Understanding Learning Environments at the Graduate Level: A Qualitative Analysis of Doctoral Engineering Education Programs within the United States

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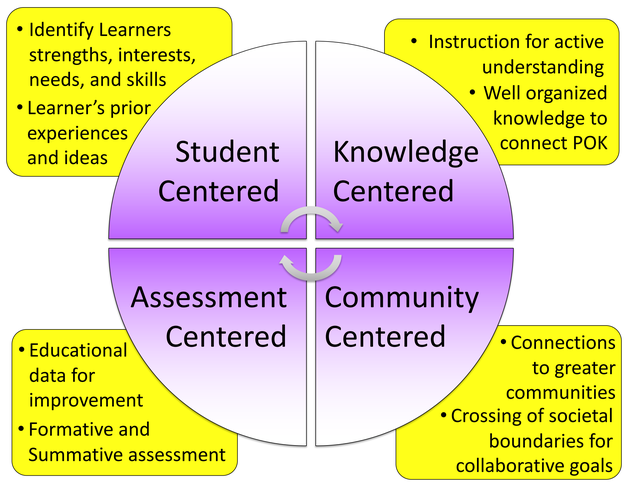
OVERVIEW & SCOPE

The purpose of this contribution is to offer insight on the methods in which current, graduate, engineering education (ENGE) programs incorporate tenets of the four learning environments from the How People Learn framework into their programs of study (Bransford, Brown, & Cocking. 1999). For over a decade, professional and academic engineering organizations have declared the need for the integration of non-technical competencies (e.g., communication, collaboration, creative thinking, and lifelong learning) into the curriculum of all engineering programs (Grasso & Burkins, 2010; National Academy of Engineering [NAE], 2004). Efforts advancing this initiative to promote holistic-style engineering requires the training of future postsecondary educators that understand and apply the four learning environments (i.e., student-centered, knowledge-centered, assessment-centered, and community-centered), reflected in Bransford and colleague's (1999) How People Learn framework. In this qualitative study, an open coding strategy was applied to public data gathered from nine, select ENGE, graduate programs to answer the following question: In what ways do current U.S., graduate ENGE programs reflect elements of the four learning environments of the How People Learn framework into their programs of study? Based on the analysis presented, the strengths associated with each program - as related to the development of holistic engineers - can be identified. These findings provide implications for the design of graduate, engineering education programs as well as conclusions useful to prospective students interested in pursuing programs that align with their personal goals to become the next generation of holistic, engineering education leaders.

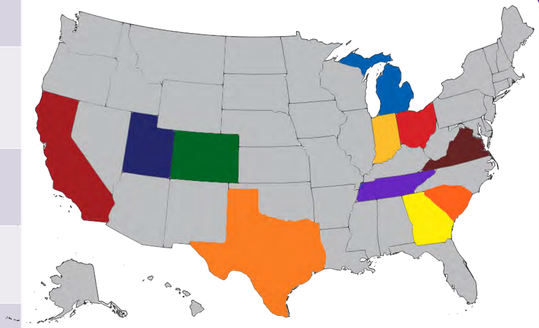
LEARNING-BASED CULTURE

Factors that influence successful transfer and understanding of knowledge are most commonly centered around the four environments within How People Learn, with slight variations of the overall implementation at each institution. (Bransford 1999)



RESEARCH METHODS

Research Question	In what ways do current U.S., graduate engineering education programs reflect elements of the four learning environments of the How People Learn framework in their programs of study?
Sample	• Selection process conducted in three phases • Selection criteria: Located within the United States; Housed within a college of engineering; Granting PhD degrees • Selected Candidates: 9 Public Universities
Data Sources	• Public documents collected from selected universities (EED&P 2018) • Characteristics: Program descriptions and statements, research endeavors, research grants, outreach programs
Data Analysis	• Primarily a qualitative study using a basic inductive approach (Ary, Jacobs, Irvine, & Walker. 2018) • As per Saldaña (2013), repetitive cycles of coding were performed using the following techniques: Open Coding, Subcoding, and Simultaneous Coding
Reflexivity / Subjectivity	• Reflexivity – Assumptions regarding engineering background were acknowledged while coding and measures were taken to self-monitor throughout (Saldaña 2013) • Subjectivity – Intrinsic incentive to enhance ENGE programs from viewpoint of potential future program creation
Trustworthiness	• Measurers were taken to ensure that all aspects of trustworthiness were addressed (Credibility, Transferability, Confirmability, Dependability) • Methods and approaches taken - Peer debriefing, referential adequacy (Ary, et.al. 2018)



- *Arizona State*
- *Clemson*
- *University of Georgia*
- *Louisiana Tech*
- *University of Michigan*
- *Ohio State*
- *Purdue*
- *Utah State*
- *Virginia Tech*

RESULTS

The purpose of this contribution is to qualitatively explore existing Engineering Education PhD programs, supported by Engineering Colleges in the United States, in order to identify prevalent themes across the programs and how those themes might reflect elements of the four learning environments of the *How People Learn* framework. As the outcome of the study, five major themes were constructed from the public data of each university's ENGE program. The five themes were able to be correlated to the learning environments, independently.

Theme	Description	Categories
Learner's Identity and Influence of Ecosystem	A learner's self-identity may be shaped by their interactions with others and their self-worth promoted by certain inputs or resources made available within ecosystems developed by Engineering Education programs, potentially influencing rates of retention.	Learner Growth Resources
Role of Pedagogy in Cognitive Functionality	Selection of instructional and pedagogical methods for the process of knowledge transfer and acquisition should reflect a learner's ability to process, identify, combine, and recall information and lead to developing higher order problem solving and critical thinking skill sets as highlighted by Engineering Education Programs.	Elements of Knowledge Delivery Learning Abilities
Exploration of Data in STEM Education	Exploring various types of data regarding research for educational development is useful for assessing STEM education components across academia.	Academic Institutions Research for Program Enhancement
Collaboration in Design Frameworks	Collaborative concepts are coupled with the elements of design synthesis to enhance learning within programs of engineering education.	Collaborative Concepts Elements of Design Synthesis
Equitable Considerations	The importance of equity in diversity and inclusion is driven by the need to increase societal relevance through Engineering Education programs.	Diversity & Inclusivity Societal Relevance

DISCUSSION & CONCLUSIONS

Student Centered Theme

- Environmental inputs, outputs, and interactions influence on developing a student's self-identity and skill-set confidence.
- Programs position students in ecosystems that promote constructive, internal interactions between students,
- Results in improving a student's self-belief and confidence

Knowledge Centered Theme

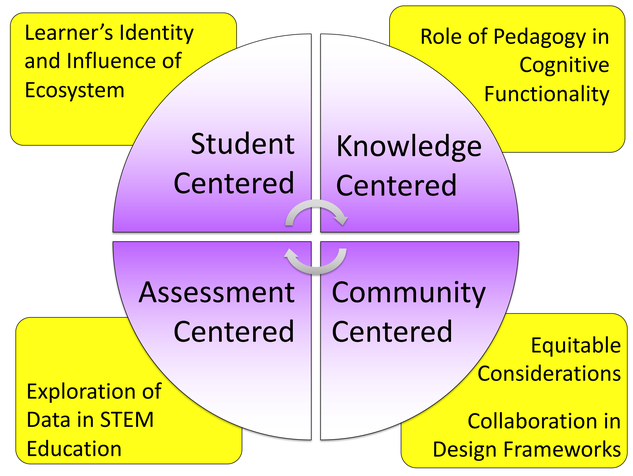
- Instructional application of different knowledge delivery methods to stimulate cognitive skills sets to improve problem solving and critical thinking.
- Selection of techniques for improving a students ability to process and understand information

Assessment Centered Theme

- Use of educational development data in assessing STEM education for different levels of academic programs to further develop such programs.

Community Centered Themes

- Focuses on breaking down disciplinary forholds in order to create highly collaborative teams to aid in design synthesis
- Consideration of groups and/or communities that are under-served or under-represented in STEM fields and how improving the equity in engineering education might drive a greater societal change in both the educational paradigm as well as on a global setting.



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