# Work in Progress: Assessing Undergraduate Engineering Students' Career Social Capital

**Adrian Nat Gentry, Purdue University**

Adrian Nat Gentry is a Ph.D. student at Purdue University in Engineering Education. They completed their undergraduate degree in Materials Engineering from Purdue in May 2020. Adrian's research interests include assessing student supports in cooperative education programs and the experiences and needs of nonbinary scientists. Adrian is involved with Purdue's Engineering Education Graduate Association and the oSTEM chapter at Purdue.

**Dr. Eric Holloway, Purdue University at West Lafayette (COE)**

Dr. Eric Holloway currently serves as the Sr. Director of Industry Research in the College of Engineering at Purdue, where he focuses on industry research in the College of Engineering. He also holds a courtesy faculty appointment in the School of Engineering Education and the School of Mechanical Engineering.

**Dr. Kerrie A. Douglas, Cornell University**

Dr. Douglas is an Associate Professor in the Purdue School of Engineering Education. Her research is focused on improving methods of assessment in engineering learning environments and supporting engineering students.

# Work-in-Progress: Assessing undergraduate engineering students' career social capital

## Introduction

While there have been many policy level calls for increasing the diversity of the engineering workforce, there is little known about the work experiences of engineering students of identities traditionally excluded from engineering (e.g., women, LGBTQ+, Black, and Hispanic/Latinx) engineering students [1]–[7]. As Co-ops and internships are many students first industry experience, it is important to understand how these experiences shape their career development.

Work-integrated learning (WIL) programs, such as Co-op programs, internships, and workforce development programs, are valuable for engineering students' career development. WIL programs provide opportunities for students to access valuable career development opportunities, such as mentorship, professional socialization, and informal and formal professional networking [8]–[10]. WIL programs provide students access to career-related social capital through their professional relationships [11]. Students' social networks are a critical component to their career development, providing them access to career-related resources, information and support [12]–[14].

The social capital that engineering students access in WIL programs offers a promising avenue for diversifying the engineering workforce. Cooperative education programs connect students with professionals they may build long-term professional relationships with, which have been shown to reduce differences in academic and employment outcomes across race, ethnicity, and gender [4], [15], [16]. Traditionally minoritized students who finish their co-op sessions are more likely to have higher GPAs, finish their engineering degree, receive a starting position, and earn higher starting salaries [15].

Although there many assessments of social capital are available to researchers to use, little to no assessments examine the social capital of traditionally minoritized engineering students in their work-integrated learning mentoring relationships. Additionally, a recent systematize literature review found that there is a dearth of literature examining concerns of fairness in existing social capital assessment instruments [17]. To open research possibilities for examining the supports that students whose identities have been traditionally excluded in engineering (such as LGBTQ+, women, and Native American and Black), it is important to develop an assessment with this use in mind. Therefore, the purpose of this work-in-progress is to describe the *Mentoring Social Capital* assessment and initial validation studies, with particular emphasis on concerns of fairness. We ask the following questions:

1. To what extent are student interpretations of items for the Mentoring Social Capital instrument consistent with how the assessment questions are intended to be interpreted?
2. To what extent do experts agree that the items for the Mentoring Social Capital instrument are aligned with the theory?

## Theoretical Framework

For this study, two theoretical frameworks, social cognitive career theory and social capital theory, were used in conjunction to understand how mentors can foster students' career interest and development. We selected the social cognitive career theory (SCCT) interest model to guide our understanding of the relationships between a students' self-efficacy, career outcome expectations, and interest and goal development [18]. SCCT is a particularly salient framework for studying mentoring since it models how environmental factors such as personal identity and contextual supports and barriers impact ones' self-efficacy and career outcome expectations [19]. Additionally, SCCT has proven a stable model across many contexts, including race, gender, STEM career interest development, and mentoring interventions [19]–[22].

According to Lent, Brown and Hackett [18], students develop interest and goals in career paths when they believe in their own abilities (self-efficacy) and the benefits of pursuing that career path (career outcome expectations). As students develop positive forms of self-efficacy and outcome expectations, students develop interests and goals related to that career path [18]. Students' who feel as if they can succeed in the field and that there are benefits to pursuing that career will be more likely to develop interest, set educational and occupational goals, and take actions to achieve those goals. Achieved goals (performance-attainments) will then become new forms of self-efficacy and career outcome expectations [18].

In addition to SCCT, we utilized Lin's social network theory [12], [23]. Social capital is the actual or potential resources embedded in one's social relationships or network [12], [24]. Specifically, an individual, or ego, can access resources through the alters in their social networks. In the case of cooperative education, alters are people who provide academic and professional resources and supports to the student, which could include mentors, managers, academic advisors, and more experienced peers. Social capital can be used to explain differences in outcomes based on access and use of resources found in the individuals' network. The impact of the social network or relationship is dependent on many factors, such as the ego's social network and the types of supports available in that network. Lin posits that social capital can be attained through three sources: purposes of action, structural positions, and network locations [23]. Purposes of action describe the type of support the actor can provide to the ego and can be broken into two categories, expressive and instrumental. Expressive supports are emotional supports, focusing on ones' emotional, mental, and physical health [12]. Instrumental supports are goal-attainment supports where goals can be career development or college success [12]. In this study, instrumental supports may be a Co-op manager passing along information about full-time employment opportunities.

Social network theory has been cited as a valuable lens for examining the outcomes of mentoring relationships [10], [25]. Mentoring relationships are an ideal situation for building social capital, focusing on the explicit resources that are shared between mentor and mentee. Social network theory emphasizes the value of relationships for impacting professional development, exploration of opportunities and increased interest in STEM [26]. For example, in

the workplace, expressive actions are more likely to be seen in mentoring relationships where the mentor provides psychological supports. For example, in a study of mentoring relationships of African American students in STEM, Mondisa found that mentoring relationships were an "evolving process that fosters social capital," providing mentees with access to social networks and offered support and empathy [10, p. 144].

Together, SCCT and Lin's social network theory are valuable for understanding the relationship between career development and mentoring. While SCCT and social capital theory are useful individually, to best understand how mentoring plays a role in students' career development, both frameworks are needed. Per Lin's social network theory, students' knowledge and available resources are highly dependent on the knowledge and resources of the mentors in their social network [23]. The access (or lack of access) to career-related knowledge and resources can impact students' career self-efficacy and positive career outcome expectations [18]. SCCT is generally focused on the students' self-perceptions of their self-efficacy, outcome expectations, interest and goals, and does not capture how individual mentors provide (or do not provide) students access to career development opportunities. Utilizing social capital theory in conjunction with SCCT can help researchers shift the expectations of career interest and development from only the responsibility of the student to the responsibility of all of the agents that make up the students' support network (e.g., mentors, faculty, support staff, WIL programs and mentoring programs) [27].

## Methods

### *Instrument*

The purpose of the *Mentoring Social Capital* instrument (MSoCap) is to assess the support engineering students have in their career development, how much they feel a sense of belonging, and are satisfied with their WIL program. There are two sections in the MSoCap: Perceived Cohesion and Career Social Capital. Perceived Cohesion refers to a students' feelings of being a part of a particular group, in this case, a part of their WIL program. This section asks students to respond to four statements on their feelings of belonging within their WIL program (e.g., I feel connected to the [WIL program] community) and five statements on their satisfaction with the SCALE program (e.g., I'm happy with my [WIL program] experiences this last year). Scores can range from 1 (little to no perceived cohesion) to 5 (high levels of perceived cohesion).

For the Career Social Capital section, we assessed students' social capital using a social capital name generator, a type of survey design that asks students to list the names of mentors that increased their social capital and to describe their relationship with that mentor. In the MSoCap, students were asked to list 3-5 people who were influential in their career and indicate which career supports they received from their listed mentors. Specifically, students reported how their mentors support them in developing career self-efficacy (e.g., [Mentor Name] … *encourages me to make decisions on my own*), positive career outcome expectations (e.g., [Mentor Name] … *affirms that I am going into a field with high employment demand*) and career

interests and goals (e.g., [Mentor Name] … *encourages me to create career goals*). Scores can range from 0 (no mentors have provided this resource) to 5 (five mentors have provided this resource). A summary of the scales in the Career Social Capital section can be found in Table 1.

*Interviews*

Semi-structured think-aloud cognitive interviews were performed to understand how items are being interpreted and ensure the readability of the *Mentoring Social Capital* instrument. Students were given a copy of the assessment and asked to 'think-aloud,' giving the researcher insight on the students' thought process in answering the questions. Think-aloud interviews are particularly useful in understanding if items are being interpreted in accordance to the researchers' intention, especially across racial, ethnic and gender identities [28]. The interview participants were chosen based on four criteria: a) participants must be undergraduate students; b) participants must be engineering students; c) participants recruited for the think-aloud have some representation across different race and ethnic groups and d) participants need to have completed an internship or undergraduate research experience. In total, eight engineering students were interviewed. Four of the participants identified as men, three participants identified as women and one participant identified as nonbinary. Two participants identified as White, four participants identified as Asian, one participant identified as Latino, one participant identified as Indigenous, and one participant identified as Black. Five of the eight students had participated or were participating in an internship or Co-op session by the time of the cognitive interviews; three of the eight students had participated in undergraduate research experiences. Per the cognitive interview protocol, students were told that there is no right or wrong answer, instead the researchers are interested in the students' thought process in answering the questions. The researcher utilized multiple probes dependent on if the student answered the question quickly or struggled to answer the question.

**Table 1**

Summary of scales in career social capital section.

| ***Scale* (# of Items)** | **Definition** | **Example Item** |
|---|---|---|
| *Mentors support of engineering… (Scale stem)* | | |
| *Self-efficacy* (18) | Mentors build students' belief in their own capabilities by increasing students' ability through **mastery experiences, vicarious experiences, verbally persuading and reducing stressful physiological states**. | [Mentor Name] … *brings my accomplishments to the attention of important people* |
| *Career outcome expectations* (7) | Mentors build positive expectations for pursing an engineering career by creating positive expectations | [Mentor Name] … *establishes the importance of my work to society* |

| | | |
|---|---|---|
| | for **financial, societal, and personal benefits.** | |
| *Interests and Goals* (5) | Mentors utilize interest developed by students' positive self-efficacy and outcome expectations to develop students' goals. Mentors encourage students to pursue interests and create outlets for interests to become goals. | [Mentor Name] … *helps me think about how to translate my interests into career goals* |

*Expert Review*

After revising the instrument with the results of the cognitive interviews, ten experts in the fields of social cognitive career theory, social capital, industry and research mentoring relationships and assessment development shared feedback on the construct and face validity of the items. The experts in this study had no connection to the eight think-aloud participants. Experts assessed the alignment between the items and the definition of the latent variable being assessed and shared feedback on the alignment and/or items.

**Results**

Based on the cognitive interviews, eleven items were revised, with four items being revised to clarify small words or phrases and seven items to clarify cognitive issues around item meaning and inconsistent interpretation of items across race, ethnicity and gender. Four items were re-wording for clarity based on students' interpretations and suggestions. For example, an item regarding mentors' support when students have "failures" did not perform well since students did not perceive that they "failed." Instead, the item was changed to prompt students to think of mentors that have supported them through "difficulties." Seven items were revised by removing items that did not align with students' interpretation of the items, adding items to strengthen students' interpretation of the items, and substituting poorly performing items with items from other scales with strong validity evidence. For example, the item "*helps me realistically examine my weaknesses"* was often found to be unclear. This item was replaced with two items about how mentors provide feedback on the knowledge and skills the mentee needs to strengthen.

Based on the expert review, six items were revised to address misalignment between the theoretical construct and the items face validity and to improve clarity of the items. Items for the self-efficacy factor received the most feedback, as some items did not clearly address the aspect of self-efficacy intended. For example, the item "*encouraged me to think about how the work is related to my own lived experience*" was changed to be associated with vicarious experiences factor instead of the reduces stressful psychological states factor. Additionally, feedback was provided on how to improve the clarity of the items, such as making items less redundant or being more specific with what is being asked. One item prompting students to think of how mentors "*teaches me 'rules of the game' of organizational politics*" was revised to a clearer

statement, "*makes me aware of the social, organization, and political norms of the organization*."

## Conclusion

The purpose of this study was to explore student interpretations of the *Mentoring Social Capital* instrument and examine expert feedback on the alignment of the instrument with the proposed theoretical framework. The results of this study were used to improve the item clarity, interpretability, and alignment of *Mentoring Social Capital* instrument for undergraduate engineering students in work-integrated learning programs. Our goal is to provide researchers, practioners, and educators with a fair and reliable tool for assessing the career support engineering students receive from their mentors at their work-integrated-learning programs. Limitations of this work include the lack of racial and ethnic diversity of the think-aloud participants. Despite efforts from the research team, we were unable to recruit a sample of students' representative of the overall engineering population. Our future work will focus on validation studies to further explore the fairness of the instrument across racial and ethnic groups. Specifically, future work will include piloting the *Mentoring Social Capital* instrument with Co-op students at a large, midwestern R1 institution.

## Acknowledgement

We acknowledge support from the U.S. Department of Defense [Contract Nos. W52P1J-20-9-3009 and W52P1J-22-9-3009].

## References


[1] E. Litzler and C. Samuelson, "How underrepresented minority engineering students derive a sense of belonging from engineering," in *2013 ASEE Annual Conference & Exposition*, 2013, pp. 23–674.

[2] T. L. Strayhorn and R. M. Johnson, "What underrepresented minority engineering majors learn from co-ops & internships," in *2016 ASEE International Forum*, 2016.

[3] M. M. Fifolt and G. Abbott, "Differential experiences of women and minority engineering students in a cooperative education program," *J. Women Minor. Sci. Eng.*, vol. 14, no. 3, 2008.

[4] J. B. Main, B. N. Johnson, and Y. Wang, "Gatekeepers of Engineering Workforce Diversity? The Academic and Employment Returns to Student Participation in Voluntary Cooperative Education Programs," *Res. High. Educ.*, vol. 62, no. 4, pp. 448–477, Jun. 2021.

[5] E. Douglas, G. Dietz, and E. McCray, "A narrative exploration of the in/authentic experiences of Black engineering interns (Work in Progress)," in *2022 ASEE Annual Conference & Exposition*, 2022.

[6] E. Anderson, K. Williams, L. Ponjuan, H. T. Frierson, and others, "The 2018 status report on engineering education: A snapshot of diversity in degrees conferred in engineering," 2018.

[7] J. Brooks, "Why Should I Care About Diversity in Engineering?," *National Society of Professional Engineers*, Jul. 2020. https://www.nspe.org/resources/pe-magazine/july-2020/why-should-i-care-about-diversity-engineering (accessed Feb. 10, 2023).

[8] S. Brown, L. Flick, and K. Williamson, "Social capital in engineering education," in *Proceedings Frontiers in Education 35th Annual Conference*, 2005, pp. S3D-S3D.

[9] A. Pennaforte and T. J. Pretti, "Developing the conditions for co-op students' organizational commitment through cooperative education," p. 16, 2015.

[10] J.-L. Mondisa, "The role of social capital in African American STEM mentoring relationships," *J. Women Minor. Sci. Eng.*, vol. 26, no. 2, 2020.

[11] J. P. Martin, S. K. Stefl, L. W. Cain, and A. L. Pfirman, "Understanding first-generation undergraduate engineering students' entry and persistence through social capital theory," *Int. J. STEM Educ.*, vol. 7, no. 1, pp. 1–22, 2020.

[12] N. Lin, *Social capital: A theory of social structure and action*. Cambridge university press, 2002.

[13] J. Skvoretz *et al.*, "Pursuing an engineering major: social capital of women and underrepresented minorities," *Stud. High. Educ.*, vol. 45, no. 3, pp. 592–607, 2020, doi: 10.1080/03075079.2019.1609923.

[14] E. Puccia *et al.*, "The influence of expressive and instrumental social capital from parents on women and underrepresented minority students' declaration and persistence in engineering majors," *Int. J. STEM Educ.*, vol. 8, no. 1, p. 20, Dec. 2021, doi: 10.1186/s40594-021-00277-0.

[15] J. B. Main, B. N. Johnson, N. Ramirez, H. Ebrahiminejad, M. W. Ohland, and E. A. Groll, "A case for disaggregating engineering majors in engineering education research: the relationship between co-op participation and student academic outcomes," *Int. J. Eng. Educ.*, vol. 36, no. 1, pp. 170–185, 2020.

[16] N. Ramirez *et al.*, "From interest to decision: A comparative exploration of student attitudes and pathways to co-op programs in the United States and the United Kingdom," *Int. J. Eng. Educ.*, vol. 32, no. 5A, pp. 1867–1878, 2016.
[17] A. N. Gentry, J. P. Martin, and K. A. Douglas, "How is social capital assessed? A systematized literature review," presented at the Annual meeting program American Educational Research Association, Apr. 2023.
[18] R. W. Lent, S. D. Brown, and G. Hackett, "Social cognitive career theory," *Career Choice Dev.*, vol. 4, no. 1, pp. 255–311, 2002.
[19] A. Byars-Winston and J. G. Rogers, "Testing intersectionality of race/ethnicity x gender in a social–cognitive career theory model with science identity.," *J. Couns. Psychol.*, vol. 66, no. 1, p. 30, 2019.
[20] N. A. Fouad and M. C. Santana, "SCCT and underrepresented populations in STEM fields: Moving the needle," *J. Career Assess.*, vol. 25, no. 1, pp. 24–39, 2017.
[21] R. W. Lent *et al.*, "Social cognitive predictors of academic interests and goals in engineering: Utility for women and students at historically black universities.," *J. Couns. Psychol.*, vol. 52, no. 1, p. 84, 2005.
[22] S. L. Mendez, C. V. Martin, R. S. Keith, C. Haynes, and R. Gerhardt, "Mentorship in the engineering professoriate: exploring the role of social cognitive career theory," *Int. J. Mentor. Coach. Educ.*, vol. 6, no. 4, pp. 302–316, Jan. 2017, doi: 10.1108/IJMCE-12-2016-0077.
[23] N. Lin, "A network theory of social capital," *Handb. Soc. Cap.*, vol. 50, no. 1, p. 69, 2008.
[24] P. Bourdieu, "The forms of capital," 1986.
[25] C. Pfund, A. Byars-Winston, J. Branchaw, S. Hurtado, and K. Eagan, "Defining attributes and metrics of effective research mentoring relationships," *AIDS Behav.*, vol. 20, no. 2, pp. 238–248, 2016.
[26] B. Sánchez, A. L. Mroczkowski, L. Y. Flores, W. de los Reyes, J. Ruiz, and H. Rasgado-Flores, "How Mentors Contribute to Latinx Adolescents' Social Capital in the Sciences," *J. Adolesc. Res.*, p. 0743558420985454, Jan. 2021, doi: 10.1177/0743558420985454.
[27] J. P. Martin, M. K. Miller, and D. R. Simmons, "Exploring the theoretical social capital 'deficit' of first generation college students: Implications for engineering education," *Int. J. Eng. Educ.*, vol. 30, no. 4, pp. 822–836, 2014.
[28] J. Blair, R. F. Czaja, and E. A. Blair, *Designing surveys: A guide to decisions and procedures*. Sage Publications, 2013.