Abstract—The Scholars of Excellence in Engineering and Computer Science Program (S-STEM) program initiated its first cohort of 20 students in fall 2009. Funded through a National Science Foundation (NSF) S-STEM grant, the interdisciplinary, multi-year, mixed academic-level program offers scholarships to students based on academic merit and financial need. The first grant ended in June 2013 and a second grant was awarded to continue the program. The innovative and engaging aspect of the SEECS program is a zero-credit seminar where students are required to attend specific development sessions and learning outcomes are realized in a team-based, project-based approach. The SEECS seminar encompasses three components: engineering design, professional development, and personal development. The engineering design component is the pivotal experience connecting and building not only engineering competency but also personal confidence. Each academic level has different professional and personal development objectives realized each semester. In an attempt to measure the effectiveness of the program and to provide performance indicators to identify early in the student’s college career a potential, at-risk student, the authors have analyzed additional elements beyond the reports required by the NSF. First, data is presented correlating high school SAT, ACT, and GPA with scholars’ retention within the program. Second, retention data of the scholars is shown as a measure of the program’s success when compared to the retention values for the university. Finally, the paper presents the lessons learned during the development, implementation, and assessment of the SEECS program.

Keywords—assessment, innovative practice;

I. INTRODUCTION

The National Science Foundation (NSF) Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) Program, established in compliance with the American Competitiveness and Workforce Improvement Act of 1998, provides scholarship funds for students in STEM fields who demonstrate academic talent and financial need. The goals of the S-STEM program are to be supported by institutions receiving the awards and are outlined as [1]:

- Improved educational opportunities for students;
- Increased retention of students to degree achievement;
- Improved student support programs at institutions of higher education; and
- Increased numbers of well-educated and skilled employees in technical areas of national need.

To-date, Gannon University has received two consecutive NSF S-STEM grants, Nos. 0806735 and 1153250. The first award (2008-2013), the one assessed in this article, consisted of one year dedicated to logistics and four years of students’ scholarships. With these funds, the Scholars of Excellence in Engineering and Computer Science (SEECS) program was established in order to achieve the following goals:

1. Increase the number of academically talented, financially disadvantaged students enrolled in Gannon University’s computer science and engineering programs, especially minority, female, and disabled students.

2. Through a program of scholarships and rigorous academic support, assist students to continue their education through graduation.

3. Foster professional development that prepares students for careers in STEM fields and graduate education.

The SEECS program structure and activities were designed, implemented and formatively evaluated to achieve four objectives:

- **Objective 1:** Provide 20 scholarships per year for academically talented, financially disadvantaged STEM majors, especially those from underrepresented groups.

- **Objective 2:** Build a referral network arrangement between Gannon University, the Erie City School District, and the local U.S. Department of Education Talent Search program to identify and recruit financially disadvantaged students from underrepresented groups who meet SEECS eligibility requirements.

- **Objective 3:** Provide a program of academic and student service support that achieves a 90% year-to-year retention rate for SEECS scholars.
• **Objective 4**: Provide scholars with academic and professional development that prepares them for graduate school and/or employment in a STEM field.

The innovative and challenging aspect of the SEECS program is the Professional and Personal Development Seminars through which Objectives 1, 3 and 4 are realized. This required zero-credit, pass-fail course offers a single, shared experience for all scholars addressing different professional and personal needs of each academic class (i.e., freshman through senior). The SEECS seminar encompasses three components: engineering design, professional development, and personal development. Through workshops, university support services, lectures, and invited speakers, the facets of professional and personal development are addressed [2]. Scholarships are renewed year-to-year for those students who maintain a minimum 3.0 cumulative GPA, demonstrate financial need as per FAFSA, and comply with seminar attendance requirements. A formative evaluation suggested enhancements to the program’s activities.

II. **The Current Student Profile**

The grant stipulates awarding requirements for high school students and renewal criteria. The potential scholars must declare one of the qualifying majors in the School of Engineering and Computer Science (ECS). In addition, high school students must achieve a minimum score of 1100 on the SAT (math and verbal) or a score of 24 on the ACT, and a minimum high school GPA of 3.0 (on a 4.0 scale) for consideration of scholarship receipt.

For each prospective scholar, the selection committee is provided the intended major, the SAT/ACT score(s), name and city of high school, and high school GPA. When provided, rank in class is also considered. The committee weighs potential as measured by SAT/ACT and achievement as measured by high school GPA. In reviewing high school data from the first four freshman classes entering the SEECS program, some interesting trends appear.

Data for Fig. 1 and Fig. 2 includes only scholars who either 1) are still in the program or graduated as members of the program, or 2) left the program because of low academic performance or transferred major with relatively weak academic performance. The values for Fig. 1 are based on either the students’ SAT or ACT score mapped to the equivalent SAT score. If the student provided scores for each, the higher score is used. Fig. 1 indicates that SAT/ACT scores do not have strong predictive value for success in the SEECS program. Scholars leaving the program are dispersed throughout the range of SAT/ACT scores. While helpful as a factor in predicting future success, SAT/ACT scores by themselves cannot be the selection criteria.

The values for Fig. 2 are based on the reported high school GPA for each student, without adjustment. Consequently several GPA values are above 4.0. This figure indicates that GPA seems to be a stronger predictor of success in the SEECS program than does SAT/ACT. Many scholars with high school GPA of 3.9 or below were unable to maintain a college GPA above 3.0 through graduation, while only one of 15 scholars with high school GPA above 3.9 was unable to maintain the required 3.0 GPA in college.

Freshman year is a hallmark year in the academic development of a student within an initial major. Modifying the environment and the interactions available to students within the year has been recommended by studies [4, 5]. Honken andRalston report (1) “…students expect to communicate with faculty outside of class” and (2) “…encourage group studying by designing a variety of assignments to be completed with other students,” [5, p. 34]. Similar recommendations had been made in 2007: “…an interdisciplinary first-year projects course should be required in all engineering programs,” [4, p. 10]. Involving students in small-group projects with high faculty collaboration is repeatedly valued as a factor for improving student retention in engineering and the sciences. The projects do not need to be within the student’s primary discipline; communication and dialogue, sharing of ideas and approaches are more important.

The SEECS Scholarship program is styled to incorporate all of these recommendations. Table 1 shows a comparison of the retention rates for SEECS scholars compared to their university peers, relative to the years of the first grant, 2008 through 2012. The percentages describe retention for the SEECS program. Retention in the program is defined within

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the grant as scholars who fit the following stipulations: (1) remain in STEM majors, maintain academic qualification, and continue with financial need, (2) remain in STEM majors with qualifying grades, but have lost financial need, or (3) remain in STEM majors, but not ones funded by the grant. The other circumstances of leaving the university entirely, dropping below academic qualification specified in program, or leaving STEM majors, but remaining in the university are considered to be “not retained.” Row 1 identifies students who entered the SEECS program as freshmen and qualified as being retained by the previously stated clause. Row 2 identifies SEECS freshmen who remained at the university either in a STEM major or another.

Comparison of Row 1 to Row 3 show the retention of SEECS freshmen did not exceed freshmen retention rates with the School of Engineering and Computer Science (ECS). Comparison of Row 2 to Row 4 shows the tendency of SEECS students, who had become familiar with the university, had remained within the university community more so than the general university freshmen. Certain anecdotal factors about the pool of SEECS freshmen can be said: (1) in any one year the size of the pool ranged from 14% to 18% of the entire ECS freshmen class, (2) the pool is not a random sample across a spectrum of abilities, and (3) students can remain in ECS with a cumulative grade point average of 2.0 while students in SEECS must maintain a 3.0 to continue in the program.

Table II shows SEECS scholars are also successful in their post-baccalaureate efforts: (1) in three of the four years, the percentage of SEECS majors employed in their field exceeded the ECS percentage; (2) in all four years, the SEECS percentage exceeded the university levels of employment within major, and (3) overall 22% of the SEECS graduates eventually continued on to graduate studies while employed.

These comparisons indicate the persistence of SEECS students to complete their STEM studies and to be employed in their fields. The SEECS program enabled the students to identify in the first year a true interest in STEM majors. Those with the interest and the ability would ultimately graduate within the STEM major and the funded scholarship enabled the SEECS students to complete their studies.

IV. Lessons Learned

As the SEECS program has developed, trends have been noted which can be used to guide future efforts.

High school GPA versus SAT as predictor: It has previously been demonstrated (Section II) that the method of selection of scholarship recipients should be reviewed in light of retention rates (Section III). A stronger correlation between high school GPA and retention is shown than between SAT score and retention. SEECS faculty members postulate that GPA is a measure of achievement, whereas SAT score is a measure of potential. It seems, within the limits of the SEECS experience, that achievement trumps potential. In the selection method used, GPA was implicitly downgraded in importance, owing to perceived non-uniformity of calculation due to honors courses and other bonus points. Possibly, the accumulation of such “bonuses” indicates character or ability which in turn indicates potential for successful retention.

Opportunities for enhanced retention: Analysis of retention rates of SEECS students in comparison to all students of the ECS shows SEECS retention is about the same. Objective 3 sought a 90% year-to-year retention rate. To be fair, renewal of a SEECS scholarship is not automatic upon continuance in an eligible major: SEECS students must also maintain a minimum 3.0 GPA; ECS has a minimum 2.0 GPA. However, in order to improve retention, SEECS faculty members have identified some specific courses, notably Physics and Calculus, which are troublesome. While the university provides on-demand tutoring for Calculus, no such on-demand tutoring for Physics is offered. Also, no mechanism within the SEECS program mandates students seek tutoring. Many students see such tutoring as stigmatizing, and therefore decline to accept it. Thus, the lesson is to provide and sometimes to mandate additional tutoring assistance for at-risk students. This approach might also provide additional opportunities to build collegiality and sense of community among SEECS students, as upper-level students can be enlisted to assist lower-level students in coursework. In effect, upper-level students may currently be an untapped or underutilized resource which can be put to effective use for building a stronger community.

STEM affinity predictors: SEECS retention rates as calculated penalize for major change to a non-STEM field. It is of course understood that students sometimes change major in college. Inasmuch as the goals of SEECS and the NSF S-STEM grant program are to recruit and retain students to graduation in a STEM field, major changes to non-STEM fields are problematic for grant objectives. It would thus be quite useful to have an idea of students’ affinity for STEM, prior to acceptance into the SEECS program. A timely means of assessing true interest in the declared eligible major must be sought, to better ensure retention.

Targeting specific populations: The paper has not presented demographic data about SEECS scholarship recipients. However, in short, the SEECS cohort has not, through the period of the grant reported here, differed significantly from the demographics of the overall student population of ECS. The NSF grant has since been renewed with special emphasis placed upon recruitment of women and underrepresented minority students. To achieve this objective, special marketing materials have been made which go only to women students and hand-written notes are sent to identified students, chosen for their ability to assist in diversification of the SEECS student cohort. There is not sufficient data to-date to definitively state whether the new emphasis is paying off in terms of conversion, but early indicators are positive – the number of women applicants and the percentage of women applicants are both significantly up this year, relative to previous years.
ACKNOWLEDGMENT

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REFERENCES


Table I. Retention Comparisons for Grant Years 2008-2013

<table>
<thead>
<tr>
<th></th>
<th>ENTERED Fall 2008</th>
<th>ENTERED Fall 2009</th>
<th>ENTERED Fall 2010</th>
<th>ENTERED Fall 2011</th>
<th>ENTERED Fall 2012</th>
<th>ENTERED Fall 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. SEECS FRESHMEN Retained In School of Engineering and Computer Science</strong></td>
<td>75.00% (6 of 8 retained)</td>
<td>83.33% (5 of 6 retained)</td>
<td>70.00% (7 out of 10)</td>
<td>77.78% (7 of 9 retained)</td>
<td></td>
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<tr>
<td><strong>2. SEECS FRESHMEN Retained In University</strong></td>
<td>100% (8 of 8)</td>
<td>83.33% (5 of 6)</td>
<td>80% (8 out of 10)</td>
<td>88.89% (8 of 9 retained)</td>
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<td><strong>3. Within the School of Engineering</strong></td>
<td>93.75%</td>
<td>85.11%</td>
<td>83.33%</td>
<td>75.00%</td>
<td>82.81%</td>
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<td><strong>4. Within the University</strong></td>
<td>81.57%</td>
<td>79.35%</td>
<td>79.48%</td>
<td>80.15%</td>
<td>79.09%</td>
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Table II. Graduation and Placement Comparisons

<table>
<thead>
<tr>
<th><strong>SEECS Scholars</strong></th>
<th>Graduates</th>
<th>Survey Respondents Employed within STEM field</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
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<tr>
<td><strong>Graduates</strong></td>
<td>3</td>
<td>100.0% (2)</td>
<td>100.0% (6)</td>
<td>75.0% (3)</td>
<td>100.0% (5)</td>
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<tr>
<td><strong>Pursuing graduate studies, full-time</strong></td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td><strong>Pursuing graduate studies, part-time while employed</strong></td>
<td>66.7% (2)</td>
<td>0%</td>
<td>0%</td>
<td>40.0% (2)</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td><strong>Employed in non-STEM field</strong></td>
<td>0%</td>
<td>0%</td>
<td>25.0% (1)</td>
<td>0%</td>
<td>0%</td>
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<tr>
<td><strong>Unreported</strong></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td><strong>Within the School of Engineering</strong></td>
<td>Responding Graduates</td>
<td>23</td>
<td>69.6%</td>
<td>66.7%</td>
<td>83.3%</td>
<td>77.5%</td>
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<tr>
<td><strong>Employed within STEM field</strong></td>
<td>13.0%</td>
<td>15.2%</td>
<td>8.3%</td>
<td>20.0%</td>
<td>0%</td>
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<tr>
<td><strong>Unreported</strong></td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td><strong>Within the University</strong></td>
<td>Responding Graduates</td>
<td>455</td>
<td>420</td>
<td>435</td>
<td>472</td>
<td>40</td>
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<tr>
<td><strong>Employed within major field</strong></td>
<td>44.4%</td>
<td>44.4%</td>
<td>42.5%</td>
<td>42.4%</td>
<td>42.4%</td>
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</tr>
<tr>
<td><strong>Pursuing graduate studies</strong></td>
<td>43.3%</td>
<td>43.6%</td>
<td>43.9%</td>
<td>43.4%</td>
<td>43.4%</td>
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<tr>
<td><strong>Unreported</strong></td>
<td>62</td>
<td>72</td>
<td>66</td>
<td>64</td>
<td>64</td>
<td></td>
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