Calculus Intervention for First-Semester Engineering Students

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Abstract: Past analyses at NC State have indicated a positive correlation between students who struggle in their first calculus class and those who ultimately leave engineering at NC. The present study was conducted to investigate the effects of early intervention for engineering students who have performed poorly on their first calculus examination. This paper presents the problem, the approach taken in this project, the resulting data, our lessons learned, and strategies being considered to scale-up the intervention in subsequent semesters to include all first-semester engineering students.

Introduction: The goal of this study was to understand the effects of intervention on engineering students who struggle in their first calculus course. We were mindful in conducting the study that, as it relates to students, ...

> *"... retention is not then the goal; retention is the result or by-product of improved programs and services in our classrooms and elsewhere on campus that contribute to student success."* [1]

As such, in understanding factors that influence student success in calculus (and their curricula) we hope to provide the necessary programs and academic support to ultimately influence their success (retention and graduation) in our engineering programs.

For many decades, curriculum and student experiences in engineering schools throughout the US have been designed and developed to achieve the goal of "educating the engineer." At the same time, many efforts have been undertaken to understand "why" certain students are able to complete these curricula and others are not.[2] Past studies in the literature have focused on identifying predictors (HS GPA, standardized test scores, class rank, personality, etc., etc.) that relate to achieving such success.[3,4] The concept is that by understanding why students are successful (and not successful) we can develop admission policies, curricula, and support systems to increase student success. However, the numbers don't always tell the complete story. We know that "excellent academic candidates" are sometimes not able to complete our curricula, and other students who were very near the admission cut-off become "academic superstars." Thus, success is not always predicted by a student's admissions "numbers." Rather, sometimes there are non-quantitative variables that affect student performance.[5] This fact complicates the goal of analytically modeling student success, but it should not dissuade us from continuing to investigate and understand it better.

In the College of Engineering (COE) at North Carolina State University (NCSU) we have developed a model to assist in our understanding of student academic success. Students enter the COE either as new freshmen, as internal transfer students from other NCSU colleges, or as external transfer students. The present paper is related to the first group of these students, of whom we admit ~1,250 each fall cohort. At NC State, new engineering freshmen are admitted as "unmatriculated" students, and this status is held until a student has completed the "first year" courses with the required minimum GPA. Upon completion of these requirements, a student "matriculates" into one of the 18 undergraduate degree programs in the college. The requirements for matriculation into an engineering program, and for graduation from an engineering program, are given below.[6]

Matriculation Requirements: Includes a "course requirement" and a GPA "requirement."

> Course Requirement: A student must complete the following courses with a minimum "passing grade" (C-);
>> *E 101: Introduction to COE and Problem Solving (1 credit hour)*
>> *MA 141: Calculus I (4 credit hours)*
>> *MA 241: Calculus II (4 credit hours)*
>> *ENG 101: Academic Writing and Research (4 credit hours)*
>> *CH 101/102: Chemistry – A Molecular Science / Lab (4 credit hours)*
>> *PY 205: Physics for Engineers and Scientists I*
>> A student must complete the following course with a "pass" grade;
>> *E115: Introduction to Computing Environment (1 credit hour)*
> GPA Requirement: In addition to the courses requirements, student's must meet the minimum overall GPA standard. This minimum GPA is a 2.90.

Graduation Requirements: Includes both a minimum "overall NCSU GPA" requirement and a "major GPA" requirement.

> Overall GPA Requirement: Students must obtain an overall GPA of 2.00 in all hours taken at NCSU.
> Major GPA Requirement: Students must obtain an overall GPA of 2.00 in all hours taken in courses in their "major." Major courses are those that are offered by degree department and are required or allowed as electives in the student's degree plan. Some academic departments include courses from other departments in their "major" GPA calculations.

Cohort Study Results: In order to investigate factors associated with student success in engineering, we collected data on all first-time engineering college freshmen admitted in the years 1996 through 2000. From a previous study, we had learned that "students who matriculate will graduate" in engineering at a rate of 85%. Thus, in this study we wanted to find out what factors were associated with matriculation. For each student, we collected admissions data, student attitudes (via survey data), and coursework data from their first semester. The complete data set for each student included the following:

- SAT scores (SAT-Math, SAT-Verbal, Overall SAT, SAT-II)
- High School GPA (weighted and un-weighted)
- Attitudes on "Freshmen Survey" given by NCSU University Planning and Analysis office during New Student Orientation in the summer before their first semester
- Courses taken during the first semester
- Grades from the courses taken during the first semester, and
- Number of semesters to matriculate into an engineering degree program.

There were 5398 students in the five years of cohorts in the matriculation study. Students were considered matriculated if they entered into an engineering program by the census date (10 days after beginning of semester) of the fall of their junior year. This provided a window of four semesters (not including summer school) for students to matriculate. Past studies have shown that most students, if they are going to matriculate, matriculate by this time. In addition, there is a COE policy that requires students to matriculate by the end of 60 hours (nominal four years). Students who do not ultimately matriculate in this timeframe transfer to another NCSU major, transfer to another institution, or discontinue schooling. Some of those who do not matriculate into one of the engineering programs are eligible to do so, but they decide not to continue with an engineering major. Of the 5398 students in the cohorts being studied, 58% matriculated by the beginning of their junior year.

The cohort data was input into a *Tree Analysis* using a chi-square test (level of significance at or less then .05) to determine which data factors discriminate the two groups: (1) those who matriculated, and (2) those who did not. Of the factors considered by the model, the most significant discriminator between the two groups was the "grade in the first math course." This discriminator held regardless of which math course the student took. Of the 3122 students who matriculated, 93% (N=2893) had a grade of higher than 2.165 (on 4 point scale) in their first math course. Of the 2276 students who did not matriculate, only 60% had a grade of higher than 2.165 on a 4.00 scale (see Appendix 1 for explanation of the 2.165 GPA value). Another way of examining the data is to say that of those who had a first math grade higher than 2.165, 68% matriculated and 32% did not matriculate.

Of the students whose math grade was 2.165, and who matriculated into an engineering degree, 92% took a first math course that was in the calculus sequence (MA 141 or 241). So, of those who had a high math grade and started in the calculus sequence, 74% matriculated and 26% did not matriculate. Of those who had a high math grade, but who started in a course lower than a calculus course (MA 101, MA 107, MA 111), the majority did not matriculate (66%). Thus, getting started in the calculus sequence and passing math are important factors associated with matriculation.

Past studies at NCSU have shown that students with poor math skills tend not to be successful in the matriculation process — the cohort study confirmed that data. The current cut-off rate for minimum qualification for Calculus-I readiness is a score of 550 on the SAT-II, level 2-C examination. However, studies have shown that students within the 550-580 range are also at risk of not passing and not matriculating.

Options for Intervention: In fall 2004 our goal was to use a pilot study to begin developing a comprehensive, and scale-able, "math intervention process" for the college. Of the ~1250 entering engineering students per cohort, roughly 50% start in Calculus-I. Thus, in fall 2004 we decided to target this student population first. After assessing the effects of intervention on this population we plan to expand the intervention to engineering students in all first-semester math courses. When considering an intervention strategy, we considered both "in-semester" and "after-the-semester" types of processes. Our goal was to assist students <u>before</u> their life and academic dilemmas became too pronounced — and to intervene with meaningful, real-time, and corrective feedback. Given these considerations, a "within-the-semester" intervention strategy was chosen.

The Intervention Process: The present study identified 180 engineering students in six sections of the Calculus-I course in fall 2004 semester. Of these, 57 were identified as "at-risk" students for not passing the course and ultimately not persisting in engineering. At-risk students were identified based on the score of their first examination during week 4 of the semester. For the purpose of the study we used a score of less than or equal to 75/100 as the "at risk" cut-off grade on the first exam. The math department, with whom the college enjoys a very good relationship, assisted in establishing this cut-off score. Although 75/100 seems to be a high level to use, it is appropriate given the fact that the first examination is a review of pre-calculus materials. The identified students were invited to participate (students were not required to participate) in the intervention via an email from the Academic Assistant Dean of Engineering (see Appendix 2). For typical email responses from the students see Appendix 3. Appendix 4 is the second email sent to interested students that described the intervention process.

The intervention process involved the following Steps:

1. Initial meeting with COE academic advisor (week 5),
2. Student follow-up on Action Plan (week 5-6),
3. Second meeting with COE academic advisor (week 6),
4. Collect data after exam #2 and assess any actions required — establish an ongoing Action Plan to increase student learning (and success).

From past experience, we know that there are several contributing factors that have potential to influence student underperformance on their first calculus exam. With this in mind, a detailed interview data collection form was developed to assist the academic advisor and student in Step #1 of the intervention process. Using the form the advisor takes notes and fills out part of Step #1, and then at the end of the meeting makes a copy of the completed form for the student. Appendix 5 (2 pages) is a blank copy of this form.

The goal in Step #1 of the intervention process is to get the student to openly discuss "what" might be contributing to their underperformance. This brings ownership to the student. The back of the form delineates several categories or "reasons" for underperformance. These include *Academic*, *Decision Making*, *Life Situational*, *Medical*, *Disability Related*, *Career/Major*. In each category, example "symptoms" have been suggested to prompt student-advisor discussion. During the meeting, the elements of this discussion are noted by the advisor on the front side of the form in section (1). For each underperformance category there are also listed several "action

items" that may be appropriate. The student-advisor dialog should lead to an Action Plan that details how the identified and discussed "reasons for underperformance" will be addressed. Details of the Action Plan should be noted by the advisor in section (2) on the front of the form. The Action Plan is the student's road map of "what" they need to do in the interval between the first and second meetings with the advisor. This is Step #2 of the intervention process. Notice that at the bottom of the front of the form are listed some key campus contacts that may be included as part of the students Action Plan.

During the initial meeting, at the time that the Action Plan is developed, the student-advisor will also set up the next meeting (item (3) on the form). Step #3 is the follow-up meeting after the Action Plan has been completed/attempted by the student. During this meeting the student-advisor will discuss follow-up items/issues. These items may relate to discussions with individuals on campus that the student may have been assigned to visit (math department, counseling center, etc.). The student-advisor discuss the outcome of these meetings as they relate to successful participation in math (and the university). Also, there may be discussion on any follow-up actions required of the student leading up the second examination. The student-advisor may schedule a meeting before and/or after the second examination to detail any on-going work.

Step #4 of the intervention process is meant to re-connect the student and advisor after the second examination. At this meeting the student-advisor will evaluate how the process is going, and what detailed steps that might be appropriate.

Results of the Pilot Intervention Project: Going into this study (which we viewed as a pilot study) we knew that there would be a few challenges, and that there would be much to learn and improve on in terms of executing a mid-semester math intervention process. We viewed our first critical challenge as attracting students to attend the individual "help" sessions with the academic advisors. Knowing that students come to the university with a very high confidence level, we thought it might be difficult to spark student interest in this pilot program. A second critical element was giving students the incentive to follow through on the "Action Plans" that they and their advisors developed. As it turned out, both of these issues proved to be prevalent in this study. Of the initial 48 students identified as "at-risk," only 15 responded affirmatively for participation (15/48 = 31.25%), and of those 15 who indicated that they were interested in participating only 6 (6/48 = 12.5%, 6/15 = 40%) actually attended sessions with an advisor.

Admissions data, Calculus-I course data, and other academic performance data were collected for all students in the pilot. Five groups of students were investigated:

> Group # 1: All eligible students who expressed initial interest in the program
> Groups #1a: Those eligible students who expressed interest and then followed up
> Group #1b: Those eligible students who expressed interest and then did not follow up
> Group 2: Those eligible students who emailed that they were not interested in participation
> Group #3: Those eligible students who did not respond to the invitation
> Group #4: All eligible students (includes all students in Groups 1, 2 and 3)
> Group #5: Random sample of 45 students not eligible for the pilot program

Appendix 6 is a tabulation of the summary data for the five groups. Given in the table is the following data:

> <u>Admissions data:</u> SAT-M Score, SAT-II Score (if available)
> <u>Calculus-I course data:</u> Exam #1 Score, Grade in Course, % Passing Course, % F's
> <u>Other academic data:</u> Semester GPA, % Dean's List, % Academic Warning

This data was chosen to investigate relationships between students' incoming profile, their performance in the first calculus course, and overall grades in their first semester. In Table 1 below several characteristics of these groups are discussed based on the group average data presented in Appendix 6. Note that the data are average data for each category and do not represent statistical significance, nor cause-and-effect — however, we offer a few observations.

<u>Group #1 (N=15):</u> This group is a combination of Groups #1a and #1b. It includes all students who upon invitation (Appendix 2) expressed an interest in participating in the pilot. Compared to Groups #2 and #3 this group's performance was lower in the Calculus-I course and overall for the semester. Roughly 40% of the students passed the course (C- or better), while 60% had "D or F" grades. Over 30% of the students in this group were placed on Academic Warning by the university based on their grades in the fall semester. Academic Warning indicates to a student that they are on track to be suspended from school after the spring semester unless their overall GPA is at or above 2.00 at that time. Overall, this is a weak academic group, although on the whole they recognized the need for assistance.

<u>Group #1a (N=6):</u> The Group #1 students who did follow up on the invitation to participate tended to do better than those who did not follow up. Group #1a students expressed an interest, or saw a need for help, and then took action to follow through. Half of these students passed the course, and only 1 in 6 ended up on Academic Warning. Compared to Group #3 (eligible students who didn't respond to the pilot invitation) this group's performance was just a bit weaker, but from the Admissions Data they tended to be weaker coming in. It is impossible to draw conclusions based on the small sample size, but either the pilot had some positive effect (comparing to Group #1b), or this group stayed in a relative position to how they entered (compared to Group #3).

<u>Group #1b (N=19):</u> Group #1b was the weakest group of students in this pilot. These students originally recognized a need for assistance, but could not find a way to execute and avail themselves of this help. Two-thirds of these students did not pass Calculus-I, and one-third were placed on Academic Warning. Although the sample size is small, and definitive conclusions not possible, there appear to be opportunities to assist this group with future efforts. Their initial self-selection identified them as needing/seeking help — we need to figure out how to get assistance to this population.

<u>Group #2 (N=4):</u> Although a small group, the performance of these four students was interesting. They scored higher on the examination, attained a higher grade in the course, had a higher semester GPA, and a lower percentage of students on Academic Warning than all other eligible students for the pilot. The fact that they explicitly declined participation may tell us something about these students. Perhaps they simply had a poor first exam in calculus (which

Table 1: Group Observations of Calculus Intervention Pilot Study Data

Group	Category	Observation
Group #1 (N=15) All eligible students who expressed initial interest in the program	**Admissions Data**	*SAT-M Score* is below those of Groups 2 & 3 indicating weaker incoming math skills. This group expressed interest in participation, thus they were able to recognize their need for some help early.
	Calculus Course Data	Scored below Group 2 & 3 on *Exam 1 Grade* and *Grade in Course* — again pointing toward a weaker math skill level. These students failed the course at a rate of 30.77%.
	Other Academic Data	*Semester GPA* is below that of Groups 2 & 3, pointing toward overall weaker academic performance. Also, 30.77% of these students were placed on Academic Warning at the university based on their first semester grades.
Group #1a (N=6) Those eligible students who expressed interest and followed up	**Admissions Data**	*SAT-M Score* is above that of Group 2.
	Calculus Course Data	*Exam 1 Grade* and *Grade in Course* are above those in Group 2. This small sample of students followed through with their interest in participation in the pilot.
	Other Academic Data	*Semester GPA* is above that of Group 2, 16.67% of these students were placed on Academic Warning at the university based on their first semester grades.
Group #1b (N=9) Those eligible students who expressed interest and did not follow up	**Admissions Data**	This group had the weakest *SAT-M Score* of all groups (601.11). They did express interest in the program but then did not follow through with participation.
	Calculus Course Data	This group had the lowest *Exam 1 Grade* and *Grade in Course* of all groups, and the highest *% F Grades*.
	Other Academic Data	This group had the lowest *Semester GPA* of all groups, and the highest *% Academic Warning*. Although small is size (N=9), this was the weakest academic group.
Group #2 (N=4) Those eligible students who emailed that they were not interested in participation in the program	**Admissions Data**	This small group had a *SAT-M Score* of 610. This is below that of Group 1a. Only one of the four students in this group took the SAT-II exam.
	Calculus Course Data	The *Exam 1 Grade*, *Grade in Course* for this group was higher than for Groups 1 & 3. Only one student did not pass the course from this group.
	Other Academic Data	This group had a higher *Semester GPA* and a lower *% Academic Warning* than Groups 1 and 3.
Group #3 (N=29) Those eligible students who did not respond to the invitation to participate in the program	**Admissions Data**	Students had higher *SAT-M Score* than Groups 1 and 2.
	Calculus Course Data	Students had higher *Exam 1 Grade* and *Grade in Course* than Group 1. However 13.79% of these students failed the course.
	Other Academic Data	These students had a 2.42 *Semester GPA,* and 10.34% of these students made the Dean's List in the fall semester. However, 24.14% were placed on Academic Warning at the university based on their first semester grades.
Group #4 (N=48) All eligible students (includes all students in Groups 1, 2 and 3)	**Admissions Data**	*SAT-M Score* at 622, *SAT-II Score* (for those who took the exam) was at 573.79.
	Calculus Course Data	*Exam 1 Grade* at 63.42, *Grade in Course* at 1.68, *% Pass Grade* at 58.33, and *% F Grade* at 16.67%.
	Other Academic Data	*Semester GPA* at 2.39, *% Dean's List* at 6.25%, and *% Academic Warning* at 22.92%.
Group #5 (N=45) Random sample of students not eligible for the pilot program	**Admissions Data**	*SAT-M Score* at 642.9, *SAT-II Score* (for those who took the exam) was at 598.
	Calculus Course Data	*Exam 1 Grade* at 86.99, *Grade in Course* at 3.22, *% Pass Grade* at 97.78, and *% F Grade at 2.22%* (1 out of 45). *Exam 1 Grade* and *Grade in Course* are statistically different (at the .001 level) than that of Group 4.
	Other Academic Data	*Semester GPA* at 3.26, *% Dean's List* at 46.67%, and *% Academic Warning* at 2.22%. *Semester GPA* is statistically different (at the .001 level) than that of Group 4.

made them eligible for the pilot), then after taking self-correcting actions were able to perform at a higher level (compared to other eligible students). The fact that they responded back with a "thanks but I think I will be okay" message indicates some level of self-awareness, and certainly seems consistent with the type of student who can take self-correcting actions. Regardless of causes and effects this group did perform well in comparison.

Group #3 (N=29): This group is made up students who were eligible for participation in the pilot, but declined to contact us for whatever reason. Students in this group had higher SAT-M admissions scores than those of Groups 1 and 3, and because of this perhaps they did not recognize the benefit that the pilot offered, or recognize a problem with their exam score. Students in this group passed the course at a rate of 65.52%, yet 24.14 % of the students in this group ended up on Academic Warning for their fall 2004 academic performance. Clearly, the first exam score was an indication of underperformance for some students in this group, while others were perhaps able to take some of the self-correcting actions necessary to succeed. More work will be needed to assess what can be done for populations that fall in this group.

Group #4 (N=48): This group is made up of all students who were eligible for participation in the program (Groups #1, #2, and #3). It is interesting to see that roughly 58% of the students in this group passed the course, yet at the same time 23% were placed on Academic Warning.

Group #5 (N=45): Students in Group #5 were not eligible for the pilot study because they all received grades of 76 or higher on the first exam in Calculus-I. Collecting data on 45 such engineering students from two randomly selected course sections formed this group. This group provides a basis of comparison for the observations from Group #4. Of the 45 students in Group #5 the average score in the first exam was 86.99, and on average students received a grade of 3.22 (B to B+) in the course. In addition, 97.78% of these 45 students (44/45) passed the course. This group had a *Semester GPA* of 3.26 and 46.67% of the students made the semester *Dean's List.* It is easy to see that this group vastly outperformed Group #4, thus leading credibility to the "intervention eligibility cutoff" score of "75 or below." Data from Groups #4 and #5 were tested for statistical significance. It was found that *Exam 1 Grade, Grade in Course,* and *Semester GPA* were all statistically different (at the .001 level). Thus, there are fundamental variables that segregate these two groups. Clearly, setting the "at-risk" level at a score of 75 on the first exam produces these two populations and lends credibility to the use of this level in the future.

Conclusions and Discussion: The College of Engineering at NC State is very interested in learning all that can be learned about how and why students succeed in our curricula. In an effort to build on knowledge from past studies, we conceived a mid-semester intervention pilot study in fall 2004 to assist struggling students. We directed the pilot effort at students in the first calculus course. An in-semester intervention plan was developed and executed for a selected number of students enrolled in Calculus-I in fall 2004. Results of the study were mixed based on the relative small sample size in the various student groupings.

Several insights were noted that inform our plans for the second phase of the project in fall 2005 semester. Below are listed some of these:

Student Participation: As mentioned earlier in this paper, a critical element is student participation. This includes participation both in the initial student-advisor meeting, as well as completing the "Action Plan" and follow-up activities. Two questions related to participation are: (1) what role does student self-selection play?, and (2) should we be using extra credit to provide an incentive and/or requiring participation?

The "Right" Students: It is important to be able to reach all students who can benefit from this type of intervention. This study has demonstrated that students with a score at or below 75 on their first calculus exam are statistically "at risk" compared to those with higher scores. Further study should be conducted on whether another score (such as 70 or 80) produces the same statistical significance. The math department at NCSU, based on experience, developed the "at risk" score of 75 used in this study.

Scaling Up the Pilot: Ultimately we would like to scale this pilot up to all engineering students in all Calculus-I sections, and further to all engineering students in their first math course. This will involve many more people, and will require processes that can be used easily by students, advisors, instructors, and other campus offices.

Other Important Measures: In this pilot we focused on the use of the first exam score. Perhaps a rubric of data can be collected to better identify and direct the intervention efforts. Perhaps additional data can point toward different types of intervention. Data such as attendance data, quiz data, homework data, entrance exams on previous knowledge, instructor observations all may prove useful.

Our plan is to take what we have learned this fall semester and to plan a second intervention program for fall 2005.

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Biographical Information:

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RICHARD F. KELTIE, Ph.D., did his undergraduate and graduate study at NC State University and received the Ph.D. degree in 1978. He has been on the faculty at NCSU since 1981, and he is currently Professor of Mechanical and Aerospace Engineering and Associate Dean for Academic Affairs in the College of Engineering at NC State University. He is a member of the Acoustical Society of America and ASEE, and a Fellow of ASME.

Appendix 1: Explanation of Tree Analysis of Cohort Data

The SAS implementation of decision trees finds multi-way splits in the data set, based on the variables input into the system. The analyst chooses splitting criteria and other options that determine the method of tree construction. In our case, the options associated with the popular features of CHAID (Chi-squared automatic interaction detection) were selected. The tree analyses, when run, automatically rank the input variables based on the strength of their contribution to the tree. The analysis finds the optimal spot to split the data set based on the strength of the variable's contribution to the tree. In the case of our cohort data set, the first split was at a First Math Course grade value of 2.165 (this in on a 4.00 GPA scale). This 2.165 GPA score is the data value that best discriminates two sets of students. Thus, once established, this value can be used to generate predictions for any new cohort of students.

Stated another way, the tree analysis seeks the split with maximum worth or -log(p-value) subject to the limit on the number of branches and the limit on the minimum number of observations assigned to a branch. We used a significance level of .05 or less. The Chi-square test uses the -log(p-value) measure. For these criteria, the best split is the one with the smallest p-value. By default, the p-values are adjusted to take into account multiple testing. See SAS System Help for further statistical explanation about this test, or contact Dr. Joni Spurlin, University Director of Assessment, North Carolina State University, 919-515-6209, joni_spurlin@ncsu.edu.

Appendix 2: Email Inviting Participation into the MA 141 Intervention Program

September 30, 2004

Dear College of Engineering Student:

Hello! I hope that your first semester has started off well and that you are getting settled into life at NC State and into your engineering studies. You have been identified as a potential participant in a new program that we are testing with the math department here at NC State. Please read the paragraphs below and respond to me with an email indicating if you would: (1) like to participate, or (2) will not be participating in the program.

We know from past academic data that students' performance in their first calculus class indicates their success in matriculating in engineering. Thus, we are contacting students in Calculus-I this fall who have scored at or below 75% on their first exam, and are inviting them to participate in a pilot study. The study is designed to assist such students in passing Calculus-I, and thus increasing their success at matriculation. You have been identified as such a student by your math instructor, and thus are being given the opportunity to participate.

If you wish to be included in this study, the first step will be to meet with one of the friendly academic advisors in the engineering dean's office. At that meeting you will be given more detail on the program and how it works. If you want to discontinue with the program at that point that is completely fine -- what we are hoping for is at least to have a first meeting with you. The academic advisors are: Mr. Brian Koehler (Coordinator of the First Year Engineering Program), Dr. Dick Keltie (Associate Dean of Academic Affairs in Engineering), and I (Assistant Dean of Academic Affairs in Engineering).

This program is a pilot study (the first time that we've tried this with just a few sections of Calculus-I) and is completely voluntary on your part. We are interested in doing this to find out more about how to help students be more successful in engineering. I am asking you to please consider participation -- at least coming to a first meeting.

Please send an email to me, indicating if you would: (1) like to participate, or (2) will not be participating in the program. Please send your email to me BY MONDAY MORNING, October 4th. For those of you who chose to participate, I will email more details next Monday afternoon or Tuesday morning. Thanks so much and I look forward to hearing from you.

Regards,
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Appendix 3: Sample Student Email response to Pilot Program Invitation

"I'd be happy to participate. I feel that I will do better on the next test but I am open to any extra help!"

"I would not like to participate. Thank you for the offer."

"I will have no problem passing calculus, the first test just threw me for a loop with stuff I didn't remember from high school. I have full confidence that I will do very well on my own."

"I might be interested in this program but I need to have the information on meeting places before I am able to commit. I live off campus and also have a job which may interfere, and lets face it , I don't want to waste your or my time."

"I am throwing myself at the opportunity to participate in this pilot program."

"So thank you for providing us with this opportunity."

"Yes, I am interested."

"I would love to participate in this program, if it is not going to be very time consuming."

"I am interested in the pilot study program for Calculus-I you talked about in your e-mail. I would like to hear more about the program."

"First of all, I'm certainly very interested and would be glad to participate in your pilot study."

"Math has generally been one of my stronger subjects, and in all honesty I'm quite curious to find out why this semester's Calculus class has proven difficult."

"I am interested in being involved in this pilot program for Calculus-I."

"I just received your email regarding the Calculus-I sessions and I am interested in participating in this."

"I am struggling in my Calculus-I class. I would like to participate in the study."

Appendix 4: Email Detailing Participation into the MA 141 Intervention Program

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10-05-04

Dear Calculus-I Student:

Hello! Thank you so much for your interest in the Calculus-I Program to
increase engineering student success. At this point in time the first action
required of you will be to schedule an individual appointment with one of
Academic Advisors in the College of Engineering. The Academic Advisors are:
Dr. Dick Keltie, Mr. Brian Koehler, and I. Each of the Advisors have set
aside some time on Monday and Tuesday of next week (October 11th and 12th)
for these appointments. Here is how you get signed up:

1. Call 515-3263 (Academic Affairs, College of Engineering)
2. Tell the person who answers the phone that you want to schedule an
   appointment with Dr. Lavelle, Dr. Keltie or Mr. Brian Koehler as part of
   the "Calculus-I Intervention Pilot Program" for Monday or Tuesday (Oct.
   11 or 12).
3. Find a time with one the Advisors that fits your schedule for Monday or
   Tuesday of next week.
4. The appointments will be for 30 minutes maximum.

In that meeting you will find out more about the resources and others options
associated with the program. Before you go home for Fall Break your job is
make the call and get yourself an appointment time for next week. Take care
and we look forward to seeing you all next week.

Regards,
Dr. Lavelle
********************************************
Jerome P. Lavelle, Ph.D.
Assistant Dean, College of Engineering
Associate Professor, Industrial Engineering
North Carolina State University
Raleigh, NC   27695-7904
********************************************
Phone: 919-515-2315
Fax: 919-515-8702
Email: jerome_lavelle@ncsu.edu
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Appendix 5: Advisor Note Sheet for Student-Advisor Meeting

College of Engineering
North Carolina State University
Calculus 141, Early Semester Intervention Project, Fall 2004

Dear Student: Hello and welcome to the College of Engineering Calculus-I Early Semester Intervention Project. This pilot study is designed to identify students early in the fall 2004 semester who are struggling with Calculus-I. The idea is to identify issues related to the student's under performance, and to assist in finding ways to increase the student's success in Calculus-I and ultimately engineering. Thank you for your participation!

First Interview Data Sheet

Today's Date: _____   Student Degree Code: _____

Student Name: _____   ID#: _____

(1) <u>Reasons of Underperformance for the Student (from items on back page of other):</u>

(2) <u>Action Plan for Student (list specific actions to be taken and goal of each action):</u>

(3) Our Next Meeting is Scheduled for: _____

Office to Contact	Contact Person	Information
Mathematics Department	Dr. Contact1	Phone: xxx-yyyy; zzz ABC Hall contact1@ncsu.edu; Tu/Th best
Virtual Advising Center	Ms. Contact2	Phone: xxx-hhhh; ccc XYZ Bldg. contact2@ncsu.edu
Counseling Center	Dr. Contact3 Dr. Contact4 Dr. Contact5	Call xxx-mnop for an appointment Student Health Center Bldg.
Disability Services (DSS)	Front desk personnel at DSS Office	Suite TTT, Student Health Center Or call xxx-jjjj for an appointment

Potential Reasons for Under Performance:

1. ACADEMIC:
Symptoms:
- I have an inadequate academic background to succeed (I'm in the wrong placement)
- I have poor study habits
- I have poor note-taking/preparation skills

Action Items:
- Meet with Math Department
- Utilize taped lectures for review of materials
- Meet with NCSU Counseling regarding student habits and academic skills

2. DECISION MAKING:
Symptoms:
- I am making poor decisions
- I lack focus on my academic pursuits
- I have poor time management skills
- I have poor attendance in class
- I have (or am beginning) unhealthy addictions

Action Items:
- Meet with NCSU Counseling Center on student success issues
- Meet with Virtual Advising Center regarding commitment and interests

3. LIFE SITUATIONAL:
Symptoms:
- I have a substantial work/outside commitment
- I am having a roommate/residential situation
- I am having financial difficulties
- I have some family issues that are serious that are affecting me
- I am feeling unsettled at NCSU and feel a desire to go back home

Action Items:
- Meet with NCSU Counseling Center on student success issues
- Meet with Virtual Advising Center regarding commitment and interests

4. MEDICAL:
Symptoms:
- I have a medical situation that is not being treated
- I have a medical situation that I am not being accommodated for
- My medical situation is impacting my academic performance

Action Items:
- Meet with NCSU Medical Staff
- Meet with NCSU Counseling Center on student success issues
- Meet with NCSU DSS Office

5. DISABILITY RELATED:
Symptoms:
-I have a non-accommodated learning disability
-I have problems concentrating/staying on task
-I have severe test anxiety

Action Items:
- Meet with NCSU DSS Office
- Meet with NCSU Medical Staff
- Meet with NCSU Counseling Center

6. CAREER/MAJOR:
Symptoms:
- I am having doubts about engineering
- I don't know what interests me

Action Items:
- Meet with your academic advisor
- Meet with Virtual Advising Center
- Meet with NCSU Counseling Center for interest inventory / major inventory

Appendix 6: Calculus-I Intervention Pilot Program Data Results

Group #	Sample Size	Admissions Data		Calculus-I Course Data				Other Academic Data		
		SAT-M Score	SAT-II Score	Exam 1 Grade	Grade in Course	% Pass Grades	% F Grades	Semester GPA	% Dean List	% Acad. Warning
1	15	606.00	555.71	59.67	1.29	40.00	30.77	2.24	0.00	30.77
1a	6	613.33	526.67	62.00	1.34	50.00	16.67	2.36	0.00	16.67
1b	9	601.11	577.50	58.11	1.26	33.33	33.33	2.16	0.00	33.33
2	4	610.00	490.00	66.75	2.17	75.00	0.00	2.72	0.00	0.00
3	29	632.00	583.81	64.90	1.82	65.52	13.79	2.42	10.34	24.14
4*	48	622.00	573.79	63.42*	1.68*	58.33	16.67	2.39*	6.25	22.92
5*	45	642.89	598.00	86.99*	3.22*	97.78	2.22	3.26*	46.67	2.22

*NOTE: These Groups were statistically different at the .001 level for *Exam 1 Grade*, *Grade in Course*, and *Semester GPA*

Group #	1	All eligible students who expressed initial interest in the program
	1a	Those eligible students who expressed interest and followed up
	1b	Those eligible students who expressed interest and did not follow up
	2	Those eligible students who emailed that they were not interested in participation in the program
	3	Those eligible students who did not respond to the invitation to participate in the program
	4	All eligible students (includes all students in Groups 1, 2 and 3)
	5	Random sample of students not eligible for the pilot program (two sections of Calculus-I)

Sample Size Sample size for each Group
SAT-M Score Average student score on the SAT Math exam for each Group
SAT-II Score Average student score on the SAT Math Level 2-c examination for each Group. *Note: not all students take the SAT-II exam.*
Exam 1 Grade Average student score on the first exam in MA 141 for each Group
Grade in Course Average student grade received in the course for each Group
% Pass Grades Percentage of students who passed the course for each Group
% F Grades Percentage of students who received a failing grade for each Group
Semester GPA Average student semester GPA for the fall 2005 semester for each Group
% Dean List Percentage of students who made Dean's List in fall 2005 semester for each Group
% Acad. Warning Percentage of students who were placed on Academic Warning in fall 2005 semester for each Group