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INCLUSIVE LEARNING COMMUNITIES: THE EXPERIENCE OF THE NSF FOUNDATION COALITION

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In 1993, the National Science Foundation (NSF) Engineering Education Coalitions program funded the fifth engineering education coalition nationally, the Foundation Coalition (FC). Within the broad mandate of the NSF program, this new coalition of higher education institutions was to explore, experiment with, and initiate a series of broad-based reforms within their undergraduate programs, to change the complexion of engineering curricula and associated learning environments. The Foundation Coalition was designed to permit diverse higher education institutions to work together from their strengths and to function as a supportive network, as they set about the task of reconceptualizing the undergraduate engineering experience of their students. In such a manner, these institutions collectively could serve as "change agents" for the larger engineering community. The vision was that over time, through their programmatic innovations, they would be able to attract and retain the very best of a "…demographically diverse student body; and to graduate a new generation of engineers who can more effectively function in the 21st century." [1]

From its founding to the present, although the Foundation Coalition has experienced several changes in its institutional membership, there has been a real continuity and partnership among the members. Today there are six Foundation Coalition partners: the University of Alabama, Arizona State University, the University of Massachusetts at Dartmouth, Rose-Hulman Institute of Technology, Texas A&M University, and the University of Wisconsin at Madison. Four thrusts define the Foundation Coalition curricular reform: integration of course work across disciplines; active and cooperative learning; the use of technology in the classroom; and on-going assessment and evaluation. Their primary focus is on the freshman and sophomore curricula. While the participating programs shared these four thrusts, each used them to develop curricula suited to their particular context.

After the design teams of each institution developed their new curricula, they tested the new program with a pilot group of students, ranging in size from about 50 to 200 students. These students took the core courses together for an entire academic year. Running a pilot allowed the designers to further refine the curricula. Over time they noticed that the cohort system itself seemed to be benefiting the students; they were acting as a type of learning community. As concerns rose about retention of women and minorities in the programs, the FC leadership became intentional in their development of these cohorts and linked them to the concept of the Inclusive Learning Community (ILC). Each institution has continued to cohort a number of their students for two or more courses each semester after the FC pilot was institutionalized, in an effort to create environments that would better facilitate learning and provide greater personal support for students.

The purpose of this study was to understand how both students and faculty experience these inclusive learning communities within the Foundation Coalition. The project was conducted by a team of qualitative researchers made up of two faculty members and two advanced doctoral students from the College of Education at Texas A&M University. The study was a collaborative undertaking involving five of the six Foundation Coalition partners. Only one Foundation Coalition partner, the University of Wisconsin-Madison, did not participate in the study. Interviews were conducted with faculty, administrators, and students at all five institutions.

In this section we first describe the program structure within which the perceptions of faculty, administrators, and students were framed. Then each of the participating institutions will be briefly highlighted, describing the unique institutional contexts and innovations undertaken on their respective campuses.

Common Programmatic Features

All of the Foundation Coalition institutions use a cohort or cluster system and block schedule some of their freshmen students, and often some sophomore students as well, for two or more courses. [The terms "cohort" and "cluster" are used interchangeably; in this report we primarily use "cohort."] This structure is usually connected to an integrated curriculum, which means that the faculty teaching those courses work together, to a greater or lesser degree, to provide coordinated instruction to these students. For the freshman curriculum, that means that faculty work across disciplines. For example, some combination of engineering, mathematics, physics, chemistry, and, at times, English courses are scheduled for students as a block. In one program cohorts are also created for students who are not in the integrated curriculum. In the sophomore year the situation is somewhat different, since most of the course work is in engineering. At the two institutions that have developed sophomore FC curricula (Rose-Hulman Institute of Technology and Texas A&M University), integration is primarily across the engineering courses, although there can be some degree of coordination with the nonengineering courses (typically physics and mathematics) as well.

All of the FC institutions employ upper level undergraduate engineering students or graduate engineering students to extend the reach of faculty teaching in the programs. Whether they are identified as teaching aides, teaching assistants, graduate assistants, peer teachers, or mentors, these persons are found in classrooms, in libraries, in the dormitories, and at other venues on the campuses working with students one-on-one and in small groups. They help to review the course material, assist in problem-solving assignments, and prepare students for upcoming examinations.

In some programs there is a link with industry. Some of the programs offer internships and co-op experiences as part of the student's academic preparation. These may be offered for credit or not-for-credit, and students are typically paid. Several of the institutions work diligently to make these experiences available to their students and see that these experiences might be a very viable path to their first position as career engineers upon graduation.

The Foundation Coalition Partners

Two of the six members of the Foundation Coalition are small institutions, one private, the other public. The remaining institutions are large public institutions. At the Research 1 and Research 2 universities, curricular reform occurs within an environment that rewards research and grants acquisition over teaching, so there is an institutional disincentive for faculty to invest additional time in teaching. All FC members value diversity and have worked to attract and retain underrepresented groups, typically manifested in terms of ethnicity, gender academic preparation, and economic resources. Below we describe the major features of each program. (for more detail, see [2])

Rose-Hulman Institute of Technology (RHIT) is a small private technical college located in Terra Haute, Indiana. Founded in 1874, the institution enjoys a strong national reputation. US News and World Report recently ranked it first among colleges that offer masters of engineering as their terminal degree. A typical freshman ranks in the top 5% of their high school class. Approximately 80% of its 1600 plus undergraduate students major in engineering. Most of the students are boarders at the campus. Students tend to be economically advantaged. The culture of the institution is directed toward excellence in teaching, and faculty members identify their work with students as their top priority. The student-faculty ratio is 15:1. Curricular innovation has historically been a hallmark of the RHIT institutional culture. In 1995, after ten years of debate and study, RHIT began admitting women. RHIT functions within an academic quarter system as opposed to the more typical semester system.

Rose-Hulman Institute of Technology has had two integrated engineering programs. An innovative integrated first year curriculum in science, engineering, and mathematics (IFYCSEM) was initiated in 1988-1989 and piloted for three years prior to the establishment and funding of the Foundation Coalition. This curriculum provided a model for the FC institutions in designing their freshman programs. This program was integrated across disciplines of engineering, physics, mathematics, and English and typically enrolled about 60 students. The curriculum was team taught and faculty worked together in presenting and sequencing the curriculum and in developing and grading academic tests. The program had never become the mandatory path for all incoming engineering students at RHIT. Rather, it was seen as an option into which faculty actively recruited newly admitted students. However, the program never garnered wide support among faculty and as of the 2001-2002 academic year it is no longer being offered.

Rose-Hulman has developed an innovative sophomore engineering curriculum (SEC). It is offered for all 200 students majoring in either electrical and computer, or mechanical engineering. This curriculum is vertically integrated, with the five engineering courses developed around the principles of conservation and accounting. It begins with a single course during the fall quarter. In this course students are introduced to the thematic integrated curriculum, conservation and accounting. In the winter quarter, students are enrolled in three discrete engineering courses that build upon the integrated principles introduced in the previous quarter: electrical systems, mechanical systems, and thermodynamic fluid systems. In the spring quarter, students are enrolled in a single capstone course called analysis and design of engineering systems.

The University of Massachusetts-Dartmouth (UMD) is a small public institution of approximately 6000 students. Originally established at Southeastern Massachusetts Technological Institute in 1964, it went through a transition toward providing more comprehensive education as Southeastern Massachusetts University before it became part of the University of Massachusetts System in 1991. UMD is located in a small community in the southeastern part of the state. Most of its students are first generation college students, many are from the Portuguese minority community in the region, and most live at home, balancing academic coursework and employment in order to assist their families in paying for their studies. The typical UMD freshman has an average SAT score of 1110 and an average high school grade point average of 2.8. The College of Engineering houses six academic programs, four of which are in engineering, one in physics, and one in textile sciences. UMD admits about 250 freshmen into engineering each year.

The FC program at UMD is known as IMPULSE (Integrating Mathematics, Physics, Undergraduate Laboratory Science, and Engineering) and was established in the fall semester of 1998. It is only in the second year of full implementation. IMPULSE is understood as a learning community that combines an integrated curriculum with active collaborative learning, teamwork, and the latest technology. It is a program that has been associated with increased retention rates, better test scores, and improved grade point averages (GPA). Faculty within the program work as members of a team with their cohort of assigned students. Approximately 45% of the incoming students are enrolled in this program. Another 25% of the freshmen engineering students are enrolled in common sections of two or more of these courses but there is no effort to integrate the curriculum across these courses. Only about 30% of incoming students are enrolled in a more traditional engineering curriculum.

The University of Alabama (UA) is located in Tuscaloosa and is ranked by US News and World Report among the top 50 public universities in the country. It is a large public institution that each year admits approximately 400 incoming freshmen into its engineering program. The College of Engineering, accounting for approximately 10% of the University student body, is the third largest college within the University, and it is made up of eight departments. It has over 30% of the University-wide scholarships and fully a third of all of the National Merit scholars. Students live on and off campus and many work to pay for their education. The University of Alabama's most visible minorities are African Americans and women, though these minorities are quite small in the College of Engineering.

The Alabama freshman FC curriculum is known as TIDE (Teamwork, Integration, and Design in Engineering), and it was implemented over six years ago, beginning with the

1994-1995 academic year. Approximately 40% of all of the incoming freshman engineering students are placed in cohorts of twenty and given a tightly integrated curriculum of engineering, calculus, physics and English. Most of the remaining freshmen are in cohorted sections of some combination of engineering, calculus, physics, or English, but without the curriculum being integrated. Less than 5% of freshmen are not in the integrated or linked curriculum but rather are enrolled independently. In this fashion, the University of Alabama has faced the challenge of working with entering students of diverse academic backgrounds by providing various permutations of cohorted courses.

Arizona State University (ASU) is the third largest institution of higher education in the United States and is located in Phoenix, one of the nation's fastest growing metropolitan communities. Founded in 1856 as a Territorial Normal School, it received Research I status in 1994. The College of Engineering admits approximately 800 new entering freshmen engineering students each fall. It has what is surely the most comprehensive formal and nonformal approach to managing the undergraduate engineering experience of any of the members of the Foundation Coalition, with an Associate Dean for Student Affairs specifically charged with meeting the needs of their undergraduate student body. A variety of initiatives have been developed to support all of the freshmen and specifically the ethnic minority and female engineering students. As a result, inclusive learning communities of many types abound. The institution has a culture of academic experimentation and a well-deserved reputation for supporting faculty development initiatives.

Currently, ASU offers several academic options for its entering freshmen. One is the Freshman Integrated Curriculum in Engineering (FIPE). This program serves approximately 75 to 80 students, or 10% of incoming engineering freshmen and includes courses in engineering, mathematics, physics, and English. In addition, ASU has a program called EnGAGE, which offers approximately 50% of the incoming students variously configured cohorted experiences in groups of 20; they are scheduled together in several courses but the curriculum is not integrated. The remaining freshmen take the traditional engineering curriculum.

Texas A&M University (TAMU), located in College Station, is the flagship institution of the Texas A&M University System. Its annual enrollment is approximately 44,000 students. The College of Engineering is the largest of the ten colleges that make up the University, and it enrolls approximately 22% of the student body. It is the second largest engineering program in the country and in 2001 was ranked by *US News and World Report* as number eleven of the top engineering schools. Although some of the undergraduate students reside in campus dorms, most live off campus in the immediate community. Many of the students work part-time either on or off campus. The diversity of the campus includes a large international contingent of students and an increasing presence of Hispanic and African American students, as well as an increasing number of women.

In the integrated freshman engineering curriculum, faculty work in teams across disciplines to deliver an integrated curriculum of chemistry, engineering, mathematics, and physics. This curriculum is required of all students. Approximately 60% of the 1800 incoming freshmen engineering students are in cohorts of about 100 students that link two or three of their courses. The program has a strong relationship with industry. Representatives from industry work with the faculty to present actual case studies to which teams of students are assigned over the course of the semester for real life projects and as a culminating experience, student and industry representatives compare and contrast their approaches for tackling the problems.

The TAMU sophomore FC curriculum, like the one at Rose-Hulman, is integrated across the engineering courses and is developed around the principles of conservation and accounting. Like the freshman curriculum, it has been adopted and is taken by all engineering majors, though the various departments determine which of the core courses their students are required to take. Only a small number of sections are cohorted for engineering and mathematics courses.

We can see that across the Foundation Coalition there are common threads within the curricula—especially the integration of course work across disciplines, the use of active and collaborative learning, the use of technology, and on-going assessment and evaluation—but each program has tailored its curriculum to meet their own particular needs. This is one of the major strengths of the Foundation Coalition. All of the programs cohort a portion of their students and consider these cohorts to be inclusive learning communities. Before we examine the ILC experience in the Foundation Coalition, we turn to the current literature on learning communities to better understand how this concept works.

LITERATURE REVIEW

What exactly do we mean by when we speak of learning communities? Learning communities are defined most broadly as "small subgroups of students… characterized by a common sense of purpose…that can be used to build a sense of group identity, cohesiveness, and uniqueness that encourage continuity and the integration of diverse curricular and co-curricular experiences." [3] Gabelnick, MacGregor, Matthews, and Smith [4] speak of learning communities as "any one of a variety of curricular structures that link together several existing courses—or actually restructure the curricular material entirely—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 as fellow participants in the learning enterprise."

Learning communities trace their origin to the pioneering work of Alexander Meiklejohn, who in 1927 formed a two-year Experimental College at the University of Wisconsin. It engaged the students based in a residence hall for full-time study. Students and faculty teams focused their energies on the study of democracy, reading and discussing classic Greek literature the first year and contemporary American literature in the second year.

In the summer between these two years, students returned home and embarked upon a study of their hometowns in order to explore the workings of democracy in their particular communities. [5, 6]

Within this tradition, other reformers have emerged. These have involved virtually every academic discipline. The works of three reformers are of special interest. In the mid 1960s, Tussman designed a special program at the University of California-Berkeley in which nine credits per semester for a two year period would be team taught to a cadre of students with an emphasis on dialogue and interaction with the great texts. In the 1970s, Patrick Hill, increasingly concerned about the fragmentation of disciplines, departments and people, created a "federated learning community" at the State University of New York at Stony Brook. Forty students enrolled in three interdisciplinary and thematically connected courses in which other students also were enrolled. Students would also meet in one of two small seminars under the tutelage of a "master learner" faculty member to discuss the connections between and among the courses. Lastly, Uri Treisman at the University of California-Berkeley, in the late 1970s and the early 1980s, discovered that those students who were consistently succeeding in calculus were those that were not only spending quality time in studying, but more specifically, were studying for exams together. Those who were not succeeding were studying alone. His work to reformulate the curriculum involved adding a weekly six-hour calculus workshop linking the lecture session to the intensive problem solving and collaborative workshop. Success followed in calculus as well as in the students' other academic arenas. [6]

On the order of 500 institutions nationwide are currently engaged with some form of curricular learning community.

> While the actual designs vary a great deal, these programs all re-form the curricular structures to make explicit linkages among courses, and to intentionally build communities of students and teachers. Even more importantly there is a range in what we would refer to as teaching teams. Joining faculty members on teaching teams are librarians, computer center staff, advisors, residence life professionals, and quite frequently students as peer facilitators in the communities. So learning communities are not merely students learning together, but teachers learning together as well, from their students and from one another. [6]

Kellogg describes five major variations, along with an almost infinite number of permutations, that have emerged within these learning communities. "Linked courses" bring together students as a cohort in two courses with one course typically being content- focused and the other being application-based; "learning clusters" link students in three or four courses around a theme or their major with a teaching team of faculty assigned to the cohort; "freshman interest groups" link students in three courses around themes or majors and incorporate a peer advising component in the structure with faculty playing a smaller role; "federated learning communities" link students in three theme-based courses and involve a faculty member from another discipline also taking the courses and then facilitating a synthesis of the courses with the participants; and “coordinated studies” engages learners and faculty in full-time active learning focused upon an interdisciplinary theme and possibly lasting for an entire academic year. [5]

Regardless of variations that can readily be found in the definition and the practice of learning communities, there are several constants. [7] There is a characteristic emphasis upon the social aspects as opposed to the individual aspects of learning. [8, 9] In this type of learning, “students and teachers are considered to be social and cultural actors with identities emerging from their wider social experiences,” [10] both having significant responsibilities in the teaching/learning transaction. In addition, one typically finds both content and processes of learning intertwined. Simply put, learning community orientations differ significantly from traditional orientations to teaching and learning. Smith [11] highlights a number of these differences and places them in perspective for us (Table 1).

Table1. Orientations of Traditional Education and Learning Community Reform Efforts

Traditional Orientations	Learning Community Reform Efforts
Curricula built around disciplines	Interdisciplinary foci
Meaning seen as something that is individually constructed	Meaning seen as socially constructed, through collaborative learning
Competitive learning environment	Cooperative learning environment
Predominantly passive modes of learning	Active learning, experiential encounters
Stresses objective nature of knowledge, rationalizes value neutrality of knowledge	Admits subjective and value-laden nature of knowledge
Emphasizes “procedural” and “separate” knowing	Encourages “connected” and “constructed” knowing
Focuses more on the nature of the curriculum than on who is in the classroom	Increases focus on who is in the classroom
Educational delivery system in discrete courses	Delivery system organized around larger packages of time and credit programs
Change happens through individual action	Change through collaboration

Hierarchical leadership	Collaborative leadership

We have seen that the concept of inclusive learning communities is not new, yet today it is increasingly the focus of attention for faculty in higher education and is taking on quite varied forms and functions across the disciplines. [12] Cross argues that interest in learning communities has increased because they are “compatible with the changing epistemologies about the nature of knowledge, because research generally supports their educational benefits, and because they help institutions of higher education meet their missions of educating students for lives of work and service.” [13] Indeed, we are experiencing a paradigm shift in our understanding of how learning happens and along with that we see the emergence of the learner as a co-responsible agent with the teacher in the facilitation of learning. We are also becoming more attuned to the myriad of contextual factors that shape the learning processes and outcomes. Further, research has been generally supportive of the positive academic and personal benefits associated with the array of practices under the learning communities’ umbrella. These benefits have been reported as improvements in student academic achievement, increased student retention, student growth in self-esteem and self-confidence, and an increase in an array of student interpersonal attributes. To the extent that these outcomes can be replicated through learning communities, faculty and administration are found as staunch supporters. Lastly, learning communities are seen as fortifying students with skill sets that ideally prepare them for a diverse array of professional careers. In essence, we seem to be about the business of fostering meaningful and lasting learning replete with “learner independence and choice, intrinsic motivation and natural curiosity, rich, timely, usable feedback coupled with occasions for active involvement in real-world tasks and occasions for reflection, exercising higher-order abilities done with other people, [and] high challenge, low threat settings with practice and reinforcement.” [6]

Specifically, over time, a number of outcomes have been associated with the development of learning communities. Retention has been significantly improved where learning communities have been formed. Higher academic achievement has also been reported as a result of forming academic learning communities. In addition to the traditional measure of GPA, student academic gains have been found in such areas as students’ ability to relate new ideas to prior knowledge, to communicate ideas in both verbal and written form, constructive attitude toward learning, and the use of computer in problem solving. Further, improved student motivation and better quality interpersonal relationships among faculty and students have been found. Likewise faculty development increases have been attributed to the existence of learning communities. Faculty have the opportunity to team teach with their colleagues and have dialogue. They experience instructional strategies heretofore untried, utilizing methodologies stretching them beyond their traditional patterns and thinking and their traditional repertoire of teaching strategies. These and additional findings have been attested to by a number of researchers. [14-17]

With the distinctions between traditional orientations to education and the learning community reforms clearly in mind, it is not too difficult to see how discussions about learning communities are frequently interspersed with discussions about associated curricular practices such as active learning, participatory learning, collaborative learning, cooperative learning, small group learning, and team learning. Basically, learning communities within the higher education community do not exist in a vacuum but within some infrastructure created to foster learning for students. Faculty working to facilitate collaborative learning build upon five fundamental principles: positive interdependence, individual accountability, interpersonal skills, team building, and evaluation and reflection. [18] In this approach, "both facilitators and learners become active participants in the educational process; the hierarchy between facilitators and learners is eliminated; a sense of community is created; knowledge is created, not transferred; [and] knowledge is considered to be located in the community rather than the individual." [19]

Closely aligned with this is cooperative learning, the "instructional use of small groups through which students work together to maximize their own and each other's learning." [20] It typically relies upon formal short-term groups; informal ad-hoc short-term groups, and long-term base groups lasting possibly for a year. Certainly, inventories of strategies and practical guides for cooperative learning have enriched the literature base on learning communities. [17]

In a similar vein, team work and small group learning both set the stage for the establishment of a community of learning among students. The criticality of this community becomes increasingly evident as one considers the diversity in the workplace and the necessity for graduates to be prepared to interact professionally with others quite different from themselves. Team work and small group learning also set the stage for the recognition of different types of assets which individuals bring to the table and predispose students to learn to access these assets routinely. [21]

Active learning refers to teaching/learning transactions that fully engage the learner in the learning process. [22] It moves the learner well beyond simple passive or receptive approaches to learning in which all learning is "deposited" into the empty vessel, sometimes referred to as banking learning. Active learning engages the learner as a responsible partner in the process of learning and in the ultimate synthesis of what has been learned. Again, this design for learning is often referred to as constructivist in nature since the learner is ultimately responsible for constructing meaning from the curriculum. Active learning lends itself to social interaction among the learners and the facilitators of learning thereby setting the stage for the development of a community of learners.

It is clear that the member institutions within the Foundation Coalition are functioning within the increasingly broad tradition of educational practice known as learning communities. The clear delineation provided by Smith [11] that highlights those features characteristic of learning community reform efforts should have a familiar ring to those faculty and students who have been engaged in Foundation Coalition initiatives over recent years.

One contribution that the FC makes to this concept is the addition of the notion of inclusivity. Caso, Malave, Morgan, Rinehart, & Yao describe this as "fully accessible groupings of students, faculty, and employers with common interests who value diversity, and work collaboratively as partners, to improve the engineering education experience." [23] An intentional component of the inclusivity involves linkages with industry, a determined effort to make connections with all students, traditional and nontraditional alike, and engaging the faculty as active collaborators in the ongoing teaching/learning initiative of curricular revision. Another component is the implementation of learning communities across an entire academic program.

The literature on learning communities supports the efforts of the Foundation Coalition to create these intentional communities for students, faculty, and industry partners. We turn now to the question of how this inclusive learning community structure shapes the learning of the students.

METHODOLOGY

This was a qualitative study in which faculty and students at the five institutions were interviewed in order to gain an in-depth understanding of their experience of the cohorted version of the Foundation Coalition curriculum. These interviews were done at each campus by a research team consisting of two professors and two doctoral students from the College of Education at Texas A&M University.

The professors conducted individual interviews with 6 to 12 faculty at each institution who were teaching in the FC program. This also included the FC program coordinators at each campus. These were semi-structured interviews lasting from 30 to 45 minutes. A total of 35 faculty were interviewed for this study.

Student focus group interviews were conducted by the doctoral students on the team. The focus groups ranged in size from 2 to 16 students, but typically were about 5 students. In most cases the students were nominated by the program faculty in order to ensure that a diversity of student perspectives would be represented; students were not required to participate, and faculty members did not know which students chose to be interviewed. At several campuses faculty allowed students to be chosen at random from their classes and released them from class for the interviews. In all cases the names of the participating students remained confidential. Separate groups were created for women students and for minority students, to give them a venue in which they could speak more freely about their experience in the program. All of the focus group interviews were semi-structured and they usually lasted about one hour. We conducted a total of 34 focus groups involving approximately 160 students.

All of these interviews were audio-taped and transcribed. We analyzed these data using the constant comparative method. [24] Essentially what this involves is reading each interview and dividing it into meaning units—segments about a specific thing, e.g., social benefits of cohorts, learning, challenges for faculty, etc. We coded or labeled each unit according to its content, and entered this information into Ethnograph, a computerized data-management program. Every segment of interview data was coded in this way, and identified by category of the speaker (student or faculty). Using Ethnograph, we then brought together all the segments coded in the same way. For example, we retrieved all the segments of data that were coded "learning" and examined them for themes across that code. In this particular area we identified two broad categories of learning: learning to survive in college; and learning how to think like engineers. Within each category we could articulate specific elements that made up that category. For example, in survival learning one of the key features was developing time management skills. This process was repeated across the entire data set until we could identify overarching themes that described the experience of the participants.

FINDINGS

The central focus of this study was on the impact of the cohort structure on the students in the Foundation Coalition programs. That structure itself, however, allows for the creation of many kinds of groups. Before we can examine the larger findings of this study, we must first understand the various group experiences that cohorting creates.

All undergraduate students find themselves in various groups—their class, their dorm, their collection of friends—and it is no different for engineering students in the Foundation Coalition programs. What the FC has done, however, is made these groups far more intentional and used different group configurations to facilitate learning. The groups take several forms. For this study our focus was on students in a cohort or cluster, defined as a group that stays together for two or more courses each semester. This can be an entire class, anywhere from 50 to 100 students, that is block scheduled, which means that being a member of the cohort automatically places them in particular course sections. Occasionally it means that a subgroup of about 20 students, within a much larger class, are scheduled together for two or more courses; this is the model of the ENGAGE program at Arizona State, and the University of Alabama has some of their students scheduled this way, as well. The cohorts at all five institutions are usually in an integrated curriculum, where the content of the courses is organized together and fundamental concepts learned in one class are reinforced in another. Some cohorts, however, take a more traditional curriculum. Cohorts, then, are a function of scheduling. The intention behind this structure is the notion of inclusive learning communities. This study essentially examines how this idea is played out for both students and faculty.

Another common group arrangement is the team, and it, too, has different permutations. Teaming is a core feature of the FC integrated curriculum; students are assigned to teams of four, usually created by the faculty but some are voluntary groupings, and they work together on specific problems during class and on their own time. They stay in their same teams for either the entire semester or a portion of it. This is the most common way that FC students experience collaborative learning. Not all the FC programs require teaming, however, so it becomes a matter of faculty choice. In those instances where teaming is not used formally, many students create their own informal teams to help learn the material.

There are other group experiences as well. Many campuses have a dormitory, in whole or in part, that is exclusively for FC engineering students. Sometimes cohorts are together in these dorms, making it easier for them to work together outside of class. There are also learning centers, either in the library or centered around a teaching assistant (TA), that are available to help students who need additional instruction. And there are the naturally formed groups of students who come together to study, either through friendship or from having met in class.

The various groupings are structural, but the rationale behind the formal ones in the Foundation Coalition is philosophical. It is the concept of the inclusive learning community (ILC). This is not a concept that is widely known within the FC programs, nor does it have a single definition. What we saw in our interviews was a stratified understanding of the concept: faculty who play a leadership role in their programs have the clearest sense of what the ILC is meant to be; other FC faculty may have heard the term but they usually think of it as the cohort structure; students rarely speak of an ILC but they do speak of being in cohorts and in teams, and they connect these groupings to active and collaborative learning.

For definitional purposes, we found the descriptions of several of the faculty helpful. One faculty member emphasized the student grouping and the broad intents of an inclusive learning community.

> It's a group of students who take a special set of courses in a special environment with the overall objective and outcome of the program to increase their learning, their ability to learn, their desire to become lifelong learners, and to help them to adjust to the university.

In addition, another faculty member highlighted the intent of inclusive learning communities as real life professional career preparation.

> [Inclusive learning communities] means bringing in students working together that are from various backgrounds, educationally, and also [in terms of] gender and ethnicity . . . It's our way in the classroom to try to model what would happen to an engineer when they go to work. They would be working with people from various ethnic backgrounds, various age levels, male or female, and they are put together in a team.

Another faculty member in defining inclusive learning communities, highlighted what each of the terms meant to him.

> First of all . . . you have people that are related to each other, just like a neighborhood community and all of the commitments and benefits. It is a community of students and teachers and teaching assistants, to a lesser degree, for the purpose of learning. Its purpose is to support learning . . . [The learning community is inclusive in so far as it has] a goal of promoting diversity, of promoting under-represented groups in engineering.

We turn now to the discussion of our findings. Here we examine the concept of inclusive learning communities from three perspectives. First, we look at the multiple dimensions of student learning that occur. Then we address how the cohort structure benefits students socially and facilitates their retention in the program. We end with the experience faculty have teaching within the Foundation Coalition program.

Learning about Learning

Learning in any program may start in the classroom, but it doesn't end there. In this section we examine what we have learned about how and what students in the cohorts of Foundation Coalition program have learned.

Learning to Work as a Team

In most programs teaming is a central feature of the FC curriculum. Typically it means grouping students into teams of four and having them work together on class assignments and projects, for which they receive a group grade. Students are usually given some training in how to function as a team. Professors have devised multiple ways of forming teams. Some do random assignment, others try to create a balance between ability levels. Many make efforts, at least in the first semester, to avoid creating teams that have only one woman or minority student on them. In some cohorts, all the team members have the same grade point average. Personality surveys, such as the Myers-Briggs, are sometimes used to create balanced teams. A few professors allow students to choose their own teams, sometimes requiring that they have representatives from each engineering discipline in their groups. Some faculty think that spending a lot of time forming the team helps to ensure successful learning. One professor said,

> We've tried every method under the sun. We've tried assigning teams, we have tried letting them pick their own, and we've tried combinations. The students are lukewarm on the results of team selection no matter how you do it, even when they pick their own.

However, we found this last opinion was not shared by the majority of students. Most students did say they preferred choosing their own teammates, especially after the first few weeks of school when they had gotten to know each other better.

Most students receive some training about how to work as a team, but the degree varies across programs. Some faculty explain team roles and the team process, try to give the students a vocabulary for talking about the team process, and try to teach them skills to deal with interpersonal conflicts. One professor spoke of it as a collaborative process:

> It's continued interaction between the instructor and the student and the students with themselves, actually with the team; to interact among themselves to learn and to do their assignment in the class or out of class.

Another suggested that students need to learn to interact productively with others, whether they've been assigned to the group or they have self-selected their team members. They need to learn that even though it is harder to coordinate with other people and to develop work relationships, it will benefit them. Students were quite aware that this skill makes them more marketable and will be of great assistance to them during the course of their careers. "Well, when we go out into work, we're going to be in teams, so the better you can work in a team, the better you will be at your job." As one professor said, "Engineers don't work in isolation." The attitude that the faculty would like to have their students adopt is "the idea that maybe we're going to learn how to work well in teams so that we can be more efficient and we can work smarter." One student agreed with this idea: "When you go out to the real world you will be with different people, and the younger you are exposed to something like that, the better off you will be." Students recognize that their teaming experience will give them an advantage when they enter the job market.

Working in teams helps students become more responsible for their own learning, and this is something faculty encourage. One professor remarked on the initiative showed by the teams in her class. Because of time conflicts, she was occasionally a few minutes late to class, but on arrival she generally found the teams had already worked their first problem and had not needed her to get them started. They had learned to work independently of the teacher. This self-reliance was a valuable trait, she observed, because "I'm not a life-saving device. I'm not going to go to their interview with them."

Students have to learn how to make teams work effectively. Some of them developed goals for the semester, codes of behaviors, intermediate deadlines, and were given opportunities to grade other team members, which helped somewhat with difficult team members. One student called it "inner deadlines." Each team member had a personal deadline by which to complete a portion of the assignment, and that portion had to be shown to one other member. One student described it as "You turn in your part of the project to me at this time, and no ifs, ands, or buts. And he did. And I showed my work to someone else and we all got done almost on time." This reduced the number of "confrontations about silly things. You just got the work done."

One student described how his team approaches an assignment:

> Well, usually—just take an example this year. George is usually the smartest one (Now he's going to go on a big, huge ego trip), but I mean we have George. He

> usually attacks the problem first; and then, I mean, me and George, we kind of follow through on the problem. If we don't know anything, we'll learn it from Jim, and we'll watch everything that he does; and if he makes a mistake one of us will definitely catch it. And Ted, he's always the quiet one (and he's not here), but like we usually try to get him involved. He usually does it by himself actually. But we'll involve him anyways, because he—we're always checking each other's answers and stuff. And lots of times if you ask Ted, he'll know the answer to something, but he won't say it right away. So, you've got to ask him, and I mean that right there brings the group together and shows up some leadership, too, because you can't forget about the fourth person in the group.

Students also appreciated having control of the team grading process when they were allowed to allocate grades, or points, or make other evaluations that differentiated the contributions of each member. At one school, each four-member team had a hypothetical $40,000 to distribute among the members according to the value of their contributions to the assignment or project.

From every Foundation Coalition school, students agreed that one of the most important things they learned in the team experience was to get along and to work with others. Difficult team members ("delinquents") had to be dealt with, compromises had to be worked out, and individual differences had to be respected. It is a struggle, according to one student:

> I've had one team where I just had what I thought was a kind of obnoxious person on the team. He thought that only one person in the group knew how to do something. So that kind of like split our group up a little bit. But eventually it came together because you have to get this done.

Explained another student, "You've got to find a medium and everybody has to give a little. Everybody has to learn to cooperate, and that's the big thing. Just trust is a big part of it, too." "You've got to communicate," one student learned. "You know, just get together. Talk to them; try to get them to work hard; and if you communicate well, they will eventually realize that grades are important…." Even if you discover that you cannot depend on a teammate, it's important "to know how to work with those people that you feel like you can't depend on."

Team members who don't do their share of the work cause problems. The work has to be done, so students take up the slack or exert pressure on the slacker. One spoke about another team member who "just didn't do anything on his part of the project until the day it was due, and that was because we gave him a serious sense of guilt and really pushed him to get it done." Another student used a more creative approach:

> There was this guy that said the first day of class, 'I don't know about you, but I'm here to have fun. I might not be here next semester.' And he ended up being in my group. So that very first day we all sat down and I [asked each member], 'Are you a hard worker? Are you a hard worker?' And they both said, 'Yeah.' I

> said, ‘Well, this is our slacker. We’re going to have to make up for him.’ And this guy was the hardest worker I have ever met. He was always trying to prove himself to me. He always had his work in. He was like our best group member. So that’s how I handled that.

But sometimes it isn’t possible to get the delinquent member to do the work and the rest of the team has to bear the burden. One student was philosophical about this:

> He wasn’t the reliable source of anything. Whether or not I gave him three days and reminded him every three days and called him every night and told him, “Ralph, you’re doing this, right?” And then he would come to class at 8:00 in the morning and he would be like, “I’m so sorry!” And I would yell and scream at him and tell him how much it affected my grade; and I told him, “You can mess with your own grades, but do not mess with mine.” And it happened anyway. There are so many delinquents and so many…you’re like, those are learned habits, and he’s 18 years old, he’s not going to…I can’t make him pick up accountability tomorrow.

Absentees, dropouts, and commuters (who are less readily available for meetings because they’re not always on campus) also affect the team’s effectiveness, providing another obstacle for the team members to overcome. All agreed that these situations are not unique to the classroom. They expect to confront the same situations when they get out into the workplace. As one student said, “I think the teamwork skills we’ve gained will be a big important part of our careers. I think I can work with just about anyone after some of the experiences I’ve had, which is good, because you run into those people in the real world, too.”

There are many benefits to working as teams. Students were encouraged to develop a trust in the responsibility of their teammates. “…you have to get together as a group outside of class in order to get it done and you had to depend on other people to do their part. And you had to just depend on everybody on your team.” When teams are given time to work together in class, they find their groups and other students to be their best resources. One student laughed, “We’re always talking in groups. We’re hardly ever listening to the teachers.” She meant that the team did not need to have the teacher continue to give them instruction after the assignment was made. “So between the four of you, you can pretty much figure it out.”

There seems to be a general recognition of not only the benefits of teamwork, but also the *necessity* of teamwork in order to reach success in their engineering programs. Some of this related to the amount of work required in their classes. An efficient way of handling the workload is to work with other students in teams. “I have to say I learn better in a group, but that might just be because of all the work they’ve given us.” Learning to use the strengths of others to elevate the team grade results in higher GPAs for individuals.

There is an emphasis on learning to work in teams. “They put so much work and so much pressure on you to be in a group and learn teamwork. If you don’t then you’re lost.”

Team membership helps individuals handle the stress and pressures of school. Teamwork also makes the work go faster. One student told us, “We figured out Newton’s law in like a day and it took him like 20 years!”

Meeting and learning to work with students from different cultures, interests, and backgrounds is a valuable experience. When teams have mixed disciplines, “we all had different ideas of how things work. And it gives you just a general idea of an understanding different to the way you think. It makes it more interesting.” Aware of the problems that sometime occur when learning to work in a team, one student said, “You’ve got to figure out how you fit in and how you work with folks and how folks work with you.” Added another, “So it’s just cool that we come from different backgrounds and like different knowledge things and you can learn from each other.”

A ‘peer effect” was described by one professor. As students observe their teammates working hard, they are influenced also to work hard. “I think it’s because they won’t let down their team,” one professor reasoned. Another said,

> I think it really surprised people when we discovered that the students in our classes had a much higher esprit d’ corps, much better morale. Attendance was like ninety-some percent as opposed to maybe 60 percent in a traditional freshman math or chemistry class.

The increase in attendance is attributed to several sources, one being peer pressure. “Hey, if I don’t do this piece of the project, I’m going to let the other three down.” Students mentioned that the demands of the curriculum require them to attend regularly, and their teammates expect them to be present to work on the projects and other assignments.

Peer pressure was also considered by some to be a factor in retention, especially of students who had difficulty keeping up with the others. When students experience “other students around them trying to work and study… maybe that’s one of the positives for the slower student,” one professor said. “The majority of the teams seem to bond together and I think that ability helps them; the fact that they have somebody to rely on. And they do seem to be more able to split up tasks and give different people things to do.” Other concerns were expressed about the role of the slower student in the team process. On the one hand, one professor thought “a lot of them would have a tough time getting through the curriculum without that resource.” On the other hand, another professor worried,

> I’m not sure that the weakest students are learning like they might in a regular class, because they can depend on the smart students to get the teamwork done. And they are afraid to ask the smart ones to tell them how to do it, because that’s going to hold them up and they can’t learn as fast.

While this wasn’t a majority opinion among faculty, we did hear this concern several times.

Professors also believed that there were emotional benefits as well, in the form of self-confidence and self-esteem. One faculty member, speaking of past freshman classes, said,

> They would walk taller, they would act like engineers, they were professional… and they continued throughout their education just to have that extra air of professionalism. And part of it was the fact that we really pressured them and they survived. And while they're being pressured and stressed, they turned to each other for help; and so when they got done, they had this tremendous sense of confidence and achievement and [personal] bonds.

An interesting observation was made when several students discussed the benefits of teamwork:

> And I think not only is that beneficial in that you get to see and meet and build relationships with other people, but you also that way find something that you can use as a reference point to yourself academically. You can see how strong someone else is doing and look at your progress and see where you need to go from here, if you need to go get help. Whereas if you were in a different class, you might think you're doing really well, but compared to other students you're not doing so well. So you get really familiarized with the skills of other people and therefore you find that you can base your own progress on it, too, relative to them.

Using others as a yardstick to measure their own progress and comprehension reveals a unique understanding of team dynamics. It also says something about the psychology of the team process. Students found a comfort in sharing their self-doubts. "It also helps like when you're feeling like 'I just don't get this,' and somebody else is like 'I don't get it, either.' It doesn't make you feel as bad. And then it also helps when that one person does get and can explain it to everybody else—on that peer level."

Although most Foundation Coalition classes emphasize team assignments, many students found that even when teams are not formed, they will choose to form work teams on their own. Thus, the benefits of the cohort/cluster and teaming experiences extend beyond the freshman year. Students from every university found the team and study group experience to be so valuable and necessary to their survival in school that they found ways to continue those experiences in subsequent semesters, even when they no longer had team assignments. One student described it as "the same group of people that feel comfortable working together are going to get together and do their homework and stuff." Another group of students meets at the Waffle House and "we work on it until we understand how to do it." A lot of times students bump into each other at the library or student center, recognize each other from earlier clusters or teams, and form study groups on the spot. One student disclosed, "We're still friends. I see people I know and we get together and do homework together. And I love that so much." Teaming becomes an accepted and preferred way of learning for many students. "We learned that style of learning and it really helped; so we do it on our own."

Using teams in the classroom has changed the way many professors teach. An instructor in science education who is studying the cohorted students at his school put it this way:

> It has had a huge impact on student learning, and we have said that we will not lecture to them anymore, and that we're going to figure out how to do this class without lecturing. And it isn't easy, but it has had the biggest impact on student learning; and it's measurable, not just in conceptual areas, but also in problem-solving.

Some faculty also believed that students will change in their expectations of faculty and the way their classes are conducted.

> The students who leave this program now go into other classrooms and they insist upon being able to ask a question whenever they want to, work with any other student they want to, define what goals they want for any class they take. They come out ready to—I mean, they're changing. And to not put up with a dull or boring or meaningless class. So I think we alter them… in a very positive way.

Another professor said,

> They understand what expectations are, and they have the ability to go to a professor and to talk to a professor. They've gained a level of comfort with us that most students don't. I think they do end up better prepared to succeed in college.

One professor summed up the benefits:

> I think they develop differently in terms of study habits, social interaction, their ability to express themselves both orally and written. I also think I see probably an increased level of maturity from them also, because they have become more responsible for themselves.

It is probably not an exaggeration to say that teaming, even with its inherent difficulties, is one of the most successful aspects of the FC curriculum. There certainly is a consensus among students and faculty on this point.

How Do I Learn Best?

When freshmen enter the Foundation Coalition programs and become part of a cohort, they recognize very quickly that they will be expected to work in groups and that that will be reflected in their grades. But they also recognize that they are responsible for their own learning, so a significant question they face is "How do I learn best?" In our interviews we heard students grappling with this question and coming up with different answers.

They talked about their preferred learning style. Many focus on the text, believing as one student said, "I have to read to know what I'm doing." This is usually combined with application:

> I found out the best way for me to study is I go through, I highlight the material that just jumps out at me that I need to know. I read over it and then usually, if somebody can work a problem for me and then I go over that problem and understand all the mechanics behind the problem, then I can do it.

Another student said, "If the materials are in front of me, I find it a lot easier….I look back in our book and I read it and do a couple of problems, and then I finally figure it out." Another does the same with class notes: "I'm mainly focused on getting my notes down and just getting everything he's writing on the board. And then at home, I have to apply what he showed us to the homework and that's how I learn." Homework was important for most students. One said, "Homework is the biggest key to your success in engineering," and another added, "If I do the homework, by the end of the homework I will understand what I'm doing."

Some think more holistically. "I'm the type of person who likes to see the theory and then work through the problems and then go back and fill in the missing links. That's the way I learn quickly." Another spoke about thinking about the material in unconscious as well as conscious ways:

> I guess I'm lucky in that I personally can step back from it and still keep on thinking about it….And so I can go and watch a movie…or go bowling or something and then come back to it, and come with a new outlook. So that's how I personally handle the difficult material.

One student described a very systematic approach that works well for him:

> Attempt each problem. First of all, start the homework a couple of days early. When you look at the problem, we first have to like identify the system and we identify what we want to figure out. Then we write down what we're given and then list our assumptions. Then, another thing I do is I look at all the equations that I've been given and try to figure out what correlates with each other….If you get stuck you go ask a friend or you go talk to your professor.

There was consensus that memorization alone no longer works for them. Here's one exchange:

> *Student 1*: There's been times where I…let something go a little too long, and you just kind of throw in the towel and memorize the equations and hope to figure it out in time for the final.
>
> *Student 2*: It never works.

Student 1: Yeah, I don't think it's ever been successful….

Another student summed up this point: "I have to actually remember what I'm learning, I can't just know it for that one test. So I had to rethink what I was doing and I had to figure out a new way to study."

Students also recognize that application is an essential part of their learning. One student explained this especially well:

> Having someone explain [a concept] to me used to work…I used to think that I could just look at something and understand the concept behind it and know it….And for awhile I was able to get by with that, but now it takes a little bit more than that. It takes application and stuff before you really understand it all that well.

A number of students talked about the value of teaching the material, either to themselves or to others. Teaching yourself was described by one student: "When the teacher teaches you, they only teach you certain things, and when you have to teach yourself…it makes you study more in-depth." The value of teaching others was even more clear: "I think that one of the best ways to prove or verify for yourself that you know [something] is if you can explain it to someone who doesn't know it." Another added: "If you can explain it to somebody else, you know it." One student who does a lot of peer teaching described the benefit he draws from that:

> I get a ton of questions, especially from last semester, cause a lot of the kids would come down to my room cause me and my roommate were in the same group and we were both top of the class. And just by sitting there and trying to teach the other kids how to do it was reinforcing it for me.

One aspect to the question of how the students learn best involves working alone or with others. Occasionally we heard students say that they preferred working on their own. One said, "I have to work hard for a lot of stuff and pretty much do it all on my own." Another elaborated: "I always felt that learning things on my own, even though it might take me longer than if somebody just tells me and makes a connection, if I can make the connection in my head, it always helped out more." Most, however, talked about learning with others. Two students talked about using the group for motivation:

> I have a hard time working. If I'm just sitting around a desk by myself, I have a hard time getting down and actually working on it, because I get distracted very easily. It helps me when other people are talking about it and I have no other distractions but to do it. So working in the groups helps me a lot.
>
> The whole [cohort] is in the same dorm, so you can walk around and there are other people and you see them with their books and they're doing the homework and you may go like, "Well, maybe I should be doing the homework right now."

In our interviews we found that students used one another as resources for learning to a great degree. We turn now to examine how and why they do that.

Accessing Help

In the focus group interviews we asked the students how they went about learning material that was difficult for them and all of them spoke about getting help from others. There was an almost invariable pattern in the way they sought out help—first they turn to their peers, either students in their team or in their cohort, or to friends. If they need further help, most seek out a TA or a tutor, and if that doesn't help, then they go to their professor; it was rare to hear students say that they went to their professors first. The primary reasons for this are that it is safe to approach other students, they are readily accessible, and peers are effective teachers.

The safety issue is a big one for students. Faculty give grades, so it makes sense that students "are definitely more willing to ask a dumb question to someone your own age [rather] than to a professor." As another student said, "It's more comfortable to talk to a student than it is a teacher." A different student elaborated:

> I can go up to my engineering group or some other students who I would trust, and I can call them up at 11:30 at night and help me with a problem that is due the next day….It all goes back to the familiarity of the cluster. You know these people because you are with them all the time. And you just kind of—you lose a lot of those fears and those inhibitions, saying "I don't want to look like a fool, and I don't know this person well enough to ask him or her this question that most people would think is silly." But who knows, that person might have the exact same question and y'all can discuss it out and talk it out. That's how the clustering has helped me.

Accessibility is also a factor. This is greatest for those who live in an engineering dorm. As one student said, "If I'm at the dorm doing something and I'm stuck on it, I can always run to someone else's room and ask them about it and they can give me their input." Another added: "We don't have to run around….We just walk across the hall or walk across the room to whoever we can get help from, and just do all our homework together and everything. Help each other out." But help is also readily available for those who don't live in the dorms, as one commuter student told us:

> I live off campus and so I don't get to study in groups, but if I have a problem with something I can come right into class, and a lot of times people will be there early, since we're in the same classroom all the time, and you can get help with whatever you didn't understand.

Another student said, "We usually see each other every day anyway, so we don't have to go out of our way to talk to a student like we would if we wanted to talk with a teacher."

There is strong agreement among the students we interviewed around the effectiveness of peer teaching. As one said, “Sometimes reading the book, it doesn’t sink in. Asking your prof, it doesn’t sink in. Sometimes, just one of your peers explaining it to you and you get it, maybe because they’re on your level.” Two other students expanded on this idea:

> I would rather go to a student first for help because if they’ve taken the time and can understand it, it’s more likely that I think that they could put it into terms that I could understand, rather than a professor who has all this knowledge. Sometimes they can’t get down to our level and tell us, you know, like how we see it….I would rather go to a student who is on my level and knows about just as much as I do. That will help me learn it better.
>
> You can tell in class who knows what they’re doing and who doesn’t, so you have to ask the ones who do know what they’re doing. They can explain it to you better than the professor can sometimes.

A similar argument obtains for the tutors, who are often undergraduates themselves: “I found the tutors to be more helpful sometimes because they’ve been where we are and they can explain it on our level.”

Faculty seem to understand this perspective, but one professor had a special insight from his experience of working with a peer teacher, an undergraduate student who had taken the course earlier.

> The peer teacher probably was the most successful way of reaching the students, in my opinion. I hold office hours, but very rarely do students come. I don’t fully know why; I don’t think I’m an intimidating person. Maybe they see that since I’m a grade-giver that if they express their ignorance that I will remember and so they tend not to want to come to me for help. But they seem very willing to go to a student of their own age, even more so than a graduate student. So what Julie, the peer teacher, did was she would hold help sessions twice a week…typically for an hour or maybe an hour and a half. And students, maybe 20 or 30 students would come to the sessions out of 100….Judging from her comments and the students’ comments, it seemed to be a very effective way to help students.

The cohort structure, then, creates a context in which peer learning can readily occur, and it is clear from our interviews that this resource is one which the students value and benefit from tremendously. This doesn’t mean that faculty are not effective—they are, as the next section will show—but students turn first to one another for help and in that sense they are using the group as a significant resource for their learning.

The Role of Faculty

Like students everywhere, these cohorted engineering students expect and value good teaching. By that they mean systematic and thorough presentation of material, where explanations are clear and where students are actively involved in the learning process. The teachers are an essential part of their learning process. As one student said, "If I didn't have him to guide me through, then I would probably be a lost soul." Another agreed: "If you tried to read the book without your teacher…you might as well be reading a different language."

In the interviews they gave examples of both bad and good teaching. They are critical of professors who do not value teaching and who make it clear that they would rather be doing their research. They object to professors who cannot explain the material well because of inadequate fluency in English. Likewise, they don't appreciate faculty who don't understand the principles of the FC curriculum and instead use straight lecturing with their Power Point presentations, rather than active learning. They recognize good teaching because with those teachers they learn better, as the following comments indicate:

> She explains step-by-step, and she points out the key points you have to know for a test, like what you should really study more on, and those help a lot.

> He keeps telling us about the engine he's building….He's bringing real life engineering stuff into the classroom and exposing us to it, which I really think helps. You can see the kind of stuff you can do.

Beyond effective teaching, there are two characteristics of faculty that students consider especially important: accessibility and helpfulness. Overall they give FC faculty high marks in these areas. They like being able to meet with faculty during their office hours, and in some programs they feel free to approach professors at any time with their questions:

> Every professor that I have had so far has been like, if you're having trouble in anything, come get help. Don't wait. And their door it always seems to be open….So, it's not a problem getting a professor to help you.

> At the beginning of every semester, all the teachers make you fill out like time schedules so then they try to accommodate everybody. There's always somebody available if you need help.

> After I failed the first couple of homework assignments, I realized I was in trouble…so I went in with the professor like every day and got help and got back on track.

In one program, students told us that their professors were willing to help any student, even those not currently in their courses.

> I took thermo with one professor and I got used to his style of teaching and I clicked, like I understood and it wasn't hard at all….I'll go to him for help on my homework [rather than] go to the professor [I have now].

They give special credit to those faculty who go out of their way to help students learn. One describes a time when the professor "came in and stayed in the lab till past midnight, because we were all in there trying to do our project, because we didn't have a clue as to what we were doing."

Because the FC curriculum is integrated, they expect the faculty teaching their cohort to coordinate, though they care most about reasonable scheduling of exams and major assignments. One student described the benefit:

> I know the English teachers last semester, if we had a lot of math tests or something, they kind of go easier on us, just to give us more time to study for the other stuff. That's where their working together helped, too. They have their week planned out already weeks ahead of time. That's actually on the web for us to look at, too.

Since students are expected to work in teams, at least to some degree, they fault faculty if they do not do the same. A student at a different program gave voice to this criticism:

> We hear about these clusters, about how the profs should work together and we come here and we don't see that. So we're kind of expecting it when we come in and we're getting a little let down here.

Students value signs that the faculty care about them. In the larger programs, that can be the professor simply knowing their names. In the smaller programs, they speak highly of faculty who are attentive to them, noting when they're absent and even contacting them if they miss class. One student said:

> I've had classes where if I missed one day, the professor would email me and ask what was wrong and where I was. They notice if you're not there.

The students overall seem to have a good opinion of their professors; that doesn't always transfer into a comfortable relationship for learning:

> A lot of times the professors, they're very smart and I know they're smart and they know what they're doing, but I guess getting on their level sometimes, the communication barriers can be difficult….You're definitely more willing to ask a dumb question to someone your own age than a professor.

This no doubt is a major reason why students turn first to their peers and to their TAs for help, rather than immediately seeking out their professors.

Learning How to Survive in College

When we asked students to reflect directly on their learning process, the kind of learning which they could articulate most freely and about which they spoke more often was learning how to survive in college. One of the questions we asked them was how learning in college differed from their experience in high school, and almost all of them voiced some degree of shock about how different it was. A piece of advice one student was given was "Freshman year is not the 13th grade; it's not like high school, so you better adjust." No one disagreed.

Many students spoke of the shock of the college experience. They're required to work harder and longer than in high school, and "free time" becomes a strange concept. One student described the difference:

> In high school…you could get out of school at 3:00 and have your homework done by 4:30 and have the rest of the night to sleep and watch TV. Here you have a class at 4:30 and you stay in the lab…and don't get back to your room until 10:00. You can be in the lab for 5 or 6 hours. You might leave and get something to eat, but you're gonna come back and try to do something [more].

The greatest shock, though, is grades. "Everybody's used to getting all A's and then fail a class and it just kind of is like 'Wow!'" One student referred to it as getting "smacked around"; another said, "You stop trying to excel and you just start trying to get by." More corrosive, though, is the self-doubt this causes. Lots of students expressed the fear that they weren't as smart as they thought. One described how disturbing this is:

> It's a big step-down not being a smart kid. We know all these smart kids in high school. I always got 100s on tests and I didn't have to try that hard, and now I'm not—and it's like that gets really frustrating when you can't learn things as quickly as you want.

They leaven this with some humor:

> You always look forward to being smart someday! [laughter] You feel really dumb right now. You're like, "Oh, when I graduate, then I'll be smart!"
>
> I know one guy, he said he went and took an IQ test just to be sure he had sense! [laughter] And he was actually serious about it. He was feeling so bad that he actually went on in there and took the IQ test to make himself feel better, to make sure he hadn't just lost his intelligence or something.

The faculty also recognize how difficult this transition can be, and one professor expressed it particularly well:

> Engineering is pretty hard—you don't go into engineering as an easy major. Everybody knows that….Every student, except for maybe 5%, could get bad

> grades. You get exams back that you didn't perform nearly as well as you did in high school. You get a lot of negative feedback in your freshman year, because typically our students are from the top 10% or so of high school, so most of the feedback they got in high school was very positive, and now they get 50s on exams and their homework only half of the questions are right. And they're having to study, and they're working hard, and it's not showing up in their grades.

As they considered how they have learned to survive in the new environment of college, their answers centered around the need to be responsible for themselves and their learning. They spoke at length about learning self-discipline and developing time management skills.

Developing self-discipline is critical, and for most that means going to class regularly; they recognize that missing class puts them behind, since the material is accumulative. One said, "When you miss class you miss a lot of work….No one can really match how your professor teaches stuff in class." Another seconded that: "You miss one day and it's like you've missed two weeks." Students agree that attendance isn't optional:

> If you have to miss a lecture—either you're on a plant trip like an interview, or you're like deathly sick and can't move—you get notes from a friend and bring them in to the prof to talk about them. That's like the best way to fill in the gaps, but you don't just [say], "Oh, I don't want to go to class today."

They also talk about staying on top of the work, by which they usually mean doing their homework regularly and on time. Comments like the following were frequent:

> The main thing was making myself study…I have to make myself sit down and stare at that stuff and try to figure it out.

> You have to tell yourself, "No, you're going to sit here and you're going to do this homework and you're not going to get up until you're finished!"

> In high school you get an assignment and you know it's due Friday and you do it Thursday night, not because you're procrastinating, just because it's not going to take that long, so why do it now. But now, if I have something I know is due next week, as soon as I get back to my room, it's like, "Now I have to start on it."

They quickly discovered that procrastination is dangerous; one student summed this up succinctly—"get it done!"—because with a heavy workload, there is little time to catch up. The fact that the learning is accumulative makes this even more important. One student talked about his own realization of this:

> I have to take 111 over again. Not because I have to—I could go on to 112—but I don't feel that I got…I'm not comfortable enough with my knowledge in 111 to try to go on to 112. Because you have to build on what you [learn]…it's accumulative. So, if you don't understand it the first time, don't be foolish. And

> I just had to admit that to myself. I have never made grades like this before in my life.

Being successful in a challenging academic program makes time management essential, and this came up in the interviews again and again. As one person said, "The time management thing was huge. That's one of the most valuable things I've ever picked up in college." Two students in one of the focus groups described their experience:

> Like before, I never really tried to keep up with my time, because I always had a lot of time to spare. But now you have to….A lot of time on Sunday I will have my week planned out before I start it. Like "I've got this test here, I've got this homework here—when I'm going to work on it and when I'm going to do this and do that."
>
> I've got a planner and it's got stuff in it through April already….You've got to have things ready to go. I never carried a planner until I got here. I thought planners were worthless and I hated that stuff, but you're forced to here.

Another expanded on that idea:

> I kind of picked up that time management thing on my own, because I don't really remember the teachers like saying anything, but really the workload forces you to change. Because if you don't change, you're definitely not going to make it. In that way it's good because it prepares you for the real world, which is the point.

There was one other element that we consider essential for survival, namely stress management, but few students spoke about this. It struck us as a very important missing piece. One of the few students who discussed it told this story:

> One of the main things I think that's gonna help me this semester is last semester all I did was study. And I never really had time for myself. I realized that by the end of the semester I was just blown out. I just didn't feel like doing anything and I went home and told my parents about it, and they were like, "Well, you've got to go out and have fun every once in a while." I didn't expect to hear that from my parents! [laughter] I was like, "OK, I guess I will." I think if I had that time for myself to go out and have fun with my friends and do whatever, that helps me a lot when it comes to, you know, taking care of stress and everything.

Given the enormous workload in these engineering programs and the degree of difficulty in learning everything they need to know, this understanding would benefit more students as they struggle to survive.

All of these elements come together for these students, giving them the skills necessary to survive in this new and challenging environment. Linked with the support they gain from one another in the cohort, they are able to turn to the task of learning the discipline of engineering.

Learning to Think like Engineers

It's clear that engineering programs are tough. The material is difficult, and the students talked about the various ways they have learned to master it. While most have some understanding of what their integrated curriculum is trying to accomplish, few speak directly about learning a concept across disciplines. What they do talk about is the importance of understanding how and why a particular concept works. As one student said, "I need to understand what makes this happen." Another thought of it as a series of questions: "OK, why is this like this? Why do you use this step?" Another student took it a step further:

> I understand the mechanics behind the problem, because if you do that, you can basically work any problem that's that way or work yourself through a problem that is similar to that or…uses the same mechanics as that.

Their focus is on application of concepts in order to solve problems. In class and in their teams and study groups, they talk, they ask questions, and they apply concepts in order to solve problems. They see problem-solving as fundamental to engineering:

> I used to think that I could just look at something and understand the concept behind it and know it….And for awhile I was able to get by with that, but now it takes a little bit more that that. It takes application and stuff before you really understand it all that well.

> A professor can lecture and show you how to do a particular thing, but it's not until you actually work with it and work with it yourself, and work out a problem—that's when you really learn the material.

> There's not that much to read. It's more just you do problems and you keep doing problems and you just keep doing them until you finally actually know how to do them.

How they achieve this is an ongoing learning process, and in that sense they are teaching themselves. But they do that through active involvement with the material, and not by passive memorization. Comments from several students underscore this:

> You've got to be more interactive. You've got to want to learn that information, cause if you're just going to be passive about it, then you're not going to do well.

> One thing I would recommend about the FIPE is that it's not like regular classes in that…there's not really much lecture at all. You're not just sitting there and getting straight lectured. It's a lot of hands-on and talking and discussing.

> I think we've generally become a little more active in our learning, because we don't just sit down and expect the teachers to totally explain everything to us and then know that going out of class we'll understand that we have to take part by reading or going and asking questions or doing whatever to make sure we understand.

These students see themselves becoming more analytical thinkers, and they are becoming more critical thinkers. One student tried to describe this:

> I've learned how to critically think about stuff, you know. It's helped a lot. Before I might have had to have somebody tell me how to do this and stuff. Now I can just look at something and kind of figure it out myself, like a problem or something like that. I don't have to have somebody tell me.

Another student described it as, "You have to really sit down and think about stuff. I don't know, it's like you open up a whole new side of your brain you've never used before."

More than one student said they were being taught "to think like engineers." Two of them elaborated:

> Just thinking through things a lot different, different strategies and attacking problems from different angles. You know, looking at a problem from three or four different views before trying to jump at a solution. That's something big that's changed [for me].
>
> I would start by thinking about the problem, what it really is, understanding the whole problem, and then trying to think about possible ways to get to the solution.

For many this is a gradual process of gaining new insight. One student caught that process for us:

> You get so used to seeing problems that when you first read it, it just kind of blows your mind and you're like "Oh crap, I have no idea where to start on this." But you get that forced down your throat so many times that you can look at stuff that originally you don't have any idea what's going on, and in your mind you can break it down and even if you don't know what you're doing, you can come up with something that looks like it actually has logical sense to it. Even if you never did know the actual strategy to attack the problem, you get used to instead of saying, "I have no idea," and throwing your hands up, you get in there and kind of dig around it and figure out some kind of an answer.

Learning in other classes can also help build a repertoire of approaches:

> You get to pick up on which way works better for you. See the physics way is easier for you and the engineering way is a little harder, but you can use the

physics way in the engineering test, so you get different views of how to do the same problem and which one works best for you.

Learning to think like an engineer is an accumulative process of understanding why things work as they do, developing critical analytical skills, and applying all this to problems in ways that are inventive and creative. This is very complex learning, and it is significant that freshman students, who predominated in our sample, were making considerable progress in learning to think in this new way.

Summary and Conclusion

We see the powerful ways in which the inclusive learning community structure works to shape and support the learning of the students in the Foundation Coalition programs. Many different kinds of student learning are evident in our interview data. A major benefit for students is learning to work in teams, and while all of them spoke of the difficulties involved, they also talked at length about how they've learned to deal with those problems. Their attitude towards teaming is positive—they see how it benefits their learning, and they recognize that this experience will be an asset when they begin their careers. Another aspect of learning is figuring out how they learn best, and in the interviews we heard them trying to discover their own style. All recognize that memorization alone is not a useful strategy and that they learn through application of concepts. Connected to their personal learning experience is learning how to get help. We saw a clear order: they first turn to their peers, either within the team or cohort, or from among their other friends; if they need further help, they seek out a TA or a tutor; if they still have questions, they go to their professors. This was not a negative statement about faculty but rather a positive statement about their peers. Students are readily available to one another; they feel safe letting their peers know they don't know something; and they find other students effective teachers. Faculty still play an important role in student learning, however. Students expect and highly value good teaching, and they discover quickly that going to class is essential to their learning. Another dimension of student learning is related to surviving in college. Most of the students were shocked at how much more challenging college is than high school, and they all talked about basic things they've had to learn in order to make it. Highest on their list is developing self-discipline and learning time management skills. Finally, when discussing how they're learning to master the material, the students talked at some length about learning how to think like engineers. What this means to them is understanding how and why a particular concept works, and developing the skills of critical analysis that will enable them to understand the problem and explore possible solutions from multiple angles.

Taken together, these findings lead to a simple conclusion—cohorts work—and they do so because they make it possible for various communities to be created. It is probably a stretch to call the entire cohort itself, especially when these are large, a learning community, but it clearly does create the possibility, even the probability, that real communities can form. Students connect with other students because they're in this contained group, trying to succeed in a difficult program, and they quickly recognize that they have a better chance of succeeding if they reach out to one another. And they succeed in great part because the cohort structure facilitates and enables their learning.

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