Board 90: EAGER: Measuring Student Support in STEM: Insights from Year 2

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Allison Godwin, Ph.D. is an Assistant Professor of Engineering Education at Purdue University. Her research focuses what factors influence diverse students to choose engineering and stay in engineering through their careers and how different experiences within the practice and culture of engineering foster or hinder belongingness and identity development. Dr. Godwin graduated from Clemson University with a B.S. in Chemical Engineering and Ph.D. in Engineering and Science Education. Her research earned her a National Science Foundation CAREER Award focused on characterizing latent diversity, which includes diverse attitudes, mindsets, and approaches to learning, to understand engineering students' identity development. She has won several awards for her research including the 2016 American Society of Engineering Education Educational Research and Methods Division Best Paper Award and the 2018 Benjamin J. Dasher Best Paper Award for the IEEE Frontiers in Education Conference. She has also been recognized for the synergy of research and teaching as an invited participant of the 2016 National Academy of Engineering Frontiers of Engineering Education Symposium and the Purdue University 2018 recipient of School of Engineering Education Award for Excellence in Undergraduate Teaching and the 2018 College of Engineering Exceptional Early Career Teaching Award.

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Janice L. Hall is a Ph.D. candidate in Engineering Education at Virginia Tech. She completed her M.S. and B.S. in Bio-engineering at Mississippi State University. Janice is a 2015 recipient of the National Science Foundation's Graduate Research Fellowship and a 2010 Pat Tillman Scholar. Her research interest focuses on broadening participation of women and minorities in engineering and normalizing non-traditional career pathways. Janice is specifically interested in understanding how career concepts influence the career mobility strategies of African American Women in the Technology workforce.

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Dina Verdín is a Ph.D. Candidate in Engineering Education and M.S. student in Industrial Engineering at Purdue University. She completed her B.S. in Industrial and Systems Engineering at San José State University. Dina is a 2016 recipient of the National Science Foundation's Graduate Research Fellowship and an Honorable Mention for the Ford Foundation Fellowship Program. Her research interest focuses on changing the deficit base perspective of first-generation college students by providing asset-based approaches to understanding this population. Dina is interested in understanding how first-generation

college students author their identities as engineers and negotiate their multiple identities in the current culture of engineering.

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Abstract

This paper is a status update for an NSF-funded project aimed at developing and collecting validity evidence for an instrument to help colleges improve the impact of their student support investments. By enabling the assessment of support provided to undergraduate students in STEM (science, technology, engineering, and mathematics), such an instrument will aid STEM educators and college administrators in monitoring progress and identifying unmet needs in local environments, thereby providing data-driven evidence for targeted interventions. In this executive summary, we present: 1) an overview of the instrument development process; 2) an evaluation of the prototype for face and content validity; and 3) a revised instrument and pilot data to determine test validity and reliability across varied institutional contexts.

Project Overview

We began the instrument development process with theoretical constructs from the model of co-curricular support (MCCS), which is a conceptual model that deconstructs student support to the latent experiences that should be facilitated to support student success. The MCCS explains how students' interactions with the academic, professional and social systems of a college could influence their success more broadly in an undergraduate STEM degree program. A more in-depth discussion on the MCCS and its development can be found in [1],[2]. Our initial item bank began with statements pertaining to six constructs from the MCCS and a review of existing instruments germane to the topic of student support. We then went through several rounds of stakeholder feedback before our first pilot (version 1.0) in spring 2018. An exploratory factor analysis (EFA) on our Pilot 1 data was used to revise the instrument, resulting in version 2.0. Additional feedback from undergraduate students and our institutional partners was then used to further refine the instrument before a second pilot in spring 2019. Data collection for the pilot of version 2.0 is ongoing. A diagram outlining our instrument development process and a partial timeline of our progress to-date can be seen in Figure 1.

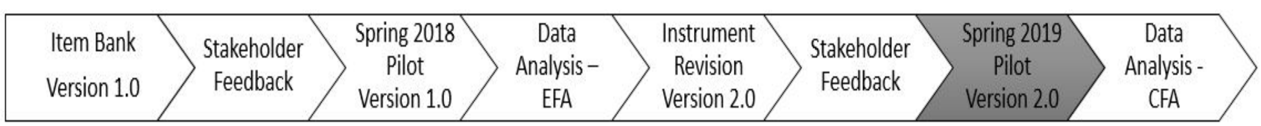

Figure 1. Overview of instrument development process for Supporting Student in STEM.

Developing Version 1.0

The initial item bank underwent a series of feedback and edits from different stakeholder groups. In total, we solicited four rounds of feedback. Two rounds involved undergraduate STEM students across two institutions, using a combination of focus groups and interviews. We also solicited two rounds of feedback from graduate-level engineering education researchers as well as STEM administrators. In total, we received feedback from 46 stakeholders (38 students, 8 administrators). We intentionally sampled for representation across (or in) focus areas, including: STEM disciplines; gender; race/ethnicity; international students; and transfer students. Feedback was important for instrument revision and aided the research team in identifying and removing items that were not consistent with project goals; rewording or expanding items for clarity; providing suggestions on dimensions of student support that had not yet been fully captured; collapsing questions that were redundant; and dividing questions that were double barreled.

Piloting Version 1.0

The initial version of the instrument consisted of eight sections: 1) academic support, 2) faculty-interaction support, 3) extracurricular support, 4) peer-interaction support, 5) professional-development support, 6) additional support, 7) student involvement, and 8) demographics. For sections about various types of support (sections 1-6), students were asked to rate their level of agreement with each statement using an anchored numeric scale from *1 - Completely Disagree* to *5 - Completely Agree.* Students were also given an option of *Does Not Apply to Me*. The instrument was deployed in spring 2018 at three universities, resulting in responses from 722 STEM students. Though participants were spread across three universities, ~82% of participants came from the same institution. A majority of respondents identified as women (~57%), followed by men (~39%). The remaining 4% identified as either genderqueer/nonbinary, transgender, agender, gender not listed, or preferred not to answer. While the majority of participants identified as white (~75%), we did have racial/ethnic participation from 8 distinct groups including: *East Asian, South Asian, Hispanic/Latino/a, Black/African American, Southeast Asian, Middle Eastern/North African, American Indian/Native American, Native Hawaiian/Pacific Islander*, with some participants choosing to identify as *Another Race/Ethnicity.*

Initial Data Analysis

We tested construct validity using a correlation analysis and a maximum likelihood exploratory factor analysis (EFA). EFA allowed us to examine if the items we used to measure the specific support constructs actually measured a common set of students' perception of support. This technique also allowed us to estimate how much error was associated with the measurement of these perceptions of support across different dimensions [3]. We followed four steps to conduct the EFA: 1) extracting the number of underlying factors measured; 2) conducting the analysis with the expected number of factors; 3) interpreting the factors as well as the quality of the solution; and 4) iteratively run factor analysis until the solution accurately fits the data and theory.

We used maximum likelihood estimate with a promax rotation. Maximum likelihood estimation method allows researchers to compute a wide range of fit indexes, test the statistical significance of factor loadings, calculate correlations among factors, and compute confidence intervals for these parameters. A promax rotation was used to allow the underlying constructs to be related to one another. Given the context of this study of student perceptions of support, we expected the factors to be correlated. We used both parallel analysis and a scree plot of the eigenvalues for models with different numbers of underlying factors to determine the number of underlying factors to extract [4]. These methods identify the most likely number of underlying factors. Once we determined the number of underlying factors, we estimated the model and evaluated it for fit.

In determining the quality of the model, we took into account several considerations: there should be more than two observed variables loaded onto each factor, all factor loadings should be above 0.32, variable communalities should be in a range from 0.40 to 0.70, and variables should not load onto two or more factors (i.e., cross-loading [5 - 7]). Observed variables that violated any one of these considerations were removed from the analysis. After removing poorly behaving variables, EFA was re-run to until a factor solution that met all the criteria was achieved.

We analyzed each construct and its associated items for factor loadings and noted some disciplinary differences among student responses. For instance, the items under construct Faculty-Interaction Support in version 1.0 loaded into three separate factors for COE (college of engineering) students but only one factor for students in COS (college of science). Upon examination of the wording, the resultant factors for engineering students appear to make distinctions among interactions with STEM versus non-STEM faculty where the following items loaded as separate factors *"A majority of my instructors want me to succeed*" and *"I had a STEM faculty member who I consider a role model.*" The COE students further responded in a manner to suggest that they perceive support from faculty interactions differently based on the context of the interaction, whether it was directly related to academic work "*I received responses from my instructor in a timely manner*" or to building a social network as demonstrated by the item, "*I was encouraged to interact with STEM faculty members outside of class*." Items like these were split among Faculty Support, Developing a Local Network and STEM Faculty Connections in version 2.0 of the survey.

Developing Version 2.0

An overview of changes from before and after the EFA are detailed in Table 1.The evolution of our instrument began with six student support constructs and 94 items regarding student support, as well as a section containing demographic items and another to capture student involvement to facilitate data disaggregation. Version 1.0 had a total of 108 items including all sections of the survey. After EFA, data analysis, we went from 6 anticipated to 13 actual student support constructs and from 94 to 54 student support items. After initial data analysis, the resulting factors were given tentative construct names. These tentative construct names and associated items were the focus for the second round of revisions to the instrument.

Next, the research team developed additional items to make each construct more robust, increasing the number of student support items from 54 to 89. We consulted with content experts (e.g., academic advisors) and referred to existing instruments to generate new items. The revised survey was then sent out for additional feedback from stakeholders. We received feedback from our Advisory Board members and Institutional Partners on the revised construct names as well as newly added items. In late Fall 2018, we also conducted nine interviews with undergraduate STEM students to receive feedback on the comprehension of newly added items, item order, and the tentative construct names. Based on stakeholder feedback we made the following changes to the instrument: expanded or re-worded items, reordered items following a logical progression (e.g. peer, faculty, university), categorized newly formed items in existing constructs, and altered language used in survey instructions to encompass more student experiences. During interviews with undergraduate stakeholders another construct also emerged (e.g., *Graduate Student Connections*), bringing the total number of student support constructs to 14 with 92 items.

Table 1. Changes to Student Support in STEM Survey Construct Labels and Corresponding Number of Items Before and After Exploratory Factor Analysis (EFA)

Instrument 1.0 Construct Name [# of items]	Instrument 2.0 Construct Name [# of items]	
Student Support Items – 94 **Total Items – 108**	Student Support Items-92 **Total Items - 107**	
Faculty-Interaction [13]	Academic Advising Support [8]	Diversity and Inclusion Support [9]
Peer-Interaction [18]	General Career Development [6]	Personal and Student Affairs Support [7]
Academic Support [12]	STEM Faculty Connections [7]	Faculty Support [9]
Professional Development [21]	STEM Career Development [7]	Cost-of-Attendance Support and Planning [7]
Extracurricular Support [14]	Academic Peer Support [6]	Graduate Student Connections [5]
Additional Support [16]	Developing a Local Network [5]	Engaging with Professionals [5]
	STEM Peer Connections [5]	Extracurricular Information [6]

Limitations & Future Work

As the project is ongoing and developmental in nature, we do not currently have any limitations to report. However, we do plan to pilot version 2.0 of our survey instrument with a broader set of STEM students and institutions in spring 2019. Our target sample for the second is 1,000 students, so we aim to distribute the survey instrument to ~6,500 students based on a 15% anticipated response rate. Given that we are piloting this version on a new student sample, we will conduct a confirmatory factor analysis following data collection to continue establishing construct validity and report on the stability of constructs. To date, we have at least 6 institutions committed to distributing version 2.0. We plan to continue investigating differences across constructs by subgroups of students as well as institutional contexts.

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