Creating a Catalog and Meta-Analysis of Freshman Programs for Engineering Students: Part 1: Summer Bridge Programs

Matthew W. Ohland, Elizabeth R. Crockett
General Engineering, Clemson University, Clemson, SC 29634

Abstract

Special programs and the curriculum itself are two primary ways to improve the freshman year experience for engineers. Following a SUCCEED-sponsored Freshman Engineering Programs Best Practices Conference held in Charlotte, NC, in May 2000, a catalog and meta-analysis of freshman programs for students in US engineering colleges is underway. This paper will briefly describe the larger project, which will study a variety of approaches to improving the success of freshman engineering students, and specifically report on the catalog and meta-analysis of summer bridge programs. The catalog will classify programs by their design options and the meta-analysis will review highlights of assessment results drawing generalizations where possible.

Introduction

Across the country, there is an extensive base of experience in the design and implementation of programs intended to improve the success of first-year engineering students. Significant resources have been spent to identify best practices in the education of first-year students (in general), including entire organizations and conferences.[1] It is safe to say that every institution that educates engineering students employs some strategy to introduce those students to the school and to engineering. Given the universal presence of some strategy for acclimating engineering students, published descriptions of these programs are less common than we might expect. Considerably fewer have published assessment data on their programs. As a result, many studies of such programs fall short of producing a true meta-analysis, which relies on finding a reasonable number of analyses.

The College Board's "Priming the Pump" study faced this challenge—after beginning with a literature search and proceeding to brochures and word of mouth, the researchers eventually realized that nearly every campus had at least one program designed to foster minority student success. The study goes on to reduce the scope of the study by grouping programs by exemplars, archetypical programs with roots around the country, yet with some form of meaningful assessment.[2] Since most programs were not founded on a particular research model, they were classified by their features rather than by their research model.[3]

The SUCCEED Freshman Programs Catalog and Meta-Analysis Project

In two significant ways, this study takes another course. Programs that target improving the success of underrepresented populations do not generally use strategies deemed to be uniquely effective for their target population, so these programs are not studied apart from similar programs that are inclusive. Thus a study of a bridge program for minority students is discussed with other bridge programs, where its focus on minority students is revealed in the description of the population served by the program; this is appropriate because the strategies used in such programs would benefit any student. The appropriateness of this decision is clearer when we consider examples such as the ASPIRE program, which is coordinated by Virginia Tech's Office Minority Engineering Programs, yet serves all first-year engineering students, not only minorities.[4] Since assessment data are sparse in the literature, at this stage the study is much more a catalog of programs than a meta-analysis, but the growth of the study should reveal the information needed to conduct a true meta-analysis. As a result, this study at this point is able to identify what appear to be a few broad conclusions and recommendations for further study. A shortcoming of the study at this point is that it cannot clearly identify best practices since, while there is a fair amount of information about the design of the programs, there is insufficient assessment data to clearly identify which programs and approaches have been the most successful.

In this study, although we have clearly given preference to programs about which there is published assessment, we do not eliminate programs for the lack of same for a number of reasons. It is likely that a number of programs use reasonable assessment procedures, yet by choice or by custom have not published the results of their assessment. Especially as university resources become more closely guarded, some level of program assessment is almost assured. We also do not eliminate programs due to their similarity to others under study--the ongoing study uses a snowball to continue expanding by word of mouth to include all the programs that can be identified in a category. Since we are focusing on engineering, programs that exclude engineering students from their population are not considered.

We use this strategy for one primary reason—because the sharing that must take place around the country for program coordinators to learn about the best practices of others requires the development of a community. Everett M. Rogers, a noted communications researcher, indicates that the dissemination of an innovation is more likely if certain conditions are met.[5] While ***relative advantage*** is among these (as would be proven by rigorous assessment), ***compatibility*** is also a significant factor—which is best determined by being able to select exactly which features are desirable for a particular institution.

Obviously, we should not and did not list all of these programs here, but a web-searchable database is ideal for accounting for such an expansive list, and will be created. Once activated, this database will be advertised to the engineering education community and its development will accelerate (and accuracy will be improved).

The rest of this paper will focus on the findings for one type of program included in the broader study, summer bridge programs. These findings are revealed by patterns in the classification matrices as well as through a review of published information on the programs under study. Many of the findings refer to the classification tables, which are also included.

Part 1: Summer bridge programs

Summer bridge programs have long been used to ease the transition of college students into the institution, community, and engineering simultaneously. They have been the focus of this phase of the project, because they are a widely recognized approach to improve retention. Through the course of this research, it is clear that these programs implement a wide range of strategies. In fact, we noted that the range of strategies for summer programs spans the set of strategies employed for programs intended for the academic year after first-year students begin. This gives us reason to consider the time in a student's academic career when the intervention occurs as simply another variable, rather than to consider summer bridge programs as a separate entity. This will be discussed further in the conclusions section. Note that other references are available for some programs, but are not necessarily added if they contain no new assessment information.

Classification. The programs in the study have been classified in the tables in the appendix. Tables 1 through 9 classify a broad range of program characteristics that can be used to identify programs of interest for comparison studies and sharing of ideas. These tables contain the following characteristics:

1. Programs included in this sample, their institution (by web address), and references
2. Population served and other logistics
3. Approaches to engineering discovery
4. Approaches to success skills training
5. Approaches to self-discovery
6. Approaches to develop affiliation
7. Mentoring / learning resources
8. Academic areas included
9. Engineering topics

Table 1 also contains a reference number for each program to avoid listing the name of the program in each of the tables. Whereas the number of student participants was often vague, details of the population served by each program are given in Table 2. In cases in which the bridge program included course credit, that is indicated in Table 2 as well.

Some programs cite positive assessment results. University of New Orleans Student Support Services pass rates for two sections of its courses were 88.8% and 81.8% compared to pass rates of 72.8% and 61.3% respectively for the institution overall. The Minority Engineering, Mathematics and Science (MEMS) program at the University of New Mexico (UNM) has observed an increase in minority enrollment at UNM from 30% before 1990 to more than 40% in 1999. Engineering degrees awarded to minority students at UNM have increased from 20% in 1992 to 40% in 1999. Math Excellence Workshop (MEW) participants at Clemson University consistently outperform non-MEW students in class and demonstrate more persistence in earning a degree. Summer Bridge-University of California at Berkeley evaluation has demonstrated a higher two-year retention rate for Bridge students when compared to their non-Bridge counterparts, while program participants generally have lower SAT scores and high school grades. Georgia Tech's Challenge Program is a flagship program; a strong record of longitudinal assessment has compared Challenge student GPA's to non-Challenge minority SEM students as well as all Tech students to find that from 1990 to 1997, Challenge students consistently outperformed non-Challenge minority students and the general pool of Tech students with respect to GPA. Retention rates for African-Americans have been comparable to the overall GT retention rate since the mid 90's.

Add research experiences and financial support as factors understudy. The Women in Science, Math, and Engineering program at Dartmouth includes a research internship program, which indicates that research opportunities may need to be considered as a strategy for discovering engineering. The research experience includes presentation of findings to faculty, staff and other students during a poster session. While Dartmouth's Women in Science, Math, and Engineering program and Marquette's Student Support Services program offer financial support to economically disadvantaged students, the University of Florida's STEPUP program charges participants $425 to defray meal costs. Thus, it may be of interest to add records for participant costs and for financial support. The latter would be consistent with the findings of Gándara.[6] The MEMS program at the University of New Mexico features both financial support and research opportunities for its participants.

While a discourse of excellence is still lacking, avoid identifying a program as remedial. The second assertion appears to be anecdotal, yet it is nearly universal. No studies have been identified that analyze the effect of such a label, yet program coordinators maintain that the stigma carries with it plummeting participation and success. Clemson's Math Excellence Workshop, NC State's Women in Engineering, are some of the programs that stress this. In spite of the charge to avoid the stigma of making labeling a program as remedial, the programs in this sample still lack what Gándara termed a discourse of excellence[7]—only two programs on the list specifically aim to recruit and develop those students with the most promise. Instead, the primary focus is to give minority students who are in some way at a disadvantage (lack of opportunity, marginal academic performance, lack of academic support structure, etc.) as good a chance of graduating as the non-minority students, (see Table 2).

Compulsory programs are rare. Many programs face the challenge of getting students to take advantage of the resources available to them, and further face the challenge to their assessment practices that their selection process involves a student motivation factor. Of those studied here, the Higher Education Opportunity Program (HEOP) at Rensselaer Polytechnic Institute is the only program that is mandatory for its target population of special-admit students in all majors at RPI. Students must meet stringent financial and academic requirements and must be residents of NY State.

Training in various success skills is much more common than engineering discovery opportunities. Table 4, which shows the success skill training included in bridge programs, is highly populated. On the contrary, Table 3, which contains approaches to engineering discovery, shows that a small number of programs account for most of the population in the table. Table 5 is clearly dominated by advising, career profiling, and special orientation programs. A significant number of programs employ some form of community building, although Table 6 shows no clear preference for one method over another. Table 7 confirms Gándara's finding that peer mentoring and tutoring programs are popular, if not well assessed. Table 8 indicates that math is, by far, the most common subject area to be addressed in special programs, most likely because it is the subject area most commonly cited as a problem area for transitioning students. Chemistry is also common; Physics lags most likely because it is not of immediate concern, since it is placed later in the curriculum at many institutions. In Table 9, we note that, as with approaches to engineering discovery, a small number of programs account for most of the engineering academic content included in these programs. There is a notable correspondence of these programs with those that that use approaches to engineering discovery as shown in Table 4.

Conclusions

In this study, in addition to the identification of financial factors and research opportunities that should be considered in classifying programs, most programs readily identify their year of founding, which may be of interest, and their source of funding support. It is likely that the inclusion of the latter of these will reveal interesting patterns of programs based upon their funding source.

The variety of approaches taken even in this relatively small sample of bridge programs would seem to indicate that they should not be studied in isolation, but should be described by the components that comprise them. This also suggests that the designation of a program as a summer bridge can be identified with a few additional categories of classification—the time in a student's academic career the intervention takes place, the number of contact hours of each component, and the duration of the program.

There will be a significant advantage to studying programs by their components—this approach will more objectively allow the study of programs of different goals. It is clear even from the sample in this study that there is considerable variation among programs that identify themselves as summer bridge programs. Plans to take the study in this direction are already underway. In implementing this new approach, the focus will shift to identifying a more complete set of information about a more exhaustive list of programs, but focusing on a more limited number of schools.

Table 1. Programs included in this sample, their institution, and references

Ref #	Program	Institution (www.______.edu)	References
1	WISE Summer Bridge Program	ASU	8,9
2	MEP Summer Bridge Program	ASU	10
3	Summer Bridge Program	Berkeley	11
4	Quest I	CSUPomona	12
5	Math Excellence Workshop	Clemson	13
6	Women in Science, Math & Engineering	Dartmouth	14
7	Engineering Concepts Institute	eng.FSU	15
8	Challenge Program	GaTech	16
9	Student Support Services	Marquette	17
10	Women in Engineering	NCSU	18
11	University Transition Program	NCSU	19
12	Summer Transition Program	NCSU	20
13	Engineering Learning Center	ODU	21
14	Pre-Engineering Program for Minorities (PEP)	Ohio	22
15	Study Techniques, Academics, and Research Skills (STARS)	OregonState	23
16	Pre-Freshman and Cooperative Education (PREFACE)	OSU	24
17	Pre-First Year (PREF) Summer Program	PSU	25
18	M & M Mentoring	Purdue	26
19	Summer Math Bridge Program	Purdue	27
20	Higher Education Opportunity Program (HEOP)	RPI	28
21	BRIDGE Summer	RPI	29
22	Opportunity Scholars Program	SC	30
23	STEP-UP	UFL	31
24	Intensive Educational Development / SSS	UMD	32
25	Minority Engineering, Mathematics and Science (MEMS)	UNM	33
26	Freshman Experience Program	UNO	34
27	Academic Summer Program Introducing Resources for Engineers (ASPIRE)	VT	35
28	Minority Science & Engineering	Washington	36

Table 2. Population served and other logistics regarding programs in this sample

Ref. #	# Students	At-risk intervention	# Credits	High-performing students	Women's program	Minority program	Assessment available
1	300+	x			x		x
2	200					x	x
3	150-200	x	3 or 6			x	x
4	Minority & transfer					x	x
5	24	x	5			x	x
6	1000				x		x
7	80					x	x
8	Black / Hispanic	x				x	x
9		x	3 & 1				x
10	130				x	x	x
11		x				x	
12	300+	x	varies			x	x
13	All Freshmen						x
14	17	x	9 or 11			x	
15	60		1	x		x	
16						x	
17			6			x	
18	111				x		x
19							x
20	23	x	0			x	
21	12	x	4				
22	50-55	x					x
23				x			
24		x	3 & 1				x
25	200+	x				x	x
26	40		3 & 1				x
27	100	x				x	
28	50-80		0			x	

Table 3. Approaches to engineering discovery used in programs

Ref. #	Build	Take apart	Experiment	Introduce disciplines	Industry tours	Alumni contact
1				x	x	x
2	x	x	x	x		
3						
4			x			
5						x
6			x		x	x
7	x	x	x	x		
8	x	x	x	x	x	x
9						
10					x	x
11						
12				x	x	
13	x	x	x	x	x	
14						
15						
16						
17				x		
18						
19						
20						
21						
22						
23				x	x	
24	x					
25			x			
26	x					
27		x	x	x	x	
28	x					x

Table 4. Approaches to success skills training used in programs

Ref. #	Computer skills	Team skills	Writing	Speaking	Studying	Test-taking	Diversity training	How to learn	Time management	Conflict resolution
1		x			x	x		x	x	
2	x	x	x	x	x	x		x	x	x
3	x	x	x	x	x	x		x	x	
4	x	x	x	x	x			x	x	
5	x				x	x		x	x	x
6		x	x	x						
7	x	x			x	x	x	x	x	
8	x	x	x	x	x	x		x		
9			x		x	x		x	x	
10										
11			x		x			x	x	
12	x	x			x	x	x	x	x	x
13		x	x	x	x	x		x	x	
14			x	x	x	x		x	x	
15										
16	x		x	x	x					
17					x				x	
18										
19					x	x		x	x	
20	x	x	x	x	x	x		x	x	
21	x	x	x	x	x	x		x	x	
22			x	x	x	x		x	x	
23		x			x					
24			x		x			x	x	
25	x	x	x		x	x		x	x	
26			x		x	x		x	x	
27	x	x	x	x	x	x		x	x	
28	x	x			x	x		x	x	

Table 5. Approaches to self discovery used in programs

Ref. #	Personality typing	Thinking preferences	Learning preferences	Career profiling	Advising	Student portfolio	Orientation	Leadership / achievement awards
1				x	x		x	
2				x	x		x	x
3					x		x	
4					x		x	
5					x		x	
6					x	x		
7					x			
8	x	x	x	x	x		x	x
9				x	x		x	
10				x	x			
11		x		x	x		x	
12				x	x		x	
13				x	x		x	x
14					x		x	
15								
16								
17					x			
18								
19					x			
20				x	x			x
21				x	x			x
22				x	x		x	
23					x		x	
24				x	x		x	
25					x			
26					x		x	
27				x	x		x	x
28					x		x	

Table 6. Approaches to develop affiliation used in programs

Ref. #	Common residence	Block scheduling	Residence hall services	Campus citizenship	Links to K-12	Team competitions	Freshman conference	Social activities
1					x	x		x
2	x	x				x		x
3	x	x	x	x				x
4	x	x	x	x				x
5	x	x	x	x		x		x
6								
7								x
8	x	x	x	x		x	x	x
9		x						
10					x		x	x
11				x				
12	x	x	x	x		x		x
13						x		
14	x	x						x
15								
16		x						
17								x
18								x
19								
20	x	x	x					x
21	x	x	x					x
22		x						
23		x	x					x
24	x			x				
25				x	x	x		x
26		x						
27	x	x	x	x				x
28			x	x			x	x

Table 7. Mentoring / learning resources in programs

Ref. #	Peer mentoring	Faculty mentoring	Tutoring	Vertical integration
1	x		x	x
2	x		x	
3	x		x	x
4	x			x
5	x		x	
6	x			x
7	x		x	
8	x		x	x
9			x	
10	x		x	
11	x		x	
12	x		x	
13	x		x	x
14	x		x	x
15				
16	x		x	
17				
18	x			
19				
20			x	x
21			x	x
22	x		x	
23	x	x		
24	x		x	
25	x		x	x
26				
27	x			
28	x			

Table 8. Academic areas included in programs

Ref. #	Multidisciplinary engineering	Math	Physics	Chemistry	History of Technology	Liberal education	Service learning
1		x	x	x			
2		x					
3		x		x			
4	x	x	x	x			
5	x	x	x	x			
6							
7		x	x	x			
8		x		x			x
9		x				x	
10							
11		x					
12	x	x	x	x			
13	x	x		x			
14		x				x	
15							
16		x	x	x			
17		x	x	x			
18							
19		x					
20		x	x	x		x	
21							
22						x	
23							
24		x				x	
25	x	x	x	x			
26		x				x	
27	x	x		x			
28							

Table 9. Engineering topics included in programs

Ref. #	Dimensions	Units	Measure-ment	Algorithms / Programming	Graphical solutions	Plotting	Open-ended problem solving	Well-defined problem solving	Statistics	Ethics
1							x	x		
2	x	x	x	x	x	x	x	x		
3							x	x	x	
4	x	x	x	x	x		x	x		
5	x	x	x	x	x	x	x	x	x	
6							x	x		
7	x	x	x							
8	x	x	x	x	x	x	x	x		x
9										
10										
11										
12							x	x		
13	x	x	x							
14										
15										
16										
17										
18										
19										
20				x						
21				x						
22										
23										
24										
25	x	x	x	x	x	x	x	x		
26										
27	x	x	x	x	x	x	x	x		
28										

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MATTHEW W. OHLAND
Matt Ohland received his Ph.D. in Civil Engineering with a minor in Education from the University of Florida in 1996. He began as an Assistant Professor in Clemson University's General Engineering program in Fall 2000 after serving as the Assistant Director of the NSF-sponsored SUCCEED Engineering Education Coalition and as an NSF postdoctoral fellow. His research is primarily in freshman programs and educational assessment.

ELIZABETH R. CROCKETT
Lib Crockett earned her M. Ed. in Counseling and Guidance Services from Clemson University in 1992. She has advised first-year engineering students in the General Engineering Program at Clemson for 10 years. Her areas of interest and expertise are quality advising, career selection, and academic coaching. Lib is a co-author of *The Mentoring Handbook* published by the National Dropout Prevention Center at Clemson.