Freshmen In Science Program

Anita Salem, Jim Dronberger, Edward Kos, and Richard Wilson
Rockhurst College
1100 Rockhurst Road
Kansas City, Missouri, 64110

Abstract: Much has been written about the lack of student interest and abilities in the area of mathematics and science. Too often students rule out careers in these areas before they ever reach college. A variety of programs have been established to encourage pre-college students to become more involved and interested in science and mathematics. Of equal concern are those students who come to college eager and ready to concentrate on their studies in science and mathematics only to drop out by the end of the first year. In 1990 the science and mathematics faculty at Rockhurst College entered into a planning process to address attrition problems. A year of bi-weekly meetings resulted in a November, 1991 proposal for a Freshmen In Science, (FIS) program. The goal of the project was to build a support system for the curriculum that would encourage students to put forth their best effort. This paper will describe the planning process, program and results from a six year effort to keep students interested in science-related careers.

Keywords: recruitment, retention, support system, freshmen in science, seminars, evaluation

Introduction
It is a well established fact that colleges are faced with many challenges when presenting their mathematics and science programs. Of specific concern is student recruitment and retention. Recruitment is a problem because many students rule out careers in science and mathematics before they ever reach college. Retaining students has historically also been a problem. Many students who begin their studies in science and mathematics drop out of these programs by the end of their first academic year. The retention of first-year college students has always been of concern in higher education, but a dramatic shift has occurred in the response of educators to this concern in the last 15-20 years. The change has come about primarily because the faculty itself has become concerned with the issue. The challenge is not merely one of retention, but also of the kind and quality of the student involved. Faculty must be concerned with the students and their success in courses and in college in general. Responses must focus on the students’ sense of satisfaction with their entire educational experience. It would seem that the more interest paid to increasing student satisfaction with the educational process, the better the retention, and the more successful the student. The primary response to this issue has been the development a first-year experience in the form of a seminar for freshmen. A review of the past history of these seminars can be found in a survey published by Barefoot (1994). Generally the seminar topics cover basic study skills and what the educational process involves (Cohen, 1979), thus familiarizing the student with what is to occur during their education. Most of the references available from ERIC on the topic of the Freshman Experience Seminar (over 4000), are basically directed at the entire freshmen class and cover the same skills and study levels. Occasionally a seminar may emphasize a novel approach such as the “Deliberate Psychological Education (DPE)” method (Young, 1986) used in one variation of the standard seminar. This semester long seminar surveyed topics in psychology and education using modules focusing on specific skills. In another seminar (Kresky, 1982), a course in Introductory Greek was added to the semester. The instructor learned Greek along with the students, and the goal was to learn something about Greek in general and native languages in particular, as well as “learning about learning”. Different times and lengths of seminars (Rice, 1989) have been attempted. Reading as a basic theme (Brown, 1994) and writing across the curriculum (Papier, 1990) have been used in several different seminars. One seminar was based on “Outdoor Adventures” (Stremba, 1988) as a means of introducing students to college work.

All of these seminars seem to have in common the attempt at highlighting fundamental skills and abilities needed by the “generic” incoming freshmen. No seminar or first-year experience of any sort was discovered which dealt with an academically specific group of students. Hence, we present our program and seminar which is designed specifically with the “science” student in mind, and is focused on any incoming student who indicates even the slightest interest in science.

Addressing Problems
Recruitment and Retention
In 1985, Rockhurst College became aware of its own recruitment and retention problems concerning science students. Eight faculty from the Science Division participated in bi-weekly meetings to address this situation. Careful discussion notes were taken and distributed to members of the group, as well as department chairs. Occasionally, our discussion group made interim reports to the entire division. Some selected topics included: advising, heavy course loads for students, diversity issues (race, gender, vocational), lab experi...
ences, and faculty cooperation. As a result, we developed a program called Freshmen in Science (FIS). The integrated products of this effort include: the Freshmen in Science Program (a collection of academic and social activities to address recruitment, retention, and a successful experience throughout a student's course of study), and the Freshmen in Science Seminar (a one credit hour class for freshmen students who have identified mathematics and/or science as their primary area of study.)

Planning Phase
Members of the FIS faculty researched the literature on attrition rates in science and mathematics, and led discussions based on their findings. It is worth noting that many of the articles that we reviewed came from discipline specific professional publications. It was clear that attracting and retaining students was a problem shared by all the disciplines in science and mathematics. Following a year of discussion, two faculty members spent the summer of 1991 completing a draft of a Freshmen in Science Program proposal. The purpose of this document was to provide a focus for discussion by the entire Science Division. The proposal included the following program components.

FIS Program Components

**Support System.** It was generally agreed that support activities could be easily developed and implemented. Our initial list of proposed activities included:

- Conducting an orientation session to introduce students to science and math faculty and welcome them into our program.
- Publishing a calendar of science and mathematics exam dates and special events.
- Providing all FIS students with a specially designed t-shirt, thus helping them identify one another as part of a special cohort group.
- Offering Sunday Night Study Sessions held by our upper division majors and supported by faculty teaching freshmen science and math classes.
- Developing special advising information sessions to let the students learn about the wide range of programs within the division.

**Curriculum Reform.** In 1990 there was a national reexamination of the manner in which science and mathematics was being presented. After some review of what was being discussed and implemented at other institutions, we decided to focus on cultivating student-centered, research-rich environments.

For us, this meant that we needed to:

- explore alternatives to the standard "lecture" format;
- re-examine the nature of our laboratory experiences;
- increase the use of technology in course delivery; and,
- require students to apply their knowledge to "real problems" in science and mathematics.

**Scientific Collaboration.** One of the most significant results of the first year discussion sessions was the forging of new faculty relationships across different scientific disciplines. As a result of constant communication, students began to view us as a team striving to help them succeed, interested in work outside our disciplines and knowledgeable about the work they were doing in other courses. Our discussion group determined that there was value in looking for opportunities to collaborate and, when possible, to integrate course material.

**Faculty-Student Interaction.** Frequently science and mathematics is thought of as all work and no play. To assist the students in understanding that both work and play are an integral part of the life of a scientist or mathematician, we proposed the creation of social events and seminar experiences that would encourage interaction among faculty, upper division majors and our freshmen.

**Freshmen in Science Seminar.** In the spring of 1991-92, following the first implementation of the FIS support system, our FIS faculty discussion group proposed the development of a Freshmen in Science seminar. To create the seminar, eleven science and mathematics faculty met during the summer of 1992 to discuss topical issues for inclusion in the course, and to consider implementation strategies and supporting activities.

**Funding Resources**
During the 1991-92 school year, some preliminary efforts to implement the FIS Program took place. A science specific orientation session was held, Sunday night study sessions were organized, and exam dates were coordinated, published and distributed to all freshmen on a calendar that also contained other important campus events. The biology, chemistry, mathematics, computer science and physics clubs also sponsored a fall picnic for the freshmen science and math students. In addition to these activities, special advising sessions were held near the middle of the first semester to help students begin to consider a broad range of science related career paths.
Our extensive planning process, detailed program
description and the small scale fall implementation
helped us attract three separate donors to our project.
To support curriculum reform efforts, two NSF Im-
provement in Laboratory Instrumentation grants were
written and funded to provide the technology that
would be required to implement curricular changes
in introductory biology and calculus. In addition to
the matching funds raised for these grants, additional
funding was sought for summer curriculum develop-
ment efforts in other introductory science courses. The
funds in this category were distributed to eight fac-
culty across all the disciplines. Table 1 shows income
sources that supported our efforts to revitalize our in-
troductory science and mathematics courses.

<table>
<thead>
<tr>
<th>Curriculum Reform</th>
<th>NSF funds</th>
<th>Corporate funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>$25,000</td>
<td>$25,000</td>
</tr>
<tr>
<td>Mathematics</td>
<td>$70,000</td>
<td>$77,000</td>
</tr>
<tr>
<td>Other</td>
<td>$50,000</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>$95,000</td>
<td>$152,000</td>
</tr>
</tbody>
</table>

Table 1. Curriculum Reform Funding Sources

In addition to the funding for curriculum reform, the
college and a local foundation provided the neces-
sary resources to maintain the support system costs.
This money has been used to pay for t-shirts, interest
inventory examinations, social events and the de-
velopment of the Freshmen in Science seminar. Table 2
shows the income sources for support system fund-

<table>
<thead>
<tr>
<th>Support System</th>
<th>College funds</th>
<th>Corporate funds</th>
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<tbody>
<tr>
<td>1991-92</td>
<td>$2,500</td>
<td></td>
</tr>
<tr>
<td>1992-93</td>
<td>$2,500</td>
<td></td>
</tr>
<tr>
<td>1993-94</td>
<td>$2,500</td>
<td>$10,000</td>
</tr>
<tr>
<td>1994-95</td>
<td>$2,500</td>
<td>$10,000</td>
</tr>
<tr>
<td>1995-96</td>
<td>$3,500</td>
<td>$10,000</td>
</tr>
<tr>
<td>1996-97</td>
<td>$4,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>Totals</td>
<td>$17,500</td>
<td>$40,000</td>
</tr>
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</table>

Table 2. Support System Funding Sources.

Freshmen In Science Seminar
The major component of the FIS Program was the one-
hour FIS Seminar. When this Seminar was initially
developed during the summer of 1992, a panel of fac-
culty met to discuss various topical inclusions consid-
ered to be essential for freshmen students. From these
discussions, major themes emerged: the role of ethics
in science, utilization of time management skills and
strategies to improve those skills; the partnership be-
tween students and faculty; the manner in which lab-
atory classes are different from and essential to their
complementary lecture courses; and the way in which
a student’s values, skills and interests can direct choices
for a major and a career. Throughout the development
of this course, these topics were interwoven in vari-
ous ways.

Once these topical areas were identified, structural is-
issues were addressed. Key issues included the design
of some topics for small discussion groups rather than
in a large lecture hall; development of a panel of teach-
ers for the course, rather than a single instructor (this
would allow each small group to be lead by a member
of the science division faculty); and recruitment of
sophomore students to be paired with each faculty
member. To help tie the themes together, the film “And
the Band Played On” was shown to the students at
the beginning of the semester during a special session.
This film about the A.I.D.S. epidemic was used to il-
lustrate real-life examples of many of the course top-
ics: the impact of personal ethics on scientific outcomes;
the necessity of partnerships in research; the potential
conflict between personal values and interests with
objective assessment; and the ways in which past ex-
periences may bias future trials. Throughout the se-
semester, this film was used as a reference point. To pro-
vide more specific information about how the various
topics were presented and structured for this course,
each week’s topic is listed below followed by a brief
explanation of its intended value and means of imple-
mentation.

FIS Seminar Topics

◊ Course Introduction: Presentation of goals and
objectives of the course are explained to the
students along with an outline of formal and
informal course activities. Faculty and student
facilitators are introduced and expectations
regarding professional behavior for this and for
all college classes are explained.

◊ Student-Teacher Partnerships: Students and
facilitators explore the manner in which teachers
seek to unite with students as partners to uncover
rather than withhold information.

◊ Ethics: Through film presentation and discussion,
ethical behavior’s impact on scientific outcomes
and its role in collaborative study are explored.

◊ Time Management: Students and facilitators are
asked to document the use of all waking hours, in
an attempt to help students contemplate alterna-
tives to both study and non-study time.

◊ Learning Through Labs: The importance of
pairing applied study (laboratory) with theoreti-
cal investigation (lecture) is presented, along
with an exercise which addresses how data are
explored.
Valuing Diversity: The importance of including all possibilities when examining a scientific questions is presented. Social implications of maintaining a broad perspective are also examined.

Core Curriculum: In keeping with the discussion on diversity, the necessity of a well-rounded education, and its effect on scientific inquiry are presented by a panel discussion.

Advising: Students are presented with the semester-to-semester structure of chosen majors as well as the possibilities for alternative majors and/or minors and graduate studies.

Presentation by Professionals: Spanning two class periods, students are required to explore four different career options by interacting with professionals from outside the college who hold science degrees and work in science related fields.

Seeking Balance: The value of stress reduction techniques and use of leisure time are explored with reference to their effect on professional performance.

Reading Science and Mathematics: Strategies for improved comprehension of scientific writing are discussed.

Course Presentation
As previously noted, we realized during the development of this course that some topics could be more fully examined within small group discussions, rather than through a large lecture presentation. Additionally, we believed that interactive small groups might create an atmosphere for developing friendships (and thus fortifying bonds to enhance retention.) Groups were kept small enough (10-12) to allow each student to participate in discussions. With enrollment in the seminar ranging between 150 and 200, fifteen to twenty faculty members served as faculty facilitators each year. As the course developed, sophomore students who had previously taken the course and who demonstrated leadership ability, were recruited and paired with faculty leaders. This provided the freshmen with both faculty and student insights and experiences.

When freshmen were assigned to small groups, an attempt was made to diversify the membership by paying attention to gender, major and intended careers. To accomplish this, demographic information was collected during the first class and was used for assigning students to small groups.

Assessment of the Seminar
Beginning in 1993, students were required to complete an evaluation of the seminar. We asked some fairly straightforward questions. Student responses to most of these questions have remained fairly constant over time, so what will be reported here is data collected from the 1995-96 freshmen class of 152 science students [see chart below]. (The college freshmen class size for that year was 288.)

Did you find this course useful?
85% - YES  13% - NO  2% - SOMEWHAT

Would you recommend this course to another freshmen science student?
85% - YES  8% - NO

Which TOPICS interested you the MOST and LEAST? (in rank order)
MOST: Presentations by Career Professionals; Work/Professional Ethics; Basic Advising; and Time and Stress Management.
LEAST: Skills, Values and Interests; How to Read Science and Math; and Collaboration, Cooperation and Coping

Which course ACTIVITIES interested you the MOST and LEAST?
MOST: Service Project; Strong Interest Inventory. LEAST: Weekly Journal Writing; Strong Interest Inventory.

It is interesting to note that the Interest Inventory was rated most liked and least liked by equally high percentage points. Our interpretation of this is that students who arrive on our doorstep confident in their choice of fields of study see little value in exploring their skills and interests. On the other hand, students who are less sure of what they want to study, find this activity both revealing and helpful. The generally overwhelming positive response from students helped us gain needed support from faculty and administrators. Student reactions, both positive and negative, to specific topics and activities provided us with clear indicators of things we were doing well and things we needed to improve upon. For example, we struggled with helping our students understand the importance of appreciating diversity. We attempted to introduce this topic in a variety of ways and were unsuccessful in the first few years. This past year, we added a session on Scientific Bias tying the discussion back into our over-arching theme of treatment of the A.I.D.S. crisis and the film “And the Band Played On.” The students were more willing to enter into a discussion of diversity when the topic was tied directly to their interest in science. This appears to have been a reasonable compromise between what the students are capable of handling and willing to consider, and faculty expectations of what should be addressed when we talk about issues of diversity.
Tracking Student Attitudes about Science and Mathematics

In addition to studying student responses to the seminar, we have been asking them to tell us about their experiences as students of science and mathematics. Information is gathered through a student survey administered at the end of the first semester. The survey instrument has evolved over a four year period, so what will be reported here are the results from the 1995-96 survey.

Demographic Information

Of 152 respondents, 69% were women and 31% were men. 77% were residential students and 23% were commuters. Distribution of students by intended majors can be found in Table 3.

<table>
<thead>
<tr>
<th>MAJOR</th>
<th>NUMBER</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>60</td>
<td>39%</td>
</tr>
<tr>
<td>Chemistry</td>
<td>13</td>
<td>9%</td>
</tr>
<tr>
<td>Computer Science</td>
<td>5</td>
<td>3%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>2</td>
<td>1%</td>
</tr>
<tr>
<td>Nursing</td>
<td>22</td>
<td>14%</td>
</tr>
<tr>
<td>Physics</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Psychology</td>
<td>22</td>
<td>14%</td>
</tr>
<tr>
<td>Sociology</td>
<td>6</td>
<td>4%</td>
</tr>
<tr>
<td>Business or Ed</td>
<td>12</td>
<td>8%</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>5%</td>
</tr>
</tbody>
</table>

Table 3. Distribution of Students by Major.

Self-Reported Study Habits

When asked how many hours per week were spent studying science or mathematics, 144 students responded with an average of 11 hours per week. In addition to study time, 73 students reported that they were tutored for an average of 1.8 hours per week in science or mathematics. 132 students said they had sought help from their instructor.

Responses to FIS support activities.

- 132 (87%) attended the brief one hour orientation session prior to the start of school. Of those in attendance 98 (74%) found the session useful.
- 125 (82%) attended the half-day Saturday orientation session. Of those, 90 (72%) found it useful.
- 41 (27%) attended the spaghetti supper held at an off-campus location and 34 (84%) of those attending found it useful.
- 141 (93%) found the FIS calendar and coordinated exam dates useful.

Overall Impression of Science & Mathematics

The students were asked about their impression of science and mathematics courses and programs at the end of their first semester of classes. A graduate student, not associated with the FIS program, was asked to interpret the narrative responses of the students on a scale of 1 to 5 with 1 being very dissatisfied and 5 being very satisfied. 143 students responded to this question with a mean of 3.8. Of concern to us was the possibility that we might be serving the needs of one group of students better than another. With this in mind, we looked at the mean response to the "Overall Impression" question with a variety of populations. The results are listed in Table 4 below.

An analysis of variance on the following seven groups (Biology, Chemistry, Math/CS/Physics, Nursing, Psy/Soc, Bus/Ed, Undecided) indicated no statistical difference in the means. In addition, a two-sample T-Test was performed on the following: male vs. female, residential vs. commuter, health science vs. non-health science, nursing vs. non-nursing, and all possible pairs among the individual majors and careers. In all but a handful of instances, there was no evidence of a statistical difference in the means. The exceptions were nursing vs. non-nursing, nursing vs. biology, nursing vs. pre-medicine and nursing vs. Occupational Therapy & Physical Therapy. In each of these instances, the nurses had a significantly lower impression of their science and math experiences. We are currently in the process of examining their narrative comments in an attempt to better understand why they appear less pleased than other constituents.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>St Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>45</td>
<td>3.95</td>
<td>0.73</td>
</tr>
<tr>
<td>female</td>
<td>97</td>
<td>3.76</td>
<td>1.01</td>
</tr>
<tr>
<td>commuter</td>
<td>33</td>
<td>3.72</td>
<td>0.87</td>
</tr>
<tr>
<td>residential</td>
<td>110</td>
<td>3.85</td>
<td>0.94</td>
</tr>
<tr>
<td>Health Science</td>
<td>100</td>
<td>3.84</td>
<td>0.94</td>
</tr>
<tr>
<td>Non-Health</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td>37</td>
<td>3.83</td>
<td>0.95</td>
</tr>
<tr>
<td>Nursing</td>
<td>21</td>
<td>3.42</td>
<td>0.74</td>
</tr>
<tr>
<td>Non-Nursing</td>
<td>121</td>
<td>3.89</td>
<td>0.94</td>
</tr>
<tr>
<td>Biology</td>
<td>56</td>
<td>4.07</td>
<td>0.71</td>
</tr>
<tr>
<td>Chemistry</td>
<td>12</td>
<td>3.83</td>
<td>1.19</td>
</tr>
<tr>
<td>Math, CS, Physics</td>
<td>8</td>
<td>3.62</td>
<td>0.74</td>
</tr>
<tr>
<td>Psy, Soc</td>
<td>27</td>
<td>3.81</td>
<td>1.04</td>
</tr>
<tr>
<td>Undecided</td>
<td>7</td>
<td>3.71</td>
<td>1.38</td>
</tr>
<tr>
<td>OT/PT</td>
<td>56</td>
<td>3.92</td>
<td>0.97</td>
</tr>
<tr>
<td>Pre-Med</td>
<td>21</td>
<td>4.09</td>
<td>0.88</td>
</tr>
<tr>
<td>Bus, Ed</td>
<td>11</td>
<td>3.55</td>
<td>1.29</td>
</tr>
</tbody>
</table>

Table 4. Overall Impression of Science & Math

Retention Data

We tracked students who had taken the FIS seminar course. Retention information can be found in Tables 5 through 7.

<table>
<thead>
<tr>
<th>Year</th>
<th># in Seminar</th>
<th># in College, Fall 95</th>
<th># in Science, Fall 95</th>
</tr>
</thead>
<tbody>
<tr>
<td>92-93</td>
<td>114(58%)</td>
<td>74(65%)</td>
<td>68(60%)</td>
</tr>
<tr>
<td>93-94</td>
<td>190(55%)</td>
<td>137(72%)</td>
<td>127(67%)</td>
</tr>
<tr>
<td>94-95</td>
<td>208(55%)</td>
<td>184(90%)</td>
<td>169(82%)</td>
</tr>
</tbody>
</table>

Table 5. Retention Data from Fall, 92 to Fall, 95
the most satisfied, points to a high degree of comfort with the program. What does not show up in the statistical analysis is the increased sense of community that is evidenced by an increase in participation by our students and faculty in outreach science and mathematics programs for area pre-college students. There has also been a noticeable increase in participation in the social events that are held for science and mathematics faculty and students. Of equal interest to us is the increase in collaborative efforts across the scientific disciplines that are occurring. Currently, there are joint research efforts taking place between biology and chemistry, mathematics and physical therapy, and computer science, physics and mathematics. There is also an NSF funded collaborative effort taking place between all the disciplines in science and mathematics. While not necessarily a direct result of the FIS program, there is anecdotal evidence to indicate that these new collaborations are an indirect result of the program. Future plans include minor modifications to the seminar and more detailed statistical analysis of the effects of the program geared toward determining if the program has an effect on the academic success of our students.

Literature Cited


