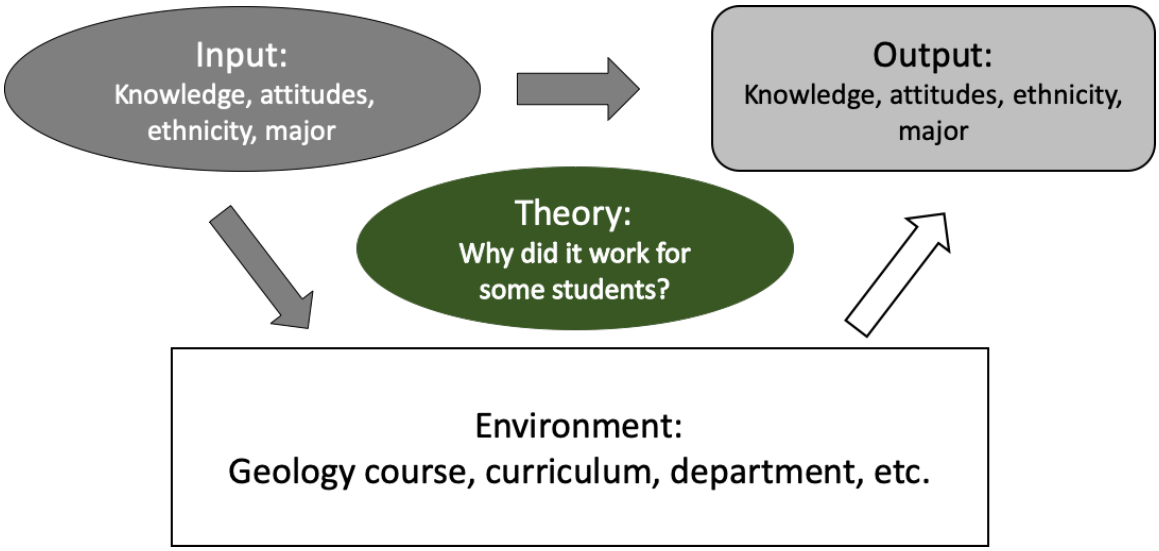
Input-Environment-Output Model

Based on Astin's IEO model (Astin, 1984; Astin and Antonio, 2012; Renn and Reason, 2013)

Summary prepared by Eric Riggs for the 2019 Earth Educators' Rendezvous

This model offers a classification scheme to evaluate how inputs (e.g., student characteristics) and environment (e.g., program attributes) may influence desired outputs (e.g., results of programs). This in turn provides classifications of program and learner attributes that enable connections to a set of social, cognitive, and psychological theories that support deeper investigation into the reasons why recruitment and retention programs are successful with particular groups. Callahan, et al. (2017) reports that there is an observable trend in the geoscience literature after 2009 toward interventions that include all components of the IEO model and which account for these factors in analysis of curricula that exist without specific interventions, what they call ''natural experiments''. The IEO model enables connection to diversity literature on self-efficacy, identity, microaggressions, stereotype threat, and social cognitive career theory that offer perspectives which can guide future programmatic interventions. Using an IEO model approach to curriculum and program design also provides a means for engaging both quantitative and qualitative measures as appropriate and with equal value and utility, and for planning and predicting the most effective theoretical approaches and outcomes in efforts to broaden participation in the geosciences.



after Callahan, LaDue, Baber, Sexton, van der Hoeven Kraft and Zamani-Gallaher, 2017 JGE Synthesis volume

TABLE I: Summary IEO framework presented in Astin and Antonio (2012).

Design	Example Data	Defined By	Limitations
I and O only	Pre- and post-test data without description of intervention	Description of the change over time of a particular variable	Assumes change in data is attributable to intervention without considering other possible environmental factors
E only	Review of course syllabi	Rich description of program without data on students or measures of outcomes	Assumes what is described is equal to what is gained by students
O only	SAT or ACT scores	Description of output data without any discussion of environment or input variables	Assumes input characteristics are equal across all students; assumes resources and experiences are equal across all environments
E and O only	Achievement data from K–12 students	Description of output and environmental variables	Assumes change for one student is comparable to change for another student; assumes input characteristics are equal across all students
IEO	Pre- and post-test data with description of intervention	Output measures related to environment and input variables	No control group data or random assignment
IEO Exp	Pre- and post-test data; description of control versus treatment groups	Output measures related to comparison between treatment and control settings	Assumes input characteristics are equal (i.e., no random assignment)

TABLE IV: This table provides two examples of how the IEO model can be applied through an atheoretical approach (left) that takes a normative approach to participation in science and a self-efficacy theory-driven approach (right) that incorporates socio-cognitive theory to understand how the inputs and environment influence participation in science.

Model Component	Atheoretical Examples	Examples Related to Self-Efficacy Theory
Input	Demographics ACT/SAT scores Concept pre-test	Family support Interpersonal confidence Interest in science
Environment	Program description	Role models Mastery experiences Peer support
Output	Program evaluations Concept post-tests Graduation rates	Resilience Managing stress Persistence

Both tables from Callahan, et al. (2017)

References

Astin, A.W. 1984. Student involvement: A developmental theory for higher education. Journal of College Student Personnel, 25:297– 308.

Astin, A., and Antonio, A.L. 2012. Assessment for excellence: The philosophy and practice of assessment and evaluation in higher education. Lanham, MD: Rowman & Littlefield.

Callahan, C. N., LaDue, N. D., Baber, L. D., Sexton, J., van der Hoeven Kraft, K. J., & Zamani-Gallaher, E. M. (2017). Theoretical perspectives on increasing recruitment and retention of underrepresented students in the geosciences. *Journal of Geoscience Education*, 65(4), 563-576.

Renn, K.A., and Reason, R.D. 2012. College students in the United States: Characteristics, experiences, and outcomes. San Francisco, CA: Wiley.