Framework for Unit Research & Evaluation: A White Paper
ABSTRACT

Timoteo Rico, Ed.D.
Executive Director, CSAA

Neil Huefner, Ph.D.
Interim Associate Director

Maria T. Frías, Ph.D.
Senior Research Associate

Ling Ning, Ph.D.
Senior Research Associate

Version 2.1

Introduction

Delays in the timely graduation of undergraduates can have costly socioeconomic ramifications for students, their families, prospective students, the State, and the University. Likewise, low student retention rates can have far-reaching negative impacts on individual students and on society at large. Between the years of 1971 and 2001, both enrollment (post-secondary education) and the number of degrees awarded increased nationally (U.S. Department of Education, 2008); however, the relative rates at which these two measures increased was often far from optimal. For example, in one study it was found that while the number of 23-year olds with some college experience rose by 31%, there was only an increase of about 4% in the number of degrees attained (Turner, 2004).

At the University of California, although the average freshmen-four-year-graduation and the transfer-two-year-graduation rates over the past decade have hovered in the mid-50% range (Institutional Analysis & Student Research Information System, 2015), disaggregation of the graduation data shows a *decrease* (of up to 10% in some cases) in the graduation rate for several subpopulations.

The Division of Student Affairs has long provided a myriad of student-focused services aimed at supporting students in their success and growth at the University; however, until recently, relatively little time and effort has been devoted to documenting and trying to gain a rigorous understanding of the actual impact such services have on key student outcomes. Both the University and the legislature have emphasized the importance of making evidence-based, data-informed decisions in the implementation and optimization of activities targeted to improve graduation rates. With a projected increase of approximately 5,000 additional undergraduates at UC Davis by the year 2020, it is especially important that we establish proper and robust

methods for exploring factors that influence student retention, academic progress (units completed), academic performance (GPA), and graduation rates as promptly as possible. What follows is an outline of the long-term research and assessment approach being undertaken by the Center for Student Affairs Assessment (CSAA) under the direction of the Division of Student Affairs. Its initial aims are to identify environmental factors (influenced or potentially influenced by the Division) that contribute, positively or negatively, to undergraduate retention, academic progress, academic performance, and graduation, and to investigate the ways in which those factors are (or may be) modulated by services, resources, and programs offered to students by the University.

Background

Historically, two important impediments to the meaningful evaluation the Division's programs have been 1) the absence of consistent, clearly defined metrics and nomenclature used across both time and programs, and 2) vague or inconsistent guidelines regarding the selection of student outcomes. Frequent shifts in focus, demands, and expectations (from the unit or program level all the way to the institutional, state, and federal levels) have fostered a reactive rather than a proactive approach in assessment and the demonstration of good stewardship of institutional resources.

From a General Systems Theory standpoint, the Division of Student Affairs functions as a system with connections to multiple components of the environment (Bess & Dee, 2008). In integrating students with the University, undergraduates are often expected to adapt to the institutional environment; however, it is also important to adapt the environment to the changing needs of the students is serves. The key unit of measure with regards to environmental engagement is undergraduate utilization (operationalized as participation frequency) of

divisional unit services that contribute to the student's *talent development*. It is important to point out that the General Systems Theory approach may provide a greater understanding of both the inputs (undergraduate characteristics prior to university enrollment) in the context of the environment, and of the inputs' relationship to the output (retention and degree attainment). To gain a clear understanding of the system, it is important to integrate student-level inputs, environmental inputs, outputs, and the relationships that exist between these components rather than considering only one or two of these components, as has often been done in the past. The *Input-Environment-Output Model* (IEO) (**Figure 1**), created by Alexander W. Astin (1991), is one approach to "…correct or adjust for such input differences in order to get a less biased estimate of the comparative effects of different environments on outputs." (Astin, 2011, p. 19)

Figure 1. The IEO Model (Astin, 1991)
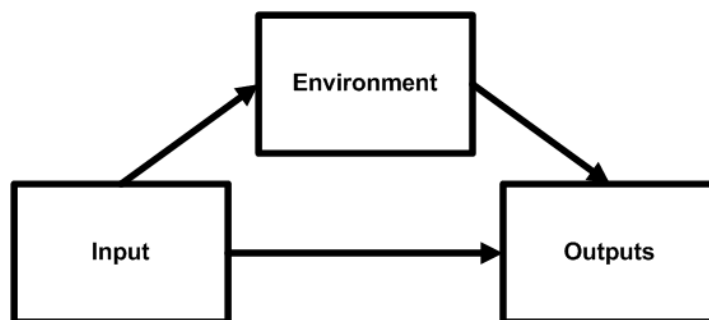
Four Different Perspectives on Need

Improved congruency in the determination of student-level undergraduate needs is also essential in the Division's efforts to enhance its assessment approach. In triangulating student needs and formulating a needs-assessment plan, four different approaches should be used in concert: 1) a *normative need approach*, which relies on standards or 'norms' established by custom, authority, or general consensus, against which the quantity or quality of a situation, condition, or set of criterion is measured, 2) a *perceived need approach*, in which needs are

identified by the users of a service according to what they perceive their needs to be, 3) an *expressed need approach*, which explores whether a need exists (and if so, whether it is being met or going unmet) based on the actual attempts (successful or otherwise) of individuals to obtain a given service, and 4) A *relative need approach*, which investigates gaps in service levels that exist between similar communities at an institution (Bradshaw, 1972).

Research Approach

Dimensions linked to Student Persistence

Lindheimer (2011) and Davidson (2009) identified eight constructs or 'dimensions' that exhibit important correlative relationships with student persistence. These factors are thought to mediate the relationship between the services the Division offers, and the student outcomes highlighted by the institution (i.e. retention, GPA, academic progress, and graduation). Each dimension encompasses a number of related factors, referred to as 'sub-dimensions' in the context of the Division of Student Affairs' assessment approach, that function as intermediate markers or finer threads in the dimension concept (**Table 1**). The sub-dimensions also serve to delineate qualities that are essential to consider in the optimization of the undergraduate experience. While the eight dimensions highlighted by Lindheimer provide a foundation on which to build, it is important to note that mediators and sub-dimensions from numerous additional sources and studies (e.g. Upcraft, 1999; Tinto, 1975, 1993, 2006; Astin, 1984; Bean 1990; etc.) are being continually considered and integrated into the assessment model, as they may offer important alternative insights.

Table 1. College Success Dimensions and Sub-dimensions

Dimension	Dimension Definition	Sub-Dimension	Sub-Dimension Definition
Institutional Commitment	The degree of commitment of the individual to obtain their degree **from UC Davis**.	Re-enrollment	Student's intention to re-enroll at the institution
		Right institutional choice	Student confidence in having selected the right institution
		Drop-out intervention	Student thoughts about continuing or stopping at the institution
Degree Commitment	The level of importance undergraduates attach to earning a degree.	Degree Determination	Students intention to finish their degree
		Degree Likelihood	Estimated likelihood that a degree will be achieved
		Personal Degree Commitment	Student self-appraised commitment to earn the degree
Social Integration	The level of involvement and satisfaction with academic and social experiences in campus.	Sense of Belonging	A student's sense of belonging.
		Shared Values	A student's sense of shared values.
		Perceived Similarity	A student's sense of similarity to others in the institutional environment.
		Respectful/Inclusive Environment	Satisfaction with living environment, how the institution deals with special needs and whether disrespect is experienced.
Academic Integration	A student's perception of how well an institution's curriculum and instruction contribute personal goals.	Classroom Discussion	Classroom discussion
		Instructional Quality	Quality of instruction to student
		Intellectual Growth	Feelings of intellectual growth
Social Support Services	The level of satisfaction with the divisional services on how well they meet their out-of-classroom, school-related needs.	Institutional Regulatory Transparency	Student's rating of the quality of communication about rules and regulations, fairness and institutional decision-making.
		Degree Social Network Support	Student's interpersonal network affirming decisions to pursue a degree, encouragement from friends, family, and parents.
		Degree Social Network Evaluation	Student's belief that family members expect degree attainment, caring of faculty and access to people with home to address personal problems
Adjustment	A student's coping skills to deal with college-related stress.	Self-Efficacy	Student self-efficacy. Students' perception that they are able to meet the requirements of college education.
		Coping Strategies	Student's coping strategies. Student's personal control.
Academic Orientation	Student's perception of the collegiate environment and how it has been viewed as consisting of learning-orientation[1] or grade-orientation[2].	Structure Dependence	Structure Dependence
		Creative Expression	Creative Expression
		Reading Pleasure	Reading for Pleasure
		Instructional Trust	Trust of Instructors
Financial Strain	Knowledge, awareness and institutional resources to advance financial literacy.	Funding Sources	Network of sources to fund and financed educational needs
		Financial Stress	Financial stress affiliated with decision-making to make ends meet.

---

[1] The focus on accumulating new knowledge and demonstrate adeptness for study skills, abstract reasoning, and self motivation.

[2] Student's primary concerned with attaining a course grade.

In addition to offering a mechanism to investigate the macro-level impacts of divisional services within the context of the General Systems Theory, the dimension/sub-dimension framework will also allow for the evaluation of unit level operations, facilitate the refinement of predictability models against changes in time, facilitate collaboration between units, and provide robust information about services/activities that impact students' persistence, progress towards timely graduation, and satisfaction with their undergraduate experience. The framework will help the Division explore not only the *effectiveness* of services rendered across all units, but also the *efficiency* of those services, and what impact they have on students' *efficacy* (Rico, 2007).

Factor Analysis

As the list of dimensions and their related sub-dimensions evolves over time to better capture as many contributing environmental-inputs as possible, the relevance, authenticity, composition, and thoroughness of the dimensions must be repeatedly tested and empirically verified. This will be done in large part via factorial analysis, a statistical procedure that identifies groups or clusters of items from a pool of elements. While our initial results support the proposed dimensions (i.e. clustered items from factorial analysis align well with the eight describe), refinement of the dimensions and their corresponding sub-dimensions will be an ongoing, iterative process.

Collection of Student Participation Data

While student attribute or 'input' data can typically be obtained in a relatively straightforward manner (e.g. student admission data), reliable data regarding student engagement with their environment can often be far more challenging to collect. In an effort to improve data integrity, establish consistency throughout the division, and facilitate the classification of services rendered to undergraduates, a web-based swipe card mechanism is being implemented

(where ethical, feasible, and appropriate) in each unit to capture participation data and deposit it in a central data repository for easy retrieval by both the CSAA and the custodial unit. Even with little to no data processing, consistent use of the swipe card system will help the campus better understand how usage of campus services impacts undergraduate success. The collection of student identification numbers will permit the retrieval of other meaningful datasets such as academic and personal characteristics that will enhance decision-making based on subpopulation characteristics (e.g. major, class status, gender) and help in the development of control groups. Unit-level directors may access aggregated student information to monitor student participation in different programs thereby allowing them to better tailor their programs to the needs of the participants. To maximize the utility and meaning of the data collected, the CSAA will work with individual units to accurately (and consistently) classify and describe the services and programs they provide.

Population Controls – Propensity Score Matching

An essential component of any meaningful assessment or evaluation is the inclusion of proper controls. Due to complicating factors (e.g. self-selection or the use of systematic judgments in selecting undergraduates to receive unit-level services), divisional units often neglect or feel unable to include appropriate control groups in their evaluations, making it difficult or impossible to draw meaningful conclusions or casual inferences from data obtained from those students who do participate. An alternative approach to establishing control groups and estimating the service effect of each divisional unit, is the use of propensity score matching. Propensity score matching uses a large set of individual attributes and observational characteristics for each student to pair participants in a unit level service with comparable students who did not participate (Dehejia & Wahba, 2002; Astin, 1993). The use of control

groups selected via propensity score matching from the general undergraduate population allows one to approximate the make-up of unit service participants among non-participants without the need to unethically restrict who may or may not participate in a program or service to establish a representative control population directly.

Hierarchical Linear Modeling through Dominance Analysis

Hierarchical Linear Modeling (HLM) through Dominance Analysis (DA) (described below) will be used to estimate the association between student participation in unit-level services and the four outcome measures previously highlighted. Dimensions and sub-dimensions will also be integrated in HLM to account for environmental inputs. Because students are not independent from each other, but rather they are clustered and similar one to another due to contextual factors, it is inappropriate to use simple linear regression (which assumes independence of observations) (Moerbeek, 2004; Van Den Noortgate, Opdenakker, & Onghena, 2005). For example, students may be thought of as being nested within majors, or within unit-level services—generally speaking, students from within the same major or students attending the same unit-level services are more like each other than students chosen at random from the student population at large. An extremely useful approach to analyzing datasets that exhibit a nested structure is Hierarchical Linear Modeling[3] (HLM) (Hox, 2002; Raudenbush & Bryk, 2002). HLM accounts not only for students' individual characteristics, but also for shared influences derived from contextual factors such as major or unit-level services; for example, it

---

[3] A two-level hierarchical model using student major as the cluster is specified as follows:

$$Y_{ij} = \beta_0 + \sum_{m=1}^{M} \beta_m X_{mij} + \mu_{oj} + \sum_{m=1}^{M} \mu_{1j} X_{mij} + \varepsilon_{0ij},$$

$$\begin{bmatrix} \mu_{0j} \\ \mu_{1j} \end{bmatrix} \sim MVN \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \tau_{00} & \\ \tau_{10} & \tau_{11} \end{pmatrix} \right] \quad \text{and} \quad \varepsilon_{0ij} \sim (0, \sigma^2)$$

where β_0 is the intercept-- an overall average across students and majors, μ_{oj} is the deviation of major j from the average, $\sum_{m=1}^{M} \beta_m X_{mij}$ is a vector of regression slopes and student-level covariates, and $\sum_{m=1}^{M} \mu_{1j} X_{mij}$ is a vector of random effects associated with each of the regression slopes of the student-level covariates.

would allow for the prediction of student-related outcomes (e.g. quarterly retention, degree attainment, etc.) from student-level predictors (e.g. student gender, ethnicity, family income, parents' education, high school academic performance) and divisional unit-level predictors (e.g. service type and duration, a student's usage frequency of a particular service).

Dominance Analysis

Once a HLM model is decided, Dominance Analysis (DA) can be used to determine the relative importance of chosen predictors (usually based on theoretical considerations) (Luo & Azen, 2013). Since the net impact of unit-level services on retention and graduation is intertwined with student-level characteristics, DA is an intuitive and appealing procedure for determining predictor importance at both the student level and unit level in a meaningful way, and it offers strong advantages over the use of standardized coefficients and their statistical significance as a measure of predictor importance (Azen & Budescu, 2009). Results from DA can be used to strengthen the HLM modeling solution by determining the relative importance of predictors in the model and by revealing the variability in modeling the outcome variable using all different subset of predictors. A very flexible technique, dominance analysis may be readily extended to three-level HLM, or to cross-classified modeling approaches (Luo & Azen, 2013).

Conclusion

Too few undergraduates persist and graduate in a timely manner. When disaggregated further, the statistics are troubling for subpopulations at the university. Delayed graduation incurs a cost on resources at the University, the State, the student, and their families. Due to limited space and resources, the problem is perpetuated and compounded as prospective students are forced to seek alternate (and perhaps ill-suited) education paths, postpone enrollment and degree completion, or both.

By first identifying negative shifts in persistence and graduation, and then investigating their underlying causes, the University will be better equipped to reverse such trends and to ameliorate the negative threats they pose to students, the institution, and the general population. The establishment of consistent assessment practices will facilitate the Division's ability to identify and understand the impact it's programs and services are having on undergraduates. Using a model that incorporates students' attributes (Input), student participation in divisional programs (Environment), student outcomes (Output), and the relationships between these factors, CSAA will assist units in understanding the impact of their services, and shed light on the efficiency and efficacy of the programs they run.

REFERENCES

Astin, A. W. (1984). Student involvement: A development theory in higher education. Journal of College Student Personnel, 25, 297 – 308.

Astin, A. W. (1991). Assessment for excellence: The philosophy and practice of assessment and evaluation in higher education: Phoenix, AZ: Oryx Press.

Astin, A. W. (1993). What matters in college: Four critical years revisited. San Francisco: Jossey-Bass.

Azen, R., & Budescu, D. V. (2009). Applications of multiple regression in psychological research. Handbook of quantitative methods in psychology, 285-310.

Bean, J. P. (1990). Why students leave: Insights from research. In D. H. Hossler & J. P. Bean (Ed.), The strategic management of enrollment management (pp. 147 – 169). San Francisco: Jossey – Bass.

Bean, J. P., & Eaton, S. B. (2000). A psychological model of college student retention. In J. Braxton (Ed.), Rethinking the departure puzzle: New theory and research on college student retention (pp. 48 – 61). Nashville, TN: Vanderbilt University Press.

Bess, J.L. & Dee, J.D. (2008). Understanding college and university organization: Theories for effective policy and practice (Vol.1). Sterling, VA: Stylus Publishing.

Bradshaw, J. (1972). The concept of need. New Society, 30, 640 – 643.

Beretvas, S. N., Meyers, J. L., & Rodriguez, R. A. (2004). The cross-classified multilevel measurement model: an explanation and demonstration. Journal of applied measurement, 6(3), 322-341.

Davidson, W. B., Beck, H. P., & Milligan, M. (2009, July/August). The college persistence questionnaire: Development and validation of an instrument that predicts student attrition. Journal of College Student Development 50:4, 373 – 390.

Eagan, K., Stolzenberg, E. B., Ramirez, J. J., Aragon, M. C., Suchard, M. R., & Huratado, S. (2014). The American freshmen: National norms fall 2014. Los Angeles: Higher Education Research Institute, UCLA.

Fielding, A., & Goldstein, H. (2006). Cross-classified and multiple membership structures in multilevel models: An introduction and review.

Hox, J. (2010). Multilevel analysis: Techniques and applications. Routledge.

Lindheimer III, J. B. (2011). The College Persistence Questionnaire: Developing Scales to Assess Student Retention and Institutional Effectiveness (Doctoral dissertation, Appalachian State University).

Luo, W., & Azen, R. (2013). Determining predictor importance in hierarchical linear models using dominance analysis. Journal of Educational and Behavioral Statistics, 38(1), 3-31.

Moerbeek, M. (2004). The consequence of ignoring a level of nesting in multilevel analysis. Multivariate Behavioral Research, 39(1), 129-149.

Raudenbush, S. W. Bryk, A. S. (2002). Hierarchical linear models: Applications and data analysis methods, second edition. Newbury Park, CA: Sage.

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. Review of Education Research, 45, 89 – 125.

Tinto, V. (1993). Leaving college. Rethinking the causes and cures for student attrition (2nd ed.). Chicago: The University of Chicago.

Tinto, V. (2006). Research and practice of student retention: What next? Journal of College

 Student Retention: Research, Theory & Practice, 8(1), 1-19.

Turner, S. (2004). Going to college and finishing college: Explaining different educational

 outcomes. In C. Hoxby (Ed.), College decisions: How students actually make them and

 how they could (pp. 13 – 62). Chicago, IL: University of Chicago Press.

Upcraft, M. L. (1999). Assessing student learning. In F. K. Stage, L. W. Watson, and M. Terrell

 (Eds.), Enhancing student learning outcomes: setting the campus context: Washington,

 D.C.: American College Personnel Association.

U.S. Department of Education. (2008). Digest of education statistics. 2007 (NCES Publication

 2008022). Retrieved from http://nces.ed.gov/pubs2008/2008022.Van Landeghem, G., De

 Fraine, B., & Van Damme, J. (2005). The consequence of ignoring a level of nesting in

 multilevel analysis: A comment.Multivariate Behavioral Research, 40(4), 423-434.