Fostering a STEM Learning Community to Promote Student Interest in STEM Disciplines

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Abstract

The main goal of the Fayetteville State University's (FSU) STEM Learning Community (SLC) is to spur the interest of a greater number of freshmen in STEM disciplines through the participation in the learning community. There is a significant body of research supporting learning communities for boosting students' learning and academic achievement. A learning community is an innovative, "inquiry-based" educational strategy, which has been adopted at many colleges and universities in the nation. The concept of a professional learning community is based on the premise from the business sector regarding the capacity of organizations to learn. Modified to fit the world of higher education, the concept of a learning organization became that of a learning community that would strive to provide an environment of interaction, connection, encouragement, and support for first-year students seeking to enroll in a STEM major or program. One of the elements of a successful academic STEM program involves extensive mentoring received by program participants at different performance levels. The sense of being welcomed on campus can be attributed to students' involvement in learning communities (Killeen, 2001). Learning communities provide an affordable and comprehensive method of addressing a variety of issues such as improving student retention, promoting student engagement and success, promoting curricular coherence, building a sense of community, and promoting student learning. The SLC provides an opportunity for participating STEM faculty to integrate 100-level courses in mathematics/computer science or in biology/chemistry into clusters that promote curricular coherence for incoming freshmen. Learning communities have been developed by the FSU University College for few disciplines since 2005, but implementation in STEM was only recently started in fall 2008. All incoming freshmen with an intended STEM major are required to enroll in a yearlong SLC. Students are enrolled in one of three clusters based on their STEM discipline: math, computer science or chemical/biological sciences. Each SLC cluster will have a STEM faculty serving as the SLC Team Leader and the instructor for the Freshman Seminar I/II (UNIV 101/102). The SLC Team Leader will restructure the Freshman Seminar course and associated course materials (Freshman Seminar text) to have a STEM oriented focus as a mechanism for early engagement of STEM majors. This articlewill share how the Fayetteville State University's current SLC model is used to support, enhance and supplement the goal of the Robert E. Noyce Scholarship Program. The goal of the Noyce Program is to encourage STEM majors to double major in either mathematics and secondary mathematics education or biology and secondary biology education.

Killeen, T.L. (2001). Mentoring interdisciplinary undergraduate courses. New Directions for Teaching and Learning, 85, 95-108.

Learning Communities

In recent years, the trend of developing and implementing learning communities at institutions of higher education (IHEs) to engage students in learning while attempting to improve the quality of instruction and retention seems to be the norm. When IHEs "purposely restructure the curriculum by co-enrolling students in two or more courses linked by a theme" and encourage "more active learning and interaction between students" they are developing learning communities (Pedersen, 2003, p. 2). The definition of a learning community is "any one of a variety of curricular structures that link together several existing courses…so that students have opportunities for deeper understanding and integration of the material they are learning and more interaction with one another and their teachers" (Gabelnick, MacGregor, Matthews, & Smith, 1990, p. 19).

Learning communities in IHEs have gained notoriety, as they are a vehicle to provide "a way to engage students in college and university academic communities" (Evenbeck & Borden, 2001, p. 4). According to the National Survey on Student Engagement (2012), 44% of first-year students and 37% of seniors reported either participating or planning to participate in some type of learning community. Amongst the variety of IHEs "regardless of institutional type or student profile, learning communities have demonstrated positive results in persistence, academic achievement, involvement, and satisfaction" (Andrade, 2007, p. 15).

The conception and evolvement of learning communities began with the reformation and reexamination of a liberal arts education (Dewey, 1938; Meiklejohn, 1932) and a call for increased accountability for IHEs (Gardner, 1986; Gordon, 2005). According to Tinto's (2000; 2005) research, despite recent innovations, the fact that most students still experience university academics as isolated learners whose learning is disconnected from others is evidence that implementing learning communities will provide a coherence, unity and conceptual understanding of ideas and concepts related to the major.

Over the past two decades, universities and colleges have employed the technique of enrolling students in common sets of classes. The implementation of the learning community structure was often credited with increasing student retention and strengthening academic achievement (Taylor, Moore, MacGregor, & Lindblad, 2003). "In an era of increased demands for quality higher education, learning communities were innovations to improve education at institutional and personal levels" (Noga, M. 2012, p. 3). Through their centralized community component, learning communities "seem to marry both the expectations of college students and some common goals of the institution as they relate to academic outcomes" (Gordon, 2005,).

According to Freeman, Alston and Winborne (2008, p. 227): "at the heart of learning communities is collaboration among students and faculty toward shared construction of knowledge and attainment of academic goals. When students grapple with material and tasks in collaboration with their peers, they are pushed to consider alternate ideas and perspectives, be responsible to others and engage in critical and divergent thinking and, therefore be intellectually enriched. Furthermore, active engagement in the learning process allows students to create, discover, and deeply understand material in a way that is hard to attain when students are exposed only to traditional, passive lectures.

These principles are the basis of the theory of social constructivism (Cross, 1998; Palinascar 1989), which is the major paradigm underlying the collaborative pedagogy of learning communities. The most recent scholarship on scientific teaching suggests that collaborative pedagogy provides the exact type of learning experiences necessary for deep conceptual mastery of science content; that is active, inquiry-based learning and innovative and diverse pedagogies that can reach diverse learners (Handelsman et al., 2004)."

According to Barbara Leigh Smith (1991) of Evergreen State College, learning communities can take many forms. Learning communities restructure the curriculum, time and space of students. There are many different restructuring models used today, however, learning community models link together courses to provide a greater coherence of curriculum, more opportunities for team teaching, and interaction between students and faculty.

There are five basic non-residential learning community models:

1. *Linked Courses*: Students take two courses: one disciplinary and the other skilled.
2. *Learning Clusters*: Student takes three or more courses which are usually linked by a common theme.
3. *Freshmen interest Group*: This model is very similar to the learning cluster, however; academic advisement and common major for all students is added.

4. *Federated Learning Communities*: Again, similar to learning cluster, however; another course (seminar) is added which a faculty member called a "Master Teacher" teaches. (S)He takes the courses the students are enrolled in.
5.*Coordinated Studies*: This learning community function as a single course that students and faculty members work full-time for an entire semester or academic year.

To successfully implement a learning community, a mission statement must be developed and the goals are well defined. Other aspects that should be considered when implementing a learning community are: (Tinto, 1995)

1. Determining causes for students who are dropping out.
2. What learning community model is appropriate for the institution?
3. The type of faculty members will be chosen.
4. The role administration, marketing, and student recruitment will play.
5. The cost associated with the implementation.

In *Seven Principles for Good Practice in Undergraduate Education*, by Chickering and Gameson (1987), these authors make several points concerning the character of a learning community. They are (a) encourage contact between students and faculty, (b) develop reciprocity and cooperation among students, (c) encourage active learning, (d) give prompt feedback, (e) emphasize time on task, (f) communicate high expectations, and (g) respect diverse talents about ways of learning.

Learning Communities at Fayetteville State University

Fayetteville State University (FSU) is one of sixteen constituent Universities and Colleges within the University of North Carolina (UNC) System, a public comprehensive regional university offering degrees at the baccalaureate, masters and doctoral levels. FSU promotes the educational, social, cultural, and economic transformation of southeastern North Carolina and beyond. The primary mission is to provide students with the higher quality learning experiences that will produce global citizens and leaders as change agents for shaping the future of the state. FSU offers programs in teacher education, the arts and sciences, health professions, business and economics, and unique and emerging fields.

Learning communities have become increasingly common in colleges and universities across the United States. Learning communities have been shown to have a number of benefits for students: (i) higher level of student engagement in learning; (ii) increased academic achievement; and (iii) increased retention. Learning communities provide opportunities for interdisciplinary collaboration and pedagogical innovation.

At FSU, learning communities (LCs) are sets of linked courses exploring a common theme; instructors in the LCs work together to develop the theme and coordinate course content. By linking student, faculty, and courses, LCs create more opportunities for enrichment, interaction and exploration. Additionally, LCs may include co-curricular activities, service learning opportunities, or other non-traditional educational experiences. Some include a residential dimension, with students living together in residence halls. (Table 1)

Table 1: FSU Learning Communities

Community	Description
Health and Helping Professions	Addresses the advisement issues associated with an intended major in nursing.
STEM	Brings together students and faculty interested in the natural and mathematical sciences.
Teacher Education	Designed to meet the needs of education majors by creatively combining required core course.
The Seekers	For students who have not yet decided on a major. Students in this community will find out more about themselves and where they might fit into the world of work.
Theater	Explores drama and the art and craft of theatre, with special attention to the role of theatre in modern society.
Social Work	Studies the historical development of social welfare, social work, and various social services.
Music	For intended music majors.
Law and Order	Helps students learn about American politics and develop their critical thinking skills.
Global Scholars*	(Invitation only) Prepares students for study abroad by introducing them to global issues and the background of their area of travel specifically. *Residential LC**
Foundations of Success	Provides firm foundation for academic success by focusing on core academic skills: writing, math, and computers.
Criminal Justice	Introduces students to the institutions and processes of law making and enforcement, the judicial system, corrections and the juvenile justice system.
Communication	For students interested in a career in journalism, mass communication, or speech communication.
CHEER	Helps students apply skills learned over the summer to 1st year success by working with familiar instructors for math, English and freshman seminar.
Bronco Women	Designed to explore experiences of women of color to improve their success by integration social and academic activities.
Athletes	Addresses issues specific to student-athletes; time management, academic success, etc.
Bronco Men	Addresses pedagogical issues most frequently associated with African-American males.

FSU STEM Learning Community

There is a significant body of research supporting learning communities for boosting learning and academic achievement. Learning communities are an innovative, "inquiry-based" educational strategy adopted at many colleges and universities in the nation**.** One of the elements of a successful STEM academic success program involves extensive mentoring received by program participants at different levels. The sense of being welcomed on campus can be attributed to students' involvement in learning communities (Killeen, 2001). Learning communities provide an affordable and comprehensive method of addressing a variety of issues such as improving student retention, promoting student engagement and success, promoting curricular coherence, building a sense of community, and promoting student learning.

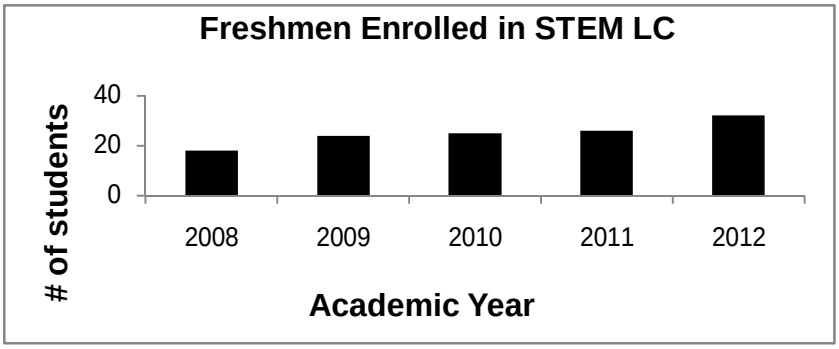

Figure 1: Freshmen enrolled in SLC. The number of freshmen participating in the SLC has increased each year since its inception in 2008. The significant increase in enrollment has led to two SLCs for fall 2013 (Bio/Chem & Math/Comp. Sci.).

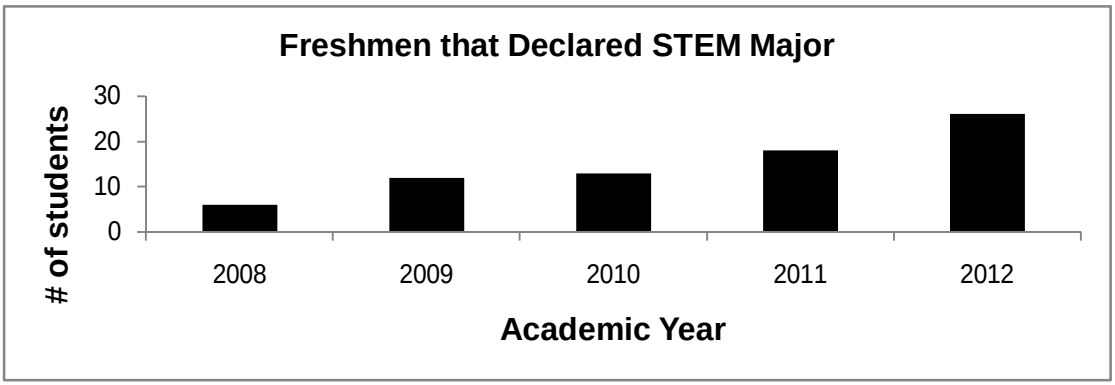

Figure 2: Freshmen SLC participants that declared STEM major. The number of freshmen declaring STEM major has increased from 33% in 2008 to 81% in 2012.

The **STEM Learning Community (*SLC)*** will provide an opportunity for participating STEM faculty to integrate 100-level (lower division) courses in mathematics/computer science or biology/chemistry into clusters that promote curricular coherence for incoming freshmen. The science and math courses listed in the learning communities operate as gateway courses that often act as a critical filter where the majority of STEM majors encounter academic achievement challenges. It has been shown that LCs, as first-year initiatives, help students transition to college and result in an increase in retention while those centering around gateway courses often show a drastic increase in student academic success rates by providing students with more time on task, with an increased sense of engagement and with a supportive community of peers (Smith et al., 2006).

Learning communities have been developed by the FSU University College for few disciplines since 2005, but implementation of a STEM LC started in fall 2008. All incoming freshmen with an intended STEM major are strongly encouraged to enroll in SLC (Figure 1), which is a yearlong. Each SLC has a STEM faculty serving as the SLC Team Leader, primary academic advisor, and instructor for the Freshman Seminar I/II (UNIV 101/102). In general, Freshman Seminar provides students with continued orientation to the university and discussion of various topics to promote retention and academic success. The SLC Team Leader restructures the Freshman Seminar course and associated course materials (Freshman Seminar text) to capture a STEM oriented focus as a mechanism for early engagement of STEM majors. In addition, a SLC Team Leader works with STEM faculty to identify at-risk students to ensure that proper advising/mentoring/academic intervention occurs (Figure 2).

Teacher Education, Robert E. Noyce Scholarship Program, and STEM LC

FSU is committed to its historic mission of preparing teachers and committed to preparing well-qualified and diverse teachers that can meet the high-need areas of science and mathematics. The FSU School of Education enjoys a proud heritage of preparing professionals who are sensitive and responsive to the diverse needs of students, parents, and the community. Graduates are employed throughout the state, region, and nation. Our teacher education major alumni demonstrate that they have the knowledge, skills, and disposition to be effective P-12 practitioners, in a technologically rich society, and are able to teach diverse populations in a variety of educational settings.

In an effort to become more involved in public education and address the need of highly qualified STEM educators, the School of Education and the Departments of Mathematics and Computer Science and Biological Sciences partners in the FSU Robert Noyce Teacher Scholarship Program, designed to encourage STEM undergraduates and professionals to consider teaching.

Table 2: STEM Learning Community Clusters

Fall Semester	
Biology/Chemistry	**Math/Computer Science**
UNIV 101 - Freshman Seminar I (STEM Faculty)	UNIV 101 - Freshman Seminar I (STEM Faculty)
MATH 129/130 – Precalculus I-II (Accelerated Course)	MATH 129/130 – Precalculus I-II (Accelerated Course)
EDUC 211- Laboratory Experiences in Area Schools (Service Learning)	PHIL 110 - Critical Thinking (STEM emphasis)
Spring Semester	
Biology/Chemistry	**Math/Computer Science**
UNIV 102 - Freshman Seminar II (STEM Faculty)	UNIV 102 - Freshman Seminar II (STEM Faculty)
PHIL 110 - Critical Thinking (STEM emphasis)	EDUC 211 - Laboratory Experiences in Area Schools (Service Learning)
BIOL 150 - Principles of Biology (BIO majors) CHEM 141 - General Chemistry I (CHEM majors)	MATH 142 - Calculus w/ Analytical Geometry

Through the FSU Noyce Program, incoming freshmen interested in majoring in mathematics and/or science will have the opportunity to enroll in the SLC (Table 2). The idea is to spur the interest of freshman in the SLC to consider double majoring in mathematics and/or science, as well as mathematics and/or science education. Students enrolled in the SLC that demonstrate strong interest in math and/or science education will have the opportunity to participate in a paid summer internship that provides exemplary STEM teaching experiences.

These internship experiences are intended to allow the participants to reflect and decide if the teaching profession is also an interested career option. If so, scholarship support is potentially available during the Junior and Senior years to assist with the completion of both degrees. While there is a specific Teacher Education LC, students in the STEM LC decide to continue their STEM degree along with acquiring teaching credentials. These dual degree students will graduate with an increased level of content-knowledge as compared to student graduates of the single-degree teacher education program.

Conclusions

STEM education is a strategic priority at FSU with emphasis on improving enrollment, retention and graduation rates in STEM disciplines.FSU is committed to excellence in the preparation of secondary science and mathematics teachers. STEM faculty plays an integral role, not only in the development of content for science and mathematics majors, but also pedagogy coursework for science and mathematics education students. The Robert Noyce Scholarship Program has expanded the scope of the SLC to include students demonstrating a strong interest in math/science, but also math/science education. This will continue to enable FSU to attract and recruit students into STEM education, provide an additional pipeline for the Teacher Education Program and increase the diversity of students who are offered the opportunity to pursue certification in science and mathematics.

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