Give them what they want: A look at student directed curriculum revision in a summer bridge camp

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Abstract – This paper presents the survey results and implementation methodology used in revising the introductory engineering portion of the Virginia Tech Center for the Enhancement of Engineering Diversity's STEP Bridge summer camp. In the spring of 2009, students from the 2008 STEP Bridge camp were surveyed on their first semester freshman year academic experience. Targeted questions solicited students' level of comfort with various concepts and software. Students were specifically asked which topics from their first semester engineering course they wished they had greater exposure to during the summer. And lastly, students were prompted to compare level of effort and test format between the summer program and their fall course. This student feedback was used to drive curriculum revision of the engineering component of the STEP Bridge summer camp.

INTRODUCTION

As stated in Waller [10], the ASPIRES/STEP program was instituted in 1995 by Dr. Bevlee Watford. The ASPIRES/STEP program is a summer bridge program designed to ease the transition from high school to college and improve student retention. Retention is a complex issue in the higher education setting. Retention is a critical issue in this country since the Education Commission of the States (ECS) has projected that enrollment in higher education will steadily increase. In fact, by 2015, 19.6 million students will be enrolled in U.S. institutions of higher education [6], compared to about 16.7 million students in 2005.

Even though these numbers look promising, Tinto's [9] study on retention reported that, on average, less than 55% of students entering four-year colleges eventually earn their degrees. Moreover, 56% of all dropouts at America's colleges and universities leave before the start of their second year. Given this information, it is not surprising that stagnating graduation rates.

How do educators engage in a discussion about retention and graduation? Higher education administrators are seeking ways to assist student in persisting and graduating especially in science, technology, engineering, and mathematics (STEM) fields. STEM administrators and faculty address this issue through transitional programs.

Transition programs are intended to aid under-prepared students in facing the social and academic complexities that usually begin in college [8]. Transition programs have been assessed by various researchers, many of whom refer to them in slightly different terms. They have been called transitional assistance programs [8], intervention programs [2], and summer bridge programs [5]. Despite the varying classification, these programs all feature similar characteristics and are principally designed to increase student retention and academic success.

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Summer bridge programs provide a method for addressing the academic and social issues that college students face in higher education. Additional interesting reading on the subject can be found in Elshorbagy & Schonwetter [1] and Seymour & Hewitt [7]. For a comprehensive survey of summer bridge programs, the authors refer the reader to Ohland and Crockett [4].

The accomplishments of the CEED STEP-Bridge program have been documented in past ASEE papers including Waller & Watford [11] and Matanin *et* al [3]. This program was broadly designed to help students transition more successfully to the college environment—and especially to the academic rigors associated with programs of engineering. Since its inception nearly 15 years ago, the STEP program, and its precursor ASPIRES, have served more than 350 students. Initially, the program was expressly designed for incoming African American freshman engineering students. Hispanic students were added to the target population in 1999. The program later grew to include students from all underrepresented populations who had applied to the College of Engineering, but did not meet the admissions criteria. Specifically, these students would enroll in the university's general studies program but could transfer to the College of Engineering if they were able to maintain a B average in all the bridge program classes, as well as pass the math readiness exam set by the University. In 2005, the bridge program also began to invite first generation college students, as well as students at the lower end of the academic spectrum who had been offered admission to the College of Engineering.

While the overarching goals of the program (listed below) have remained consistent, the various programmatic logistics associated with implementing the program have undergone necessary modifications, such as increasing the number of faculty associated with the program, expanding class schedules, and increasing the number and involvement of the resident assistants in the program.

The program's specific goals include the following:

- Provide students with academic enrichment opportunities in all of the classes offered.
- Provide students with an atmosphere and activities conducive to social development.
- Provide students opportunities to develop personally and professionally, both within the university setting as well as within the larger community when and where appropriate.

To summarize, the STEP program aims to support and aid in the development of students through non-credit bearing college courses that focus on content that has been historically difficult for first-term students (chemistry and chemistry lab, math, and engineering). The program aids students in developing better time management skills and academic strategies to be successful in college. It also provides students with vital opportunities to become acclimated to more rigorous, complex, or ambiguous material during courses designed to mimic what they will experience during their fall freshman term. The program gives students an opportunity to familiarize themselves with the institution and the community prior to their academic year. Finally, the program provides students with personal and professional development through various activities both on- and off-campus.

STEP ENGE

One component of the STEP summer camp is an engineering fundamentals portion, STEP ENGE. The primary mission of the STEP ENGE course is to prepare students for their freshmen year engineering classes; as such the key components include familiarization with technology and software used in the curriculum, engineering coursework, and hands-on, engineering, team-oriented activities.

SURVEY OF 2008 COHORT

Instrument

The survey instrument used to assess STEP ENGE 2008 is presented in full in Appendix A of this paper; the 2009 survey is similar with questions added to assess the curricular revisions detailed below. The intentions of the survey were to identify:

- Student perceived strengths
- Student perceived weaknesses
    - Weaknesses remaining in material they had been exposed to
    - Weaknesses identified in new material struggled with during the freshmen year

- Student perceived relative level of effort between STEP ENGE and their freshmen year
- Student perceived relative level of preparation by STEP ENGE for their freshmen year

Feedback—Course Material

The 2008 cohort survey respondents overwhelmingly indicated their desire for coverage of flowcharting (71% requested coverage of this conceptual topic) and LabView (37% requested coverage of this software) in the STEP ENGE curriculum. The next highest ranked topic for increased coverage in STEP ENGE was problem solving (35% requested greater coverage of this conceptual topic), though 74% of the respondents indicated that as a result of STEP ENGE, their problem solving skills are good or very good. It was hypothesized that students did not necessarily perceive the degree to which they were problem solving as part of the curriculum. That is, students are solving problems without realizing it. For example, 92% of respondents indicated their ability to conduct a hands-on engineering project (the students designed and built an underwater robot based upon the SeaPerch model) is very good or good, from which one might infer the students are indeed strong problem solvers. Clarity in definition of problem solving was identified as a potential area for improvement in future years.

Feedback—Level of Effort

The results of the question, "How did your level of effort for STEP ENGE compare to ENGE 1024," ENGE 1024 being the first semester Freshman engineering course, are tabulated as follows:

How did your level of effort for STEP ENGE compare to ENGE 1024	**2008 Cohort % Respondents**	**2009 Cohort % Respondents**
STEP ENGE was much harder than ENGE1024	4%	0%
STEP ENGE was harder than ENGE1024	12%	13%
STEP ENGE was about the same as ENGE1024	35%	31%
STEP ENGE was easier than ENGE1024	31%	40%
STEP ENGE was much easier than ENGE1024	8%	13%
No answer	10%	4%

Table 1: Self-Reported Level of Effort

The fact that only 16% of the 2008 cohort respondents found STEP ENGE to be some measure more difficult than their introductory engineering course indicated to the instructors a need to increase the rigor of the summer program. The STEP ENGE course benefits from small class sizes, 25-30 students in a classroom. As such, the STEP ENGE course in concert with the overall STEP program are able to maintain a highly nurturing environment during the summer. The philosophical argument can then be made that students will be most benefited from being pushed harder during the summer program than they will be their freshman year. If a student feels overwhelmed at the challenges of engineering during the summer, the STEP staff and administration are able to dedicate a great deal of one-on-one time to encouraging and mentoring the individual student. Whereas, if the student is overwhelmed at the challenges of engineering in a large course environment, it may be easier for them to 'fall through the cracks' and thus adversely affect retention. Therefore, ideally the STEP ENGE graduates will find themselves in their freshman year saying 'I can do this' based on past experience in a STEP ENGE course that is somewhat, though not dauntingly, more challenging than the freshman year curriculum.

Feedback—Level of Preparation

The survey also sought to gauge students' perceived levels of preparation for the freshman year based upon their STEP ENGE experience. Table 2 shows a strong correlation between STEP ENGE grades and ENGE1024 grades. The actual STEP ENGE grade distributions for 2008 and 2009 are presented in Table 3. Comparison of Table 2 to Table 3 however would indicate that the higher performing students were the ones to respond to the voluntary survey, thus potentially indicating some bias to the results presented herein. The data in Table 4 illustrates that 76% of the 2008 cohort respondents felt their performance in ENGE1024 was helped by having taken STEP ENGE.

Additionally, students were surveyed on the test format of STEP ENGE. Due to the small class size, it is entirely feasible to assess students' performance on examinations in a long-answer format allowing for partial credit and a great deal of analysis on where conceptual barriers are present for students. However, in much of the engineering curriculum, due in part to class size, multiple choice test formats are employed. Therefore the students were asked to indicate how they felt about the test format for STEP ENGE versus ENGE1024, and multiple answers to this

question were permitted. Of the 2008 cohort respondents, 51% indicated they would have been better prepared for ENGE1024 had they been given multiple choice tests in STEP ENGE, although 29% indicated they prefer long-answer tests to multiple choice tests.

Grade	2008 Cohort What grade did you receive in STEP ENGE?	2008 Cohort What grade did you receive in ENGE1024	2009 Cohort What grade did you receive in STEP ENGE?	2009 Cohort What grade did you receive in ENGE1024
A	14%	8%	27%	8%
B	55%	57%	54%	50%
C	24%	22%	15%	31%
D	4%	4%	4%	4%
F	0%	0%	0%	2%
No answer	4%	10%	0%	4%

Table 2: Self-Reported Grade Comparison (percentage)

Grade	2008 Cohort Actual STEP ENGE grades	2009 Cohort Actual STEP ENGE grades
A	9%	11%
B	48%	45%
C	28%	31%
D	13%	11%
F	1%	1%

Table 3: STEP ENGE Actual Grade Distribution (percentage)

Did STEP ENGE prepare you for ENGE1024	2008 Cohort	2009 Cohort
My performance in ENGE1024 was helped by having taken STEP ENGE.	76%	77%
My performance in ENGE1024 was unaffected by having taken STEP ENGE.	16%	17%
My performance in ENGE1024 was hurt by having taken STEP ENGE.	0%	4%
No answer	8%	2%

Table 4: Perceived Performance Influence of STEP ENGE

CURRICULAR REVISIONS

As described previously in this paper, curricular revisions were warranted based upon student feedback to include both flowcharting and LabView into the STEP ENGE curriculum. With the aim being to best prepare the students for their freshmen year, it seemed reasonable to incorporate one conceptual topic and one software item in the curriculum. A brief description of the added material follows in the following subsections.

Course Material—Flowcharting

In past years flowcharting was addressed as a sub section of some of the other topics covered in EngE 1024, including Lab View and programming with Matlab. Instead of devoting class time to teaching flowcharting, students are given a handout on the basic symbols and terminology used along with some guidelines for how to use flowcharts to solve programming problems. The foundational nature of flow charting, combined with students perceived deficiency in this area, enabled us to redesign a portion of the STEP program to introduce flow charting as an entire class module.

During the summer of 2009 a short lecture was modeled after the handout from EngE 1024 to guide students through the terminology and procedure of creating a flowchart. In addition, an instructor lead tutorial of Microsoft Visio was used to introduce students to the flowcharting elements of the program. In order to give the students hands on practice with flowcharting, they were given an in class activity to develop their own flow chart for a driver at a traffic light. This activity had three parts, with each part adding another layer of complexity to the traffic light decision structure. First students created a flow chart for the decision a driver would make at a red, green or yellow light. In the second stage, students added another decision at the yellow light, allowing the driver to decide to stop

or go through. In the final flow chart addition, students were asked to come up with a set of consequences for going through a yellow light and add these to their flowchart. Students were able to work in pairs or small groups during the class activity with the instructor walking around the room to help students when needed. Most of the students used their tablet computers to generate their initial flowcharting iterations, with the final flowchart assigned for homework to be completed using Visio.

Course Material—LabView

LabView by National Instruments (NI) is a Graphical Programming Language that uses intuitive icons and connections to develop measurement, test, and control systems in a data flow format. This format resembles a flow chart, because all inputs must be received before a block is able to pass its data downstream. The programming language is optimized for rapid fabrication of a Graphical User Interface (GUI), a minimal learning curve for an engineer to write effective software, and simplistic integration of powerful hardware. It is popular in many engineering applications due to its functionality for signal processing, embedded systems, machine vision, realtime control, and support for many other noteworthy tasks. Perhaps one of the most unique features of LabView is its programming environment, which is divided into the Block Diagram the programmer uses for program logic, and the front panel, which is the building block for the user interface. Both the front panel and block diagram share indicators and controls that tie them together as the program is written.

During STEP ENGE, students were provided with a basic introduction to programming in LabView. Topics included familiarization with the front panel and block diagram, dataflow programming, manipulation of data types, case structures, loops, and debugging techniques. Because LabView combines elements from flowcharting, Matlab, and Mathematica, some of the basic building blocks were already in place to accelerate learning. Students' previous experience with basic programming terminology helped them to differentiate between data types and to understand basic structures such as for loops and while loops. LabView also afforded the opportunity to teach by providing students hands-on examples. Students used a base package of LabView 8.5 to demonstrate the aforementioned lesson topics. By the end of the lecture, students were able to create and execute a program that was capable of doing a unit conversion.

Level of Effort

As discussed previously in this paper, the student feedback indicated STEP ENGE was about the same level of difficulty or easier than their first semester engineering course. Reiterating the philosophy described previously, it is deemed better to stretch students' capabilities in the nurturing environment of the STEP ENGE program. Therefore, the decision was made to simply add the items described above to the curriculum without reducing scope in any other area of topical coverage.

Level of Preparation

Based on the 2008 survey results, level of preparation appeared satisfactory. The only modification made was to include a mixture of multiple choice and long answer questions on the examinations to allow for detail assessment of students conceptual understanding while also preparing for the multiple choice nature of many engineering examinations.

SURVEY OF 2009 COHORT

Feedback—Course Material

The impact of the curricular revisions was apparent in the survey of the 2009 cohort. Whereas the 2008 respondents had a high demand for coverage of flowcharting (71% as reported above), only 33% of the 2009 cohort survey respondents requested coverage/more coverage of the flowcharting topic and 50% of the 2009 cohort respondents stated their ability to flowchart is very good or good. Indeed, of the 2009 cohort, mechatronics was the subject for which the greatest number of students requested coverage with 44% of respondents. The second most in demand subject was again LabView with 42% of respondents requesting greater coverage of this topic, similar to the 37% response rate of the 2008 cohort. When asked "As a result of STEP ENGE, my ability to use Labview is:…," 42% of respondents answered with very good or good. Finally, as stated previously 35% of the 2008 cohort had indicated a need for greater coverage of problem solving, but the authors/instructors had hypothesized that students were unclear on what precisely problem solving is, and thus did not realize they knew how to do it. Emphasis was placed

on clarity in defining "problem solving" and this clarity was reflected in the 2009 cohort survey where only 21% of respondents requested greater coverage of this topic area. Similar to the 2008 cohort results, 90% of the 2009 respondents indicated their ability to conduct a hands-on engineering project is very good or good, again likely due to the SeaPerch activity.

Feedback—Level of Effort

To the surprise of the authors, despite the increased rigor of the 2009 STEP ENGE course, the student perceived level of effort did not change markedly. This is reflected by the results presented in Table 1. While the classroom time commitment of STEP is similar to that of the Freshman year, due to the fact that students are enrolled in Chemistry, Chemistry Laboratory, Mathematics, and Engineering during the STEP program, the smaller class sizes enable a more nurturing environment than the typical Freshman experience. Therefore, one might hypothesize, that perceived level of effort is different from actual level of effort, by the very nature of this supportive environment. It is recommended that future assessments be revised to probe this topic specifically.

Feedback—Level of Preparation

The data presented in Table 4 shows the 2009 cohort, much like the 2008 cohort, largely (77%) felt STEP ENGE helped their performance in the freshman engineering course ENGE1024. Based on the 2008 cohort feedback, a mixture of long answer and multiple choice questions was used on examinations in STEP ENGE 2009. This change did not meet any significant resistance from students and the percentage of students who felt they would have been better prepared for ENGE1024 had they been given exclusively multiple choice tests in STEP ENGE fell from 51% in the 2008 cohort to 38% in the 2009 cohort.

Also related to level of preparation, the authors note with great interest that while 73% of respondents in the 2008 cohort participated in a theme housing community, either Galileo for male engineers, Hypatia for female engineers, or the Corps of Cadets, all of which provide additional support structure, 85% of respondents in the 2009 cohort participated in Galileo, Hypatia, or Corps of Cadets. Without introducing too much hypothesis as to the implications and/or future of such enrollments, one might hope this reflects the instructors and staff members associated with STEP successfully emphasizing the importance of capitalizing upon a support structure for success in engineering.

CONCLUSIONS

The purpose of this paper was to highlight the effective use of student feedback in defining the curriculum of a high school to college engineering transition course. While the specifics of topics/software covered are not needed in a broad sense, they are presented here to illustrate how student feedback was utilized in one sample program. The crucial step is making constructive use of the student feedback in a curricular sense to help them reach their potential. Further conclusions will be drawn pending the completion of the 2009 cohort survey.

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APPENDIX A: SURVEY INSTRUMENT

Dear STEP ENGE students, This survey is intended to assess how well STEP ENGE prepared you for your freshman year engineering curriculum. With your feedback, we will continue to revise the curriculum to make STEP ENGE as effective as possible for future students. Your participation is much appreciated!

STEP ENGE 08

Please indicate your level of understanding of the following tools and topics presented during STEP ENGE 2008.

As a result of STEP ENGE, my ability to use Blackboard is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my ability to use a Tablet PC is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my ability to use Dyknow is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my ability to use OneNote is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my ability to manage unit conversions is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my problem solving skills are:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my understanding of decision matrices is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my understanding of engineering design is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my ability to conduct a hands-on engineering project is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my ability to use Matlab is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my ability to sketch is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my ability to graph by hand is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my ability to graph by computer is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my understanding of empirical functions (e.g. linear, power, exponential fits) are:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

As a result of STEP ENGE, my ability to work on a team is:

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very poor

If you did not take ENGE1024 at Virginia Tech, please enter where you took an approved substitute course,

and proceed with the survey substituting ENGE1024 for the course that you took.

To best prepare you for ENGE1024, which of the following topics from ENGE1024 do you wish were covered, or covered more, in STEP ENGE? (You may select multiple answers.)

- Hands-on Design
- Problem Solving
- Sketching
- Flowcharting
- Sustainability
- Graphing by hand
- Graphing by computer
- Empirical functions
- Ethics
- Mechatronics
- LabVIEW
- Nanotechnology
- Globalization of engineering practice

other:

How did your level of effort for STEP ENGE compare to ENGE1024?

- STEP ENGE was much harder than ENGE1024
- STEP ENGE was harder than ENGE1024
- STEP ENGE was about the same as ENGE1024
- STEP ENGE was easier than ENGE1024
- STEP ENGE was much easier than ENGE1024

How did you feel about the test format for STEP ENGE versus ENGE1024? (You may select multiple answers.)

- I would have preferred multiple choice tests in STEP ENGE.
- I would have been better prepared for ENGE1024 had I been given multiple choice tests in STEP ENGE.
- I prefer long-answer tests to multiple choice tests.

other:

What grade did you receive in STEP ENGE?

A B C D F

How many times did you visit your engineering professor during STEP?

☐ 0 ☐ 1-2 ☐ 3-5 ☐ 5-10 ☐ 10-15 ☐ 15-20 ☐ >20

What grade did you receive in ENGE1024?

☐ A ☐ B ☐ C ☐ D ☐ F

How many times did you visit your engineering professor during the fall semester?

☐ 0 ☐ 1-2 ☐ 3-5 ☐ 5-10 ☐ 10-15 ☐ 15-20 ☐ >20

Are you participating in any of the following communities?

Galileo

☐ Yes ☐ No

Hypatia

☐ Yes ☐ No

Residential Honors

☐ Yes ☐ No

Corps of Cadets

☐ Yes ☐ No

Did STEP ENGE prepare you for ENGE1024?

☐ My performance in ENGE1024 was helped by having taken STEP ENGE.

☐ My performance in ENGE1024 was unaffected by having taken STEP ENGE.

☐ My performance in ENGE1024 was hurt by having taken STEP ENGE.

Please feel free to provide any additional comments here.