AC 2010-1480: STUDENT SUCCESS – ORIENTED NEEDS ANALYSIS FRAMEWORK: A PILOT STUDY

Tracee Gilbert, Virginia Tech

Tracee Walker Gilbert is a Ph.D. candidate in Industrial and Systems Engineering at Virginia Tech. Her research focuses on designing and applying ISE methods and tools to improve engineering education, with particular emphasis on new approaches that will have lasting effects for the success of women and minority students in K-12 and higher education. Prior to pursuing graduate studies full-time, she worked as a Senior Systems Engineer in private industry where she lead projects to develop Geospatial Intelligence Systems from concept through implementation.

Janis Terpenney, Virginia Tech

Janis Terpenney is a Professor in Mechanical Engineering and Engineering Education, and an affiliate faculty of Industrial & Systems Engineering at Virginia Tech. She is Director of the NSF Center for e-Design, a multi-university I/UCRC center. Her research focuses on process, methods, and tools for early design and on engineering design education. She is a member of ASEE, ASME, IIE, and Alpha Pi Mu and is the Design Economics area editor for The Engineering Economist and the Associate Editor for Design Education for the ASME Journal of Mechanical Design.

Sharnnia Artis, The Ohio State University

Sharnnia Artis is a Postdoctoral Researcher in the College of Engineering at The Ohio State University (OSU) where she conducts research in engineering education with a focus on engaging women and under-represented populations. Prior to joining OSU, Dr. Artis worked as a Human Factors Engineering Consultant in the private sector. She received a B.S., M.S., and Ph.D. in Industrial and Systems Engineering from Virginia Tech.

Student Success-Oriented Needs Analysis Framework: A Pilot Study

Abstract

Student success research in higher education has provided an immense understanding of those factors that explain why students decide to leave, and to some extent, why students persist on to graduation. However, few studies have leveraged student success research to identify an inventory of needs that should be met in order for students to succeed in college. This paper leverages a collection of influential student success theoretical perspectives to develop a needs analysis framework to elicit and identify engineering student success needs. The framework provides a structured participatory method to translate vague student needs into actionable statements that holistically capture the needs of engineering students. The results of a pilot study are presented to demonstrate the applicability of this framework.

I. Motivation

For over 70 years, researchers have been attempting to unravel the complexities associated with enhancing student success in higher education¹. Student success research has resulted in a better understanding of why some students decide to leave, and to some extent, why students decide to persist on to graduation. In spite of all the research that has been conducted, little work has been devoted to translating the various theoretical findings into specific strategies that will guide institutions in improving student success outcomes^{2,3}.

This paper is a part of a larger research effort to develop a Student Success-Oriented System Design (S²OSD pronounced “SAWS-D”) methodology, which will integrate student success research with a growing body of knowledge on customer-oriented systems approaches in order to address the following pressing need: How can institutional leaders in higher education translate the needs of their students into actionable solutions that will foster student success? In order to provide a concrete course of action for institutional leaders to design practices that meaningfully facilitate student success, institutional leaders must first have an understanding of the needs of their students. Therefore, this paper presents a framework that describes the development and the results of a pilot study to test the Student Success-Oriented Needs Analysis (S²ONA pronounced “SAWNA”) framework. Specifically, this paper will provide:

- a framework that is guided by student success theoretical perspectives;
- a participatory method to elicit, identify, and document student success needs;
- a mapping process to develop precise need statements that holistically capture a comprehensive set of engineering student needs of students; and a
- questionnaire to evaluate the S²ONA framework

II. Student Success Theoretical Perspectives

The S²ONA framework (within the S²OSD methodology) is motivated by a collection of student success theoretical perspectives. A cursory review of the most comprehensive and influential theoretical perspectives is presented in Table 1 to provide an understanding of those factors associated with student success.

Table 1: Relevant Student Success Theoretical Perspectives

Perspective	Theory	Purpose
<i>The Sociological Perspective</i>	Student Integration Model ⁴	Students' decisions to persist or to drop out are based on their integration into the formal and informal academic and social systems of the institution.
<i>The Organizational Perspective</i>	Student Attrition Model ⁵	Concentrates on the impact that the institution (i.e., organization) has on the socialization and satisfaction of students.
<i>The Psychological Perspective</i>	Student Attrition Model ⁶	Focuses on the role of psychological characteristics that distinguish between those students who persist and those who drop out.
<i>The Financial Perspective</i>	Financial Nexus Model ⁷	Highlights the role that finances play in persistence decisions.
<i>The Minority Perspective</i>	Student/Institution Engagement Model ⁸	Emphasizes the unique challenges that diminish the quality of the minority student college experience.
<i>The Involvement, and the Engagement Perspective</i>	Theory of Involvement ⁹ , and Student Engagement ¹⁰	Focuses on the behaviors that students engage in and the institutional conditions that are related to student success.

These perspectives provide insight into those factors that foster student success, which include academic preparation and the student experiences while in college¹¹. Student experiences emphasize both student characteristics/behaviors and institutional conditions that impact student success. Student behaviors include involvement in extracurricular activities, interaction with faculty and peers, motivation, and commitment, while institutional conditions include the resources and educational practices that facilitate positive student behavior¹¹. Since this research is focused on providing the foundation for designing student success practices, the S²ONA framework is focused on student experiences that the institution can impact. Therefore, pre-college characteristics and preparation are excluded from the S²ONA framework because they are beyond the direct control of the institution.

Additionally, each of the theoretical perspectives (with the exception of the Involvement/Engagement Perspective) in Table 1 focuses on attrition, retention, and persistence. Even though these perspectives provide a thorough understanding of the factors that explain why students decide to leave and/or stay in college, these theories fail to provide decision makers with an inventory of needs that should be met in order for students to succeed in college. For example, African-American students may leave their engineering programs because of the psychological effects related to racial discrimination. While Asian students do not typically experience feeling left out because they are perceived as inherently inferior, they do experience

feeling left out because of their perceived academic superiority. As a result, the student need is to have a welcoming environment where students feel a sense of belonging.

Lastly, a multitude of variables from each of the student success theoretical perspectives can be used to guide our understanding of those factors that are critical to student success. Based on a review of these theoretical perspectives, Gilbert et al.¹² developed a typology of student success needs that will serve as the foundation for this study.

III. Needs Identification and Analysis

While higher education research has focused on success from a student orientation, there is also a large body of research that is devoted to understanding and satisfying customer needs as the means for achieving success. From a marketing perspective, organizations adopt a customer orientation to obtain and use information from customers, develop strategies to meet customer needs, and implement those strategies by being responsive to customer needs. Similarly, a quality management approach adopts a customer orientation that requires the entire organization to focus on providing products and services that fulfill customer needs¹³. Lastly, systems engineering provides an interdisciplinary process to transform customer needs into system solutions^{14, 15} that optimally satisfy their need. Central to each of these approaches is the underlying assumption that the customer needs form the basis from which success is realized.

In order to provide a concrete course of action for institutional leaders to design practices that meaningfully facilitate student success, institutional leaders must first have an understanding of the needs of their students. This is the goal of any engineering design problem: to translate the voice of the customer (VoC) into a description of what needs to be improved¹⁶. This process is often referred to as a needs analysis, which is concerned with determining the true needs of the customer¹⁷.

Although the “student as a customer” metaphor is widely debated, this paper adopts a more commonly accepted fundamental premise that students are the primary beneficiary of the college experience. Therefore, they should be incorporated into the process of identifying their needs and designing student success practices to meet their needs. It should also be noted that there are multiple stakeholders (e.g., students, faculty, industry, and society) in the higher education system that should also be incorporated into this process (see Gilbert et al.¹⁸). However, this study focuses on the students to demonstrate the applicability of the S²ONA framework, and to highlight the importance of the voice of the “student”.

While engineering design has not traditionally focused on students, its fundamental premise offers promising insights for understanding and designing a system of practices that meet the needs of engineering students. Just as technical systems perform specific functions, institutional practices are designed to fulfill specific actions and activities required to facilitate student success. Therefore, “requirement-like” statements will be developed to precisely capture the fundamental actions required of institutional practices to foster student success. These actionable need statements will subsequently be used to develop improvement strategies (in a later phase of the S²OSD methodology) that address those needs.

A. Student Success-Oriented Participatory Design Method

The S²ONA will utilize the S²OPD method, which is defined as a participatory system design method that facilitates a team-based meeting approach to identify and document student needs, improvement strategies, and a plan of action that fosters student success. In this paper,

the S²OPD method will be used to identify and translate the voice of the “student” into actionable need statements. Central to this approach is a participatory and customer-centered design philosophy^{19,20} that incorporates the primary beneficiaries (i.e., the students) of the college experience into the S²ONA framework.

Figure 1: S²OPD process

Gilbert¹⁸ summarizes key aspects of the S²OPD method, which have been adapted from commonly used qualitative and participatory design methods. The structure of the S²OPD method follows a five- step process illustrated in Figure 1. The *Inform* step educates participants about the goals and objectives, procedures, and key outputs to inform participants of their roles and responsibilities during the meeting. During the *Elicit* step, the researcher guides a group discussion to obtain information to help determine the perceptions and ideas of the group based on the scope of the meeting. The *Generate* step then uses system design and quality management tools to organize the initial brainstorming ideas (resulting from the *Elicit* step) into a structured format. Finally, the group will ensure that the final output addresses meeting objectives during the *Validate* step. At the conclusion the meeting, participants will then be asked to *Evaluate* the usefulness of the framework.

B. Participants

A snowball sampling approach was used to recruit freshmen engineering students to participate in the pilot study. Former students from the Patriots Technology Training Center were recruited to participate in this study. Participants were contacted by phone, and four freshmen engineering students from two Northeastern universities participated in the study.

C. Student Success-Oriented Needs Analysis (S²ONA) Framework

The S²ONA framework provides a guide to elicit, generate, and document the needs of engineering students. The purpose of this framework is to translate the voice of the “student,” often expressed as vague ideas in their own words, into functionally precise statements. These actionable need statements (i.e., requirements) are developed to capture a comprehensive set of engineering student needs. As illustrated in Figure 2, the S²ONA framework incorporates the S²OPD process as described below:

Figure 2: S²ONA Framework

Step 1: Inform

Participants were asked to share their experiences in a group discussion that was guided by the researcher over the course of a 2-hour period. Prior to conducting the meeting, three goals were established. Additionally, three objectives were also established to ensure that the meeting was focused on identifying student needs in the context of the student success theoretical perspectives.

- ***Goal #1: Identify enablers and hinderers of engineering student success.*** Identifies enablers or causes that lead to student success, and hinderers or barriers that impede student success.
 - ***Objective #1: Define critical factors in the context of student success.*** Identifies those factors that will lead to retention, graduation, and academic achievement in the engineering program.
 - ***Objective #2: Include only post-enrollment factors.*** Identifies only those factors that the institution can directly impact (e.g., “improving high school math instruction” could not be included because this is outside the scope of the institution’s influence).
- ***Goal #2: Translate enablers/hinderers into student need statements.*** Defines functionally precise need statements.
 - ***Objective #3: Generate actionable need statements.*** Defines functionally precise need statements that provide a specific or discrete action that must be performed by institutional practices.
- ***Goal #3: Provide a comprehensive set of student needs.*** Organizes the student need factors (i.e., categories), and groups them with their associated need statements to provide a comprehensive set of student needs.

To achieve these goals, Figure 2 summarizes the mapping process that is embedded in the S²ONA framework to execute each part of the meeting. The mapping process describes the process of translating the voice of the “student” into a comprehensive set of student needs that will foster student success. The following color coding scheme was used in the remaining steps to track key aspects of this process:

- Blue – Enablers
- Pink – Hinderers
- Yellow – Student Need Statements
- Green – Student Need Factors
- White – Pre-defined Student Need Factors (based on the student success theoretical perspectives)

Step 2: Elicit

Once participants had an understanding of the scope of the meeting, they were guided through a brainstorming exercise by the facilitator. The discussion questions allowed the group to reflect on their own experiences and provide their perception of those needs that facilitate engineering student success. To ensure that participants clearly understood what is expected of them, each discussion question was initially posed to the group to provide an example.

- **Discussion Question #1: What characteristics of your engineering experience have enabled and/or hindered your success?** (Each *enabler* was written on a blue Post-it note and each *hinderer* on a pink Post-It note.)

The starting point for the brainstorming exercise was the typology of “student success” needs: academic, social, psychological, environmental, and financial needs. For each of these student need factors, the group was asked to write down their ideas on a piece of paper. On the left side of the paper, participants were instructed to affix the blue Post-It notes that describe characteristics of their engineering experience that have enabled (or caused) their success. On the right side, participants were instructed to affix pink Post-It notes that describe characteristics that have hindered their success.

- **Discussion Question #2: How would you group the enablers/hinderers into major categories?** (Each category will be written on a separate green Post-it note.)

Once the students identified the enablers and hinderers, then they grouped their responses into major categories. In a round-robin fashion, each participant was asked to share their ideas by putting their self-adhesive Post-It notes (from discussion question #1 and #2) onto the walls of the conference room and discussing their input with the group.

- **Discussion Question #3: What needs must be fulfilled in order to facilitate the success of engineering students?** (Each need statement was written on a separate yellow Post-It note.)

The purpose of this question was to transform the enablers and hinders into actionable need statements using yellow Post-It notes. This required the group to write functionally precise statements that describe those actions that are needed to facilitate student success.

Step 3: Generate

The third step in the process required the team to analyze and structure the need statements into a hierarchical structure using the affinity method. This method is a brainstorming technique for generating ideas in a group setting, which is used to analyze and organize ideas based on their natural relationships⁴².

Next, the group graphically organized the student need statements based on the initial pre-defined student need factors (white Post-It notes). The associated student need statements (yellow Post-It notes) were connected to generate the affinity diagram in the form of a tree.

Step 4: Validate

The final step of the meeting allowed the group to determine whether the output satisfies the meeting’s goals. First, the group reviewed the meeting’s goals to ensure that they had been achieved. Then, the team reviewed the final affinity model to ensure that there was agreement among the group with respect to its ability to meet the stated goals. In some cases, open issues still remained and the group iterated through the meeting process to elicit, generate, and validate the output.

- **Discussion Question #4: Are all of the need statements critical to student success?**

- **Discussion Question #5: Do you have additional input that needs to be added to make the affinity model complete?**

Step 5: Evaluate

A formative evaluation was performed to collect feedback from the users of the S²ONA framework in order to evaluate the usefulness of the approach. A performance-based approach to evaluation was used to collect quantifiable information that helped to determine if the S²ONA framework actually met the goals it set out to achieve. Performance-based evaluations are useful in clarifying the efficacy of the process and the quality of the outputs produced^{20,21}. As shown in Table 2, a 5-point performance-based Likert scale was used to evaluate the S²ONA.

Table 2: S²ONA Evaluation

	Please answer the following questions.	1 = Strongly Disagree	2	3	4	5 = Strongly Agree
Design Goals	This meeting was able to draw out needs that I may not have considered at the start of the meeting.	☐	☐	☐	☐	☐
	This meeting was able to transform my needs from my initial broad ideas into functionally precise statements.	☐	☐	☐	☐	☐
	This meeting was able to comprehensively define the needs of engineering students that facilitate their success.	☐	☐	☐	☐	☐
Ease of Learning	I did not encounter problems in learning the process.	☐	☐	☐	☐	☐
	My peers could learn how to use this process.	☐	☐	☐	☐	☐
	My role in this was clear and understandable.	☐	☐	☐	☐	☐
Ease of Participation	My participation in this process was straightforward.	☐	☐	☐	☐	☐
	My peers could participate in this process with ease.	☐	☐	☐	☐	☐
	I did not encounter problems participating in the process.	☐	☐	☐	☐	☐
Usefulness	I would recommend this approach to faculty and program administrators.	☐	☐	☐	☐	☐
	The information generated from this meeting can be used to understand the needs of engineering students.	☐	☐	☐	☐	☐

What aspects of the meeting were effective?
If you encountered any problems, please explain.
What needs to be improved?

IV. Results and Discussion

This paper presented a S²ONA framework that described a team-based approach to elicit, identify, and document the needs of engineering students. Engineering design concepts were adapted to define a framework that transformed broad ideas into a comprehensive set of functionally precise statements in a team setting. Additionally, student success theoretical perspectives were presented to provide a guiding theoretical framework for justifying relevant student needs.

The results of the S²ONA framework are described in Table 3, in which the final affinity model was transcribed into a table format. The output of the framework is consistent with the student success theoretical perspectives. Unlike the theoretical perspectives, the S²ONA framework provides decision makers with a set of student need statements that describe a concrete set of actionable requirements that institutions must perform to facilitate student success. However, the omission of various aspects (e.g., campus climate, active and collaborative learning) highlights the importance of conducting 3 to 5 group sessions to increase the likelihood of capturing a more comprehensive set of student needs.

Figure 3 illustrates the results of the S²ONA evaluation. The four participants reported high levels of satisfaction with the S²ONA framework in terms of meeting the design goals, ease of learning, ease of participation, and usefulness of the framework. Participants were overwhelming satisfied with the mapping process to translate their broad ideas into concrete student need statements. One participant indicated that “the process of brainstorming for topics and solutions for ways to generalize areas needed for a successful experience in engineering” was effective. The only area that is in need of improvement is to ensure that participants have a clear understanding of each discussion question. This is accomplished by having the team first answer an example question collectively as a group before they individually provide their responses.

Figure 3: S²ONA Evaluation Results

V. Conclusion

Research in engineering student success can benefit from the S²ONA framework presented in this paper to enhance our understanding of how to elicit, identify, and document student needs. Additionally, this paper introduces a fundamental premise that is germane to most, if not all, engineering design efforts; however, it is missing from the student success theoretical perspectives. A structured approach to understanding needs is a prerequisite for designing effective practices. Based on the results of this study, the S²ONA framework will be used to develop an Engineering Student Needs Questionnaire. During this phase of the S²OSD methodology, institutional decision makers will be assisted in understanding the unique needs of their student population, as well as prioritizing the most important needs, which will then be used to develop improved student success practices.

Table 3: Output of the S²ONA Framework

Categories (White)	Student Need Factors (Green)	Student Need Statements (Yellow)	Hinderers (Pink)	Enablers (Blue)
Environmental	Safety	To feel safe		
	Facilities	To have up to date facilities	Library	Library
Academic	Study groups/Tutoring	To assist with time management	Time management	Mandatory Tutoring
		To help adjust to college life		
		To help understand concepts		
	Professional Development	To be aware of opportunities related to your major	Lack of broadcasted opportunities	Plethora of opportunities
		To gain insight on what your career will entail		
		To have practical opportunities to apply coursework		
	Peer Support	To have a positive peer group that challenges you academically	Friends (Peers)	Focused friends/peers
		To have an upperclassmen peer support to provide academic success	Other Students	Other Students
				Studying/Mentor
				Mentors
Psychological	Teachers/Professors/Advisors	To effectively communicate with professors	Hard time understanding professors	
		To have accessible and approachable professors		Office hours
		To receive clarification on coursework		Easily accessible professors
	Coursework/Problem Solving Skills	To familiarize you with your major		Intro to engineering class
		To have the ability to be able to work and analyze different situations		Courses associated with major
Financial	Support	To ensure you are on the right track.		Strong support system
		To check up on you		
		To support you through your freshmen year		
		To get incentives to do well		
Social	Financial	To ease the financial burden	Financial aid	Scholarships
		To promote a comfortable lifestyle		
	Networking Relationships	To advise you to make good decisions		Mentor
		To build relationships that support you		
	Extramural Participation	To provide a network of students with a common goal	Campus activities	Student Organizations
		To be a part of campus life		Engineering Student Organizations
		To provide a network of opportunities external to the university		

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