student persistence in STEM majors. He conducted rigorous research and statistical analysis to collect comprehensive data about college student experience in a research-intensive university using a survey grounded in holistic theoretical frameworks on retention (Tinto, 2006) and also compared the factors leading to college students' intention to drop out between STEM and non-STEM majors. The survey revealed that the common component of all theories on college retention, be it sociological, organizational, cultural, and psychological, is the interaction of individual students with the academic institute (NCES Digest of Educational Statistics, 2014). The institutional culture shifts and environmental changes exert great influence on student attitude, behavior, commitment, and success. It is, therefore, critical to assess all the above factors and provide also quality teaching and better STEM resources.

According to the author (Xu, 2016), there is a strong evidence that poor teaching skills in STEM courses obscure the subject, diminish students' confidence and interest, and discourage them from becoming STEM courses. Class sizes significantly influence retention as well. In large classrooms, it is difficult for students to make personal contact and gain individualized attention even with faculty members who are effective teachers and willing to support. The

institutional or departmental intervention will be helpful in providing pedagogical training for faculty members and set a reasonable cap on class size. Structuring courses so that students may engage in authentic research activities, and opportunities are made available for students to take part in ongoing research projects in the department or outside. Academic quality provided by the institution, student's formal academic integration, and motivation for active learning are identified to be the most influential factors to their retention. To improve student persistence in STEM majors, the author (Xu, 2016) suggested that the institutional administrators invest in improving faculty members' teaching skills, reducing class sizes, and engaging students in active learning and research participation.

Apart from paying attention to faculty teaching styles, quality STEM education, providing an opportunity for students to think, respond and interact in class may also have a substantial impact on the retention of students in STEM disciplines. Addressing STEM retention at undergraduate level was further studied by Watkin and Mazur (2013). Watkin a Physicist at Harvard University uses Peer Instruction (PI) technique in an introductory Physics course. Peer instruction is an interactive teaching technique popularized by Mazur in the late nineties. Mazur developed his version of this practice to address his students' struggle to apply factual knowledge to conceptual problems. In Mazur's technique, multiple-choice conceptual questions are posed at key parts of the lecture. If the majority of the students' responses are incorrect they are asked to turn to their neighbor to convince them of their answer. Peer instruction works on the theory that students at similar cognitive levels can at times explain content where educators may experience the "expert blind spot" (Wiggins & McTighe, 2006). Mazur claims his technique works best if students prepare before class and then test their application of knowledge in class where they have opportunities for rich feedback (self, peer and teacher). Mazur also sees this

technique as a form of the flipped classroom which presents an opportunity for educators to understand the basis of the flipped classroom model. It was encouraging to see that double the number of students were retained compared to when traditional lecture-based classes were held. The authors (Watkin & Mazur, 2013) examined the relationship between changing the pedagogy from regular lecture to Peer Instruction (PI) in an introductory physics course and higher student retention in STEM majors. Previous research (Crouch & Mazur, 2001; Mazur, 1997) in physics education has also shown that activity-based courses yield better results in higher scores on assessments of students' conceptual understanding than traditional courses. The increased overall learning gains with the use of PI have not only been found at highly selective institutions but when the similar strategy was replicated at a community college (Lasry, Mazur, & Watkins, 2008), it suggested that PI is effective with heterogeneous student populations also. Further, authors remark that the positive results of PI are not limited to physics courses but encouragingly studies have shown that PI is useful in improving learning in a vast number of other courses. Driven by these findings, Mazur and Watkins (2013) emphasize that PI has long-term impact on the retention of students in STEM majors as it positively impacts students both during the course and beyond. Mazur worked with Lasry (Lasry et al., 2008) to correlate absence of PI instruction and attrition and further strengthening their findings that active and cooperative learning methods are useful in reducing student attrition in science programs.

While it is very important to address retention of undergraduate students in STEM fields, it is equally significant to understand the reasons for rapid attrition of college graduates from STEM fields. In the survey conducted by Rask (2010) it was found that the proportion of science majors has remained steady over the sample period; however, the number entering the college intending to major in STEM fields has fallen. Rask (2010) used administrative data from the

graduating classes of 2001-2009, roughly 5000 graduates, from a northeastern liberal arts college to model the progression of students through STEM majors. The author projects that grades and pre-collegiate preferences play a compelling role in STEM attrition rates. Much to the expectation of Rask (2010) it was found that the grades received in a course are an important factor of whether a student takes another course in the major. Pre-college preparation predominantly measured by SAT scores and AP credits is also consistently correlated with taking more STEM courses. The results from this study (Rask, 2010), suggest that to increase our output of STEM graduates we need to focus on high school preparation to change preferences for STEM disciplines.

Within this context, the study by National Center for Education Statistics (NCES, 2013) presents an examination of students' attrition from STEM fields over six years in college using data from the 2004/09. Based on this survey, students' reported major fields, 28 percent of bachelor's degree students and 20 percent of associate's degree students chose a STEM major field at some point during their postsecondary enrollment from 2003 to 2009. Many of these STEM entrants—48 percent at the bachelor's degree level and 69 percent at the associate's degree level—exited STEM fields several years later by changing majors or leaving college without completing a degree or certificate. The results from the work of Chen (2013) showed that STEM entrants' overall college performance and their level of success in STEM courses led to students staying in or moving out of the STEM fields. The survey by Chen (2013) also reflected through intense research and rigorous analysis that less success in STEM courses than in non-STEM courses, due to earning lower STEM grades relative to non-STEM grades, was also associated with an increased probability of dropping out of college for STEM entrants at the associate's degree level.

To further understand student departure from STEM fields, authors (Graham et al., 2013) found that many talented college students flee STEM majors because they find introductory courses uninspiring, which they think can be corrected by incorporating classroom teaching practices that engage students in the learning process, known as “active-learning.” This goes strongly in accordance with Watkins and Mazur’s research (Mazur & Watkin, 2013) on using the pedagogical approach in teaching. The elements of the persistence framework are universal and can be tailored for any classroom. There is a need in the United States for a concerted effort to implement evidence-based strategies that will pay off by advancing the goal of having sufficient STEM college graduates to meet projected workforce needs (Graham et al., 2013). This section of the literature review, looked-into extensive efforts to check attrition, boost retention and fortify persistence of undergraduate students in the STEM fields. Understanding first-year student retention in STEM fields is very helpful in catching the issues related to retention, attrition, and persistence early on.

Retention of first year STEM major students

The first year of college is a particularly risky time during which many students entering with an interest in science or mathematics switch to a major outside the STEM disciplines (Graham et al., 2013). This attrition rate may be as high as 60% overall, and even higher for women and minorities (President’s Council of Advisors, 2012). The low success rate of first-year college students in Science, Technology, Engineering, and Mathematics (STEM) programs has spurred many academic achievement studies and interventions as discussed in earlier section. The majority of students who enter postsecondary education with aspirations to earn a credential in STEM either switch out of STEM or drop out of school altogether. Van Soom and Donche (2014) in their analysis profiled first-year students in STEM programs based on autonomous

motivation and academic self-concept and its relationship with academic achievement. In this study authors use a person-oriented research perspective, taking-into account both autonomous motivation and academic self-concept, to provide the first evidence of the presence of various motivational profiles among STEM students to explore associations with early academic achievement.

Authors (Van Soom & Donche, 2014) agree that STEM programs require a strong academic preparation in mathematics since mathematics modules of varying complexity are obligatory in most first-year STEM programs. As a result, numerous STEM retention studies focus on grades and mathematics test scores as explanatory factors of study success (Piper & Krehbiel, 2015, Van Soom & Donche, 2014). They state that various motivational factors have been found to be important predictors of first year academic achievement and study persistence. It was found that academic performance in general, performance self-efficacy, followed by high school GPA and ACT scores were biggest motivators. It was expected that profiles with high levels of autonomous motivation and academic self-concept would be associated with higher academic achievement. In particular, academic self-concept is an essential prerequisite for successful studies in STEM. Even though academic self-concept of freshman students entering higher education is necessarily based on previous high school success and might not always be very accurately measured, it still is a better predictor of academic achievement than the level of autonomous motivation. Students with low initial levels of autonomous motivation in combination with low academic self-concept are at risk for procrastination behavior when they are confronted with the high demands of STEM studies in the first months of the academic year. Therefore, it would be useful to provide these students early on with explicit feedback on their

motivational drive and academic self-concept regarding their study, complemented with content-specific support and training in study and time management skills.

To attract and retain more academically qualified students in science and mathematics, interventions in early years are of prime significance. Departure from STEM majors emerge early in undergraduate education and hence impacts STEM retention. To further address this problem, Piper and Krehbiel (2015) emphasize that increasing STEM enrollment using targeted scholarships and an interdisciplinary seminar for first- and second-year college students. They ascertain that the first year of college is a particularly risky time during which many students entering with an interest in science or mathematics switch to a major outside the STEM disciplines. They put forth strategies to increase STEM matriculants, through scholarships, by recruitment to STEM, incorporating STEM learning community course, special orientation for new STEM students, forming a cohesive learning community, involving new students in research experiences and group projects. Authors (Piper & Krehbiel, 2015) articulate that beyond providing essential financial support for students in STEM, the scholarship and academic support program has led to significant institutional change. The authors indicate that to attract and retain more academically qualified students to science and mathematics, they developed a merit-based scholarship program for incoming students with STEM interests. Also, to keep the students on merit based a scholarship right on track throughout, interventions like career counseling, visits and presentations by STEM professionals, and internship opportunities were suggested. This statistical study (Piper & Krehbiel, 2015) suggest that targeted scholarships combined with engagement in collaborative undergraduate research are useful tools for enhancing STEM recruitment and persistence.

In this section, we addressed to some extent the first-year undergraduate student departure from STEM fields. It is clear, that not all STEM students start out equal on key pre-college factors. Positive engagement of STEM undergraduates is essential in the first year of college. Equally important to retention is to create experiential learning opportunities like research and internships to reinforce the academic learning in STEM.

Implementing Student Centered Research Programs

A variety of methods have been shown to increase retention, including mentorship, tutoring, course enhancements and merit based scholarships that we reviewed in earlier sections. This study demonstrates how by including first-year students in research programs involved a culture shift in the institution. First year undergraduate student participants work with a wide variety of graduate research mentors. Schneider et al., (2015) pointed out that amongst one of the most important interventions to retention in undergraduate teaching, especially in STEM fields is the inclusion of undergraduate research programs for first-year STEM undergraduates. As research often serves as a capstone experience, most students do not get involved in research until the end of their undergraduate career (Kenny et al., 2001). Student participation in an early undergraduate research experience (i.e., first or second year) (Schneider et al., 2015) has been shown to increase retention rates and the pursuit of graduate education. Authors (Schneider et al., 2015) review here that students who were involved early in undergraduate research programs, moved into professional and graduate schools at higher rates than students who were not. The graduate students are volunteers with different levels of mentoring experience. It was observed in this analysis (Schneider et al., 2015) in the second year and third year, significant gains in student STEM retention were achieved, ascertaining thereby that students gained critical-thinking skills, as a result of this research oriented program.

The National Research Council has stressed that undergraduate research is a key component for science education and that undergraduates should be engaged in research as early as possible in their college career (National Research Council (NRC), 2012). To engage undergraduate students in research, authors Felix and Zovinka (2008) submitted a proposal to the National Science Foundation's Science, Technology, Engineering, and Mathematics Talent Expansion Program (NSF-STEP) for a project focusing on early introduction to research for biology, chemistry, and computer-science majors. Their work in this paper describes the development of a new summer-research program at Saint Francis University (SFU) designed to help retain freshman and sophomore STEM majors. Offering summer research opportunity at their institution helped to allow students and their faculty mentors to focus on a research project full-time. During the summer-research period, the faculty members trained their students to perform necessary research techniques. It is inspiring to note that the proposal allowed for a unique arrangement of connecting the high-school students with university faculty members and students, "research shadowed". This summer opportunity for high-school students is a significant step in generating interest in area high school students and hence ensure future incentives for enrollment. The authors (Felix & Zovinka, 2008) recognize the positive preliminary evidence suggesting that early introduction into research is a valuable tool for STEM retention. It is important to note that Saint Francis University is a private, Catholic liberal-arts university and the dynamics somewhat match that of Merrimack College, hence a comparison can be set.

Graham et al., (2013) also contend in their paper that interventions like active learning, early research and learning communities can help inspire STEM students stay in the pipeline. Authors (Graham et al., 2013) insist well known benefits of research experience and claim that most of the undergraduates are not offered research opportunities until late in college, but the

critical period for attrition is first two years. Students who engage in research in the first 2 years of college are more likely to persist in STEM majors.

This section, looked-into the significance of introduction of early research in undergraduate STEM classes that can be a great motivator in retaining students, it however does not explain why women still choose to opt out of STEM fields. Understanding how to encourage involvement of women in STEM undergraduate programs and stop their attrition is a major challenge. Reviewing efforts made in this direction is of prime significance to boost overall undergraduate STEM enrollment.

Undergraduate Women's Persistence in the STEM

According to the National Science Foundation, women earned more than 50% of the bachelor degrees yet are underrepresented in the science and engineering workforce (National Science Board,2014). There is a lot of research (White and Massiha, 2016, Diekman et al., 2015) around about women in STEM. Women participation in STEM is of prime significance. The authors Diekman et al., (2015) recognize gender-disparity throughout the STEM pipeline. The study shows women as underutilized pool of STEM talent, work-family challenges as the main reasons of under representation of women in STEM. An interesting solution offered is, elevating women interest in STEM through communal goal congruity, early intervention, examining recommendations for policy actions, overcoming STEM stereotypes and engaging in science and mathematics in curricular and co-curricular opportunities. I agree with the authors' (Diekman et al., 2015) belief that with effective interventions to recruit, retain and reward the highly-qualified women in STEM, will play an important role in their increased STEM participation.

It is not possible to change thinking or instill sudden passion for STEM in women overnight, a consistent proactive childhood with exposure to scientific toys early on and the

necessary encouragement will set a foundation for future interest around scientific set up and future interest. In an interesting analysis of mixed methods study on what propels women to choose STEM majors Bieri Buschor et al., (2014) state that the study helped them gain an understanding of whether female academic high school students who intended to study science, technology, engineering, or mathematics (STEM), enrolled in such studies continued STEM courses in undergraduate years, and how these women perceived this process retrospectively. The study reflected high persistence of students' intentions with demonstrated higher competencies in mathematics, to pursue a career in STEM areas compared to students who entered the social sciences or humanities. The authors (Bieri Buschor et al.,2014) state further through qualitative analysis that learning experiences, parental support, and role models were decisive in terms of the female students' choice of studies. More childhood scientific experiences helped them develop a sense of identity as scientists.

The authors (Bieri Buschor et al., 2014) stress that teaching in science should be focused on providing challenging scientific experiences. Paramount significance needs to be attached to enhancing girls' competence and self-efficacy beliefs relating to mathematics and natural sciences in-order to strengthen their early sense of identity as a (future) scientist. Empowering through role models, such as enforcing problem-solving tasks in a technical area, for instance, could be presented along with images of female role models in engineering or science. This may ensure adolescent female students seeing the link between early science learning at school and future occupational activities including reflection on gender stereotypes rather than on early vocational decision making. Authors (Bieri Buschor et al., 2014) feel this link may contribute to reducing gender stereotypes and further suggest that encouraging teachers' awareness of their own gender stereotypes relating to mathematics and science may be an important precondition.

Teachers can create awareness by educating parents to banish gender stereotypes at home and encourage their girls to learn mathematics and science early on. Once these young female students enter first year of their undergraduate colleges it is critical that colleges look at their SAT, ACT and overall scores, stimulate their interests and create opportunities and environment to retain them in STEM fields.

Further, White and Massiha (2016) in their recent publication emphasize that there are numerous factors impacting the attrition of women from STEM fields. Lower self-confidence than males even when academic preparation and performances are equal or superior and above all anticipation of conflicts between work and family in STEM careers, may be some of the key reasons for attrition of women from STEM. Authors (White and Massiha, 2016) indicate that despite women being STEM qualified as men and have more early success indicators like parents with college degrees, equal or higher SAT scores, high school test scores and conceptual understanding of the sciences. Despite what should be an advantage, in many cases women do not perform as well as men thus creating lower retention rates. Hence creating conditions of persisting interest, based on precepts of positive pleasant attitude about the academic area of interest, high degree of absorption, concentration, and being challenged and recognized by the rigor of the academic discipline, women can be retained in STEM.

One of the positive interventions in facilitating the retention of women in STEM is supporting students' especially women through Living-Learning Programs (L/L) (Soldner et al., 2012). First-year women continue to be less likely than their male counterparts to express an interest in choosing STEM majors, resulting in generalized under-representation. Authors (Soldner et al., 2012) feel that the problem is particularly severe among bachelor's degree recipients in engineering and computer science, where only between 20 percent and 25 percent

of students are female. Interestingly, we see in this analysis that while African American and Hispanic students earn only 4.1% and 3.5% of the nation's undergraduate physics degrees, respectively, those same student groups represent 9.0% and 7.9% of the nation's bachelor's degree recipients, respectively. Apparent inequities also exist in earth and atmospheric sciences and aerospace, civil, and materials engineering (NSF, 2008, Soldner et al., (2012).

Given the challenges universities have experienced in STEM degree production, it is not surprising that institutions have begun to develop L/L programs targeted exclusively to students interested in pursuing STEM careers. It is exciting to observe that STEM-focused L/L communities have a shared curriculum and special resources are concentrated on STEM-related interests. Authors (Soldner et al., 2012) here emphasize that these programs, which generally attract students who have declared or plan to declare a STEM major, provide opportunities for students to participate in field trips, courses, research projects, and other activities that promote involvement in STEM. It is encouraging to note that faculty interaction around courses was related to students' more positive outcome expectations, and enhanced interest in STEM pursuits. This work suggests that STEM-focused especially L/Ls may be one useful intervention in the promotion of student success, and more so in women and underrepresented communities. At Merrimack College, School of Science and Engineering is offering Women in Stem Living Learning Community (LLC) for Fall 2017 (Appendix C).

The proposal for the Women in STEM LLC is a part of this Capstone. It is a major step in the creating change at institutional level and was possible due to supportive leadership team at Merrimack College. In this program, first year women in STEM majors or undeclared majors will be formed into cohorts that are managed and supported as active learning communities. Such participation will foster a sense of academic community, build ties to the STEM

disciplines, integrate lower-level students with their upper-level counterparts, and provide a supportive network that will encourage ongoing academic success while informing students about career opportunities in STEM fields. Also, the seminar series will engage female students in multiple activities to develop significant relationships with female STEM faculty and guest speakers, while building and enhancing a cohesive learning community with their peers. Activities will be designed to increase excitement in the sciences and awareness about STEM fields, thereby improving the likelihood that female students will pursue a STEM-related career after graduation and try to fix the leaky pipeline (Schneider et al., 2015).

Authors (Schneider et al., 2015) emphasize how through the creation of a strong, cohesive living-learning community that focuses on early exposure to mentored academic research helps retention in STEM. Students living 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 (Dagley et al., 2016). These benefits increase when intentional learning communities are introduced to the residence hall (Pascarella, Terenzini, & Blimling, 1994). The Living learning communities can be linked to service learning opportunities and STEM outreach programs, creating opportunity to participate in out of the classroom learning activities such as interactions with faculty, service projects, field trips, speakers and other theme based social events.

STEM Education Outreach

One of the mechanisms through which higher education institutions can make a difference in their community is by making STEM education available to everybody, area high schools and through summer program involvement. Ward (2015) conducted an extensive research to study the challenges that arise from leaks and gaps in the STEM career pipeline for

U.S. students. The author (Ward, 2015) found that the major reasons were, underrepresentation of women and minorities interested in STEM careers, lack of interest and preparedness of U.S. students entering STEM higher education programs, and declining retention of U.S. students in STEM programs. To address these issues, a STEM Education Outreach (STEM-EO) Model for promoting strategic university outreach programming at Penn State University was proposed (Ward, 2015). The model promotes utilizing universities' resources such as personnel, facilities, and funds to impact STEM learning outside of the institution's own, particularly education domain. The approach is to draw from the expertise of university's STEM faculty, undergraduate and graduate students, and education outreach professionals to engage a variety of audiences in STEM-related outreach activities like area high school students, elementary schools, volunteering for science clubs etc. The STEM-EO Goals identify core aspects of STEM learning that support STEM literacy and address challenges facing the STEM pipeline. This approach can be utilized in any of the higher education institutions. In the STEM Student Center proposal for School of Science and Engineering at Merrimack College, including the STEM outreach-program will be a valuable addition and may help attract more students to choose STEM majors.

Combination of more concrete aspects, such as the STEM-EO, with pedagogically oriented aspects, such as learning goals and learning contexts, high impact practices lead to the development of predictive models for informing strategic planning for STEM success and retention (Ward, 2015).

High Impact Practices in STEM Retention

A fairly, successful STEM student center proposal should address almost all the STEM issues that were discussed in the preceding literature review. Apart from these, on many campuses, assessment of student involvement in active learning practices made it possible to

assess students' cumulative learning. Educational research suggests that the high-impact practices increase rates of student retention and student engagement (Kuh, 2006, 2008, 2010, 2012, 2016). The teaching and learning practices suggested by Kuh (2016) have been widely tested and has shown to be beneficial for college students from many backgrounds, especially historically underserved students, who often do not have equitable access to high-impact learning. These practices are categorized as: First-Year Experiences, Common Intellectual Experiences, Learning Communities, Writing-Intensive Courses, Collaborative Assignments and Projects, Undergraduate Research, Diversity/Global Learning, Service Learning, Community-Based Learning, Internships and Capstone Courses and Projects.

American Association of Colleges and Universities (AAC&U) works to advance broad-based systemic innovation to build and sustain strong undergraduate education in the fields of science, technology, engineering and mathematics. AAC&U does this work through several campus-based initiatives and partnerships. Project Kaleidoscope (PKAL) is AAC&U's (AAC&U Work on Diversity, Equity, and STEM, 2014) center of STEM higher education reform dedicated to empowering STEM faculty, including those from underrepresented groups, to graduate more students in STEM fields. PKAL also works to develop a scientifically literate citizenry as part of its commitment to principles and practices central to AAC&U's Liberal Education and America's Promise (LEAP) initiative. Since its founding in 1989, PKAL has been one of the leading advocates in the United States for transforming undergraduate STEM teaching and learning. It has, to date empowered an extensive network of over 7,000 STEM faculty and administrators committed to the principles, practices, and partnerships that advance cutting-edge, integrative STEM higher education for all students. All PKAL undertakings are uniquely designed to foster quality, diversity, and social responsibility.

Adopting AAC&U's High Impact Practices (Kuh, 2016) in the proposed STEM Center for Student Success and Retention will help develop models for broader institutional change and to advance evidence-based and culturally competent teaching in STEM fields at Merrimack College. The overall goal of this systematic teaching and learning initiative is to increase the learning outcomes and retention of students related to STEM disciplines. The observation of these strategies will help develop and implement curricula that will enhance underrepresented STEM student interest, competencies, and retention rates; and empower STEM faculty to adopt culturally sensitive pedagogies and sustain the necessary changes in practice required for relevant and inclusive STEM teaching.

This review of the literature provided a strong foundation on the specific factors in the study of retention that are significant to this capstone. From why the first-year is a critical time in the undergraduate experience to what characteristics are important to student persistence, all have been shown to have strong empirical backing. Living-learning communities (LLC) are a comprehensive strategy for combating student attrition. LLCs combine best practices from across the institution: active learning pedagogies, student involvement with academics, peers, and faculty, and use of out-of-class, co-curricular activities to name a few. For STEM disciplines, due to diminishing student interest, there is a great need to retain all students, but specifically women and underrepresented minorities. The literature review helped us reflect on the historical work conducted on studies of persistence, retention, and graduation in STEM fields. The significance of undergraduate research and internship in STEM retention helped us look-into the initiatives that can be taken at School of Science and Engineering at Merrimack College. Equally important is to reach out to the community and share the passion for Science, Technology, Engineering and Mathematics through service learning, science clubs and mentoring.

Theoretical Framework

This Capstone uses Tinto's Interactionalist Theory and Bolman and Deal's Organizational Theory as combined by Berger and Braxton (1998) in their study to support the need of STEM Center at School of Science and Engineering, Merrimack College. Combining the effects of organizational attributes on academic and social integration in-particular, and more generally on the student retention process by revising Tinto's interactionalist theory of individual student departure clearly fits the objective of this capstone to address STEM retention at Merrimack College. The results from this study provide strong support for elaborating the revised version of Tinto's theory through the inclusion of concepts from organizational theory (Tinto, 2012, Bolman & Deal, 2013, Berger & Braxton, 1998). A model for the STEM Center is proposed for School of Science and Engineering using the theoretical framework (Tinto, 2012, Bolman & Deal, 2013, Berger & Braxton, 1998) coupled with high impact practices as suggested by Kuh (2012, 2016).

Figure 1 Theoretical Framework for STEM Center proposal at Merrimack College

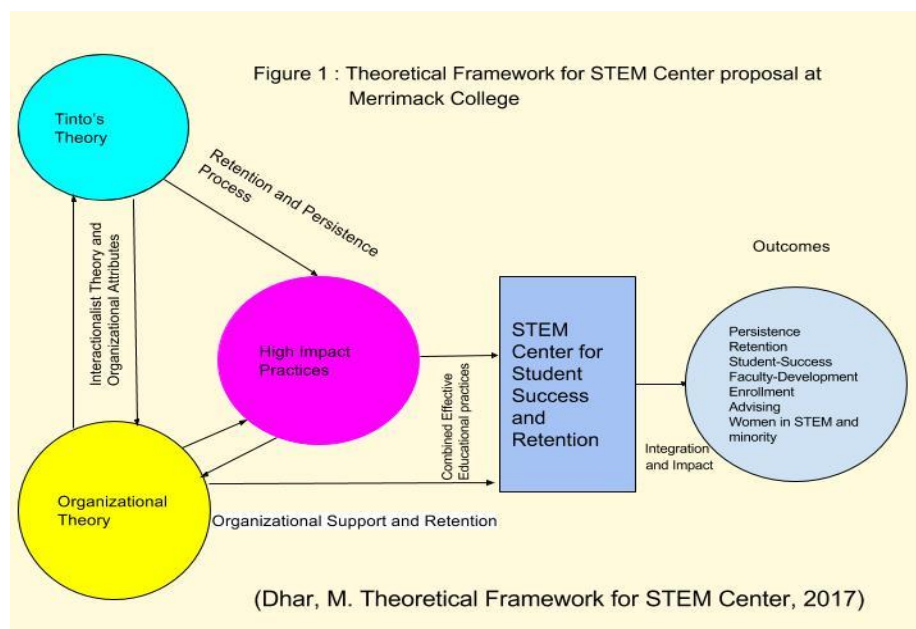


Figure 1 represents the theoretical framework of the proposed STEM Center model created by intentionally mixing the theories and drawing on the key aspects. When Tinto's theory is mixed with Bolman and Deal's Organizational Theory and supported by High Impact Practices, the combined outcome is proposed to deliver improvements in myriad of sectors of the STEM Center such as, student success and retention, faculty development, women and minority STEM representation, quality teaching and undergraduate research and career development.

A historical look at the past forty years of higher education's expert on student retention, Vincent Tinto's work (Tinto, 1993, 2000, 2004, 2007 and 2012) on undergraduate retention reveals the student integration into an institution can occur along two dimensions, the academic and the social. Academic integration occurs when students become attached to the intellectual life of the college, while social integration occurs when students create relationships and connections outside of the classroom. These two concepts, though analytically distinct, interact with and enhance one another. And, while students must be integrated into the institution along both dimensions to increase their likelihood of persistence, they need not be equally integrated along the two. Likewise, Tinto notes that there are both formal and informal systems within institutions that can encourage integration and persistence. By bringing in many new and interesting perspectives to retention study and practice (Berger & Braxton, 1998) is used to help with the revision of Tinto's interactionist theory of individual student departure (Tinto, 2012). Tinto (2012) has described the decision-making process concerning student goal commitment and dropout and the need to match student expectations to institutional mission. His argument that moving beyond theory and planning for effective institutional action stressing that the field of higher education needs an action-oriented approach toward improving student retention (Tinto, 2012).

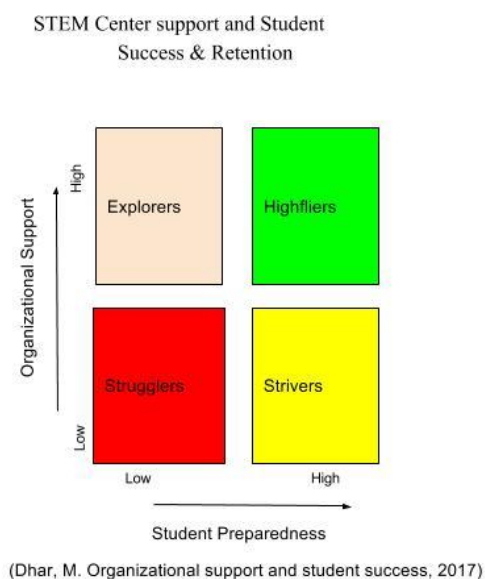
Also, Organizational Theory suggests that institutional mission, which is generally denoted by sector difference or institutional type, is related to student success because colleges and universities that align their mission with their educational policies and programs generally are more effective and efficient (Bolman and Deal 2013). Progressive, clear and consistent institutional objectives are critically important in creating an educationally powerful institution. To be able to create a STEM Center at Merrimack College demands institutional intervention and involves infrastructural needs, budget approvals, new hiring and reorganization of several administrative components. Bolman and Deal's (2013) organizational theory is therefore necessary, to weave in the four frames of references, structural, political, symbolic and human resource.

The STEM Center proposal at Merrimack will utilize best practices in STEM recruitment and retention strategies to address STEM retention issues at Merrimack College. To integrate social and academic processes, it is suggested to use both Tinto's Interactionalist Theory (2012) and Bolman and Deal's (2013) Organizational Theory to propose STEM Center. The Center will act as supplemental resource center specifically designed for STEM students at Merrimack, providing students with services like additional academic and advising resources, undergraduate research and connections, living learning experiential opportunities, women in STEM initiatives, all in a hub-location within the School of Science and Engineering.

In-order to, create a successful STEM Center, it is necessary to create a learning environment for STEM students that includes High Impact Practices (Association of American Colleges & Universities, n.d), put forth and endorsed by the Association of American Colleges and Universities (AAC&U) and widely supported by Kuh (2012) on a variety of liberal arts educational outcomes. Some of the high-impact practices that contribute to students' cumulative

learning (Kuh, 2012) included in this capstone are: first-year seminars, living learning communities, undergraduate research, project based learning, service learning, internships, and outreach experiences. Findings (Brownell & Swaner, 2009) suggested that active and collaborative learning as well as undergraduate research had broad-reaching positive effects across multiple learning outcomes, such as critical thinking, need for cognition, and intercultural effectiveness. With positive organizational support students can be retained. Figure 2 describes that in presence of high organizational support and high student preparedness there is greater possibility of student success and retention, while even if organizational support is optimum but the student is not prepared or motivated to succeed, retention can be a challenge. The proposed STEM Center will work with the students one-on-one to ensure that proper attention and care is rendered in the initial years to help them stay in STEM majors and above all stay in College.

Figure 2. STEM Center support and Student Preparedness



To conclude, it is important to note that an interesting mix of the theories (Tinto, 2012,

Bolman & Deal, 2013, Kuh, 2012) may successfully address STEM retention, departure and persistence at Merrimack College. Figure 1 illustrates these mixed theories. The influence of the High Impact Practices combined with theories discussed above, communicates how institutional intervention, changes the way students approach college and what they do after they arrive. Under high institutional support and high student preparedness (Figure 2) the students thrive and are retained successfully and with low institutional support and high student motivation possibility of retention is still there, but with low institutional support and low student preparedness retention, persistence and student success is impossible. Merrimack College's Strategic Plan: The Agenda for Distinction 2011 - 2021 (Merrimack College, 2017), resonates with the STEM Center proposal to create a modern, academic enterprise grounded in innovative teaching, learning, and scholarship that provides intellectually vibrant, socially engaged, entrepreneurial student experience.

Project Summarization

This is an initial proposal to establish STEM Center for Student Services in the School of Science and Engineering at Merrimack College. The Center will provide, assistance for students seeking academic support, additional coaching and support during registration, experiential learning opportunities, STEM-focused clubs, Living Learning Communities (LLCs), and other administrative and student support issues. The center will also supplement and coordinate with faculty advisors, the Academic Success Center, the O'Brien Center for Career Development, and other offices throughout the school year and over the summer months.

While the success of the STEM Center is specifically linked to program objectives and outcomes, gauging success of the STEM Center as a whole is done through a broad-based

examination of pointers confirming STEM major for students who exhibit difficulties in declaring majors in their first year, stay undecided for long time, drop out of STEM or worst case scenario, increased enrollment in STEM courses; reduced time to complete STEM course sequences; increased student engagement, retention, and persistence; and an increase in the number of STEM majors. This proposal will outline STEM Center development, highlight the benefits of programs and services that are offered, examine success indicators, and discuss obstacles that have been addressed throughout this process.

Need for a STEM Center

U.S. Department of Education is taking attrition of students out of the STEM fields very seriously. Under former President Obama's governance and his personal interest in Nation's STEM initiatives, have received tremendous support. Programs like Educate to Innovate, White House Science Fairs, Engage to Excel (Producing one million additional College Graduates with degrees in Science, Technology, Engineering and Mathematics are already underway in many higher education institutions. Merrimack College is making tremendous efforts in achieving this milestone, including the current implementation of the NSF "iTEC" Grant, which has shown to improve first- to second-year retention in engineering and computer science (Noonan et al., 2016). It is the responsibility of the School of Science and Engineering to work collectively and collaboratively, under one banner to achieve Merrimack's STEM retention goals. Hence the need for STEM Solution Center is critical to unify the cause.

The STEM Center at Merrimack will utilize best practices in STEM recruitment and retention strategies, including:

- Improving student support, especially in the first two years of STEM education in college, by providing a centralized resource for drop-in advising and assistance, and by connecting students to the various referrals and resources to succeed;
- Provide all students with access to tools and resources needed to excel in STEM fields – tutoring, mentoring, workshops and advising resources, experiential and STEM service learning opportunities, STEM focused student clubs and Living Learning Communities (LLCs), and connections to financial aid resources;
- Work to expand and connect students with opportunities in experiential learning, including internships and co-ops, student research, access to alumni and industry speakers/mentors, and preparation for graduate school or employment pathways after college;
- Work actively with the Admissions office to promote and create awareness of opportunities in STEM at Merrimack; facilitate exploration of the wide array of career opportunities in STEM majors;
- Diversify pathways to STEM degrees – assist/facilitate change of Majors, work with transfer students and academic departments to create pathways to Merrimack STEM majors/programs.

Conclusion

Students in their undergraduate years especially in their first year need extra incentive and encouragement to get involved on campus and promote their academic success. They are frequently under-prepared for STEM courses and this consequently leads to lower retention and persistence levels. The proposed STEM Center at the School of Science and Engineering will consolidate programs under a single, recognizable entity and create a continuum of resources

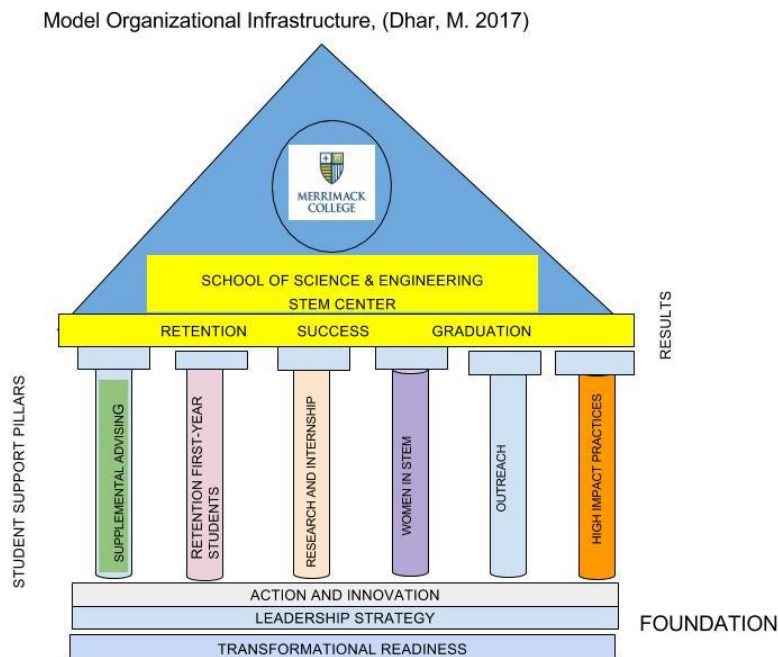
designed to support students at every stage of their education. In this Capstone, we study the factors influencing STEM students' intention to drop out of college and the potential institutional interventions that may help improve the persistence of STEM majors. Theoretical research (Berger & Braxton, 1998) points to the positive effects of organizational attributes on social and academic integration in-particular and more generally on the student withdrawal process.

Bolman and Deal's Organizational Theory (Bolman & Deal, 2013) along with revised version of Tinto's interactionalist theory (Tinto, 2012) of individual student departure has been used in conjunction with High Impact Practices (Kuh, 2012) to support the necessity and significance of STEM Center at Merrimack College. The impact of this project on the faculty and particularly learning centered instructional practices is a major takeaway from the STEM Center success. The STEM Center will serve as resource, connector, and advocate for the nearly all the programs in STEM and STEM Education on Merrimack College campus. As a long term plan the STEM Center intends to support the programs that advance all students' success, particularly for women, underrepresented minorities and first-year and first-generation college students. The Center through specialized student services, supplemental drop in advising sessions, and administrative support, will try to advance the Colleges' collective mission for excellence and inclusion in STEM education and success for all students across campus.

This Capstone carefully reflected on the analysis, theoretical discussion and review of literature for the genuineness of the need of STEM Center at Merrimack College. A model of the Organizational Infrastructure (Figure 3) exhibits that, with strong foundational capacities of transformational readiness, powerful leadership and clear strategies for innovation and action, it is possible to create strong pillars for student support. These pillars, in our STEM Center are : supplemental advising, first-year student retention, research and internship, women in STEM and

underrepresented minorities, outreach and high impact practices. These pillars can act as levers for student success, retention and graduation. Once the leadership of the institution recognizes the value a new initiative can bring, the change is imperative. Following the seven stages of Kotter (Kotter, 2016)

Figure 3. Organizational Infrastructure for STEM Center



Organizations are facing unprecedented calls for change, higher education included, yet leading change in established organizations is a daunting task. The eight-stage leadership process based on Kotter's (2016) publication is a step-by-step plan for managing change. It requires a powerful guiding coalition to develop a vision and monitor the implementation of changes (Kotter, 2016). The process is complete when the organization institutionalizes the change. In the eight-stage leadership process vision, decisions, and expertise are present in the beginning of the process and the guiding coalition (the high-level individuals) creates or manages them. The middle level individuals tell the low-level individuals what change to implement. In the eight-

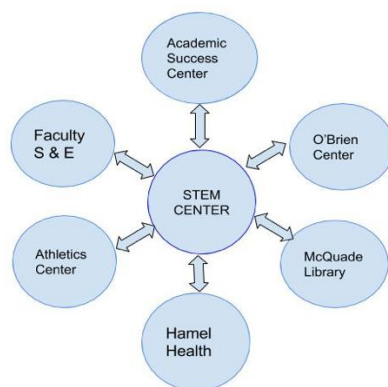
stage process, the high-level individuals are the most important and most decisions are made in the beginning of the change.



Figure 4. Kotter's Eight Steps to Successful Change (Kotter, 2016)

Shifting focus from retaining high risk students to promoting academic success for all, Merrimack College, the STEM Center echoes the initiatives of College's Strategic plan. A sense of urgency is created to ensure that Merrimack College becomes the hub of all scientific activity in the region (Merrimack College, 2017b). To communicate the vision, Academic Success Center and all its affiliate programs will continuously monitor and advance this vision through excellence in classroom teaching and scholarship, diversity and globalization, the development of professionally oriented graduate programs, investments in faculty, the enhancement of student life and experiential learning. The STEM Center will work in close co-ordination with all the entities of the College to communicate the vision and empower people to act on it (Figure 5).

Figure 5. STEM Center and its coalition with College Resources



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APPENDIX A



MERRIMACK COLLEGE
SCHOOL OF SCIENCE & ENGINEERING



SCIENCE | TECHNOLOGY | ENGINEERING | MATHEMATICS

STEM CENTER PROPOSAL FOR STUDENT RETENTION AND SUCCESS

**DR. MADHU DHAR
DEPT. OF SCIENCE AND ENGINEERING
MERRIMACK COLLEGE**

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Summary and Rationale for creating STEM Center

This proposal proposes a STEM Center that provides an infrastructural support for undergraduate students in the School of Science and Engineering at Merrimack College. The STEM pipeline, a commonly used analogy (Kuh, 2006; Tierney, 2000), has been shrinking. Furthermore, degree attainment for women and underrepresented minority students in STEM are even lower than for undergraduates (National Science Foundation, 2007). With low numbers of students enrolling in STEM fields and even smaller numbers of women and minorities in the STEM pipeline, colleges and universities need to pay attention particularly to retain the students they have. The Center will consolidate programs under a single entity and create a continuum of resources designed to support students at every stage of their education. Specifically, using George Kuh's high impact practices (Kuh, 2012) faculty and staff will plan and implement retention initiatives including experiential learning opportunities, undergraduate research, STEM-focused clubs and a Women in STEM, Living Learning Community (LLC). The Center intends to create increased coordination between faculty and staff to provide targeted advising during critical points in the semester. Although, there is enough scholarly research around STEM initiatives, successes of universities and colleges with a well-established STEM focus, but information on the STEM practices employed by small private liberal arts catholic institutions is scant (Rask, 2010). An effort has been made in this proposal to justify the urgency of creating a STEM Center at our private, liberal arts College. Well-documented trends have been reported nationally of declining interests, poor preparedness, a lack of diverse representation, and low persistence of U.S. students in STEM fields of study (PCAST, 2012).

Brief description of Merrimack College

Merrimack College strategically located in the idyllic Boston suburbs, is a selective, independent college in the Catholic, Augustinian tradition (Merrimack College, 2017a). The college leads with a mission to enlighten minds, engage hearts and empower lives. The college boasts about its commitment

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to scholarship and service to others, and providing boundless opportunities to students to develop intellectually, spiritually, socially and ethically. The school's deep rooted dedication to the Augustinian values of hospitality, community and the pursuit of truth welcomes the students and challenges them to explore the world and gain the experiences they need to shape their future.

According to The National Center for Education Statistics (NCES, 2016) data Merrimack College a four- year private, mainly residential Catholic college is accredited by New England Association of Schools & Colleges (NEASC). Recently Carnegie Classification declared the College as a Master's Colleges & Universities: Medium Program. Merrimack College has a predominantly white student population of 72 percent, 5% Hispanic and 1% Asian. While the first to second year retention rate of Merrimack College is 83 percent and the graduation rate is nearly 71 percent, there is great scope to increase this rate. The tuition and fees for full-time (2015 - 2016) beginning undergraduate students was around \$37, 670 and with boarding expenses student pays around \$53,620 annually. The College boasts of a great financial aid package of 99% for full-time beginning undergraduate students and the percent of all undergraduate students receiving Pell Grants was about 23 percent. The data from NCES (2016) also reveals that for the fiscal year 2013 cohort default rate is 3.8 percent.

The undergraduate enrollment for 2015-2016 was about 3,167 which is 79 percent of the undergraduates admitted. Merrimack College is a proud member of NCAA Division I with Ice Hockey and NCAA Division II with Football. There are nearly 14 total athletic teams, with 697 Merrimack Warriors (athletes) recruited, out of which 363 are males and 334 female athletic recruits. The NCES data (2016) on faculty percentages tells a universal story across higher education in US, with higher percentage of part time or adjunct faculty. The total faculty count at Merrimack College is 375, out of which 168 are full time and 207 are part time. Merrimack is a strong proponent of service learning and offers many programs to address civic causes. The college has garnered great reviews in the past five years and has been ranked by U.S. News & World Report as amongst the top 10 colleges in the United States' North region for the fifth year in a row (Merrimack College, 2017c).

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Mission, Vision and Values of Merrimack College

Merrimack College embraces its mission to enlighten minds, engage hearts, and empower lives. Faithful to their Augustinian tradition, this mission calls to actively engage the passion and emotion of hearts with the discipline provided by intellect and reason.

Merrimack College's vision is to be a highly ranked, internationally respected, selective master's comprehensive Catholic college, which is residential, student-centered, professionally focused and rigorous in the liberal arts, sciences, and business. Merrimack College has a vision to nourish and sustain five core values of scholarship, service, leadership, community building and awareness (Merrimack College, 2017a).

Brief History of Merrimack College

Merrimack College was founded in 1947 in North Andover, Massachusetts, by the Order of St. Augustine O.S.A. The Augustinians, at the invitation of Richard Cushing, archbishop of Boston, established the college as a direct response to the needs and aspirations of local soldiers returning home from World War II (Merrimack College, n.d.). Merrimack College is a tribute to the Rev. Vincent A. McQuade. A native of Lawrence, Massachusetts, Rev. McQuade led the college to eventually become a showcase of the Merrimack Valley, approximately 25 miles north of Boston. Since that time, Merrimack College has graduated nearly 22,000 students. Today's 220-acre campus comprises nearly 40 buildings and now students at Merrimack College now come from all-across the United States and around the globe.

Merrimack College Strategic Plan

Retaining students is the goal of all colleges and universities. Acceptance rates serve as a proxy for selectivity and are closely correlated with retention rate (Allen & Vince, 2011). Merrimack College through its strategic plan (Merrimack College, 2017b) successfully offered over 100 academic programs. But even for institutions with a transparent focus on persistence, putting effective programs in place is

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not an easy task. In the Fall of 2010 Merrimack College embarked upon a journey with President Hopey's strategic plan called "Advancing Merrimack in the 21st Century: The Agenda for Distinction" (Merrimack College, 2017b). One of the intended outcomes of the plan was to develop a seamlessly integrated academic culture of excellence in which vibrant intellectual activity intersects with the physical, social, and spiritual development of students. College's success plan that supports to develop distinctive models of undergraduate and graduate education through strategic investments in unique programs to expand enrollment helps retention significantly (Padilla, 1999).

The strategic plan lay the foundation for the college to grow, in size, diversity, and stature as well as being recognized as a leading institution of higher education (Merrimack College, 2017c). Under the strategic plan, broad spectrum of course offerings have been introduced, promoting and facilitating campus-based research using the campus as a laboratory, and engaging and partnering with community organizations to address needs in the region.

Retention and Success Strategies at Merrimack College

To promote academic success of Merrimack College students, the Academic Success Center (ASC) was created to provide a wide range of opportunities to students wishing to enhance their academic performance (Merrimack College, 2017d). The ASC offers workshops, programs, tutoring, individual and/or group meetings to all students on important topics like academic expectations, time management, preparing for tests, dealing with test anxiety, effective reading, and study skills. Active strategies to engage and encourage all students to achieve academic and personal success are important for self-advocacy and persistence both in and out of the classroom (Bean & Eaton, 2001).

Influenced by Tinto's research on retention and persistence (1993, 2010), the Academic Success Center and its Dean, Dr. Ellard are trying to help college retention by supplementing the primary advising of the faculty. Student retention and completion is, among other things, influenced by the availability of clear and consistent expectations, specifically about what students need to do during college to be successful. Dr. Ellard (P. Ellard, personal communication, March 15, 2017) described how

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his retention model (Ellard, 2016) proposed an early alert system that warned faculty and advisors of the students' possible risky academic situations. The plan targeted the most at-risk freshmen and the endeavor is a significant success. The ASC and all its affiliate programs were created to advance Merrimack College's vision through excellence in classroom teaching and scholarship, diversity and globalization and the development of professionally oriented graduate programs.

Apart from the ASC, the Center for Excellence in Teaching and Learning (CETL) (Merrimack College, 2017e) was designed to serve the Merrimack community through support for innovation and excellence in teaching and learning. Dr. Kathryn Nielsen, Director, CETL (K. Nielsen, personal communication, March 28, 2017) reflected how the teaching circle groups, faculty development workshop series, research and faculty fellow programs have changed the teaching and learning experience at Merrimack and subsequently helping retention and enrollment.

Innovation through Engineering and Computer Science (iTEC), a Science and Engineering department initiative with a multi-year, National Science Foundation grant (Foundations for STEM Success) was awarded to Merrimack College to design and implement retention initiatives for all first-year engineering and computer science students (Merrimack College, 2017f). In an effort, to reduce the engineering students' withdrawal rate due to mathematics (Gleason et al., 2010), the College developed a unique, informal, interactive, and interdisciplinary residence program called the iTEC program.

Despite these interventions, data (Table 1 and Table 2) shows significantly low student interest in selecting STEM majors. To address this issue of student departure from STEM courses, a STEM Center is proposed for the School of Science and Engineering, Merrimack College.

Creation of STEM Center at School of Science and Engineering

U.S. Department of Education has in the past taken attrition of students out of STEM fields very seriously. Under former President Obama's governance and his personal interest in Nation's STEM initiatives had received tremendous support. Programs like Educate to Innovate, White House Science Fairs, Engage-to-Excel. The goal was to produce one million additional College Graduates with degrees

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in Science, Technology, Engineering and Mathematics that are already underway in many higher education institutions (PCAST, 2012). Statistics on the state of education in the United States indicate a decreasing trend in undergraduate students choosing to major in and successfully complete degrees in Science, Technology, Engineering, and Mathematics (STEM) disciplines (National Science Board, 2004). Data published in the Chronicle of Higher Education (Farrel, 2001) also reflects the disproportionate number of underrepresented minorities and women in STEM fields. Faced with low STEM persistence and success trends at Merrimack College (Table 1) it is imperative that the institution establishes and maintains high quality and effective STEM academic and student support services. Merrimack College must meet the needs of its students by increasing the number of STEM graduates and particularly women and minorities who lack proper preparedness. Students at Merrimack College seek diverse educational outcomes, ranging from personal development, career advancement, and degree completion to better their chances at jobs or going for higher degrees. It is therefore, essential for the School of Science and Engineering to work collectively and collaboratively, under one banner to achieve Merrimack's STEM retention goals. Hence the need for STEM Center is critical to unify the cause.

STEM Center Vision and Mission

A thriving global community requires citizens with expertise and knowledge in Science, Technology, Engineering and Mathematics (STEM). The mission of the STEM Center is to “To develop programs and initiatives that will establish the School of Science and Engineering at Merrimack College as a nationally recognized center of excellence in STEM education”. The Center will coordinate and enhance excellence in science, technology, mathematics and engineering (STEM), advising, retention and experiential learning at Merrimack College and beyond by providing, supporting, integrating, and disseminating STEM education research and related outreach programs and professional activity. The vision of the Center is to position Merrimack college as a leader in K-20 STEM education by (1)

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providing leadership in research, evaluation and practice to advance knowledge about successful STEM pipeline, professional development and academic programs; (2) working with STEM faculty (throughout the Merrimack College system) and with K-12, community college, and other public and private sector partners to ensure students are well-prepared to be successful in college and career pathways in the STEM fields (3) creating strategies to increase the availability of campus resources to the community at large and to our education partners; and (4) addressing the challenges of diversity by supporting efforts for recruitment and retention of STEM students, particularly with regard to women and minority student populations.

STEM Center and Strategic Plan

The proposed STEM center directly aligns with Merrimack College's strategic plan (Merrimack College, 2017b) to create a modern, academic enterprise grounded in innovative teaching, learning, and scholarship. Opportunities like research and internship can facilitate excellence in undergraduate and graduate STEM education and help create an intellectually vibrant, socially engaged, entrepreneurial student experience. Intensive advising can supplement faculty advising and improve student services for Merrimack students by improving access to advisors through drop in hours and coordinating with faculty advisors and other mentors and success coaches. This will inspire and engage Merrimack community in STEM initiatives. By offering outreach programs the STEM center links the Merrimack College's values to engage other educational institutions, industry, and agencies of social change in collaborative efforts fostering a just and sustainable world.

Need for the STEM Center: An Analysis of the problem

To better understand STEM retention and success at Merrimack College, I looked at the enrollment data by first major related to STEM disciplines from years 2012 to 2016. Significantly low enrollment data for Sciences was surprising and the number of women enrolled in engineering programs was astonishingly sparse (Table 1). It is clear that while health sciences is doing better with nearly 13

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percent enrollment by first major, sports medicine has been doing consistently well for the past five years. The pure science majors have an overall enrollment of 8% of College enrollment with biological sciences doing well with 4% enrollment. There is very low enrollment performance for key science majors like Mathematics, Chemistry, Information Technology and Physics (0 % to 1%). In the engineering courses, civil and mechanical engineering are attracting better numbers than electric and computer engineering (Table 1, Figure 1).

The data also reveals a wide disparity in gender enrollment for some majors in the science and engineering disciplines. While women outnumber men in health sciences and biological sciences at Merrimack College (Table 2, Figure 2), there is still a wide disparity in enrollment numbers for computer sciences, engineering and information technology. This is true for the nation-wide research conducted by National Science Foundation (2007) and National Center for Education Statistics (NCES, 2014).

To address these concerns, the proposed STEM Center apart from offering support and service to students, plans to research and analyze the reasons for low STEM enrollment at Merrimack College, departure of students from STEM majors, declining interest of female students in computer, engineering and mathematical sciences. Special attention will be paid to assess the issues related to students with undeclared majors. There is a need to study the data carefully to arrive at more conclusive reasons for low STEM enrollment and retention at Merrimack College. Looking for helpful data that allows the researcher to become more familiar with the problem to be studied is significant to prove the point. The data is in the form of tables and charts that can be quantified and summarized. Patton (2002) explains that the qualitative research is any qualitative data reduction and sense-making effort that takes a volume of qualitative material and attempts to identify core consistencies and meanings. To make better argument for the necessity of STEM Center at Merrimack it is essential to check the enrollment data first. Based on the data for past few years some initial inferences can be drawn.

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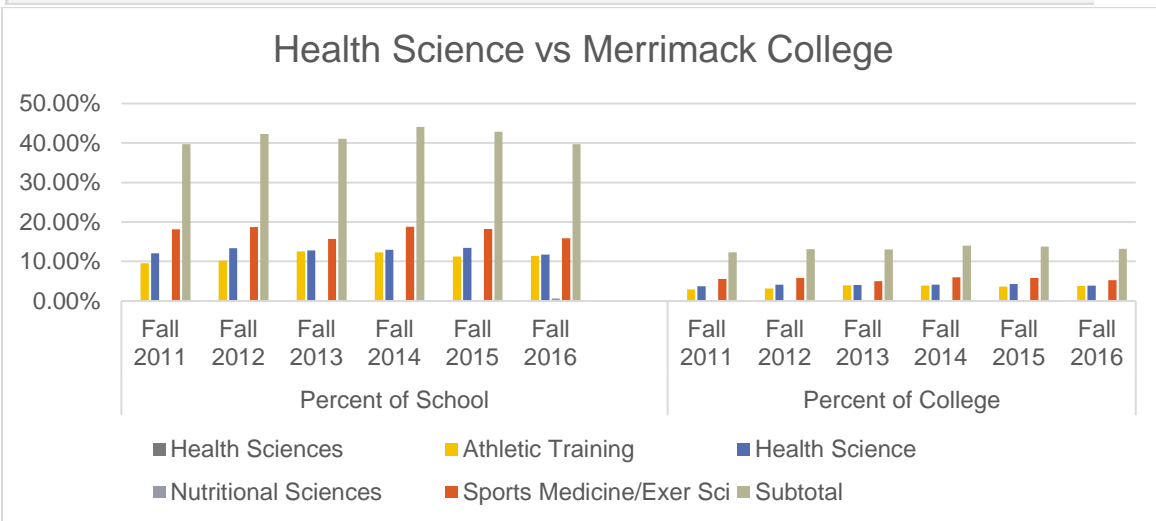
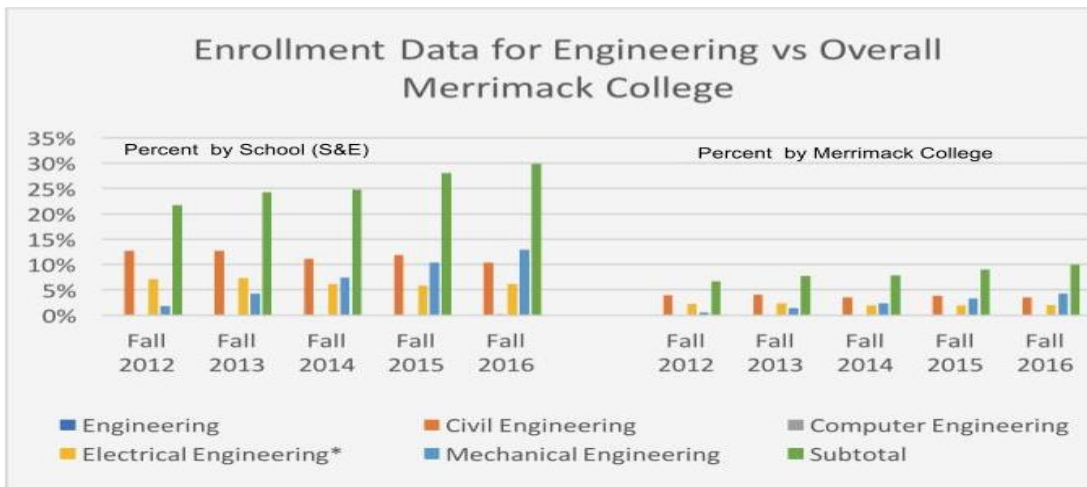
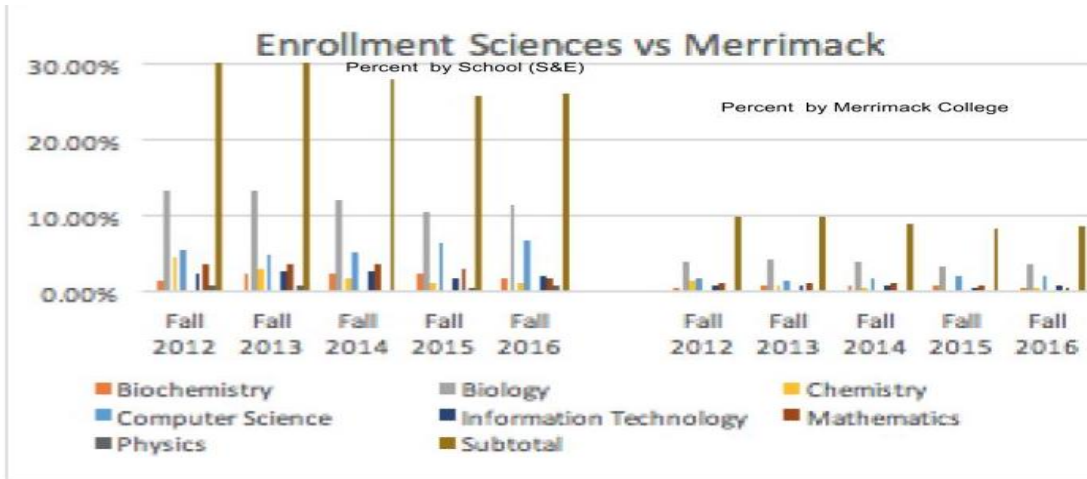
Table 1. School of Science and Engineering: Percent Enrollment Data (2012-2016) by First Major

	Departments	2012 (%)	2013 (%)	2014 (%)	2015 (%)	2016 (%)
1.	Health Sciences*	13	13	14	14	13
2.	Mathematics	1	1	1	1	1
3.	Computer Science	2	2	2	2	2
4.	Information Tech	1	1	1	1	1
5.	Chemistry	1	1	1	0	0
6.	Bio-Chemistry	0	1	1	1	1
7.	Biology	4	4	4	3	4
8.	Physics	0	0	0	0	0
9.	Civil Engineering	4	4	4	4	3
10.	Mechanical Eng	1	1	2	3	4
11.	Electric Eng.	2	2	2	2	2
12.	Computer Engineering	-	-	-	-	0
13.	Overall S&E	31	32	32	32	33

	Health Science *	2012 (%)	2013 (%)	2014 (%)	2015 (%)	2016 (%)
1.	Athletic training	3	4	4	4	4
2.	Health Science	4	4	4	4	4
3.	Sports Med/Ex-science	6	5	6	6	5
4.	Nutritional Sciences	-	-	-	-	0

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Figure 1. Enrollment Data Science and Engineering



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Table 2: Merrimack College Science & Engineering Traditional Undergraduates (Male/Female): first majors.

Department	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	Fall	2012	Fall	2013	Fall	2014	Fall	2015	Fall	2016
Health-Science	110	180	124	206	141	250	141	271	135	295
Engineering	135	18	172	23	193	27	229	41	276	47
Sciences	124	100	132	115	129	118	133	115	153	130

Figure 2:

Science and Engineering Male vs Female enrollment chart.

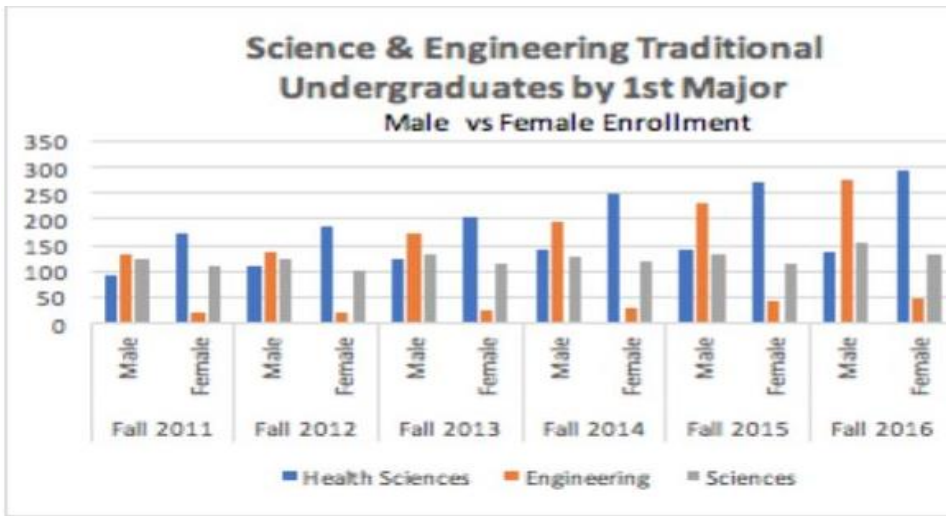
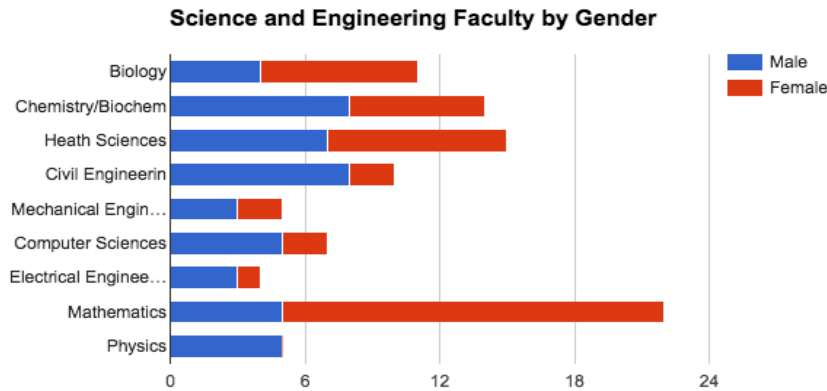


Table 3: Enrollment breakdown by Gender for Science and Engineering Majors (2016)

	Fall 2016			Fall 2016			Fall 2016	
	Male	Female		Male	Female		Male	Female
Health Sciences			Engineering			Science		
Athletic Training	57	67	Civil Engineering	95	18	Biochemistry	7	13
Health Science	19	108	Computer Engineering	2	1	Biology	38	85
Nutritional Sciences	0	7	Electrical Engineering*	61	6	Chemistry	7	7
Sports Medicine/ Exercise Science	59	113	Mechanical Engineering	118	22	Computer Science	67	6
						Information Technology	20	4
						Mathematics	8	11
						Physics	6	4

Figure 3: Science and Engineering current number of faculty by gender* (2016)



To check whether teacher gender plays an important role in higher education by influencing student achievement and subject interest, especially for this study for Science and Engineering, data trend from 2016 which is very similar to past the four year trend, was used to help identify how this effects enrollment. We find instructor gender plays some role in determining college student enrollment by major. Female students may avoid male dominated science majors not only due to the bias against them but also due to underrepresentation of the faculty in these fields (Bettinger & Long, 2005). From Figure 3 and Table 3, we see that more female students are enrolled in Mathematics where there are majority female instructors. Comparatively for Electrical Engineering, there is low female enrollment (61 male vs only 4 female) corresponding to low female faculty representation. Similar trend is observed in Information technology, Computer Science and Physics majors.

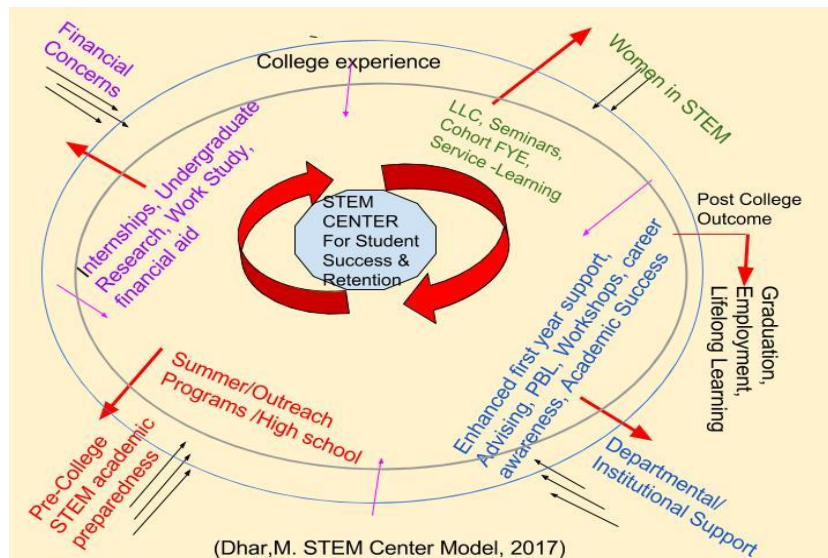
It will be interesting to study how the College's female undergraduate enrollment in the sciences and engineering can be increased by raising female representation on the faculties in those fields. To examine the relationship between the gender composition of the students in an academic department and the gender composition of its faculty at the time the students are choosing their majors, a thorough quantitative analysis and research needs to be conducted.

* This includes all faculty, tenure, non-tenure and adjunct or part-time.

STEM Center Model

This research mirrors the findings in STEM and general retention literature by suggesting that when planning for STEM student retention, college leaders should review current and future initiatives to look for opportunities to intentionally enhance those relationships among faculty, staff, and students that might exert positive peer pressure on student intention to graduate. A model for the proposed STEM Center (Figure 4) depicts positive role played in retaining students by institutional intervention coupled by best practices in teaching and learning. The Center plans to enhance first year undergraduate student

Figure 4. STEM Center Model for Student Retention and Success



support, assess and address pre-college STEM preparedness, offer extensive opportunities for undergraduate research and internships and more specifically retaining women in STEM. High impact practices like, undergraduate research and internships, outreach and summer bridge programs, career counselling, project based learning, living learning communities and seminars are proven practices (Kuh, 2016) responsible for student retention, success and persistence. The theoretical framework for this Capstone is mentioned in the write-up. Using these practices the STEM Center using modified Tinto's retention theories, Bolman and Deal's Organization theory (Berger & Braxton, 1998; Kuh, 2016; Bolman & Deal, 2013; Tinto, 2012).

STEM Center Objectives

The proposed STEM Center will help School of Science and Engineering build a sound retention plan. Though retention is not centric to the strategic plan of Merrimack College (Merrimack College, 2017b), but undergraduate retention and success is possible by utilizing best practices in STEM recruitment and retention strategies. Some of the key objectives of the STEM Center include:

- Improving student support, especially in the first two years of college, by providing a centralized resource for drop-in advising and assistance, and by connecting students to the various referrals and resources to succeed (Dagley et al., 2016, Xu, 2016). First year students represent the most sensitive population of the institution. Positive college experiences in the initial years determine if the students will be retained. With my many years of advising and teaching experience, I found that students entering the STEM courses in their first year expect to major in sciences, but the intention changes by the end of first year of the Fall semester. Several factors play a role in this departure. Students who felt they had good pre-college math skills are surprised to see the results of their first mid-term performance. Students begin to worry and assess if their choice of science courses was good enough. It is at this juncture that good advising from the department(s) can help them rethink or reconsider their choices. A centralized resource center, accessible most of the time to address student concerns can possibly help retain the students in STEM fields.
- Providing all students with access to tools and resources needed to excel in STEM fields – tutoring, mentoring, summer bridge programs, workshops and experiential learning opportunities and adequate incentives to form STEM focused student clubs (White & Massiha, 2016; Graham et al., 2013). The STEM Center will primarily focus on enhancing team based learning to increase student learning and engagement, immersive learning strategies, that help faculty to incorporate metacognition into their teaching and maximizing technology for teaching and learning inside and outside of the classroom. Research shows (Flanigan, Skinner & Prager, 2015,

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Kuh, 2012) that teaching and learning programs combined with High Impact Practices can play a pivotal role in promoting and supporting the retention strategies of the institution.

- Financial pressures are the most common cited reason for leaving college. The cost of a college education has never been higher, and the reality of paying for this privilege often rests on the student. These pressures force students to work more hours than they can afford to offload and ultimately limits their ability to study and keep up with the rigors of science and engineering courses (Johnson, 2012). Offering internship and research opportunities can help them stay connected to their courses and create opportunities for future jobs. Guiding students to financial aid offices for possible tuition relief, work study programs or scholarships. Often students do not invest time in looking for helpful resources. To cut through the chase and minimize student anxiety, STEM Center will offer adequate guidance and connect them to the right resources.
- High Impact Practices and access to alumni and industry speakers/mentors, and preparation for graduate school or employment pathways after college; (Kuh, 2006; Tierney, 2000). Health Science programs at Merrimack College skew the data positively in health related subject areas because of their high program requirements, professionalism, research funding and nearly perfect passage rates. A similar structure needs to be extended to the rest of the science and engineering departments. This serves as a model and resource for similar institutions, particularly the community of small Catholic colleges and universities, to adopt and develop best practices in teaching and learning (Kuh, 2012) that have a direct relationship to retention.
- Faculty mentoring provides an opportunity to develop a relationship in which faculty members can exert positive peer pressure toward graduation (Foltz, Gannon, and Kirschmann 2014). Similarly, peer mentoring provides an opportunity for student mentors to exert positive pressure to graduate and helps anchor students to their major (Holland, Major, and Orvis 2012).

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- Work actively with the admissions office to promote and create awareness of opportunities in STEM at Merrimack. Facilitating exploration of the wide array of career opportunities in STEM majors (Braxton & McClendon, 2001) helps student retention and success.
- Diversify pathways to STEM degrees – assist/facilitate change of Major process, work with transfer students and academic departments to create pathways to Merrimack STEM majors/programs.
- To offer ample opportunities to women to excel and be retained in STEM majors. Recent approval of Women in STEM – Living Learning Community (Appendix A), is a positive step in this direction. Living-learning communities in STEM disciplines combine the impact of peer and faculty mentoring to support student persistence and success (Soldner et al. 2012).

STEM Center Goals - Year 1

The proposed Center integrates STEM student support services in a hub-location within the School of Science and Engineering which maintains drop-in hours. This model provides students with drop-in advising and resources, promoting success and retention in STEM fields of study. The proposed goals for year one are:

Goal 1: Drop-in academic advising

Supplement faculty advising and improve student services for Merrimack students by improving access to advisors through drop in hours and coordinating with faculty advisors and other mentors and success coaches. This is especially important for students shifting between majors.

Performance Outcome

Improved persistence, success and rise in graduation rates. Use of academic and student support services will increase.

Goal:2 First year undeclared STEM majors and at risk students

Provide exploration and advising for first year students with undeclared STEM majors (Undeclared Science and Undeclared Engineering), to monitor and follow up with ‘at risk’ Science and Engineering students, and follow up with students who did not register (DNR) or who are under registered.

Performance Outcome

Students who are undecided with their majors will be more confident to choose their STEM major in the first year or decide to join some other major. This will help retention.

Goal 3: Experiential Learning

Provide an integrated experiential learning component for students in STEM fields of study, including opportunities for internships and co-ops, research, and service learning in areas of interest to them which will help their long-term career prospects. (Schneider et al., 2015).

Performance Outcome

Increased connectivity, better career prospects and graduate on time.

Goal 4: STEM Outreach

To serve as a hub for interdisciplinary, co-curricular, and STEM outreach initiatives for the Science and Engineering students at Merrimack, including student clubs, Living Learning Communities, STEM Education and other interdisciplinary initiatives (Ward, 2015 , Soldner et al., 2012).

Performance Outcome

Service Learning, Peer Mentoring, Tutoring.

Goal 5: Women in STEM

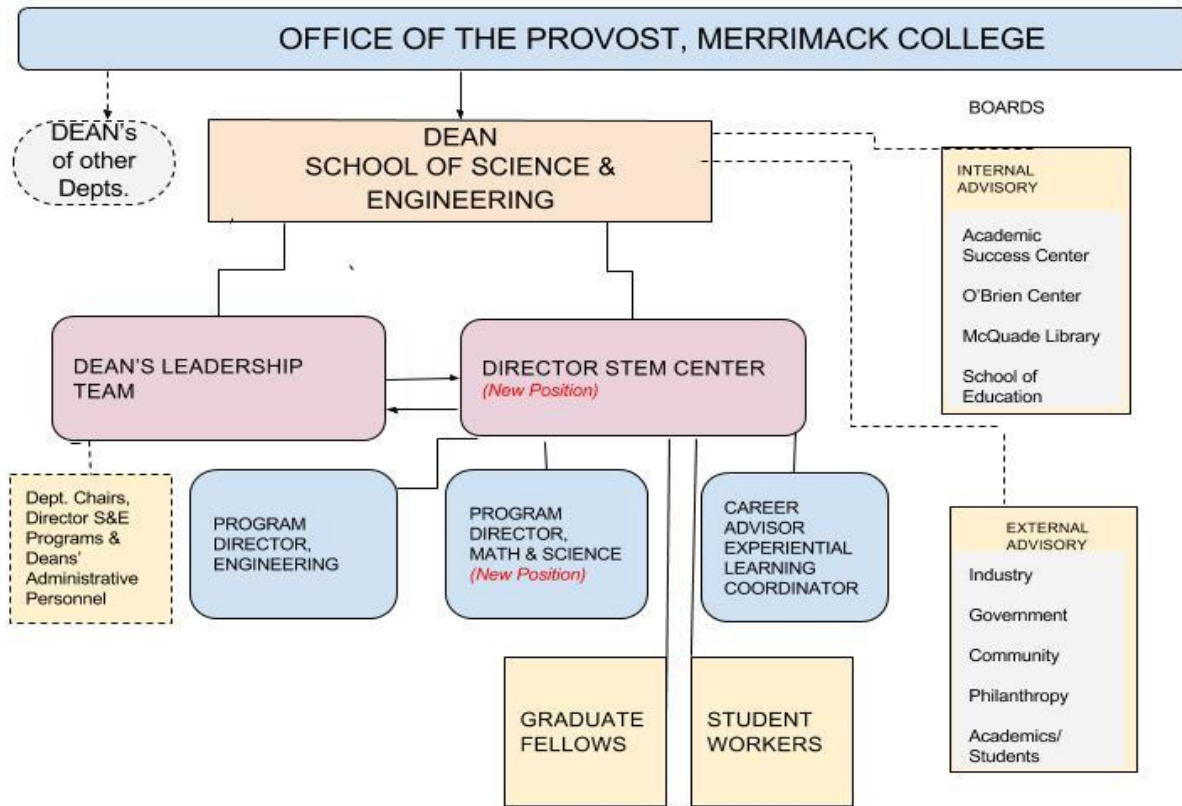
To provide diversity resources and support to STEM students including helping to expand Living Learning Communities (Women in STEM), student clubs such as Society of Women Engineers (SWE), referral to diversity resources on campus and for professional development opportunities (White and Massiha, 2016, Diekman et al., 2015).

Performance Outcome

Increase in diversity and women in STEM participation.

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Organizational Structure of STEM Center



While the basic organizational structure of School of Science and Engineering remains unaltered, it is recommended to include two new positions for the proposed STEM Center. The Center will be able to offer graduate fellowship and student worker positions as needed. This serves the goal of the Center to help students in getting experiential learning and work study programs. The STEM Center will primarily report to the office of Dean, School of Science and Engineering. By creating the internal and external advisory boards will help facilitate information flow between different departments of the Merrimack College. While the external advisory board handles important dealings, issues between industry, government and community, the internal advisory board will be responsible for corroborating between key arteries of the College like ASC, Library etc.(Figure 4). The advisory board programs will

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be run through Dean's office. A new position for the STEM Center Director is proposed to oversee the functioning of the new facility. The details of the position are:

Position: Director, STEM Center, School of Science and Engineering, Merrimack College

Job Summary

The Director is expected to establish collaborative partnerships with Merrimack College stakeholders, industry, government, foundations and community leaders; Merrimack faculty. In addition, the Director will oversee STEM student recruiting, STEM experiential learning, Cooperative Education, Career Counseling and Special STEM Programs for School of Science and Engineering students. The programs and services of the Center include, but are not limited to, career assistance; counseling, and testing; internships and fellowships; job listings; STEM networking opportunities; on-campus interviewing and employer information sessions; career and job fairs for undergraduate and graduate students, as well as alumni/ae for the nine different science departments in School of Science and Engineering. The Director is expected to oversee the strategic use of the resources and budget of the Center.

Minimum Qualifications

- Ph.D in a STEM field or Ph.D in Education with Bachelors in STEM.
Two (2) or more years of professional experience in a teaching or leadership role in an institution of higher education
- Experience in developing strategic partnerships through collaborations with STEM academic affairs/faculty, and working strategically with employers
- Experience in developing corporate funding opportunities and in supporting the development of a broad range of co-op and internship endeavors and industry and government partnerships
- Experience in fiscal planning and budget management, strategic change management, and in the supervision of staff.

Preferred Qualifications

- Experience in higher education and placement of science, technology, engineering and math (STEM);

The Minimum Knowledge, Skills, and Abilities

- Demonstrated ability to effectively communicate and to influence others in-order to meet organizational goals
- Demonstrated success in building collaborative relationships with diverse constituencies
- Demonstrated commitment to diversity and inclusion
- Demonstrated commitment to student success and achievement
- Demonstrated planning, organizing and effective time management skills
- Ability to analyze and interpret financial and other data
- Excellent interpersonal and communication skills
- Ability to work effectively under pressure and meet established goals and objectives
- Ability to anticipate and solve problems

STEM Center Office Programming

The STEM Center will involve wide range of initiatives to increase student participation in STEM. The complexities of today's world require all people to be equipped with a new set of core knowledge and skills to solve difficult problems, gather and evaluate evidence, and make sense of information they receive from varied print and, increasingly, digital media. The learning and doing of STEM helps develop these skills and prepare students for a workforce where success results not just from what one knows, but what one is able to do with that knowledge. Thus, a strong STEM education is becoming increasingly as a key driver of opportunity, and data needed for STEM knowledge and skills will grow. Those graduates who have practical and relevant STEM precepts embedded into their educational experiences will be in high demand in all job sectors.

To this effect, STEM Center will in the first year will offer following services:

1. Advising one-on-one all days of the week between 8am - 10:00pm. The personnel helping in this will be faculty from different departments on rotation, student peer mentors and graduate fellows.
2. Collaborative research opportunities with area Universities and Colleges.
3. Outreach and service learning opportunities.
4. Women in STEM, speaker series in Fall 2017 and Spring 2018
5. Science Fair 2017 in the month of October 2017. The Science Fair will showcase STEM student talent from undergraduate, area high schools and middle schools.
6. Organizing a Hackathon event for sustainability related issues.

Conclusion

The demographics of student populations are vastly changing, and faculty are finding their classrooms are increasingly made up of academically, socially, culturally and linguistically diverse students. This proposal presents opportunities to increase STEM persistence, success, and graduation rates of this diverse student body, including underrepresented minority, women, first generation, and low income students by serving as a hub and communication center for STEM students, utilizing best practices for student advising and retention. The model provides a theoretical basis to see which interventions change student intentions. Future research should consider using student intention survey as well to design customized programs to further improve STEM student retention. This information could then be used by planners to assess the effectiveness of various initiatives and thus contribute to the continuous improvement cycle. Comparative research in future will examine the effect of these intervention in the same manner to non-STEM students. Longitudinal research should also be conducted to see if the intent to graduate is modified by institutional support. With this information, planners can review existing and proposed initiatives to look for a positive relational component. This model holds promise as a method of measuring student retention, success and graduation intention in STEM fields.

BUDGET PROPOSAL

APPENDIX B



MERRIMACK COLLEGE
SCHOOL OF SCIENCE & ENGINEERING



STEM CENTER BUDGET PROPOSAL

PREPARED BY

DR. MADHU DHAR

FOR

SCHOOL OF SCIENCE AND ENGINEERING

MERRIMACK COLLEGE,

315 TURNPIKE ST. , NORTH ANDOVER,MA



Budget Proposal for STEM Center

To propose a STEM Center for School of Science and Engineering at Merrimack College, it was required to check if the budget was adequate to support the project. The budget planning provides the resources to execute the goals, objectives and outcomes. The budget details each major line item with reasonable costs for operation of an activity of this size. STEM Center proposal budget was carefully constructed with federal regulations to adequately support the activities, make effective use of federal and local resources, and allow the project to successfully obtain the goals and purpose of the proposal. It is estimated that the project will need minimal STEM supplies, equipment, travel, and other resources for the first year, but will project for future inclusion 1) instructional multimedia materials; 2) student educational resources; 3) consumables; 4) specialized computers and software; 5) video-streaming equipment; 6) Science Club committee needs; 7) faculty development, workshop, advising tools and conference support. These necessary supplies will assist in record maintenance, evaluation the STEM center functioning and monitoring of STEM student services.

The description of the budget proposal is given in the following sections of budget breakdown as Annual Operating Budget, Capital Budget, Auxiliary Budget and Special Budget. Table 1 describes this overall budget break up for the School of Science and Engineering including the expenses for proposed STEM Center. The total budget after combining the four categories is **\$704,361**. This amount has exceeded from past years by just few thousand due to inclusion of STEM Center basic necessities. The STEM Center in the first year of its launch will not cost a lot. The Dean, School of Science and Engineering has promised to provide a small



office with basic office facilities. Hence , there is no projection for great spending.

Table 1 : Breakdown of the budget

School of Science and Engineering STEM Center Overview and Budget Breakdown		
BREAKDOWN OF BUDGET		
Budgets	Total	Comments & Explanation
Annual Operating	\$411,760	New STEM Center included to S&E
Capital	\$246,251	
Auxiliary	\$42,950	STEM Center expenses included
Special	\$3,400	
Budget Total	\$704,361	

1. Annual Operating Budget

Day-to-day functionality of the Science and Engineering office budget depends upon the annual operating budget. An operating budget is a combination of known expenses, expected future costs, and forecasted income over the course of a year. Operating budgets are completed in advance of the accounting period, which is why they require estimated expenses and revenues.



Table 2a: Operating Budget General

School of Science and Engineering STEM CENTER Annual Operating Budget Description 2017-2018			
Budget Description	Cost (US Dollars)	Quantity	Price (\$)
College Fair	1000	1	1000
Meetings/ conferences	15000	2	30000
Faculty Development grant	1000	1	1000
Assessment Workshop Series	200	1	200
Seminars/Workshops	4000	2	8000
Membership Dues	13,000	1	13,000
Subscriptions	2,500	1	2500
Student Academic activities	4500	2	9000
Software Maintenance	5000	1	5000
Hardware Maintenance	8000	1	8000
Credit Card fees	30	1	30
Telephone charges	15000	1	15000
Accreditation	50	1	50
Travel	17500	2	35000
Contractors	500	1	500
Maintenance Contract Lab	15000	1	15000
Maintenance Supplies	100	1	100
Departmental Supplies	15000	1	15000
Office Supplies	23000	1	23000
Salary *	227880	annual	227880
Postage Expenses	2500	1	2500
Operating Budget Total			411,760

Table 2b : Salaries

School of Science and Engineering STEM Center - Salary new positions*			
Position	Salary (\$)	Fringe Benefit (40%)	Total(\$)
Director STEM Center	60000	24000	84000
Assistant Director S&E	50000	20000	70000
Professional Instructors	47000	18800	65800
Graduate Fellows		Tuition Waiver	
Undergraduate Student worker	4000	2	8000
Salary Total			227800



The total operating budget after adding the totals from table 2a and table 2b is **\$411,760**.

Apart from the regular expenses, there are two new positions suggested for STEM Center. The Director will assume the role and responsibility of running the STEM Center. The **\$84000.00** salary seems fitting for the high commitment role. The Program Director, Science and Engineering will coordinate the Science program in STEM Center. The salary total for Science and Engineering is **\$227,800.00**.

2. Capital Budget

Capital budget helps plan for raising large and long-term sums for investment in the organization over a period greater than the period considered under an operating budget. These are high level funding/expenses for large projects for institutional improvement. In Table 3, the capital budget for School of Science and Engineering has been prepared.

School of Science and Engineering STEM CENTER Capital Budget (2017-2018)			
Budget Description	Cost (\$)	Quantity	Price (\$)
STEM Center Furniture			
Desks	200	3	600
bookcases	90	2	180
filecabinets	100	1	100
computers	600	3	1800
chairs	55	3	165
Lamps	150	3	450
Glass panel for writng	250	1	250
STEM Center Office Total			3545
Science and Engineering General			
Equipment Rental/Repair	15000	1	15000
Classroom Materials	150,000	1	150000
Lease and Rental Expense Equipment	100	1	100
Discretionary Expenses	4606	1	4606
Non-Capital Software	20000	1	20000
Furniture S&E	23000	1	23000
recruitment costs	30000	1	30000
Total Science and Engineering General			242706
Cumulative			246251

Table 3: Capital Budget for Science and Engineering



In the Capital budget the STEM Center expenses have been estimated to be **\$3545.00** and the Science and Engineering capital budget general expenses are **\$242,706.00**. The total Capital budget amounts to **\$246,251.00**. The details of the expenses are given in the table and the spreadsheet is attached separately.

3. Auxiliary Budget

No institutional support will be received for this part of the budget, hence the School of Science and Engineering is expected to generate sufficient income to cover all operating expenses. The department should be ready to pay any overhead to the institution to cover the costs of institutional services. Table 4 shows the break up of Auxiliary spending of **\$42,950.00**

Table 4. Auxiliary Budget

School of Science and Engineering			
STEM CENTER Auxiliary Budget 2017 -2018			
Budget Description	Cost	quantity	Price
Sodexo / Misc Catering	30,000	1	30000
Special Events	12000	1	12000
Internal Expense Transfer	0	0	0
Miscellaneous Operating expenses	200	1	200
STEM Union	150	1	150
STEM Recreation	150	2	300
STEM conference shirts	10	30	300
Total Auxiliary Expenses			42950

4. Special Budget

A one time event like department sponsored conference constitutes a special budget. In



the STEM Center proposal, a \$3400.00 amount is expected to be used mainly for the functioning of the special event related to STEM Center launch. Hence, many of the costs are non-recurring.

School of Science and Engineering			
STEM CENTER Special Projects Budgets			
Budget Description	Cost	Quantity	Price
STEM CENTER EVENTS			
Women in STEM -Speaker(inaugural)	100	1	100
Inaugral day -refreshments	400	1	400
STEM Club Launch	100	1	100
First Year STEM Industry tours	200	2	400
First Year STEM Research Tour	200	2	400
STEM Seminars	100	2	200
Observatory Tour : Science Club	100	2	200
Science Fair S& E	1000	1	1000
HackMAck - Sustainability Hackathon	500	1	500
Info Session STEM	100	1	100
Total Special Budget			3400

Many interesting events have been planned for 2017-2018 with the launch of STEM Center. Events like Women in STEM speaker series , STEM club launch, industry and university tours and a STEM Hackathon based on climate change and sustainability. The amount spent on these events over the entire year will help generate interest in STEM and possibly help retaining students in science majors.

The prepared budget for the STEM Center will be presented to the management team of School of Science and Engineering , Merrimack College for approval.

WOMEN IN STEM - LLC

APPENDIX C



MERRIMACK COLLEGE
SCHOOL OF SCIENCE & ENGINEERING

Merrimack College Women in Science, Technology, Engineering and Mathematics - Living Learning Community (MCWiSE-LLC)

Brief Draft :

MC WiSE-LLC will be a dynamic community designed to increase the talent pool of future women scientists and engineers that can support their academic success as a STEM major. This LLC will be open to first year women majoring in Engineering, Computer Science, Mathematics, Physics, Chemistry, Biochemistry and Biology.

An LLC is a group of students that are focused on a particular area of interest and live together in an on-campus residence hall. The Merrimack College WiSTEM LLC will provide a stimulating and supportive living environment, where women who are interested in STEM fields can build strong personal and academic connections with each other and with faculty and professionals. The Merrimack College WiSTEM LLC initiative is dedicated to provide students with a nurturing environment, support network for academics and everyday life, and an exciting college experience. This atmosphere can help with the transition to college life and provide an opportunity for members to develop meaningful and lasting connections.

Requirements for Course Enrollment:



Template for Living Learning Community Structure, Roles, and Responsibilities For Academic Year 2017-2018

February 21, 2017

In preparation for academic year 2017-2018, please fill out the following form. This information will be shared with the LLC Committee and be used to help in working through logistical needs.

Name of LLC	Women in STEM
LLC Mission	To increase retention and self-efficacy of first year female STEM students through community building, peer support, understanding of STEM career paths, introduction to female role models, and social integration into the STEM community.
Number of Students	25 est. (opt in approach, numbers will vary)
Housing Location(s)	Deegan West 3 rd floor
Name of Director	Maureen Sakakeeny
Director Position Description	Assist ResLife with dorm location/room placement and RA selection. Provide academic integration and coordination, social and professional programming, peer mentor selection, student data gathering, promotion of LLC at recruiting events (with other Faculty/Staff partners)
Faculty/Staff Partners	Cynthia McGowen, Madhu Dhar, Lindsey Mattos, Anne Gatling, Program Coordinator/Grad Fellow
Academic Sponsor(s)	School of Science & Engineering – All 9 academic departments, including Health Sciences; School of Education – STEM Education
Role of Academic Sponsor(s)	Assist in providing guest lecturers (faculty, alumni, upperclass students) and mentorship; sponsor future 2-credit STEM Explorations course
Courses Involved	FYE or New 2-credit STEM exploration course
Experiential Component	Weekly Volunteering with Science Club for Girls in Lawrence
LLC Activities	Social and professional activities by RA and Program Coordinator & Director
Names of Dedicated R.A.s	2 female STEM majors
Roles of R.A.s	Normal RA duties, plus coordination with Program Director.
Funding Source	N/A



MERRIMACK COLLEGE
SCHOOL OF SCIENCE & ENGINEERING

**WOMEN IN STEM
LIVING LEARNING
COMMUNITY**

COMMUNITY MEETING: WOMEN IN STEM

Monday, June 19th AND Wednesday, June 21st , 2017

10:30 am - 11:00 am

ROOM:169, FIRST FLOOR, MENDEL HALL

MEET MERRIMACK COLLEGE
WOMEN IN STEM FACULTY
&
STUDENTS

LEARN ABOUT OUR EXCITING OPPORTUNITIES FOR
WOMEN IN STEM MAJORS,
SERVICE LEARNING PARTNERED WITH SCIENCE CLUB FOR GIRLS
&

**OUR NEW WOMEN IN STEM LIVING LEARNING
COMMUNITY**



MERRIMACK COLLEGE
SCHOOL OF SCIENCE & ENGINEERING

**WOMEN IN STEM
LIVING LEARNING
COMMUNITY**

SPECIAL SESSION ON
ADMITTED STUDENT DAY,

Saturday, April 8th AND Sunday, April 9th

1:30-2:30 pm and again 3:00-4:00 pm

ROOM:128, FIRST FLOOR, MENDEL HALL

MEET MERRIMACK COLLEGE WOMEN IN STEM FACULTY,
STUDENTS AND
DR.CYNTHIA MCGOWAN
DEAN SCIENCE AND ENGINEERING

LEARN ABOUT OUR EXCITING OPPORTUNITIES FOR
WOMEN IN STEM MAJORS,
SERVICE LEARNING PARTNERED WITH SCIENCE CLUB FOR GIRLS
&

**OUR NEW WOMEN IN STEM LIVING LEARNING
COMMUNITY**
