"I Want to be an Engineer, Why Should I Study Biology?” - Using Future Time Perspective to Understand Students’ Beliefs about Foundational Courses

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Jenefer Husman received a doctoral degree in Educational Psychology from the University of Texas at Austin, in 1998. She served as an Assistant Professor at the University of Alabama from 1998 to 2002, when she moved to Arizona State University. In 2008 she was promoted by ASU to Associate Professor. She is currently an Associate Professor in the Educational Studies Department at the University of Oregon. Dr. Husman served as the Director of Education for the Quantum Energy and Sustainable Solar Technology Center - an NSF-funded Engineering Research Center from 2011-2016. Dr. Husman is an assistant editor of the Journal of Engineering Education, and is a member of the editorial board of Learning and Instruction. In 2006 she was awarded the U.S. National Science Foundation CAREER grant award and received the Presidential Early Career Award for Scientists and Engineers from the President of the United States. She has conducted and advised on educational research projects and grants in both the public and private sectors, and served as an external reviewer for doctoral dissertations outside the U.S. She publishes regularly in peer-reviewed journals and books. Dr. Husman was a founding member and first President of the Southwest Consortium for Innovative Psychology in Education and has held both elected and appointed offices in the American Psychological Association (APA) and the Motivation Special Interest Group of the European Association for Research on Learning and Instruction.

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Katherine Cheng is a doctoral student at the Sanford School of Social and Family Dynamics at Arizona State University. She is interested in understanding the origins of students’ academic performance and their well-being. Kat completed her BS and MA in Psychology, and is currently majoring in Family and Human Development. Her research emphasizes a multi-disciplinary perspective, including bringing together constructs from the fields of motivation, human development, and biopsychology. Her research is dedicated to understanding the links between students’ emotions, emotion regulation, attention, and future-oriented motivation with respect to optimal school performance and physiological well-being.

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“I want to be an engineer, why should I study biology?” Using future time perspective to understand students’ beliefs about foundational courses.

**Literature Review**

With attrition being a major concern in engineering programs nationwide [1], efforts to recruit and retain students in engineering have emerged. Coupled with the need to not only get engineers, but also to train them well, practices that promote student success and learning have been emphasized. One major hurdle that engineering students face is getting through their early course work [2,3,4]. The primary challenge for this foundational course work is that it is seeped in complex technical content (e.g., calculus, chemistry, physics, biology, computer science, etc.) that is generally not directly tied to engineering. Foundational courses can be either a limiting factor or a pathway for future success - GPA is a predictor for persistence beyond first-year engineering courses [5,6]. Taken together, even though these courses are necessary to properly scaffold students regarding technical content that they will apply throughout the course of their engineering degree, students struggle to grasp the content which can result in poor performance, which in turn can have a negative impact on their grades.

One approach to research that can be used to understand how and why engineers are successful in their pursuit of an engineering degree, particularly when they are taking foundational courses, is achievement motivation. Research studies have aimed at understanding engineering student motivation [7,8,9], but little of that work has focused on students taking foundational courses. Nelson, Shell, Husman, Fishman, and Soh (2015) did research on students motivations in foundational courses and found that engineering students taking a foundational computer science course had maladaptive motivational beliefs and engaged in maladaptive self-regulated learning behaviors. Even though this work demonstrated that students were not motivated to achieve in foundational courses, more details are needed to properly understand why students were not motivated.

Different theories in motivation offer different insight into how and why students are successful in their engineering pursuits. This research considers three different theories; future time perspective, interest, and belongingness. Future time perspective generally offers explanations for choices students make as they plan for their futures. Two facets of future time perspective include (1) how engineering students see the present task as instrumental for their future as engineers – perceived instrumentality, and (2) how engineering students connect the present activities with their future engineering goals – career connectedness [11]. Students that see the instrumentality of the present task for the futures, and better see the connection between their present goals with their future engineering goals are more likely to be successful. [8,9]. Interest reflects a student’s interest for a particular course. Interest is described as a 4-phase model whereby individuals progress from triggered situational interest to well-developed individual interest through sustained and cultivated affectual and cognitive engagement [12]. Students that are highly interested in a course are more likely to learn the material and be successful. Interest
has been well-studied in underrepresented STEM groups, such as science [13], however little research has looked at interest and/or interest development in engineering. Social belongingness is a more recent construct that represents how well a student feels that they belong to a certain course or domain [14]. Recent work in engineering has shown that social belonging interventions can reduce students’ sense of belonging uncertainty and enhance GPAs [15] - meaning that these interventions lessened students feelings that they did not belong in engineering.

The purpose of this work was to better understand the implications that foundational courses have on students’ motivations in engineering. Particularly, research on belongingness and interest has been described [16], however this research has not been extended to include future time perspective, or to consider engineering student populations. As such, we sought to understand the relationships between future time perspective, belongingness, and interest as a means to explain engineering students’ intentions in foundational courses.

Method

Participants

Engineering students (n = 143: 104 male; 39 female) were recruited from an Introduction to Biology course at a large midwestern university. Participants were 73% White, 24% Asian/Asian American, and 3% Native American, Hispanic, and Black/African American, collectively. Ten participants did not consent, reducing the sample size 133 (97 male; 36 female). Introduction to Biology is one foundational course option that fulfills engineering students natural science requirement for their engineering degree. Engineering students are mixed in with other students taking the course, primarily premedical and biology majors. The course is not tailored to engineering in so much as the content covered is not presented or framed within the context of engineering. Different than pre-medical or biology majors, the engineering students are not required to take the laboratory portion of the course.

Instruments

The engineering students were given a series of instruments at the end of their biology course. Four different instruments were utilized to assess the relationship between future time perspective, course belongingness, and interest.

Future time perspective was measured using two different instruments that represent the two components of future time perspective: perceptions of instrumentality and career connectedness:

Perceptions of Instrumentality (PI): The four items of the endogenous PI instrument were used to assess students’ perceptions of the instrumentality for learning the course material (e.g., “I will use the information I learn in this biology class in the future; What I learn in this biology class will be important for my future occupational success”).
Validation information is available in Husman and Lens (1999), and Husman et al. (2007).

**Career Connectedness (CC):** The eleven items of this instrument assess connections between a student’s present and future career goals (e.g., “One should be taking steps today to help realize future career goals; What will happen in the future in my career is an important consideration in deciding what action to take now”). The instrument was an adaptation of the Future Time Perspective Scale connectedness subscale from Husman and Shell (2008).

**Course Belongingness (CB - E, CB-B):** This instrument contained five items for students feelings of belongingness in engineering (e.g., “The field of engineering is a good fit for me; I think of myself as an engineer”), and six items for students feelings of belongingness in the course (biology) (e.g., “I feel like an outsider in this course, the field of biology is a good fit for me”) - see Walton & Cohen (2011).

**Interest (I):** The four items of this instrument assess students interest in their biology course (e.g., “I’m really looking forward to learning more about biology; Biology fascinates me”). See Harackiewicz, Canning, Tibbetts, Priniski, & Hyde (2016).

For all instruments, students indicated their agreement with each question using a seven-point Likert scale as follows: 1 (Not at all True), 4 (neutral), 7 (Very True). All scores were computed as the mean of the items in the scale, with negative items reverse scored. Reliability was assessed for PI, CC, CB-E, CB-B, and I as $\alpha = 0.85, \alpha = 0.95, \alpha = 0.73, \alpha = 0.76, \alpha = 0.87$

**Analysis**

A set of Pearson correlations were conducted using IBM SPSS Version 22 between the five variables: PI, CC, CB-E, CB-B, and I. All correlations are reported.

**Results and Discussion**

Strong and positive correlations were found between PI and CB-B ($r = .57, p < .05$), PI and I ($r = .69, p < .05$), and CC and CB-E ($r = .70, p < .01$).
Table 1. Correlation Matrix

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<td>2. Career Connectedness</td>
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<td>3. Course Belongingness - Biology</td>
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<td>4. Course Belongingness - Engineering</td>
<td>.12</td>
<td>.75**</td>
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<td>5. Interest</td>
<td>.63**</td>
<td>-.03</td>
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Note: **Correlation is significant at the p<.01 level (two-tailed).

PI were positively and strongly related to I and CB-B, indicating that students who perceived this foundational biology course as instrumental for their future, were interested in the content and felt that they belonged there. CC and CB-E were positively and strongly associated, demonstrating that students who were strongly connected to their engineering careers felt that they belonged in engineering. However, the lack of association between CC and PI and CB-B and PI showed that engineering students who want to be engineers found little instrumentality in the course. The lack of association between PI and CC specifically showed that students’ present goals to become engineers were not related to how they perceived the course as instrumental in reaching that goal. Further, The lack of association between CB-B and PI indicates that students belongingness to biology was not related to how they perceived the course as being instrumental to reach their futures are engineers. Taken together, those students that want to be engineers did not find the course useful for becoming an engineer. Traditionally CC and PI are highly related [9], but in the context of a foundational non-major course, students lacked the association between PI and CC.

PI is an important variable for predicting student’s good strategy use and performance in courses [9], especially, high PI is associated with use of knowledge-building strategies. Knowledge-building strategies are fundamental for learning because students that engage in self-regulated learning are more likely to learn the content [20]. Because the engineering students in this study did not see the the course as instrumental as it relates to their futures as engineers, they may disengage from the content, leading to possible problems with student learning and course performance.
If one of the major limiting problems with foundational courses is poor performance (as described by French et al. (2005) and Veenstra (2009)), then enhancing students’ PI for foundational courses by better connecting the subject matter to engineering (and their perceptions of what an engineer is) may be a possible solution to that limitation. Froyd and Ohland (2005) found that integrating foundational courses with engineering content increased student retention. However, integrating engineering content in foundational courses does not always spell success, as was the case in the research conducted by Nelson et al. (2015) (integrating engineering content into a foundational computer science course did not prevent engineering students from having maladaptive motivational beliefs self-regulated learning behaviors). As such, additional research is needed to understand what the implications of the lack of association between PI and CC and CB-E are for foundational engineering courses. Furthermore, research is need to look at how engineering educators can helps students better connect PI, CC, and CB-E to encourage student success in foundational courses.

Conclusion

Engineering students taking this foundational biology course demonstrated that their belongingness to engineering was no congruent with their belongingness for this biology course. This, in turn, impacted the way in which they perceived this course as both instrumental for their futures as engineers as well as how they connected the present goals to their future goals as engineers. Specifically, engineering students did not connect the instrumentality of this course with their future career goals, and their belongingness in engineering. More research is needed to understand how best to bolster these associations when students take foundational courses in engineering.

References


Motivation-based learning interventions, Advances in Motivation and Achievement series, Volume 18 (pp. 107-140). London: Emerald Group Publishing.


