

## **A Systematic Review of the Intersections of Engineering Identity and Financial Need Literature**

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Sarah Rodriguez, PhD, is an assistant professor of Higher Education at Iowa State University. Dr. Rodriguez's research addresses issues of equity, access, and retention for Latina/o students in the higher education pipeline, with a focus on the intersections of gender and race/ethnicity for Latinas in STEM. She has experience coordinating large-scale interdisciplinary research projects focused on engineering and other STEM disciplines which have been sponsored by the National Science Foundation (NSF). Dr. Rodriguez has also worked with the project Engaging Latino Students for Transfer and College Completion a national initiative focused on helping institutions strengthen Latina/o student engagement, transfer, and college completion. She has also served as a New Mathways Project Mentorship Program Coach for the Charles A. Dana Center, supporting college implementation of multiple mathematics pathways, acceleration to complete college level math courses quickly, and intentional use of strategies. Dr. Rodriguez has presented at conferences at the national, regional, and local levels and authored journal articles, book chapters, policy briefs, and other publications on Latina/o student success.

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A Systematic Review of the Intersections of  
Engineering Identity and Financial Need  
Literature

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Iowa State University

## Engineering Identity & Students with Financial Need

- Need high-quality, diverse engineering workforce; all socio-economic levels access and complete engineering degrees.
- Students from low-socioeconomic backgrounds and students with financial need may experience difficulty seeing themselves as engineers.
- Little research has connected the concepts of engineering identity and financial need.

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S-M: will discuss issues that are effecting engineering identity and students with financial need based on information that has been found.

There is a gap in the literature that focuses on this topic, thus conducting a systematic literature review.

No systematic way to look for information in this area.

To address the need for a high-quality, diverse engineering workforce, it is imperative that students from all socio-economic levels can access and complete engineering degrees. However, students from low-socioeconomic backgrounds and students with financial need may experience difficulty seeing themselves as engineers. Previous literature has documented the challenges of engineering students; yet, little research has connected the concepts of engineering identity and financial need.

This systematic literature review focused on engineering identity and its connection to student financial need. After an exhaustive review of peer-reviewed materials from 2000-Present, the researchers found few studies that connected concepts of engineering identity and financial need. The majority of existing studies which connect these concepts are focused on traditional-aged, full-time, undergraduate students at four-year institutions. The existing studies focus less on the engineering identity experiences of post-traditional students (25+, working full-time, financially independent, or military) and of graduate students or those situated at community colleges or private institutions. In addition, these studies do not fully explore the intersecting identities (e.g. race/ethnicity, LGBT, gender) of engineering students from varying socio-economic levels.

## Systematic Literature Review Process

- Filters
  - Peer-reviewed
  - All Documents
  - 2000-present
- Databases
  - Compendex
  - EBSCoost
  - PsychINFO
- n=11 articles relevant to Engineering Identity and students with Financial need through the initial search.

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S-M: Start with the purpose of doing a systematic literature review.

The filters that were chosen focus on understanding the most relevant information currently in the field.

Furthermore, as we analyzed the literature, there were different methodologies that were used in the studies. In the Compendex articles, there were a total of three quantitative studies, one qualitative study, five mixed methods, and two assessment studies.

This then was further divided, there were ten single instance studies, one longitudinal, eight that involved surveys, one focus group, four that had semi-structured interviews, one pilot study, one value co-creation, two program assessments, three that involved reflections, one case study and one action plan. There six of the Compendex articles incorporated more than one way of synthesizing information.

We also explored the triangulated articles to reference the methods those articles used. In these studies, there were two quantitative studies, five qualitative studies, three mixed methods, and one assessment. With these methods, there were six single instance studies, three longitudinal, four surveys, four interviews, one program assessment, 1 that involved reflections, two case studies, three observations, and one literature review.

The methods that were chosen to encompass the different ways that research have been trying to encompass the identity of engineers. Having this array of methods, this provides a path for research to continue to happen and gain perspectives in what method best suits the study they will conduct and what side of the experience they want to capture.

## Overview of the Findings

- Multitude of different frameworks used to examine engineering identity and financial need
- Majority of studies employed mixed methods
- Studies investigated a variety of engineering contexts (50% = electrical, mechanical, computer, civil; 50% = other subdisciplines)

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Through the literature, there is a gap in understanding the experiences of students and their development of an engineering identity alongside being a student with financial need. In this review of literature, currently, the literature is reflecting that there is a conversation with large public institutions with three studies being conducted with their students, there are three gathering data at private suburban institutions, one at a technical public, one at an urban public institution, seven Chinese International institutions, three Lebanon institutions, a minimum of eighteen four-year colleges and one community college.

## Multitude of different frameworks used to examine engineering identity and financial need

### Compendex

- Achievement Value
- Astin's IEO Model
- Critical Pedagogy
- Cultural capital
- Feminist Theory
- Intersectionality
- Maslow Hierarchy of Needs
- Motivation Action Theory
- Motivation theory
- Social Capital
- Value co-creation theory

### Triangulated

- Astin's IEO Model
- Expectancy value theory
- Gender Theory
- Motivational theories
- Navigational Capital
- Self-Efficacy

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We separated the frameworks based on what information was gathered. We first show that there are the findings from Compendex. These are the frameworks that arose from the original 11 articles that were gathered. The triangulated articles are the ones that were gathered from the references from the compendex articles due to the low amount of reference found. As shown, there are a few that overlap and are in both areas.

In the original Compendex search, this revealed that there are 11 different frameworks that were used to understand engineering students. Three of the articles involved contributions from the National Science Foundation (NSF).

The major observation is that there is not a single framework that focuses on the development of engineering identity. Each of the eleven articles had their own framework and foundations that the researchers believe to encompass the experience of these engineers.

From these theories, the major groups of theories that are present are Motivational theory (McLeod, 2007), Feminist Theory (Bell, 1989), Intersectionality (Samuels & Ross-Sheriff, 2008), environmental theory (Astin, 1995), Expectancy - Value Theory (Wigfield & Eccles, 2000), Value Co-Creation (Pralhad, & Ramaswamy, 2004), Cultural and Social Capital (Bourdieu, 2011), Critical Pedagogy (Freire, 2018) and Self-Efficacy (Bandura, 1977).

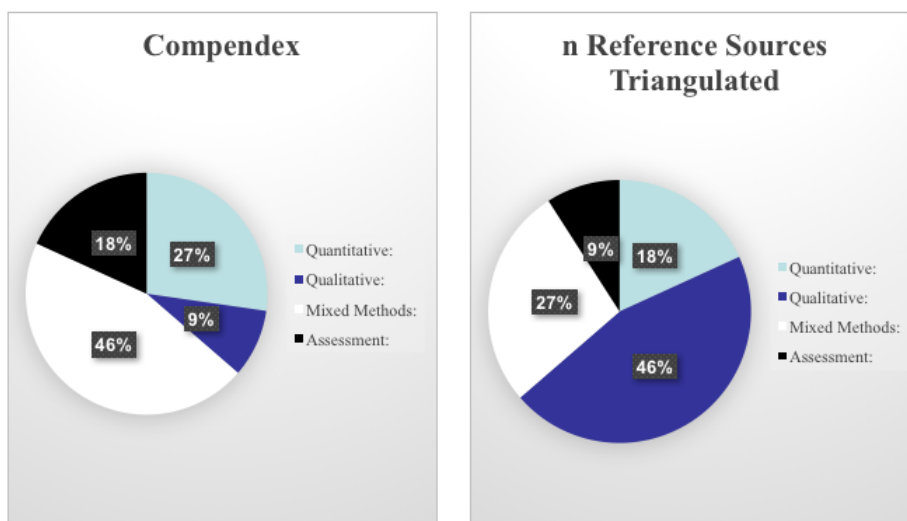
When reviewing the different theories, the researchers are being informed by a number of fields that are influencing the lens of the researchers when understanding engineering identity development. They integrate with each other because students are multi-faceted and have a number of intersecting identities that are informative to the whole person. When comparing Astin's (1995) I-E-O Model, environmental theory, and Value Co-Creation Theory (Wigfield & Eccles, 2000), these two help understand how the environment that the students navigate day to day provide a service to themselves as students and to their development as engineers situated in the higher education. When looking at Motivational Theory (McLeod, 2007), Maslow's hierarchy of Needs, and Bandura (1977), Self-Efficacy, provides the student development aspect of a student with the understanding the psychological aspects that develop through the students' experiences. When looking at engineering development, in conjunction to the intersections, there is a void in understanding that specific identity.

Having so many and different fields of study shows that there needs to be an emphasis on creating or adopting a framework that will better reflect engineering identity development. It is important to have a framework to define and allow the scholarship to develop and situate itself in. This is important so there is a field of study and a framework for individuals that want to learn and gauge information about engineering identity. Currently, the topics of Professional Identity and Engineering Identity are being discussed in different concentration areas. This means that the knowledge and information being created can be lost due to not have a centralized way to look for and understand the identity development of engineering that have financial need. With the original Compendex articles, these articles showed that there needs to be a framework in the motivational theory to grasp and understand the experiences that engineering students.

From the articles found in the Compendex search, we then analyzed the references of each of the articles that were relevant to the topic. From the eleven original articles, there were eleven articles that were important to reflect on. One of the reference articles was mentioned twice. These triangulated references were used to understand the foundations and information that the researched used to inform their studies. These articles add perspective by helping understand the what frameworks these new articles used and theory perspective on engineering identity.

These theories were generally similar to the frameworks from the original Compendex articles. Motivational theory was a framework in five of the articles, in Compendex and triangulated. Two articles used Self-Efficacy as their framework. Environmental theory, Astin's (1995) I-E-O Model was used in two articles and gender theory and intersectionality was also used in two articles. Navigational Capital was used as a framework in two of the triangulated reference articles that did not appear in the Compendex articles. This information from the triangulated articles refers to bringing navigational capital into the conversation. When students understand how to navigate the college experience and academic world, they can have this capital to make students successful.

## Majority of studies employed mixed methods



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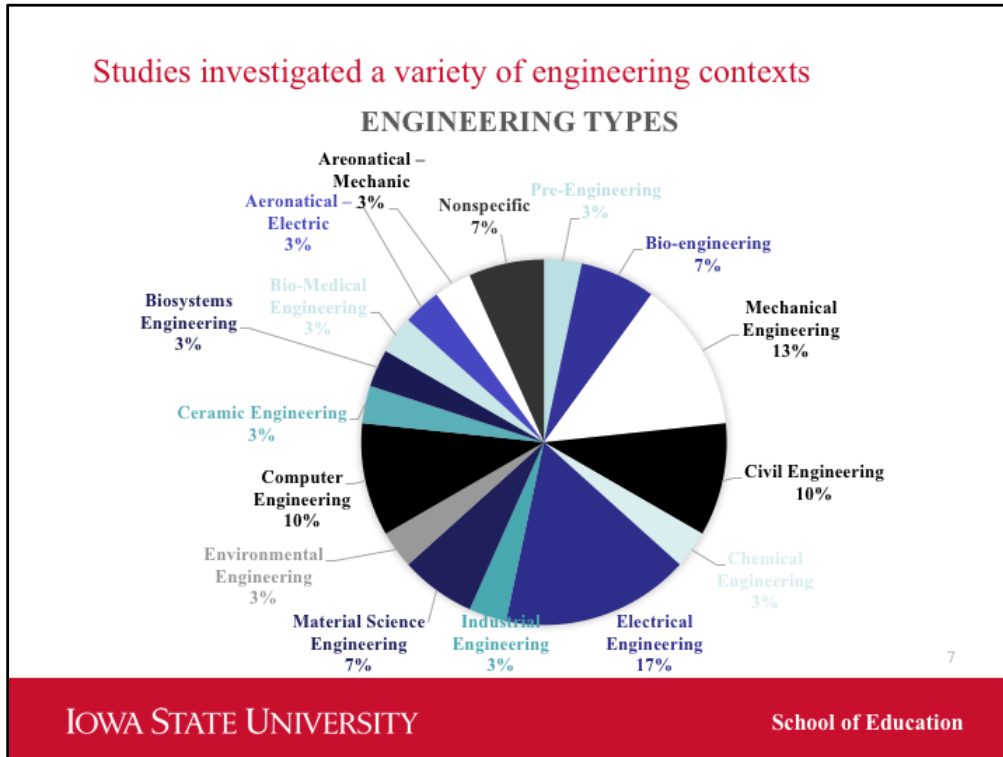
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There are 11 articles that emerged in the compendex search. 11 articles also emerged when the articles were triangulated within the reference section of each for the initial compendex articles. This provided articles that are relevant to understand engineering students with financial need.

Furthermore, as we analyzed the literature, there were different methodologies that were used in the studies. In the Compendex articles, there were a total of three quantitative studies, one qualitative study, five mixed methods, and two assessment studies. This then was further divided, there were ten single instance studies, one longitudinal, eight that involved surveys, one focus group, four that had semi-structured interviews, one pilot study, one value co-creation, two program assessments, three that involved reflections, one case study and one action plan. There six of the Compendex articles incorporated more than one way of synthesizing information.

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This provides a visual of the engineering types that are being studied. These shows that there are 16 different types that are mentioned.

All eleven articles mentioned on or more types of engineering students. One of the major observations made is that there was an absence in Software Engineering. In most of the studies, there the population of students that they were studying consisted of four studies that were program focused, seven that involved first-year students, three that involved second year students, one first-generation student, one women of color and one women. Ten out of the eleven were studying traditional aged college students. All of the studies involved students that were enrolled as undergraduates. Only one study mentioned that their student population were full-time students.

This set of literature provided a number of recommendations. Four of the Compendex articles mentioned being able to recruit and expose students to the field of engineering prior to being in higher education. That would help and engage the students partake in an engineering major in the first year. In two articles, first and second year students were found to want to experience and practice what an engineer actually does. This would allow career development that two articles also suggest to further research.

After digesting all of the information from the literature, there were a few overarching themes that resonated as we coded the findings. First and foremost, there was a lack of perspective students of marginalized identities. There was an article that mentioned people of color. There was a lack of acknowledging the community and identities of these student's other than that broader context. Also, there is a large gap when focusing on different intersections of people of color, especially focusing on women of color engineers and their experiences. When intersectionality is use, it is used in race and sex. There are identities that have not been explored like understanding the intersection of SES and gender and engineering or LGBTQ and Engineering, to name a few.

Another population of students that need to be focused on is adult learners and the contribution adult learners as engineers comes into conversation. This adds depth to the understanding the development an engineering identity development from a nontraditional student perspective. This can further add to the information on intersectionality and understanding the student's whole persona while navigating their engineering identity.

Furthermore, when studying engineering identity development and students with financial need, there needs to be a way to systematically search and locate information. There is limited research that has been done to attribute to these students. This gap in literature needs to filled. With the diversifying and implementation of programs to help student transition to engineering programs, understanding the students that have traditionally steered away from engineering is important to understand the social, cultural, and environmental factors that contribute to their engineering identity.



## Implications: Future Research

Qualitative  
Research

Lack of  
marginalized  
identities in  
engineering

Lack of  
intersecting  
identities

Adult learners

Systematic way to  
find information  
on engineering  
students

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The absence of a robust grouping of studies connecting these topics emphasizes the need to more fully understand engineering identity through the lens of financial need and expand how scholars investigate these concepts. If engineering education scholars fail to consider engineering identity from a variety of student standpoints, including those from all socio-economic backgrounds, our understanding will remain limited.

## Implications: Policy & Practice

Considering  
identity and  
financial need

Engineering as an  
identity process

Contextualizing  
by sub-discipline

Understanding  
factors of identity  
for students with  
financial need

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Ultimately, this work will provide a more robust understanding of the connections and gaps in the engineering identity and financial need literature as well as support new directions for future scholarship, policy, and practice.

# QUESTIONS?

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