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Work in Progress: Understanding Differential Experiences of Identity in Computing Environments Using a Computing Privilege Inventory

Cecilé Sadler, Massachusetts Institute of Technology

Cecilé Sadler is a PhD student at the Massachusetts Institute of Technology in the MIT Media Lab with the Lifelong Kindergarten group. Her interests lie at the intersection of computing and education in designing equitable learning environments that cultivate creativity through technology-mediated creative learning experiences. She focuses on investigating how computing can be leveraged to create spaces for Black and brown youth to practice agency and develop their cultural identity through playful learning experiences. Cecilé is a graduate of North Carolina State University and Duke University, earning her B.S. and M.S. in computer engineering. She is also on the Cultural Competence in Computing (3C) Fellows Program research team and serves as senior personnel on the Alliance for Identity-Inclusive Computing Education (AiiCE).

Dr. Alicia Nicki Washington, Duke University

Dr. Nicki Washington is a professor of the practice of computer science and gender, sexuality, and feminist studies at Duke University and the author of Unapologetically Dope: Lessons for Black Women and Girls on Surviving and Thriving in the Tech Field. She is currently the director of the Cultural Competence in Computing (3C) Fellows program and the NSF-funded Alliance for Identity-Inclusive Computing Education (AiiCE). She also serves as senior personnel for the NSF-funded Athena Institute for Artificial Intelligence (AI). Her career in higher education began at Howard University as the first Black female faculty member in the Department of Computer Science. Her professional experience also includes Winthrop University, The Aerospace Corporation, and IBM. She is a graduate of Johnson C. Smith University (B.S., '00) and North Carolina State University (M.S., '02; Ph.D., '05), becoming the first Black woman to earn a Ph.D. in computer science at the university and 2019 Computer Science Hall of Fame Inductee.

Shaundra Bryant Daily, Duke University

Shaundra B. Daily is a Cue Family professor of practice in Electrical and Computer Engineering & Computer Science at Duke University and Levitan Faculty Fellow, Special Assistant to the Vice Provosts. Prior to joining Duke, she was an associate professor with tenure at the University of Florida in the Department of Computer & Information Science & Engineering. She also served as an associate professor and interim co-chair in the School of Computing at Clemson University. Her research focuses on the design, implementation, and evaluation of technologies, programs, and curricula to support diversity, equity, and inclusion in STEM fields. Currently, through this work, she is the Backbone Director for the Alliance for Identity-Inclusive Computing Education as well as Education and Workforce Director for the Athena AI Institute. Having garnered over $40M in funding from public and private sources to support her collaborative research activities, Daily's work has been featured in USA Today, Forbes, National Public Radio, and the Chicago Tribune. Daily earned her B.S. and M.S. in Electrical Engineering from the Florida Agricultural and Mechanical University – Florida State University College of Engineering, and an S.M. and Ph.D. from the MIT Media Lab.

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Introduction

The purpose of this work-in-progress research paper is to outline the development and initial assessment of a tool designed to measure privilege within academic and professional computing environments. The computing industry has grappled with diversity gaps and equity issues for decades [1], [2], [3]. While some progress has been made, women, racial/ethnic minorities, LGBTQ+ people, those with disabilities, and working-class individuals remain underrepresented [4]. Peggy McIntosh's conception of unseen privileges might provide insight into the representation disparities in computing. In her pivotal article "White Privilege: Unpacking the Invisible Knapsack," she [5] used the metaphor of an invisible, weightless backpack full of assets to illustrate the everyday privileges afforded white people. Though focused on racial inequity, her idea of invisible privilege applies to other types of social advantage and marginalization [6]. Since its inception, she and others have developed activities that allow participants to explore privilege and disadvantage in various contexts, including global health and environmental justice [5], [6], [7], [8]. Expansions have also focused on other aspects of identity (e.g., sexuality), English as a second language learners, and women in STEM fields. [9], [10], [11], [12].

Although prior work has explored the impact of privilege in computing education [13], [14], it primarily focuses on how lack of privilege serves as a barrier to entry into academic computing spaces [1], [15]. More research is required to better assess the different and nuanced ways privilege manifests in computing environments. This work expands prior work by 1) focusing on multiple axes of identity, 2) emphasizing computing contexts, and 3) using an intersectional approach to understand the results. The proposed Computing Privilege Inventory (CPI) seeks to unpack the invisible assets afforded to groups overrepresented in technical spheres. Quantifying privilege disparities is an initial step toward dismantling barriers and creating more inclusive computing spaces where all identities are welcomed and valued.

Positionality statement

We recognize the importance of reflexivity and how our identities as researchers shape and inform our approach to designing this tool. As three Black women in computing who consistently operate in computing spaces, we have experienced the impact of identity and privilege in our academic, professional, and personal lives. We acknowledge the varying levels of privilege we hold based on different parts of our identities (e.g., education level, socioeconomic status, and ability). We draw upon our "insider" [16] experiences in computing and existing theoretical frameworks to inform instrument development.

Methods

Instrument development

The original CPI contained 30 items: ten items related to socioeconomic status, eight to race, seven to gender, and five to disability status. Table 1 lists a sample of items. Three items in the race construct were developed by adapting McIntosh's initial statements of white privilege, such as: "If a traffic cop pulls me over or if the IRS audits my tax return, I can be sure I haven't been singled out because of my race [5]." Items that were not adapted were developed from knowledge of several theoretical frameworks to support content-related validity, including critical race theory, disability theory, and queer theory [17], [18], [19], [20]. While these theories provide initial grounding, further validation studies have yet to be conducted to provide broader evidence for construct validity, criterion validity, or reliability.

Table 1. Sample of the CPI items, grouped by identity construct.

Identity Construct	**Items**
Socio-economic status	I grew up in a household with at least one computer. I have a stable and reliable internet connection at home. I can apply for a wide range of financial aid and other paid campus opportunities if I want to.
Race	Growing up, I could identify professionals in computing who shared my ethnoracial identity. At least 50% of the faculty in my department share my ethnoracial identity. I have never been stopped and questioned (by campus security, faculty, staff, or other students) if I should be in a room, classroom, or other space on campus.
Gender	I have never been misgendered (e.g., someone referring to you using the pronouns "he/him" when you identify as a woman). I feel safe when walking around my college campus at night. I have never been concerned if people knew my gender identity or sexuality.
Disability status	I have never been diagnosed with a disability or chronic condition. The inability to read lips due to masks was not a barrier to understanding my instructor. I am completing this survey without the assistance of a screen reader.

Participant demographics

Respondents included computing professionals (N=93) and students (N=161). Data on race, ethnicity, gender, and disability status were collected. Participants completed the assessment anonymously via Qualtrics in spring 2023 (students) and fall 2023 (professionals).

Results and Discussion

We analyzed overall scores and scores within each construct to calculate average (μ), standard deviation (σ), minimum, maximum, and statistical significance using an independent samples *t* test. Each item allows yes/no responses (coded as 1 for yes and 0 for no), and overall scores (ranging from 0-30) were calculated by summing all coded responses. A higher score indicates a greater level of privilege. Preliminary results reveal patterns among computing professionals and students, with higher privilege among identities that are overrepresented in computing.

Table 2. Results for gender construct.

	Student				**Professional**			
Gender	Man (n=73)	Non-binary (n=3)	Self-identify (n=0)	Woman (n=84)	Man (n=27)	Non-binary (n=7)	Self-identify (n=1)	Woman (n=57)
Total (μ)	22	17	--	20.5	20.7	15.4	20	16.8
Gender (μ)	5.5	1.7	--	3.5	5.6	1.3	1	2.9

Table 2 summarizes responses based on gender. Men reported a statistically significant higher average overall and gender-related score across students and professionals. Non-binary respondents reported the lowest scores.

Table 3. Results for disability status construct.

	Student		**Professional**	
Disability?	N (n=135)	Y (n=25)	N (n=65)	Y (n=25)
Total (μ)	21.7	17.8	18.8	15.8
Ability (μ)	4.5	2.8	4.3	2.7

Table 3 presents responses based on disability status. Non-disabled individuals reported higher overall and disability-related scores than those with a disability.

Table 4. Results for race construct.

		Total (μ)	**Race (μ)**	**Race (σ)**	***p*-value**
Asian	Student (n=73)	21.5	4.6	1.52	< .001
	Professional (n=16)	16.1	3.6	1.36	< .001
Black or from the African Diaspora	Student (n=22)	16.1	2.4	1.1	< .001
	Professional (n=12)	14.3	2.2	1.19	< .001
Latinx/e/o/a	Student (n=8)	18	2.5	1.77	< .001
	Professional (n=6)	11.7	2	1.26	< .001
Middle Eastern or Northern African	Student (n=0)	--	--	--	--
	Professional (n=3)	21.7	5	1	< .001
Multi-racial 1	Student (n=10)	20	3.9	1.37	< .001
	Professional (n=4)	10.8	1.8	0.96	< .001
Multi-racial 2	Student (n=8)	21.8	5.3	2.25	< .001
	Professional (n=7)	18.8	4.4	1.72	< .001
White	Student (n=39)	24	7.1	1.15	< .001
	Professional (n=44)	20.7	6.5	1.42	< .001

Table 4 outlines results based on race and ethnicity. Construct analysis displayed significant variability between students and professionals. Among students, white individuals reported the highest privilege, with an average overall score of 24, and a race-related score of 7.1. Among computing professionals, Middle Eastern or Northern African individuals had the highest average overall score (21.7), followed by white professionals (20.7). The order reversed for race-related questions: white professionals reported the highest average score (6.5), followed by Middle Eastern or Northern African respondents (5). Participants could select multiple options within the race demographic. For a more nuanced analysis, respondents with multiple racial identities that are historically underrepresented (e.g., Black and Native) were grouped as "multi-racial 1", while those with multiple overrepresented race identities (e.g., white and Asian) were in the "multi-racial 2" group. Both professionals and students in the multi-racial 2 group reported a higher average overall and race-related score than those in the multi-racial 1 group.

Students selecting Latinx/e/o/a as their only racial identity reported lower overall and race-related scores compared to both multi-racial groups. Conversely, Latinx/e/o/a professionals reported higher scores than multi-racial group 1 and lower scores than multi-racial group 2. Some individuals identified Latinx/e/o/a as their sole racial identity, while others selected it alongside another racial option, categorized into a multi-racial group based on the pairing. This variability highlights how race and ethnicity can be perceived and experienced in diverse ways, impacting one's privilege level (e.g., Afro-Latinx vs. white Latinx).

Multiple constructs

While analyzing individual identity constructs reveals trends in computing experiences reflecting societal power dynamics, each isolated identity offers a limited perspective. Intersectionality [21] guided analysis conducted across identity constructs: (1) race and gender, (2) gender and disability status, (3) disability status and race, and (4) race, gender, and disability status. An intersectional analysis revealed that participants with multiple minoritized identities reported less privilege. Black students reported an average score of 16.1. The score decreased for Black women (14.7) and decreased again for Black women with a disability (10.3). In professionals, the score slightly increased when combining race and gender for Black women (from 14.3 to 14.4); adding disability status dropped the score significantly (10).

Results also indicate an amplification of privilege for both students and professionals who hold overrepresented identities. For example, white professionals reported an average overall score of 20.7, which increased for white men (22.6) and white non-disabled men (22.7). Asian students reported an average overall score of 21.5, 23 for Asian men, and 24 for non-disabled Asian men.

Data demonstrates the nuanced impact of privilege for someone who holds an identity that is overrepresented in one construct and minoritized in another. While white professionals reported an average overall score of 20.7, white women reported a score of 20.2. Although this increases for non-disabled white women (21.7), it is still lower than white men with a disability (22.3).

Students consistently reported higher scores on individual identity constructs and intersections than professionals. Among students at the intersection of gender and ability, non-disabled men had the highest average overall score (22.4) and the highest average for gender-related questions (5.6). Conversely, non-disabled women reported the highest average for disability-related questions (4.5). Among professionals, men with a disability reported the highest average overall (22.3) and the highest average for gender-related questions (5.8). For disability-related questions, non-disabled men had the highest average (4.4). This pattern in the intersectional analysis underscores the absence of a singular indicator of privilege in computing environments.

Limitations and Future Work

The pilot study revealed multiple areas for strengthening the assessment. First, although we had CPI items about socioeconomic status, we did not analyze this construct because we did not collect demographic information as a proxy. Future iterations of the demographic collection will add respondent age and affiliation (i.e., undergraduate student, graduate student, or professional) plus a broader spectrum of options for gender identity. Other updates include addressing the conflation of identity constructs in items (e.g., #3 in the gender construct). Moreover, the original CPI allowed respondents to select multiple races mixed with ethnicities, complicating analysis in two significant ways. Firstly, it markedly reduced sample sizes for specific multi-racial identities. Although we addressed this by creating our multi-racial groups (1 & 2) to avoid omitting individuals based on low sample sizes, we acknowledge that these aggregations may assume experiences inaccurately. Secondly, as previously discussed, the failure to delineate Latinx/e/o/a as an ethnicity that can be combined with other races resulted in an incomplete understanding of privilege variations within Latinx/e/o/a identities.

Another tool limitation is the imbalance between the number of items for each identity construct. Because the distribution was unequal across constructs and biased towards questions about socioeconomic status, the overall scores may be skewed depending on a singular identity. This distribution may also account for higher scores reported by students than professionals, as all students attended the same private institution known for having a student body with a higher socioeconomic status. While we accounted for this imbalance by analyzing each identity construct and refining the item set, we aim for balance among items in each measured construct. Further adjustments include rephrasing the responses to be true/false (vs. yes/no) to avoid confusion of items that may result in false positives. We also plan to modify phrasing and remove items (e.g., *"I do not have to work to pay for my college education (including work study."*) to ensure they are explicit about computing environments to improve specificity.

Conclusion

This preliminary study of the CPI offers valuable insights into the ways privilege tied to identities like race, gender, and disability status manifests in subtle ways to benefit some groups in computing environments over others. Results demonstrating higher overall privilege for individuals holding multiple overrepresented identities like white, male, and non-disabled underscore persistent disparities and barriers for minoritized groups seeking to access and fully participate in computing.

While promising, this initial pilot study had limitations such as uneven construct question distributions and limited demographic data collection, which we plan to address through instrument refinement and additional validation studies. Key next steps include establishing reliability estimates and gathering valid evidence to support the CPI's utility for assessing privilege dynamics across various collegiate and professional computing contexts. We aim for such efforts to expand awareness of privilege gaps and promote more intentional inclusion of individuals from historically excluded backgrounds. Like McIntosh's Invisible Knapsack, the CPI holds theoretical and practical significance. The instrument can be used on a macro level in various research settings to illuminate experiential trends within computing environments. This, in turn, would be followed by a critical analysis of policies and practices that perpetuate these disparities, and shifts in cultures that address and support the needs of those who are negatively impacted. The CPI can also function on a micro level as a pedagogical tool, aiding individuals in better understanding their privilege. Unpacking the "invisible knapsacks" of advantages and disadvantages in computing is an essential step toward dismantling oppressive practices and progressing equity in the field.

References

[1] J. Margolis, *Stuck in the shallow end: education, race, and computing*. Cambridge, MA: MIT Press, 2008.

[2] S. B. Daily *et al.*, "Alternate Pathways to Careers in Computing: Recruiting and Retaining Women Students," presented at the 2013 ASEE Annual Conference & Exposition, Jun. 2013, p. 23.144.1-23.144.11. Accessed: May 14, 2022. [Online]. Available: https://peer.asee.org/alternate-pathways-to-careers-in-computing-recruiting-and-retaining-women-students

[3] T. Camp, "'Computing, we have a problem…,'" *ACM Inroads*, vol. 3, no. 4, pp. 34–40, 2012.

[4] A. N. Washington, "When Twice as Good Isn't Enough: The Case for Cultural Competence in Computing," in *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, in SIGCSE '20. New York, NY, USA: Association for Computing Machinery, Feb. 2020, pp. 213–219. doi: 10.1145/3328778.3366792.

[5] P. McIntosh and C. Cleveland, "White privilege: unpacking the invisible knapsack", Accessed: Oct. 19, 2023. [Online]. Available: https://jstor.org/stable/community.30714426

[6] P. McIntosh, "Extending the Knapsack: Using the White Privilege Analysis to Examine Conferred Advantage and Disadvantage," *Women Ther.*, vol. 38, no. 3–4, pp. 232–245, Oct. 2015, doi: 10.1080/02703149.2015.1059195.

[7] T. Milstein and S. Griego, "Environmental privilege walk," *Environ. Commun. Pedagogy Pract.*, p. 212, 2017.

[8] R. Siddiqui, "Unpacking the invisible knapsack: addressing privilege in global health contexts," *Glob. Health Annu. Rev.*, vol. 1, no. 2, Art. no. 2, 2016, Accessed: Jan. 10, 2024. [Online]. Available: https://journals.mcmaster.ca/ghar/article/view/1322

[9] K. Moore, "The Rainbow Knapsack Revisited: Being a Gay Teacher in a World of Heterosexual Privilege," *Multicult. Perspect.*, vol. 22, no. 2, pp. 101–105, Apr. 2020, doi: 10.1080/15210960.2020.1741368.

[10] K. Tollefson, "Straight Privilege: Unpacking the (Still) Invisible Knapsack," May 2010. Accessed: Jan. 10, 2024. [Online]. Available: https://eric.ed.gov/?id=ED509465

[11] S. Vandrick, "No 'Knapsack of Invisible Privilege' for ESL University Students," *J. Lang. Identity Educ.*, vol. 14, no. 1, pp. 54–59, Jan. 2015, doi: 10.1080/15348458.2015.988574.

[12] B. A. Kerr *et al.*, "Development of the Distance From Privilege Measures: A Tool for Understanding the Persistence of Talented Women in STEM," *J. Psychoeduc. Assess.*, vol. 30, no. 1, pp. 88–102, Feb. 2012, doi: 10.1177/0734282911428198.

[13] Y. A. Rankin, J. O. Thomas, and S. Erete, "Black Women Speak: Examining Power, Privilege, and Identity in CS Education," *ACM Trans. Comput. Educ.*, vol. 21, no. 4, p. 26:1-26:31, Oct. 2021, doi: 10.1145/3451344.

[14] M. C. Parker and M. Guzdial, "A critical research synthesis of privilege in computing education," in *2015 Research in Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT)*, Charlotte, NC, USA: IEEE, Aug. 2015, pp. 1–5. doi: 10.1109/RESPECT.2015.7296502.

[15] J. R. Warner, J. Childs, C. L. Fletcher, N. D. Martin, and M. Kennedy, "Quantifying Disparities in Computing Education: Access, Participation, and Intersectionality," in *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education*, in

SIGCSE ’21. New York, NY, USA: Association for Computing Machinery, Mar. 2021, pp. 619–625. doi: 10.1145/3408877.3432392.
[16] W. Luttrell, Ed., *Qualitative educational research: readings in reflexive methodology and transformative practice*. New York, NY: Routledge, 2010.
[17] R. Delgado and J. Stefancic, *Critical race theory: An introduction*, vol. 87. NyU press, 2023.
[18] R. F. Devlin and D. Pothier, *Critical disability theory: Essays in philosophy, politics, policy, and law*. UBC press, 2006.
[19] A. Jagose, *Queer theory: An introduction*. nyu Press, 1996.
[20] N. Sullivan, *A critical introduction to queer theory*. NYU Press, 2003.
[21] K. Crenshaw, “Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics,” 1989.