An Evaluation of an Integrated Pre-Engineering Program: Results From the Freshman Year and Beyond

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Abstract

In the fall of 1996, faculty in engineering, mathematics, and physics departments at Auburn University launched an experimental pre-engineering program. The 2-year program consists of a team-taught sequence of mathematics, engineering, and physics courses that have been integrated so as to enable pre-engineering students to grasp the interrelatedness of the concepts in each of these domains. The program is undergirded by a strong and comprehensive mathematics foundation. Enhanced usage of computing/visualization technology and an academic environment specifically structured to encourage and motivate students to learn are also programmatic features. Reported in this paper are results from an on-going evaluation of this program.

I. Introduction

An educated workforce capable of responding to the diverse demands and complex problems in this time of rapidly changing world conditions is no longer a preference but a necessity. Even though a schooled populace is crucial, an alarming percentage of the students who matriculate into institutions of higher education fail to graduate. Over half of the students--1.5 million of the 2.4 million who entered in 1993--will leave their first institution without a degree[1]. This general exodus is mirrored in math, science, and engineering programs as well. Hewitt and Seymour[2] noted an attrition rate of 60% from math, science, and engineering programs. Results from a retention study[3,4,5,6] conducted at Auburn University, a major land-grant university with a strong engineering program, were similar. Here, also, approximately 60% of the students indicating as freshmen an intention to major in engineering actually did not persist to graduation with a degree in the area. Lack of relevance in the pre-engineering curriculum has been cited as a contributing factor[7].

In response to the demonstrated need for a more applicable early experience, an experimental integrated pre-engineering curriculum (IPEC)[8] was developed and implemented fall 1996 with sponsorship from the National Science Foundation. The fundamental goals of this project were as follows:
1. To improve the students' depth of understanding of the mathematical models of the physical world;
2. To deepen students' understanding of the physical principles that are the foundation of engineering problems;
3. To increase students' use of mathematical models in solving basic engineering problems;
4. To increase students' involvement and sense of belonging in and personal commitment to the academic community;

5. To improve retention of students of varying cultural and mathematical backgrounds.

In order to meet these broad goals, the project's authors proposed four basic thrusts. First, they proposed to unify mathematics and engineering in order to present mutually reinforcing concepts. Second, they proposed to create a strong mathematical foundation augmented with physics and engineering experiences. Third, they proposed to introduce computing technology. Fourth, they proposed to create an enhanced academic atmosphere which would include small group interactions, mentoring, supervision, and remediation.

II. Brief Overview of IPEC

The IPEC program differs markedly from the traditional pre-engineering program which leads students through sequences of mathematics classes, physics classes, and chemistry classes with little or no overlap and little instruction on how concepts from these varied domains are integrated in addressing engineering problems. The first and second quarters focus on building a strong mathematics base and applying these mathematical principles to engineering problems. The structure is a mathematics (MH) class and an engineering (EGR) class. However, in practice, the courses are taught in a seamless fashion. The IPEC students meet with both math and engineering professors present so that, as the math principles are taught, the engineering professors can see exactly what the students are learning and, on the spot, describe how one might view the same principle from an engineering viewpoint. Thus, real-life engineering problems are introduced to help students understand the links between mathematics and engineering. In the third, fourth, and fifth quarters, a physics (PS) class is introduced along with the continuation of mathematics classes and engineering classes. The structure of the sixth quarter allows for optional courses in mathematics and engineering.

Courses by quarter may be summarized as follows: Quarter 1: MH 181 (5 hours) and EGR 181 (2 hours); Quarter 2: MH 182 (5 hours) and EGR 182 (2 hours); Quarter 3: MH 183 (5 hours), EGR 183 (2 hours), and PS 183 (3 hours + 1 hour lab); Quarter 4: MH 281 (5 hours), EGR 281 (3 hours), and PS 281 (3 hours + 1 hour lab); Quarter 5: MH 282 (3 hours), EGR 282 (3 hours), and PS 282 (3 hours + 1 hour lab); Quarter 6: MH 283 (3 hours) and EGR 283 (3 hours).

As is evident, this program begins with an emphasis on building a strong, comprehensive mathematics base. The focus is on vector-based calculus, differential equations, and linear algebra which is supported by a text[9] which has been specifically designed for this course. As the mathematical models are taught, the engineering applications are included. An example of this interplay is that once the students have addressed the "theory and methods of solving first order linear differential equations with constant coefficients . . . the class would begin with an engineering instructor discussing the use of belts to transmit power."

The physics course was also redesigned so as to integrate with the concurrent math and engineering emphases. The goal was to create a solid foundation of physical principles on which to base the applications to engineering. As the students gain proficiency with mathematical models and physical principles, these are immediately applied to engineering problems so that the interconnections among these three domains are recognized and considered from the beginning. Technology is an integral part of this program as students are required to use a programmable graphing calculator and are introduced to computer software packages such as MathCad and Mathematica. These technological applications are helpful in illustrating the mathematical connections of the physical laws, while the engineering components provide the real-world arena for application. Thus, through this integrated approach, students develop concepts that are linked to other domains and to real-world applications thereby increasing their breadth and depth of understanding.

In the IPEC program, there are several avenues through which the students' involvement in an academic community is enhanced. The freshman student group stays together over 6 quarters, and cohesiveness and camaraderie develop. IPEC students meet for study sessions, and graduate students and advanced undergraduate students work as mentors and facilitators . Group projects are also assigned to the teams to provide opportunity for collaboration in problem solving.

The final goal is to recruit and retain minority students and students who come to the university with weak math and science backgrounds. The proposal for recruitment of students includes flyers sent to regional public and private high schools in addition to recruitment through Auburn's Minority Introduction to Engineering (MITE) program. For students graduated from academically weak schools, a summer bridge program has been proposed which would focus on increasing basic algebra and trigonometry skills, as well as introducing chemistry and physics topics.

III.A The Students: Selection and Assessment

Students were recruited for the IPEC program through presentations made at Camp War Eagle, the summer program at which freshmen are welcomed to the Auburn University campus. All incoming pre-engineering students take a placement test assessing their mathematical understandings to help determine the appropriate level for the beginning math classes. Results from this math placement test were used to help select students for IPEC. Before classes began fall quarter, all IPEC students and a stratified (based on gender and ACT Composite) random sample of regular program pre-engineering students were selected as the study subjects--an experimental IPEC sample of 62 and a comparison group of 119. All students in the study were asked to complete the College Freshman Survey[10].

Evaluation procedures during the first year were multifaceted. IPEC students completed questionnaires each quarter regarding each course, and a small sample of students were interviewed (selected from those who persisted with IPEC into the second quarter and those who switched out after the first quarter). Grade and retention data were also obtained for both IPEC and comparison students.

III.B The Students: Demographic Data

In this section we present the demographic information on the IPEC students and the comparison group in order to compare and contrast trends and patterns in this particular sample. Specifically, the information can be used to understand the typical IPEC student in order to be aware of his or her needs and concerns and to determine if any factors influence whether or not the student opts to remain in the IPEC program or in pre-engineering in general. The data have been organized and analyzed by three categories: IPEC students who chose to remain in the program, IPEC students who chose to leave the program, and the comparison group of students who did not participate in IPEC. (Note: Initially, all but one of the students leaving the IPEC program remained in the pre-engineering program.)

As is true of the general population of pre-engineering students at Auburn University, the typical IPEC student who opted to remain in the program is male (76%) and White (90%). Interestingly, approximately one quarter of the students who decided to remain in the program is female (24%), yet females account for one third of the students (33%) who opted to leave IPEC, suggesting that females did not find the program as satisfying as their male counterparts. Like their comparison counterparts, the IPEC persisters are predominantly Baptist (31%) with only four students acknowledging a non-Christian religious preference or no religious preference. The students who decided to switch out of IPEC are all self-reported Christians with a lower percentage (22%) belonging to the Baptist denomination. None of the IPEC students are married. Again, like the overall population of pre-engineering students at Auburn University, the students who participated in IPEC are a fairly homogenous group--White, single, Christian males.

Most of the students from both the group who opted to remain within the IPEC program (persisters) and the group who opted to leave the IPEC program (switchers) live within 250 miles of their hometowns or parental homes (persisters = 65%; switchers = 61%). The interesting difference in these two groups is that 22% of the IPEC students who left the program were more than 500 miles from home, as compared with 6.9% of the persisters. This additional distance could possibly affect the switchers' ability to gain needed emotional, financial, or academic support from home, causing greater anxiety or less desire to remain in the program. In other words, it appears as though it may be easier for the students who have remained with IPEC to have access to their homes for support. Seventy-nine percent of the IPEC persisters are from town or suburban environments. This percentage is highly consistent with the comparison group. The percentage of students, however, who come from rural environments differs for the three groups. Like the comparison group, approximately 7% of the IPEC persisters come from rural settings as opposed to 22% of the IPEC switchers. Again, this circumstance could result in the switchers having a more difficult time adjusting to an unfamiliar town environment. Most of the students from all three groups live in dorms (comparison = 56%; persisters = 52%; switchers = 56%) or rental units (comparison = 40%; persisters = 38%; switchers = 44%), with only a small percentage living with relatives (comparison = 2.5%; persisters = 7%). In other words, most of the students seem independent of commitments to family and able to submerge themselves fully in the university environment.

All three of the groups come from fairly well-educated families. Over 90% of the IPEC persisters have fathers with some form of post-secondary education, while 100% of the IPEC switchers have fathers with some form of post-secondary education. One noteworthy point is that the IPEC switching group had a much higher percentage of mothers with university degrees (83%) as compared to the IPEC persisters (55%) or the comparison group (61%). Like their parents, all three groups are comprised of students who are academic achievers. The majority of the students (comparison = 72%; IPEC persisters = 90%; IPEC switchers = 60%) ranked in the top 20% of their graduating class. However, these differing percentages for the groups clearly show discrepancy between the two IPEC groups: the IPEC switchers did not achieve academically as did their persisting counterparts.

Understandably, based on their families' level of education, students in all three groups indicated that they intend to pursue graduate degrees (comparison = 67%; IPEC persisters = 78%; IPEC switchers = 88%). It appears as though IPEC students in general have higher career aspirations than the comparison group, and the IPEC switchers have the highest expectations of all, with approximately 28% intending to pursue doctoral degrees. With such high academic expectations and goals, it may have been more difficult for the IPEC students to cope with the academic demands and rigors that they encountered during their first quarter of IPEC. This first confrontation with university-level academics may have prompted the IPEC switchers to leave the program.

Most of the mothers for all three groups are employed, with below 25% for all three groups remaining at home. An interesting difference, however, can be noted for the fathers' occupations. With the IPEC switchers, approximately 44% of the students have fathers in the engineering profession as opposed to 17% of the comparison group and 10% of the IPEC persisters. Possibly, a strong family influence encouraged the IPEC switchers to pursue engineering. Another interesting difference between the IPEC switchers and the other two groups is their expectations for freshman-year grade point averages (GPAs). Only 6% of the IPEC switchers expect GPAs of 3.75 or above as opposed to 24% of the comparison group and 28% of the IPEC persisters. In general, the IPEC switchers appear to have more realistic expectations of their grades during their college careers. A final difference between the IPEC switchers and the other two groups concerns their ACT Composite scores. Fifty-eight percent of the IPEC persisters and 40% of the comparison group had ACT Composite scores of 28 or above, as opposed to only 25% of the IPEC switchers.

To summarize the demographic information, the group that appears to differ the most demographically from the other two groups is the IPEC switchers. This group notably differs from the comparison group and the IPEC persisters on a number of factors: gender, size of hometown, distance from parental home, mother's highest level of education, educational expectations, father's occupation, grade point average expectations, and ACT Composite score. Indeed, the IPEC switchers appear to be a group quite unique from the other two groups, indicating that their needs and expectations as they first confront the university environment and pre-engineering course of study could be factors which have influenced them to change their curriculum pursuits.

IV.A Outcomes: Grade Point Average

One of the goals of the IPEC program is for the students to have a stronger comprehension of math, physics, and basic engineering concepts. Inasmuch as the program is designed for mutual reinforcement of the concepts being taught in these different domains, the goal was to increase student understanding within the various domains which might be reflected in grades. Significant variation between the groups ($F = 8.7947$, $p = .0002$) was found when examining the cumulative GPAs as of the end of the freshman year. The mean cumulative GPAs were 2.76, 3.07, and 2.20 for the comparison group, the persisting IPEC students, and the switching IPEC students respectively. These results suggest several things. One is that the students who left IPEC early continued to experience academic difficulties in the regular program. The second is that the IPEC students, as a group, show high academic achievement. Some of these differences may be due to programs of study, but some may be due to the strength in academics of the persisters which was evident in self-reported high school grades, particularly in mathematics and the sciences, from the College Freshman Survey data (see subsequent discussion).

IV.B Outcomes: Retention

Retention After One Year

By the end of the first quarter 27 students (41.9%) had switched out of the IPEC program. All but one of those students remained within the College of Engineering, switching into the regular pre-engineering program for the second quarter. Some of the reasons for this switch are explored later in this document. For now, we will focus on the end of freshman year retention rates of both the original IPEC group ("experimental" group) entering as freshmen fall quarter of 1996 and the comparison group. As seen in Table 1, the retention rates at the end of the first year are very similar between the groups with 84.7% and 80.5% of the experimental group and the comparison group, respectively, remaining in engineering at the end of the first year. For those who switched out of engineering, 11.0% and 10.2% of comparison and experimental groups respectively left with poor grades (GPA < 2.20 which is the cutoff for admission to engineering from pre-engineering), while 8.5% and 5.1% (comparison and experimental respectively) chose to leave engineering with adequate grades (GPA ≥ 2.20). The contingency coefficient of .064 indicates a nonsignificant relationship between group and status in engineering at the end of the first year.

TABLE 1

	STATUS IN ENGINEERING Count / Row Pct / Col Pct / Tot Pct	pre-engineering 1.00	exit GPA <2.20 2.00	exit GPA ≥2.20 3.00	Row Total
1.00 COMPARISON GROUP	Count	95	13	10	118
	Row Pct	80.5	11.0	8.5	66.7
	Col Pct	65.5	68.4	76.9	
	Tot Pct	53.7	7.3	5.6	
2.00 EXPERIMENTAL GROUP	Count	50	6	3	59
	Row Pct	84.7	10.2	5.1	33.3
	Col Pct	34.5	31.6	23.1	
	Tot Pct	28.2	3.4	1.7	
Column Total		145	19	13	177
		81.9	10.7	7.3	100.0

Because such a sizeable group of students switched out of the IPEC program at the end of the first quarter, the outcome for them by the end of the first full year in pre-engineering was of interest. Table 2 illustrates the first year retention outcomes with the experimental group subdivided into those who stayed with IPEC after the first quarter and those who switched out at the time. Here we find a significant difference (p = .02427) between the groups with a contingency coefficient of .24408. At the end of the first full year of pre-engineering, only 66.7% of the students who chose to switch out of the IPEC program at the end of the first quarter were still in engineering. Of those who persisted with IPEC, 97.1% persisted. Of the students who switched out of IPEC, 25% left pre-engineering with poor grades.

TABLE 2

	STATUS IN ENGINEERING				
	Count Row Pct Col Pct Tot Pct	pre-engineering 1.00	exit GPA <2.20 2.00	exit GPA ≥2.20 3.00	Row Total
COMPARISON GROUP	1.00	95	13	10	118
		80.5	11.0	8.5	66.7
		65.5	68.4	76.9	
		53.7	7.3	5.6	
IPEC - STAYERS	2.00	34		1	35
		97.1		2.9	19.8
		23.4		7.7	
		19.2		.6	
IPEC - SWITCHERS	4.00	16	6	2	24
		66.7	25.0	8.3	13.6
		11.0	31.6	15.4	
		9.0	3.4	1.1	
	Column Total	145	19	13	177
		81.9	10.7	7.3	100.0

Retention After Two Years

Here the students' final status with regard to admission to the engineering program is examined. Final results were available for 174 students out of the total sample of 181. Six students were still in pre-engineering and had not made the transition either into engineering or into another program. One student dropped out of the university first quarter before obtaining any grades.

Table 3 provides a cross tabulation of student group and student status regarding engineering. In this table the students are divided into the experimental group (IPEC) and the comparison group of students who entered Auburn University at the same time but were involved in the regular pre-engineering program. These results represent final status in that the vast majority of students had either been accepted into engineering or had switched programs either by choice for a new major or due to poor grades.

Outcomes for the two groups are very similar as one can see by a quick perusal of Table 3. There is no statistically significant difference in outcomes regarding retention of students in engineering between these two approaches (Contingency coefficient = .0303, $p = .9231$). The percentage of pre-engineering students from this sample who entered the engineering program was 62.8 and 65.6 for the comparison and experimental groups respectively. Strikingly similar percentages of students from each group left the pre-engineering program either with poor grades (18.6 and 18.0) or with good grades but a change in major (18.6 and 16.4).

TABLE 3

GROUP	Count / Row Pct / Col Pct / Tot Pct	STATUS: engineering	STATUS: left eng GPA<2.20	STATUS: left eng GPA≥2.20	Row Total
COMPARISON	Count	71	21	21	113
	Row Pct	62.8	18.6	18.6	64.9
	Col Pct	64.0	65.6	67.7	
	Tot Pct	40.8	12.1	12.1	
EXPERIMENTAL	Count	40	11	10	61
	Row Pct	65.6	18.0	16.4	35.1
	Col Pct	36.0	34.4	32.3	
	Tot Pct	23.0	6.3	5.7	
Column Total		111	32	31	174
		63.8	18.4	17.8	100.0

A little more information can be gained by examination of the outcomes when the IPEC group is further differentiated between those students who stayed with the IPEC program and those who switched out as can be seen in Table 4. Of the 32 students who had switched out of the IPEC program by the end of the first year, approximately one third continued through the regular pre-engineering program and entered engineering, one third left the regular pre-engineering program due to poor grades (GPA < 2.20), and one third chose other majors but did have the GPA which would have enabled them to enter engineering if they had chosen to do so.

TABLE 4

GROUP	Count / Row Pct / Col Pct / Tot Pct	STATUS: engineering	STATUS: left eng GPA<2.20	STATUS: left eng GPA≥2.20	Row Total
COMPARISON	Count	71	21	21	113
	Row Pct	62.8	18.6	18.6	64.9
	Col Pct	64.0	65.6	67.7	
	Tot Pct	40.8	12.1	12.1	
EXPERIMENTAL - STAYERS	Count	29			29
	Row Pct	100.0			16.7
	Col Pct	26.1			
	Tot Pct	16.7			
EXPERIMENTAL - SWITCHERS	Count	11	11	10	32
	Row Pct	34.4	34.4	31.3	17.8
	Col Pct	9.9	34.4	32.3	
	Tot Pct	6.3	6.3	5.7	
Column Total		111	32	31	174
		63.8	18.4	17.8	100.0

Number of Missing Observations: 7

V.A Predictors of Success: ACT and Math Placement

The students who began the IPEC program were, on average, within the top one third of beginning pre-engineering students at Auburn University based on ACT Composite score; thus, they would be expected to succeed in this program. Minimal differences existed in ACT Composite scores between those students who remained with the IPEC program (mean = 28.31) and those who switched out (mean = 27.08) at the end of the first quarter. Correlations between ACT Composite score as an explanatory variable and outcome measures of program status at the end of the first quarter, grade in EGR 181, and grade in MH 181 were modest: .2291, .4569, and .3353 respectively. A much larger difference was found with the math placement score. The correlations between math placement score as an explanatory variable and the three outcome variables of program status, grade in EGR 181 and grade in MH 181 were considerably stronger for the first and last variables: .7281, .3722, and .6275 respectively. When the scores on the math placement test were dichotomized into above 16 and 16 and below and cross tabulated with the status variable (staying in or switching out), we found that all 16 students scoring at 16 or below switched out of the program by the end of the first quarter.

V.B Predictors of Success: College Freshman Survey - Self-Reported Grades

A follow-up question would be what kind of math background IPEC students had coming into this program. When we examined the correlation of self-reported high school grades, from the College Freshman Survey, as explanatory variables for grades in MH 181, EGR 181, and program status, we found mainly modest levels. In examining the outcome variable of persistence in the IPEC program, the explanatory variables of algebra II, calculus, chemistry, and foreign language yielded correlations of .3336, .5821, .3973, and .3497 respectively. What these results mean in general terms is that persistence in IPEC is quite strongly related to high school performance in calculus and moderately correlated with high school grades in algebra II, chemistry, and foreign language. In order to examine calculus as an explanatory variable, we cross tabulated program status with high school grades in calculus. For the 47 IPEC students on whom we had this information, we found that 29 of the 37 students who took and passed calculus in high school continued with the program beyond the first quarter, while all 10 students with no calculus background switched out, as well as 8 students with good high school calculus grades. Thus, having calculus does not insure that a student will perform well or persist with this program, but a lack of calculus appears to have a significant relationship to persistence decisions.

VI. Student Feedback Regarding Courses

Throughout the implementation of the 6 quarters of the IPEC program, we tracked the students' thoughts and reactions to this experimental program by means of a questionnaire presented at the end of each quarter. The questionnaire had two main sections: (a) a series of open-ended questions addressing the perceived strengths and weaknesses of each course and suggestions for improvement and (b) a set of statements presented in a Likert rating scale format which addressed issues of instruction, course materials, evaluation procedures, level of difficulty, availability of assistance, and help seeking behaviors. At the end of each year, additional open-ended questions were included which addressed additional programmatic concerns. The initial quarter of the IPEC program was a definite period of adjustment for both students and faculty, with 27 students electing to switch out of the program. In order to understand more fully what the students were thinking and experiencing, we also conducted personal interviews with 13 of the students, 8 who were continuing and 5 who were switching out. The following is a summary of student responses to these formative evaluation concerns organized by quarter.

<u>Quarter 1 - MH 181 and EGR 181</u>

For MH 181 the most commonly reported strengths were the teaching staff (available, knowledgeable, and encouraging) and the emphasis on application of calculus in the field of engineering. Reported weaknesses were the text, the fast pace of instruction which precluded enough time for thorough explanations, and the level of difficulty. Suggestions were to improve the text, to slow the pace, and to provide more thorough explanations. On the Likert scale items there was a strong dichotomy between the persisting and switching groups on a number of questions. A majority of persisting students agreed that course organization was good, expectations of students were made clear, explanations were clear, course material was well organized, tests were not too difficult, and their high school math preparation was adequate. A majority of switching students disagreed on all of these factors. Both groups did agree on a number of issues: professors were willing to help, grading was fair, and the course was definitely challenging. A larger proportion of switching students indicated that they sought assistance from the professor (40% compared with 23% of persisters) and that they attended tutoring sessions (70% compared with 49%).

For EGR 181, the most commonly mentioned strengths were the teachers (knowledgeable, available, encouraging) and the emphasis on practical applications. When asked about weaknesses, the students were quite varied in their responses, but a few common themes emerged. These included lack of a written text or set of background materials, level of difficulty of assignments, and the time required to complete assignments. Suggestions for improvement included more labs or hands-on experiences and some written materials for the course. Again, in general, the persisting and switching students differed in their responses to the rating scale statements. The persisting students agreed that there were good organization, clear expectations, clear explanations, good organization of materials, and not-too-difficult tests. The persisters also felt that their high school math preparation had been adequate. On all of these factors, the switching students were quite evenly split. Both groups found the professors willing to help and generally committed to the success of the students. Both groups agreed that the course was challenging and that grading was fair. A larger proportion of switching students reported that they sought help from the professors (50% of switchers compared to 20% of persisters) and that they attended tutoring sessions (80% compared with 52%).

From the 13 personal interviews, a number of basic themes emerged that addressed issues such as calculus background, AP classes in high school, sophistication of study skills, use of support services, reasons for choosing engineering, comfort of transition to college, and adjustment to multiple professors. With regard to calculus background, all of the interview sample students who stayed with IPEC had a calculus background from high school, and half of those students took AP calculus. Only two of the five interviewed students who switched out of IPEC had calculus in high school, and neither took AP calculus. Those students with good calculus and physics backgrounds found the transition relatively painless and often described the MH and EGR 181 courses as somewhat review-like because the language and concepts were familiar and they could more readily transfer from one field to the next. Those with weak math backgrounds did not think they had a good grasp of the calculus principles. Basically it seems they were working with knowledge of which they had only a tenuous grasp, and the transfer to new areas was much more confusing.

With regard to AP classes, five out of the eight continuing students had at least one AP class in high school, while none of the switching students reported any AP classes. AP classes were frequently described with the adjective "challenging."

With regard to study skills, four out of five of the switchers stated that they brought poor study skills from their high school days and indicated that they were still wrestling with this problem. More of the continuing students reported good study habits, but five out of the eight described themselves as being in the process of adjusting to the different demands of university and developing better study skills. They addressed issues such as efficiency of effort and changing mind set from learning to memorize to learning concepts for broader application.

With regard to support services, the continuing students sought help from a variety of sources--friends, tutors, and professors--and they started seeking help early in the quarter. In contrast, many switchers waited longer to seek help and often were in academic trouble before reaching out. The switchers tended to seek classmates more frequently, tried the tutors but did not find that experience especially helpful, and only rarely approached the professors. Some expressed reluctance to ask for help in group settings because they were concerned that their questions would be too elemental.

With regard to choice of pre-engineering, the majority of continuing students expressed multiple reasons for selecting engineering which included familiarity with the role, strength in math and science, and frequently a family member who was an engineer. Most of the switchers described fewer reasons for choosing engineering, and the predominant reason for this group was a strength in math and science.

In responding to questions about transition issues, the continuing students generally (seven of eight) reported a relatively easy transition to the university. Three reported some initial stress which eased over time as they became more comfortable and more at ease with the academic demands in particular. Three of the five switching students used words such as "rough" or "overwhelming" to describe their transition experience. Overall, students primarily addressed the academic transition as some of these students described an easy social transition, but a present and continuing need to improve study skills was voiced.

One interesting theme to emerge was difficulty in adjusting to change of professors within a class. Five of the thirteen interviewees reported this difficulty, and four of the five were female. This finding may relate to findings from our other research interviews with students that for female students the personal relationship aspect of the academic setting is more of a factor in establishing a comfort level; hence, a change in teaching faculty may create more discomfort.

Quarter 2 - MH 182 and EGR 182

We initially asked the students about differences in their reactions to the program between the first and second quarters. A majority (53%) cited a change in comfort level which they described in various ways, such as knowing what to expect, being better prepared, being more sure of oneself, feeling more relaxed with the professors, and having overall reduced feeling of stress.

For MH 182, the students mentioned three main strengths. The integration of math concepts into the world of engineering was most frequently mentioned, along with aspects of teaching skill and the personal attention. The textbook was the most commonly cited weakness of the course with concerns centering on poor organization and difficulty understanding the text. Students expressed some concerns about the difficulty in understanding the teaching staff at times, as well as concerns about poor organization in instruction. Suggestions for improvement included improvement of the textbook and more focus on the students' level of comprehension which was elaborated with ideas such as slower pace, full explanations, better structure to lectures, and more in-class direction with examples of homework problems. On the rating scale items, a strong majority of students indicated that expectations of students were very clear, instruction was well organized, instructor was willing to answer questions, instructor was perceived as committed to students' success, the workload was reasonable, grades were fair, and the course was challenging. Approximately 25-33% of the group registered concerns about clarity of explanations in class as well as clarity and organization of course materials. When asked about help seeking behaviors, approximately 30-38% of the group indicated that they did work with groups of classmates, did seek help from the professor, and did attend tutoring sessions. Some students were undecided in their responses, but about 50% of the students reported that they did not engage in these behaviors.

For EGR 182, the most commonly mentioned strength was the teachers and the teaching, while a second area of strength was the focus on real-life engineering applications. Students also indicated that the correspondence between this class and the math class was an important strength. When asked about weaknesses, the largest percentage of responses indicated no weaknesses perceived in this course. Smaller groupings of students indicated some instructional concerns and desire for a textbook. Suggestions were quite varied with some mention of providing a textbook, more guidance on problem solving techniques, and more hands-on activities and demonstrations. Responses to rating scale items indicated that for a majority of the students the expectations of them were clear, explanations of material was clear, tests were not too difficult, the workload was reasonable, grading was fair, course was challenging, and the instructors were committed to the students' success. Some ambivalence was noted regarding the organization of classroom instruction and clarity of course materials. In addressing help-seeking behaviors, a slight majority of these students (55%) indicated that they met regularly with classmates to work on projects or problems for this course, 50% attended tutoring sessions, but only 27% sought assistance from the professors during office hours.

At the end of this quarter we also asked the students some more general questions about their adaptations to university life as well as questions that addressed some of the broader goals of the IPEC program. Although only 41% of the students indicated that their study skills had improved, 59% agreed that they had really begun to understand how to manage their time. We asked about proficiency in the use of computing/visualization techniques, one of the goals of the program, and found that 59% of the students thought that their skills had increased considerably. Another goal of the program was to provide a supportive academic community. Fully 97% of the respondents agreed that this was indeed a supportive academic community and that academic assistance could be easily accessed. We also wanted to examine what impact the coordination of the math and engineering classes had on understanding of mathematics or increased skill in application of math concepts. A large majority of the students (80%) agreed that their skill in application of math concepts had increased considerably, and 88% agreed that the integration of these courses had strengthened their understanding of mathematics.

Quarter 3 - MH 183, EGR 183, and PS 183

For MH 183 the two strengths mentioned most frequently were the availability of two instructors and, again, the course emphasis on application of math to real-life engineering problems. As this sequence of courses has progressed along and adjustments have been made by professors and students alike, the percentage of students finding no weaknesses in this course has increased. Smaller numbers of students still describe concerns with the textbook, poor organizational structure to the course (students do not know what sequence of topics to expect and topics seem to jump around a lot, and level of difficulty. Fully 40% of the students had no suggestions this time, while a few recommendations were made regarding the textbook, pace of the course, and provision of a syllabus to help with structure and continuity. By this third quarter the students' responses indicated that they were very pleased with the way these courses were developing. Strong majorities (80%+) indicated that expectations of the students were clear, instruction was well organized, explanations were clear, materials had improved and were now considered clear and well organized, instructors were willing to work with students, tests were not too difficult, workload was reasonable, grades were fair, course was still considered very challenging, and 100% reported that the instructors were committed to the students' being successful. Help-seeking behaviors changed somewhat as 40% of the students now reported that they did work regularly with groups of classmates and 52% sought help from the professors. Only 16% of the students reported attending tutoring sessions for this class.

For EGR 183, the students again reported that the greatest strength of this course was the teaching staff whom they described as helpful, clear, available, fun, and interesting. Again the second area of strength was the course emphasis on practical applications. Approximately one quarter of the students indicated that this introduction to actual engineering problems and professors was helping them to figure out if they really did want to pursue engineering. In this course, just as in MH 183, fewer students reported specific weaknesses with 40% stating that they perceived no weaknesses in this course. Some areas of concern included not enough class time, lack of textbook, and assignments. Again, 40% of the students had no suggestions and the suggestions which were provided were quite varied, some directly addressing the concerns listed earlier (i.e., include a textbook, increase class time, and several suggestions regarding homework. The students' responses to the rating scale items for this course were very similar to their responses to MH 183 regarding instruction, course structure, materials, and support systems. The pattern of help seeking was a little different as 64% of the students reported that they worked regularly with classmates on material or projects for this course, 48% reported seeking assistance from the professors, and 17% attended tutoring sessions.

The physics course (PS 183) started during this third quarter provides an interesting contrast between familiarity with professors, expectations, and structure and an entirely new facet of the program. IPEC students identified a variety of strengths for this course including the use of demonstrations, videos and labs, the interrelatedness of this course material with the math and engineering courses, reasonable workload, and adequate textbook. Course weaknesses were difficulty in understanding the instructor, rapid pace (although several reported that this problem had improved over the quarter), and difficult homework which factored heavily in the grading for the course. Suggestions included slowing the pace of the course, more time for thorough explanations of the material, and inclusion of more examples and problem solving during instructional time. The uncertainty and lower levels of satisfaction with this new course were also evident in the ratings of statements regarding the courses. Approximately 60% of the students indicated that the course matched their expectations, that expectations of the students were clear, that instruction was well organized, and that the workload was reasonable. Only 40% found that the instructor explained the material clearly and 48% registered concerns about the level of difficulty of the tests. When asked if their high school physics course had been adequate preparation for this course, 40% said yes and 40% said no, indicating wide disparity in preparatory work. On the other hand, a strong majority of the students found that course materials were clear and well organized, that the instructor was very willing to help and committed to the success of the students, and that grades were fair. The pattern of help seeking behaviors noted in the students' responses regarding this course was similar to the pattern for EGR 183: 56% met with classmates to work on projects or problems for this course, 44% sought out the professor, and 20% attended tutoring sessions.

At this point the students were halfway through the program, and we gave them a set of open-ended questions which addressed some broader concerns. One concern was the necessity of high school preparation in calculus and physics for success in the IPEC program. Sixty-eight percent of the students reported that calculus was necessary with a slim majority of that group (52%) responding that it was very necessary. Another 16% said it was helpful, but not necessary, and 12% indicated that they did not think it was necessary. With regard to high school preparation in physics, the opinions were more evenly distributed. Fifty-six percent indicated that they thought preparation in physics was necessary (opinions ranged from very necessary to somewhat necessary), 16% stated that it was helpful but not necessary, and 28% did not think it was necessary. Of this sample of students, 84% had taken at least one physics course in high school. A slight majority of those students indicated that they did not think that their high school physics course had been adequate preparation due to poor teaching, low level of difficulty, or emphasis on plugging in formulas, not conceptual learning.

When asked their opinion about the program, a majority responded with strong positive comments. Some students wrote about the level of difficulty, while others focused on the interest factor, the early introduction to engineering, and the opportunities to learn more than what they perceive they would have found with the regular program. Approximately 48% stated that participation in IPEC had increased their desire to continue in engineering.

We asked the students to reflect on experiences and habits from both high school and their first year of university that they thought had helped them to be successful in IPEC. High school themes included a strong background in math, good study skills, personal attributes such as strong work ethic, persistence, and dedication, and group work with academic teams. First-year university themes were quite varied, but a majority of students described help-seeking behaviors as very beneficial. Other habits included a regular study and homework routine, as well as self-management and time management.

Students were then asked to compare and contrast their IPEC courses with their other university courses. The most frequent theme was the subject matter: level of difficulty and complexity of IPEC material, increase in the amount of detail, higher expectations, and the pattern of building on previous information. The second strongest theme was the high level of support found in the IPEC courses. Other themes included the faster pace of IPEC classes, the personal feel of the IPEC classes due to familiarity with professors and classmates, enjoyment of the IPEC classes, greater group participation, variety of instructors and better teaching, and a more professional orientation in the IPEC courses. When asked if IPEC would be a good replacement for the regular program, a majority (64%) replied in the affirmative primarily because of the emphasis on helping students to see the interconnectedness between subjects and starting to address engineering problems right away. Those with reservations expressed concerns that the level of complexity and fast pace might be more problematic for some students.

<u>Quarter 4 - MH 281, EGR 281, and PS 281</u>

Quarter 4 marks the beginning of the second year of the IPEC program. Twenty-nine of the beginning IPEC students were still registered in the program. For MH 281, the major areas of strength reported by the students were instruction, the interrelatedness of material from this class to the engineering class and physics class, the organization of the course, and the professor. Many students found no weaknesses in this course, while other small groupings identified concerns with regard to instruction, evaluation, and textbook. Suggestions for improvement addressed the text for the course, development of a syllabus, slower pace, and grading suggestions. The strong positive responses to this course were also seen in the rating scale portion of the questionnaire. As we found toward the end of the first year, the students continue to agree that this course offers clarity of expectations of students, organization of instruction, clarity of instruction, willingness of instructors to work with students and commitment to students' success, reasonable workload, and a challenge. A change can be seen in help seeking behaviors as more students reported that they were likely to attend tutoring sessions and work with classmates on projects or problems for this course. Little change was found in the percentage of students who reported seeking assistance from the professor.

The major strengths of EGR 281 as identified by the students were the instructor, the lab, the integration of math and engineering, and the tutoring/help sessions. There was little consensus regarding weaknesses of the course, but some of the areas reported were the level of difficulty, lengthy tests, and some instructional concerns. When asked for suggestions, approximately one third of the group had no suggestions to make and others tailored their recommendations to the particular weakness that they had identified, such as shorter tests and more time spent on the basics. In examination of the rating scale responses, it is clear that some of the students found this course to be quite different than they had anticipated. Forty percent of the group indicated that they found the tests to be too difficult and approximately 25% expressed discomfort with the workload. On the other hand, the students continued to report well organized instruction, clarity of explanation, well-organized course material, fair grading, and professors who were willing to work with them and interested in their success. The help seeking pattern also was different as a large majority (84%) reported taking advantage of tutoring sessions, 76% met regularly with classmates to address work for this course, and 28% of the students reported seeking help from the professor during office hours.

In PS 281, the most commonly identified strength was the instructor, with specific comments addressing good teaching, sense of humor, and willingness to help. Other areas of strength were the demonstrations, the interrelatedness with math and engineering, and the opportunity to approach problems from different directions. When describing weaknesses, the students identified several concerns about difficulty. These included the overall difficulty of the course, difficulty understanding the instructor, difficulty in understanding the text, and the difficulty of tests.
For improvement, the students suggested a change of textbook and several instructional suggestions such as slower pace, more demonstrations, and more time working problems in class.
Students agreed the PS 281 had well-organized instruction, clear expectations of the students, an instructor who was willing to work with the students and interested in their success, fair grading, and a high level of challenge. The difficulties identified in the open-ended questions surfaced here as well with only 32% of the students reporting that the instructor explained the material clearly, 44% expressing comfort with the work load, and 52% reporting that the tests were too difficult.
A change can be seen in help seeking behaviors as fully 80% of the group reported that they met with classmates to address problems or projects for this class, 84% attended tutoring sessions, and 32% met with the instructor during office hours for assistance.

Quarter 5 - MH 282, EGR 282, and PS 282

For MH 282, the primary strength identified by the students was the professor with specific mention of good instruction, strong organization, and concern for students. A related strength was continuity in teaching staff as students reported that they really liked being familiar with their instructors. Students also saw the interesting course material as a strength of this course. A sizable number of students found no weaknesses with this course, but others raised evaluation concerns. These included concerns about the quiz policy, number of tests, and difficulty of tests. Not surprisingly, a sizable number of suggestions addressed these evaluation concerns. Several students reported that they would like more engineering applications and inclusion of more problem solving in class. When expressing their agreement or disagreement with various statements regarding this course, the most universally positive responses were that the instructors were willing to work with students and were genuinely interested in their success. A large majority of the students also found a challenging course, clear expectations, strong organization and a reasonable workload. Some of the students indicated concerns with clarity of course materials and classroom explanations. Approximately the same percentage also indicated that they had found tests and other course requirements to be too difficult. For this course it appears that a majority of the students approached the work by themselves as only 15-30% of the students reported that they availed themselves of any of the help-seeking options: working with classmates, seeking the professor for help, or attending tutoring sessions.

For EGR 282, a majority of the students (68%) indicated that the strength of this class was the professor who demonstrated excellent teaching skills. A second area of strength was the lab or problem sessions. The largest consensus on weakness was that there were no weaknesses. Smaller groupings of concerns included the amount of homework, the amount of material covered, and a weaker correlation with the math course this quarter. When asked for suggestions, almost 70% of the students replied that the course was fine as is or that they had no suggestions to make. When asked to respond to the more specific statement of the rating scale section of the questionnaire, the strong positive response to this class continued to be very evident. Almost all of the students (90-100%) agreed that expectations of students were clear, instruction was well organized, explanations were clear, course materials were clear, instructors were willing to help and committed to success of the students, workload was reasonable, and grading was fair. Meeting regularly with a group of classmates to study or address projects for this course was the most prevalent form of help seeking (about 70%), while 32% reported taking advantage of tutoring sessions, and 21% sought the professor for assistance.

Here again, for PS 282, like the other courses this quarter, the most frequently reported strength was the instructor with many students specifically identifying his willingness to help students. Various aspects of the instruction--such as reasonable workload, good pace, interesting presentations, and thorough explanations--were also identified as strengths. The largest consensus on weaknesses was that there were none. Smaller clusters of concerns included difficulty understanding the instructor, concerns about the textbook, and the need for more examples. Suggestions for improvement included more classroom demonstrations, a better textbook, and a more spacious classroom. The strong positive response continued in the rating of statements regarding this course. A huge majority (90-100%) indicated that expectations of students were very clear, instruction was well organized, course materials were clear, tests were not too difficult, workload was reasonable, grading was fair, and the instructor was very willing to work with students and committed to their success. Seeking help by working with classmates was the choice of the majority of students (73%), while approximately 58% attended tutoring sessions, and 26% approached the professor during office hours.

As this fifth quarter was the last section of IPEC that a number of students would take, we asked them for overall strengths and weaknesses of the program and suggestions for improvement. The nine top themes in order of frequency were strong challenging program; a good program; correlation of math, physics, and engineering which provided a good concrete understanding; continuity of professors; continuity of peers which provided a ready support group and helped create a comfort level in class which was more conducive to asking questions; students feeling well prepared; good professors; early start in major which enhanced pride and eagerness in classes; and a program which helped students to develop analytical thinking skills. Students noted occasional problems due to lack of background in math and/or physics. Suggestions included bringing in professors from more areas of engineering, finding better textbooks, keeping the course challenging but lighten up demands a little, and making sure advisors know all about this program and how these courses fit into a plan of study for each major.

<u>Quarter 6 - MH 283 and EGR 283</u>

These final classes were not required of all majors; thus, 17 students responded to our questions regarding MH 283 and 12 students for EGR 283. The identified strengths of MH 283 were the instructor, the usefulness of the concepts both in other courses and in understanding applications, and the depth of material in this class with emphasis on theories of math. Three areas of concern were the fast pace of the class, the assessment procedures, and the meeting time. About half of the group had no recommendations for improvement, but those that did focused most of their comments on evaluation procedures. When rating specific aspects of this course, students provided a strong positive response to the clarity of expectations, organization of instruction, clarity of instruction, clear course materials, reasonable workload, and willingness of instructor to help. Several students registered concerns about the level of difficulty and assignment of grades, but the majority were satisfied. In seeking help with this course 56% of the students worked with classmates, 33% approached the professor during office hours, and 18% attended tutoring.

For EGR 283, a majority of students identified the usefulness of the information and skills learned as the major strength. Other strengths included the range of materials addressed within this class, the instructors, and the comfortable class atmosphere. There was not much consensus regarding weaknesses, but the areas mentioned most frequently included the emphasis on breadth as opposed to depth of coverage, class structure, and some lack of clarity about projects. The two most frequently made suggestions were to include more in-class hands-on instruction time or computer lab sessions with the professor present and a text or source book to provide general information about the various programs covered in this course. When rating their agreement or disagreement with statements regarding various aspects of this course, 100% of the students agreed that the instructor was willing to help and interested in the success of the students. A large majority agreed that classroom instruction was organized, that materials were clear, that the workload was reasonable, and that grading was fair. The expectations of students and clarity of explanations appear to have been somewhat ambiguous for 25-33% of the group as they were undecided in their responses. Patterns of help seeking for this course indicated that these students worked in groups frequently (84% of the students), while 41% sought assistance from the professor. Tutorial assistance may not have been available for this course as only one student indicated seeking help in this way.

Summative Comments

Inasmuch as this was the final quarter for the first cohort of IPEC students, we once again asked a series of broader open-ended questions about their opinions and experiences of IPEC. When asked their opinion of the program after having completed 2 years, this group was very positive. A sizable group (39%) wrote general comments that they had really enjoyed the program. A second grouping (39%) were somewhat more specific in that they found the program beneficial in a number of ways: provided a head start in engineering, placed them ahead in math, and prepared them well for other courses. A third group of students (30%) focused on the level of difficulty of this program, some emphasizing that the challenge had helped while others were concerned that their grades had suffered, at least initially. Some students responded that they would recommend that others take this program, while others especially liked the emphasis on integration of math and engineering.

Given that one of the goals of the program was to help increase motivation for engineering, thereby increasing the retention rate, we asked the students about the impact of the program on their interest/commitment to engineering. Responses here fell into five basic categories. The largest group (39%) indicated that participation in IPEC had expanded their interest in engineering and/or made them more confident in their initial choice. The second category (13%) also described a positive impact but qualified the amount of impact to partially accelerated their interest or commitment. The third positive impact category (9% of the group) stated that the program had boosted their confidence that they really can be successful in the engineering program. The fourth category (17%) stated that the program had helped to hold their interest constant. The final group, while still positive about engineering, stated that the program itself had little impact on their commitment to engineering because that decision was already made.

Another area of interest was to gain an understanding of what factors helped students to be successful in their engineering studies**,** so we asked this group about habits or experiences that they thought had contributed to their success. There was considerable consensus on the experiences and habits that help one to be successful in this program as fully 70% of the students identified group work, studying with friends, and seeing one's classmates as the key. The second most commonly named habit (30% of the group) was to study consistently, keep up, and do your homework regularly. The third most frequently named habit (22%) was seeking help from the instructors and developing a comfort level in working with your instructors. Thirteen percent of the group stated that perseverance had helped them to be successful. Other habits which contributed to success were learning time management, learning to cope with stress, and learning a systematic approach to addressing problems.

Because this was a new experimental approach to pre-engineering education, we wanted to hear the students' perceptions of the differences in subject matter, pace, instructional format, expectations, and support between IPEC courses and the regular curriculum courses they were taking. Although the question was quite broad, many students limited their response to addressing one or two areas; thus, this summary will identify the percentage of students addressing each of the five facets named in the question. Forty-three percent of the students made comparisons of subject matter, describing the IPEC subject matter as more integrated, more meaningful, and more advanced. Pace was mentioned by 39% of the group with the majority stating that in IPEC classes the pace was a little faster. Thirty-five percent of the group addressing instructional format indicated that IPEC classes were more personal with more individual attention. Expectations were addressed by 39% of the student group. They identified IPEC courses as more challenging, with higher expectations. The issue of support received the largest number of comments (57% of the group). Students wrote that the level of support was higher in the IPEC classes, that the instructors were more helpful, and that fellow IPEC classmates provided valuable study and support help.

All of these students thought that the IPEC program would be a good replacement for the current program although some qualifiers were included. Overall, 74% of the students thought that IPEC would be a good replacement, in essence because of the emphasis on application and the early exposure to engineering. Several students replied in the affirmative but with a general "yes" and no elaboration of reasons. Other individual reasons for replacement with IPEC included the opportunity to learn teamwork, the small class size, and the chance to gain confidence in one's abilities as a result of working with this set of teachers. Several students indicated that although they thought highly of the program, they had concerns that it might scare some students away and thus should be considered as an option rather than a replacement.

When asked what advice they would give to a student considering the IPEC program, quite a range of expectations and advice was offered. In the category of what to expect, the following suggestions were made and are reported in descending order of frequency: expect a harder program, expect to work hard, expect more in-depth coverage, expect more personal relationships with your teachers and classmates, expect a jump start in understanding engineering, expect to enjoy the program, expect lots of study time, expect good teachers, and expect the pace to be fast but fair. In the category of advice the following was offered: take the program, get into study groups as soon as possible, keep up with your work, persevere (even when your grades are lower than you like), seek help early, review your math (you will need it), and be willing to making sacrifices.

We gave the students a “magic wand “ type of question asking what changes they would make in the program given an opportunity. Most of the suggestions involved aspects of the curriculum or program itself. Some students needed more hours in the dynamics class for their major, while other students thought that the program seemed geared toward one particular major (mechanical engineering). There were requests for more hands-on activities and for more incorporation of computers/electronics. There were also a number of changes suggested regarding the schedule: reduce the number of required hours first year, change the early class meeting time, have more class times available to avoid conflicts, and synchronize better with co-op students so they can take all of the engineering courses.

For our final question, we asked students to consider the questions we had been asking and then to fill in any details or aspects of the program which they thought we had missed considering. On this very open question, a number of students returned to familiar themes to re-emphasize, it seemed, what they liked best about the program. Thirty percent wrote about the professors. They mentioned that their professors were excellent, that they had been able to get to know the professors well and had felt that they received personal attention, that the professors were dedicated to seeing the students succeed thus were very encouraging and helpful, and that the professors worked together as a team which made it a good program. Seventeen percent addressed class issues emphasizing the value of the small class size, teamwork among the students, and the coordination between classes which helped with scheduling major tests**.** Seventeen percent returned to the theme of the heavy work load. Some suggested that students either not have jobs or take a lighter load; one reported a frequent desire to leave the program when swamped with work, but was overall very pleased with the introduction to engineering; and one wrote that the course conformed to a basic principle of engineering that sleep was not really necessary. And finally, several students indicated that they had really enjoyed the engineering environment and the opportunity to find out right away if they felt comfortable in this field.

VII. Summary

Because this paper is itself a summary of number of studies examining various aspects of the IPEC program, this section will only address ways in which these studies shed light on the five primary goals of the IPEC program as stated at the beginning. We primarily investigated the impact of this program on retention in engineering and on the students’ involvement in and sense of belonging to the academic community. The comparison between the IPEC students and the regular program students indicates no difference between the programs in terms of rates of retention. The students who persisted with the IPEC program certainly were very strong in their recommendation of the program as an excellent introduction to engineering, but once again this program was not able to slow down the early attrition from pre-engineering. Many of those who did persist with the IPEC program past the first quarter were strong in their belief that the integration of math and engineering courses and thus the early introduction to engineering had definitely helped them to feel more confident in their choice of engineering. One specific area of concern with regard to the IPEC program is that part of the goal was to provide a good introduction to the mathematical base of engineering, especially targeting those students with weak math backgrounds. The reflection of this cohort was that having a strong math background was important for experiencing success in this program, and many of those who left early had weaker math background**.** The group of persisting IPEC students were also identified as being academically solid, both in terms of pre-university indicators such as ACT scores and university GPAs. On the other hand, in the eyes of the students, this program was a resounding success in providing an excellent nurturing academic community. Every quarter these students identified the commitment of their IPEC instructors as a major strength of the program. They took advantage of tutoring programs that were offered, visited with the professors during office hours, but primarily learned how to work together so that everyone could succeed. Time and again these students remarked on the positive value of small classes, familiarity with the professors and their classmates, and knowing what to expect in these classes.

In conclusion, this report documents the characteristics and chronicles the experiences of the first cohort of students who entered the Integrated Pre-Engineering Curriculum (IPEC) at Auburn University and corroborates the positive impact of this experimental program upon the students.

Bibliography

1. Tinto, V. (1993). Leaving college (2nd ed.). Chicago: University of Chicago Press.
2. Hewitt, N. M., & Seymour, E. (1991, April). Factors contributing to attrition rates among science, mathematics, and engineering undergraduate majors (Report to the Alfred P. Sloan Foundation). Boulder, CO: University of Colorado, Bureau of Sociological Research.
3. Halpin, G., Halpin, G., Benefield, L., & Walker, W. (1994, October). Factors related to success in college: Preliminary results from a longitudinal study of student retention. Paper presented at the meeting of the Southern Association for Institutional Research/Southern Region of the Society for College and university Planning, San Antonio, TX.
4. Halpin, G., Halpin, G., Benefield, L. D., & Walker, W. F. (1996, March). Broadening participation: Attracting and retaining minority students. Paper presented at the meeting of the American Society for Engineering Education/ Gulf Southwest Section, San Antonio, TX.
5. Halpin, G., Halpin, G., Benefield, L. D., & Walker, W. F. (1996, June). Student persistence in college: What makes them stay? Presentation at What Works II: Postsecondary Education in the 21st Century, a National Conference Sponsored by the National Center on Postsecondary Teaching, Learning, and Assessment, University Park, PA.
6. Halpin, G., Halpin, G., Benefield, L. D., & Walker, W. F. (1997, March). Retention in engineering education: Longitudinal race and gender differences. Paper presented at the meeting of the American Educational Research Association, Chicago, IL.
7. MacGuire, S., Halpin, G., & Halpin, G. (1996, April). Factors related to access and retention: The student perspective. Paper presented at the meeting of the American Educational Research Association, New York, NY.
8. Zenor, P., Thaxton, D., & Slaminka, E. E. (1995 in publication). Calculus for engineering and science. West Educational Publishing.
9. Zenor, P., Cutchins, M. A., Fukai, J., Knight, R., Madsen, N., Shumpert, T. H., & Rogers, J. Jr. (1996-98). Integrated Pre-engineering Curriculum. Auburn, AL: Auburn University/Authors.
10. Halpin, G., & Halpin, G. (1996). College Freshman Survey. Auburn, AL: Author.

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