AC 2011-316: GUIDANCE COUNSELORS' BELIEFS AND EXPECTATIONS ABOUT HIGH SCHOOL STUDENTS' PRECOLLEGE ENGINEERING PREPARATION

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Guidance Counselors' Beliefs and Expectations about High School Students' Pre-College Engineering Preparation

Abstract

Results from a reliable survey instrument show that guidance counselors (GCs) in *Project Lead the Way* (PLTW; n = 67) and non-PLTW (n = 58) schools hold many common views regarding advising for enrollment in pre-college engineering courses and expectations for future engineering careers. However, GCs in PLTW schools perceive greater availability of school resources for engineering education (p<.001), and greater likelihood that college preparatory skills and concepts in math and science are effectively integrated with engineering activities (p = .02) than non-PLTW GCs. While GCs report that socio-economic factors do not influence advising decisions, comparative analyses across vignettes of fictional students, show SES does influence GCs' beliefs about who should enroll in engineering courses, and expectations of who will succeed in future engineering careers.

Guidance counselors (GC) play an important role in shaping course-taking and career choices. This is of particular importance in career and technical education (CTE). Yet less is known about GCs' views regarding preparation for fields like engineering. The National Research Council[1] calls for educational leaders to optimize knowledge-based resources and energize the United States' science, technology, engineering and mathematics (STEM) career pipeline.

In this study we documented high school GCs' beliefs and expectations about engineering preparation. We administered the Engineering Education Beliefs and Expectations Instrument (EEBEI)[2]. The EEBEI-C (modified for counselors) includes Likert scale items and vignettes asking how GCs advise fictional students with varied academic and socio-economic profiles. We documented statistically reliable differences in the views of those GCs whose schools did and did not participate in a formal, widely adopted pre-college engineering curriculum program. These data provide a portrait of GCs' views regarding students' academic trajectories and career paths of engineers and technicians.

Background

Social-cognitive career theory (SCCT)[3], which guided the data analysis in this study, addresses how internal and external factors influence students' personal agency when forming and pursuing educational and career goals.

School counselors can have a significant impact on student academic achievement and behavior[4], and on the school-to-work transitions of students[5]. Moreover, GC support instruction is associated with engineering students' academic performance[6].

The EEBEI-T is a reliable survey instrument that has been used in two previous studies of teachers (N1 = 144[7]; N2 = 87[8]) to document the beliefs and expectations about pre-college engineering preparation and future career success. Because of the influence of GCs on student

course-taking and the career decisions of students and their parents, we set out to document the influences on GCs' beliefs and expectations for engineering education using a modified version of the instrument specifically designed for GCs.

The Project Lead the Way *Program*

The pre-college engineering program that we focused on is *Project Lead the Way* (PLTW). The PLTW high school program, *Pathway to Engineering™*, offers seven high school courses accredited for college credit. At each PLTW-certified school, at least one counselor must attend a PLTW Counselor Conference offered by the Engineering school or college at one of the 34 affiliated universities. The *PLTW* program has been adopted by over 15% of US high schools, and is present in all 50 states in the US. Thus, *PLTW* is a well-regarded, widely adopted curriculum. Consequently, findings based on its use have far-reaching implications.

Method

Participants

The GC sample included counselors from high schools in the Midwestern US. Names and emails were obtained through the state Education Department. Of the original 150 GCs, 25 contained missing information on at least one of the construct items. This led to a final sample size of 125 complete responses used for the major analysis. In the vignette data we only obtained full responses from 117 GCs, so those analyses reflect the smaller sample size (Figures 1-3). The majority of respondents in the initial sample were white (84%) and female (60%). 53% came from *PLTW* certified schools.

Procedure

The EEBIE-C was administered as an online assessment, using a secure system provided by the university. At the outset, participants reviewed an informed consent statement and learned about the $10 compensation for completed surveys.

Data Source

Instrument Design

The EEBIE-C included 53 Likert items and four vignettes. Below are sample Likert items used in the on-line survey. A 5-point scale (midpoint of 3) was used for rating the *frequency* of events stated in some survey items.

> Item 8a. The math content being taught in courses at my school is explicitly connected to engineering.
>
> 1 (Never) 2 (Almost Never) 3 (Sometimes) 4 (Often) 5 (Almost Always)

A 7-point scale (midpoint of 4) was used for rating the level of *agreement* with statements.

> Item 6a. To be an engineer a student must have high overall academic achievement.
>
> 1 (Strongly disagree) 2 (Disagree) 3 (Somewhat disagree) 4 (Neutral)
>
> 5 (Somewhat agree) 6 (Agree) 7 (Strongly agree)

GCs selected the "radio button" that best matched the degree to which each statement matched their own views.

In addition to the Likert scale items, GCs were presented with four vignettes in order to elicit their views in a less overt, and more situated manner. GCs were asked to predict the likelihood of success in post-secondary engineering studies and careers for four fictional students based on information about course grades, gender, ethnicity, family income, technical experiences in and out of school, and engineering interests. The vignettes were designed to investigate two factors that may be perceived as important predictors of student success in engineering studies: student academic abilities and family social/cultural background. This underlying design was not explicitly stated to participants. For example (Table 1), vignettes V1 and V3 represent two fictitious students who share similar characteristics such as gender, social class status, and interests in engineering, yet differ in academic achievement, as indicated by their GPAs and course grades. Differences in advising and predictions of these students' success can be attributed to GCs' perceptions of the students' academic abilities. Similarly, Vignettes V2 and V4 highlight the differences in students' social backgrounds, controlling for gender, academic achievement, and technical interests.

Results and/ Conclusions

Construct Reliability

Analyses revealed seven reliable constructs ($\alpha \geq .67$), with sample means falling midway on the Likert scales. Two of the constructs (B and F) were split into two sub-constructs to further refine the interpretations of the collected items.

Guidance Counselor Beliefs: Likert Scale Construct Verification

Constructs A, B1, B2, F1, F2, & G used a 5-point scale, with a midpoint of 3 to assess GCs' ratings of the frequency of occurrence. Data from Construct A show that, on average, advising was sometimes shaped by students' academic performance. Construct B1 shows that, as a group, GCs often use students' goals and interests to inform course selection. Construct B2 shows that GCs tend to not use students' cultural, home or ethnic backgrounds to inform course selection advising. Construct F1 shows that GCs believe students sometimes experience the connection between science or math content to engineering activities. Construct F2 shows GCs believe they often advise students about careers in engineering. Construct G sits squarely mid-scale, revealing that GCs, collectively, believe their schools sometimes provide resources, such as internships, for students interested in engineering.

Constructs C, D, & E used a 7-point scale to assess GCs' levels of agreement. The responses from Construct C were the most skewed (mean at 5.926), indicating that GCs agree that students learn science, math and technology in out-of-school settings such as the home or community

centers. Construct D shows that GCs generally agree that high academic performance in math, science and technology courses is pre-requisite to a career in engineering. Data from Construct E reveal that GCs believe that one's cultural or social background (e.g., parents as engineers, or being of Asian descent) has no effect in their decisions about advising students to pursue a career in engineering.

Guidance Counselor Beliefs: Engineering Career Vignettes

Likert scale items ask GCs to respond to overt statements about their beliefs and expectations in the abstract (i.e., to students in general). The vignettes (Table 1) provide insights into tacit views GCs may hold as they make recommendations about specific, fictional student cases. Because the same counselors responded to each vignette, exact McNemar tests (signified by the X statistic) for correlated proportions were conducted to determine whether GCs were treating the vignette students differently[9]. As Figure 1 shows, GCs are generally inclined to recommend enrollment in pre-college engineering courses for all of the students. There are also a considerable number of GCs (25.6%) who would advise the student in V3 away from engineering. Even when controlling for low SES, significantly different proportions of GCs recommended enrollment for V3 (weak academic record) compared to V1, $X(31,0.5) = 1$, $p < 0.001$, and V4, $X(28,0.5) = 2$, $p < 0.001$. Clearly, student academic achievement influences GCs advising practices.

As Figure 2 shows, while student SES was seldom identified as a factor when considering student enrollment in these courses, family background (e.g., parents' occupations) was somewhat endorsed, particularly for V2, where 47% of GCs reported using it in their decision. However, to the GCs in this sample, student social background appears to be much less important than one's prior academic performance.

The third question (Figure 3) asked GCs to predict student's success in a future engineering career. V3 and V4 received the least favorable support. V3, as noted earlier, is a male with a history low academic achievement. GCs' views of V3's academic challenges appear to outweigh V3's interest and experience in technical avocations (assembling cars). The reported influences were significantly different between V1 versus V3, $X(56,0.5) = 1$, $p < 0.001$. V4 is a female with a relatively high GPA, who comes from a family with blue-collar employment and low SES. The difference in GC responses for females described in V2 (similarly high GPA but from a high-SES family with an engineering father) and V4 is striking, $X(59,0.5) = 0$, $p < 0.001$. This suggests that SES influences GCs' decision making in a manner that GCs do not report when asked overtly using other methods (e.g., Figure 2 and Construct E in Table 2).

Differences Between Schools With and Without Project Lead the Way *Certification*

So far, we have addressed the views of GCs as though they represent a homogeneous population with consistent views. The second goal of this study was to see whether the EEBEI-C could detect differences between GCs at schools with different programmatic foci. About half (53%) of the GCs came from schools certified to offer PLTW courses. The final two columns of Table 1 include the inferential statistics comparing GCs responses from PLTW and non-PLTW schools for each of the constructs.

For Construct G, PLTW GCs (mean rating 3.33) were more likely than non-PLTW GCs (mean of 2.61) to report that their schools provide institutional resources such as internships and staff development that support engineering studies. Clearly, the substantial local, school-level human and financial investment in the PLTW teaching and learning innovation is evident to the GCs, and moreover suggests that active counselor engagement is vital to program success. Construct F1 reveals that PLTW GCs believe that the extent to which math and science instruction is connected with students' engineering activities is greater (mean of 3.23) than non-PLTW GCs (mean of 3.00). This important difference suggests that PLTW GCs believe that the PLTW program is more effective at providing the integrative program called for by the National Research Council and the Perkins Act. This may reflect a more integrative curriculum, or it may be due to different definitions or criteria for what constitutes sufficient integration.

Significance of the Study

Overall, GCs in PLTW and non-PLTW schools hold many common views about how their advising practices are influenced by students' academic, cultural and social circumstances. They differ, most importantly, on the degree to which they perceive the integration of technical education and academic subject areas, with non-PLTW GCs more skeptical. Other research, however, suggests STEM integration in curricula[10] and classroom instruction[11] is rare and has negligible benefits for student performance on high stakes achievement tests in math and science[12]. Since integration of technical education and academic subject areas is mandated at both federal (Perkins Act renewal) and professional levels [13], GCs need to be cognizant of the key undergirding values and beliefs in counseling practices that enable all students to develop both academic and career competencies. While GCs overall report that academic factors do and socio-economic factors do not influence advising decisions, the comparative analyses across vignettes showed that academic *and* SES factors influenced both GCs' beliefs about who should enroll in engineering courses, and expectations of who will succeed in future engineering careers. GCs using an accountability framework can challenge views that SES and ethnicity determine children's futures[14]. Given the equity goals of public education and the potential of technical careers to benefit historically under-served groups, this suggests that greater attention to these tacit views needs to be addressed during staff development in the schools and the pre-engineering training programs of GCs.

Limitations of the Study

The EEBEI-C is limited in its scope and does not collect data that specifically probe GCs' views or definitions of engineering. One improvement is future studies is to use the current instrument alongside instruments such as the one created by Yasar and colleagues, that documents teachers' knowledge, familiarity and perceptions of engineers and engineering practice. We also note that generalizations from one sample of GCs from one region of the US are inherently limited and that a replication of these views in other regions or that draws from a national sample is warranted.

Tables & Figures

Table 1. Comparative structure of the four vignettes.

	Vignette 1 (V1)	**Vignette 3 (V3)**
Compares Academic Performance	*Gender*: Male *Grade*: 10th *Background*: low SES *GPA*: 3.85 *Interests*: To enroll in *Principles of Engineering* course; attend college.	*Gender*: Male *Grade*: 10th *Background*: low SES *GPA*: 1.35 *Interests*: Assembling body kits on foreign cars; attend college.
	Vignette 2 (V2)	**Vignette 4 (V4)**
Compares Social Background	*Gender*: Female *Grade*: 11th *Background*: high SES *GPA*: 3.45 *Interests*: To enroll in *Digital Electronics* course; thinks father's work as an engineer is "cool."	*Gender*: Female *Grade*: 11th *Background*: low SES *GPA*: 3.45 *Interests*: To enroll in *Digital Electronics* course; uninterested in her parents' blue-collar jobs.

Table 2. Construct reliability and descriptive statistics for guidance counselors (N = 125), along with inferential statistics for the differences between counselors in PLTW and in non-PLTW schools (* for $p < .05$).

Constructs			Descriptive Statistics					Inferential Statistics	
Construct Title and Interpretation	Scale [Mid]	No. Items	Mean	St. Dev.	Min.	Max.	α	Mean Diff.	p 2-tailed
A. **Influences on Advising: Students' Academic Abilities**. I advise students based on their prior academic performance.	1-5 [3]	5	3.318	0.541	2.20	5.00	0.721	.062	.520
B1. **Influences on Advising: Students' Goals and Interests.** My advising is informed by knowledge of students' goals and interests.	1-5 [3]	4	3.740	0.478	2.50	5.00	0.67	.075	.387
B2. **Influences on Advising: Students' Cultural Backgrounds.** My advising is informed by knowledge of students' cultural backgrounds.	1-5 [3]	3	2.672	0.912	1.00	5.00	0.809	-.192	.244
C. **Beliefs and Knowledge about Student Out-of-School Activities.** Science / math / technical learning takes place in the home and community.	1-7 [4]	5	5.926	0.625	4.60	7.00	0.765	.008	.939
D. **Careers in Engineering: Academic Achievement.** To be an engineer a student must have high academic achievement in math, science and technology courses.	1-7 [4]	7	5.031	0.746	3.00	6.86	0.72	.144	.288

Constructs			Descriptive Statistics					Inferential Statistics	
Construct Title and Interpretation	Scale [Mid]	No. Items	Mean	St. Dev.	Min.	Max.	α	Mean Diff.	p 2-tailed
E. **Careers in Engineering: Social Network/Background.** Students' gender and social background affects how likely they are to pursue engineering.	1-7 [4]	7	3.950	0.948	1.00	5.86	0.851	.002	.991
F1. **Engineering Education: Explicit Integration.** The science and math content taught at my school is explicitly connected to engineering.	1-5 [3]	3	3.123	0.545	2.00	5.00	0.761	-.229	.020*
F2. **Engineering Education: Career Advising.** I advise students about careers in engineering.	1-5 [3]	3	3.845	0.595	3.00	5.00	0.937	.009	.928
G. **Support for Engineering Studies**. We support pre-college engineering at my school.	1-5 [3]	7	2.998				0.794	-.724	.000*

Figure 1. Guidance Counselors' (N = 117) recommendations for the vignette students' enrollment in engineering courses.

Would you advise student to enroll in pre-engineering course the following year?
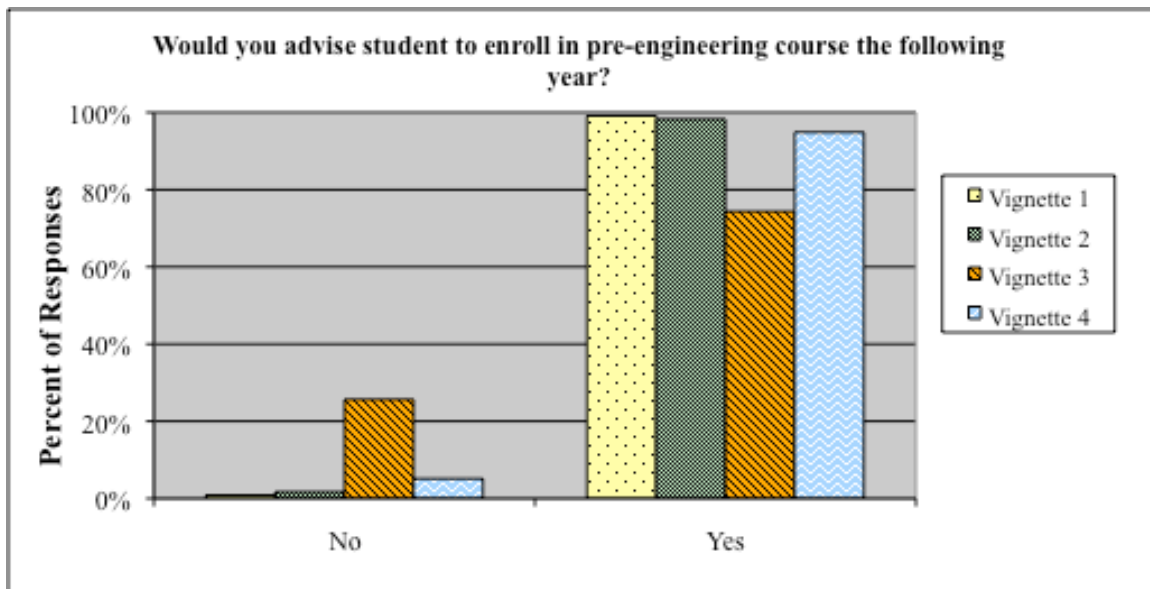
Figure 2. Guidance Counselors' (N = 117) perceptions of factors that influence their recommendations for enrollment of the vignette students' in pre-college engineering courses.
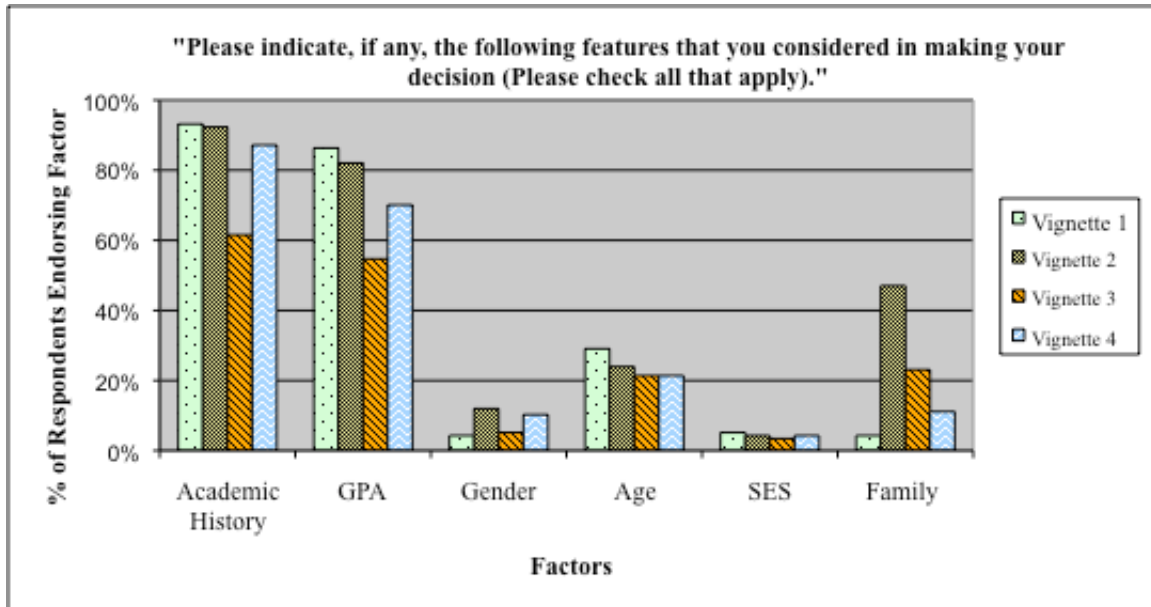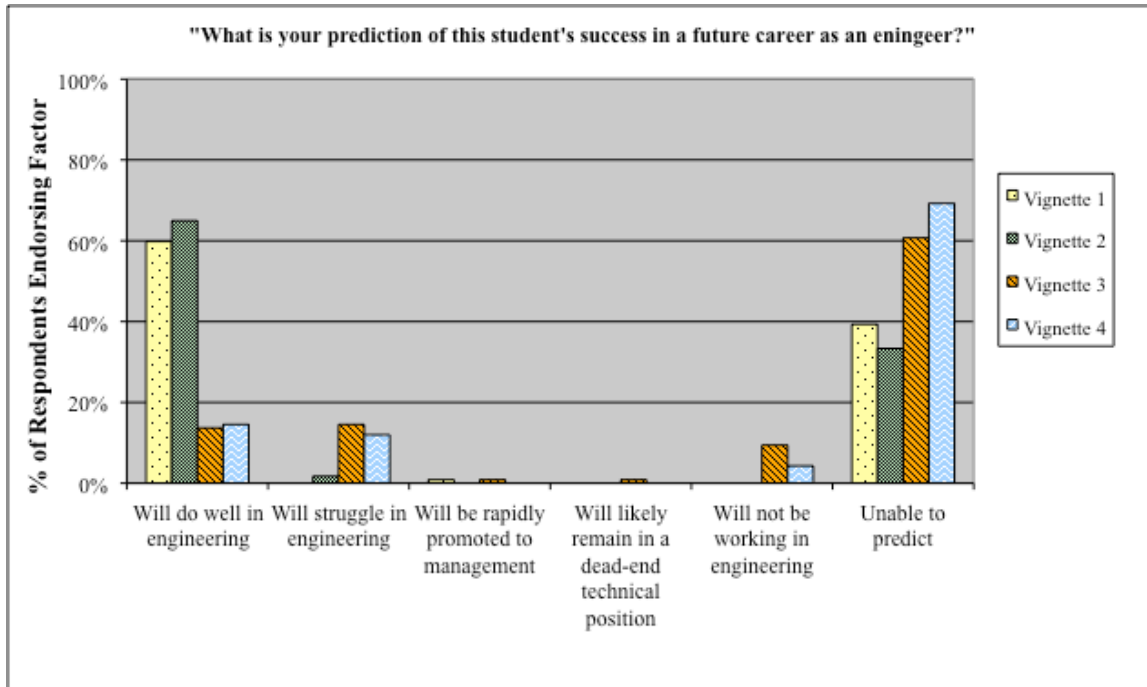
Figure 3. Guidance Counselors' (N = 117) predictions of the vignette students' successes
        in engineering careers.

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