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# Examining Information Processing Skill Proficiencies Among Black Adults in the U.S.

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**Examining Information Processing Skill Proficiencies Among Black Adults in the U.S.**

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## Introduction

The Black or African American<sup>1</sup> population has grown 29% since 2000 - representing one of the largest racial groups in the U.S. and roughly 14% of the total population (Tamir, 2021; U.S. Census Bureau, 2019). The Black population comprises people with increasingly distinct ethnic and immigrant identities and experiences (Charles et al., 2022; U.S. Census Bureau, 2021; Waters, 2012). The majority (56%) of the Black population lives in the South, 10% live in the West, while 17% live in both the Midwest and Northeast (Tamir, 2021), and the state of Texas is home to the largest population of Black adults (U.S. Census Bureau, 2021). Any large populace in a geographically diverse area, like Black adults in the U.S., with a wide diversity of demographic characteristics, skills, beliefs, concerns, and interests should never be considered a homogenous or monolithic group (Charles et al., 2022; Waters, 2012).

However, a preponderance of literature in educational and health-related scholarship categorizes Black adults in precisely these terms and, often, also focuses on Black adults from a deficit and comparative perspective (Goings, 2016). Moreover, Jaima (2019) argued that “There is a discursive tendency when examining questions of race and racism to address a reader who is implicitly white. This discursive orientation limits the range and rigor of our research questions and proposals” (p. 210). A consequence of Jaima’s argument is that much of the research on educational or employment attainment compares Black adults in the U.S. to the larger population, highlighting the “achievement gap” or “employment gaps” (Ladson-Billings, 2006; Selden et al., 2020). Similar findings are frequently reported in health care, where Black adults’ health outcomes are compared to the general population and deficiencies are underscored (Bediako & Griffin, 2007). Thus, while we have gleaned comparisons of Black adults’ information processing skill proficiencies, or the “skills essential for full participation in the knowledge-based economies and societies of the 21st century: literacy, numeracy

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<sup>1</sup> We recognize the Census uses Black or African American in their descriptions of people who have origins in any of the Black racial groups of Africa. In this paper, we use the PIAAC term Black which is defined as inclusive of African American to designate this racial group.

and problem solving in technology-rich environments,” to other racial groups in past research (OECD, 2013c, p.18), we still know very little about the within-group differences among Black adults’ information processing skills. Having this information can lead to development and evaluation of specific, targeted policy and practice interventions and/or supports for this historically minoritized and heterogenous population in the U.S.

### **Policy Context<sup>2</sup>**

Beginning with the Atlantic slave trade in the 1450s and continuing through 1866, over 200 separate exacting statutes in what is now the U.S. were written to support, legalize, exploit, and propagate the enslavement of 12-13 million African people for large financial gain by the ruling white elite (Finkelman, n.d). Following the Civil War, in several states, theories of white supremacy were reinforced through statute and legislation like Black Codes and Jim Crow Laws which continued to thwart people of color, particularly Black people, from fully participating in civic life, educational opportunities, the economy, medical care, and other related spaces (U.S. Commission on Civil Rights, 1963). Yet, Black people individually and through structured community organizing continuously asserted their constitutional and civil rights through civic engagement and legal challenges (U.S. Commission on Civil Rights, 1963). These challenges were met with the U.S. Supreme Court’s ruling in *Plessy v. Ferguson* (1896) which cited that “separate but equal” access to public facilities, including public schools, for white and Black people in the U.S. was constitutionally permissible under Amendment XIV to the U.S. Constitution. Over fifty years later, because of multiple Black communities’ continued leadership in organizing civil and legal challenges to equitable access to public education, the U.S. Supreme Court reversed the *Plessy* precedent and declared segregated schools unconstitutional in *Brown v. Board of Education* (1954), and long and contested process of federally required desegregation of public schools began (U.S. Commission on Civil Rights, 1963). However, until the Civil Rights Act (1964), discrimination and segregation in other public spaces was legal and enforceable. The last U.S. school was

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<sup>2</sup> The policy context outlined in this paper is not exhaustive as the jurisprudence of equitable educational access in the U.S. is not the primary focus of this report.

officially desegregated in 2016 in Mississippi (Domonoske, 2016).

However, the policies of slavery and segregation as well as their contemporary vestiges do not impact all members of the Black population equivalently (Crenshaw, 1991; Go, 2018). Recognizing the significant differences in experiences of Black people “by gender, class, nativity, generation, or experience with segregation” is key to distinguishing the distinct impacts of these policies on the diverse Black population of today (Charles et al., 2022, p. 2).

### **Research Purpose**

Given the history of legal suppression of civic participation for some Black adults in the U.S., contemporary researchers have robustly documented that some Black adults in the U.S. continue to encounter many institutional/systemic barriers such as inadequate access to equitable education and health care which can lead to deleterious outcomes (Henderson et al., 2019; Walters, 2012). For example, although some K-12 educational spaces are shifting to “frame linguistic, literate, and cultural pluralism as a part of schooling for positive social transformation and revitalization,” educational policies and programs for adults are often not sites for “sustaining the cultural ways of being of communities of color” (Ferlazzo, 2017, para 4). As evidence, Rhodes’ (2018) review of the literature on culturally responsive teaching in adult education found that while adult educators know the importance of understanding the identities and experiences of learners to “enhance teaching practices and curricular design,” there is little research which supports related policies and practices in use (p. 39). Conversely, contemporary researchers have also identified that many Black adults in the U.S. achieve high levels of education, employment, and corresponding health outcomes (Charles et al., 2022; Fries-Britt, 2017; Goings, 2016; Henderson et al., 2019; Walters, 2012). In a recent example, Charles et al. (2022) analyzed Black diversity at selective colleges and universities. They found that today’s young Black professional adults “come from many different places, have diverse racial origins and phenotypes, and hail from a variety of socioeconomic backgrounds” and have different access points to elite educational experiences (Charles et al., 2022, p.34).

Therefore, we believe exploring relationships between contextual factors and assessed information processing skill proficiencies is necessary to understand how multiple and evolving dimensions of diversity, including nativity, gender, age, and educational experiences vary within the Black population. This study will benefit policymakers and practitioners by providing an understanding of the related within-group differences of the growing Black adult population's assessed information processing skills. Unfortunately, previous research which examined unique demographic characteristics of Black adults and their information processing skills has been limited by the types of processing skills investigated or longevity of the assessment (National Center for Educational Statistics [NCES], n.d.; Organization for Economic Co-operation and Development [OECD], 2012, 2013a, 2013b, 2013c). As scholars who work for/with culturally and linguistically diverse populations, we believe that a closer investigation of the Black population is warranted to better understand how heterogeneous experiences and identities are related to information processing skill proficiency.

Therefore, in this research report, we uniquely focus on the variability *within* the Black population by using a nationally representative sample of Black adults in the U.S., the PIAAC U.S. 2012/2014/2017 Restricted-Use File (RUF) data, to explore and describe the three information processing skill proficiencies of literacy, numeracy, and digital problem-solving skills across low, mid, vs. high proficiency levels and corresponding differences in larger categories of demographic, household, background, and language characteristics, educational characteristics, employment characteristics, health characteristics, and characteristics related to social trust, civic engagement, and political efficacy for this significant population over two data collection cycles (NCES, 2019b). Identifying potential differences in information skill proficiency *within* the Black adult population is vital to creating culturally sustaining (Alim & Paris, 2017; Rosa & Flores, 2017) and equitable policies and practices across employment, health, and educational systems which support and advance the plurality of identities, experiences, skills, and practices of Black adults.

### **Literature Review**

As this is an initial exploratory study, in this literature review, the PIAAC's assessed information processing skills and corresponding concepts are defined, and existing current research on the information processing skills of the aggregate (whole) population of Black adults in the U.S. are reported. Finally, the limited existing research describing the Black adult population by larger clustered categories of key demographic and personal characteristics associated with information processing skills for U.S. adults (NCES, 2020; Rampey et al., 2016) is reviewed. These larger clustered categories include demographic, household, background, and language characteristics, educational characteristics, employment characteristics, health characteristics, and characteristics related to social trust, civic engagement, and political efficacy.

### **Overview of the PIAAC Assessment**

The Program for the International Assessment of Adult Competencies (PIAAC) is an Organization for Economic Cooperation and Development (OECD) developed recurring, large-scale study of adults' information processing skills and is administered by the National Center for Education Statistics (NCES) in the United States (NCES, 2014, 2016, 2019a). According to NCES, the information processing skills assessed by PIAAC are the "cognitive and workplace skills needed for individuals to participate in society and for economies to prosper" (NCES, n.d., para. 1). Using nationally representative samples, researchers utilizing the information processing skill data from the PIAAC can "better understand their education and training systems and the distribution of these basic skills across the adult working-age population" (NCES, n.d., para. 1). Therefore, the PIAAC's assessed information processing data is a powerful dataset for the study of the variability Black population's information processing skills and associated variables, because "it is cross-sectional in nature so it can compare skill proficiencies of adults who are in different generations of life, and who were raised and educated with various values and [across different] educational systems" (Saal et al., 2020, p.186). In the U.S., the PIAAC was administered for two rounds (2012 and 2017) with one

supplemental sample administration in 2014 and measures adults' proficiency in three key information processing skill: literacy, numeracy and problem-solving in digital environments (NCES, 2019a).

### ***Information Processing Skills Defined***

Each of the three key information processing skills are discretely defined by the OECD. The PIAAC defines literacy as “the ability to understand, evaluate, use and engage with written texts in order to participate in society, achieve one’s goals, and develop one’s knowledge and potential” and uses both print-based and digital texts to assess these abilities (OECD, 2016, p.38). Numeracy is defined as “the ability to access, use, interpret and communicate mathematical information and ideas in order to engage in and manage the mathematical demands of a range of situations in adult life” (OECD, 2016, p.48). Finally, the OECD defines digital problem-solving proficiency as the ability to use digital technologies and tools “to access and assess information, communicate with others, and perform practical tasks” (OECD, 2012, p.47).

### ***Information Processing Skill Proficiency Levels Defined***

Each information processing skill (literacy, numeracy, and digital problem-solving) is often reported by population or subgroup scores (NCES, 2014, 2016, 2019a). Scores range from 0-500, and the PIAAC’s literacy and numeracy scores are associated with a corresponding proficiency scale which are each divided into six levels of proficiency: Levels 1 through 5 and below Level 1 (OECD, 2012) respectively. For literacy and numeracy information processing skill scores and associated proficiency scales, higher, middle, and lower performance are categorized by “Level 3 or above,” “Level 2,” and “Level 1 or below,” correspondingly (NCES, 2014, 2016, 2019a). Digital problem-solving scores are associated with a comparable proficiency scale which is divided into four levels: Levels 1 through 3 and below Level 1 (OECD, 2021). For digital problem-solving scores and associated proficiency scales, higher, middle, and lower performance are categorized by “Level 2 or above,” “Level 1,” and “Below level 1, respectively (NCES, 2014, 2016, 2019).

Discerning the distribution of information processing skill proficiencies across the adult working-age population by associated variables is necessary to not only evaluate current education, health, and employment

policies and programs for Black adults but also to determine future directions for differentiation of public initiatives according to specific sub-group needs and assets. As a frame to this exploratory evaluation, before proceeding to the results of our study investigating the in-group variability of the information processing skills of the Black population in the U.S., we will first describe the current (existing) research on the information processing skills of the aggregate (whole) population of Black adults in the U.S.

### ***Existing Research on the Information Processing Skill Proficiencies of Black Adults***

According to existing research reports, when looking at the whole group of Black adults, the average information processing skill proficiency levels for Black adults in the U.S. have neither improved nor decreased over an almost ten-year data collection cycle (NCES, 2014, 2016, 2019a). When comparing the skillsets of the nationally representative sample of Black adults (ages 16-65) over the two administrations of the PIAAC assessment, the average scores for all three information processing skills (literacy, numeracy, and digital problem-solving) were not significantly different across rounds (NCES, 2020). The average literacy scores for Black adults were 246 (2012/2014) and 246 (2017) (NCES, 2014, 2016, 2019a). According to OECD (2013a), these scores fall within proficiency Level 2. Level 2's associated tasks involve skills like accessing and navigating a document to identify information from multiple places or comparing and contrasting information in a document order to answer questions (OECD, 2013).

For numeracy, the average scores for Black adults were 217 in 2012/2014 and 216 in 2017 (NCES, 2014, 2016, 2019a). According to OECD (2013a), these scores fall within proficiency Level 1, and Level 1 is characterized by “tasks [that] usually require one-step or simple processes involving counting; sorting; performing basic arithmetic operations; and identifying elements of simple or common graphical or spatial representations” ( p. 76). Finally, the average score on the digital problem-solving assessment for Black adults was 248 for 2012/2014 and 2017 (NCES, 2014, 2016, 2019a). This score falls within proficiency Level 1, where associated tasks “require the use of widely available and familiar technology applications, such as e-

mail software or a web browser... involve few steps and a minimal number of operators...simple forms of reasoning...[and] no need to contrast or integrate information” (OECD, 2013a, p. 88).

Correspondingly, the average skill proficiencies of Black adults in the U.S. are categorized and documented as “middle level” skill for literacy and “low level” skill for numeracy and digital problem-solving over the last decade. These recently reported outcomes in many ways parallel performance for Black adults in the U.S. on the previous nationally representative assessment of U.S. adults’ literacy skills, the 2003 National Assessment of Adult Literacy (NAAL) (NCES, 2007). In this assessment, Black adults’ assessed literacy skills in prose, document, and quantitative literacy all fell within the *Basic Level* characterized by “skills necessary to perform simple and everyday literacy activities” (Kutner et al., 2007, p. 4). The construct of quantitative literacy, as assessed by NAAL, could be considered a part of the numeracy skills assessed in PIAAC.

While previous research has not contextualized these results by identifying relationships between Black adults’ assessed information processing skills by proficiency level and other variables, scholars have explored these relationships for the larger U.S. adult population.. Therefore, the remainder of this literature review outlines the larger categories of associated demographic, household, background, and language characteristics, educational characteristics, employment characteristics, health characteristics, and characteristics related to social trust, civic engagement, and political efficacy which have been found to be associated with information processing skills for U.S. adults in previous research. Although limited, research and/or the most currently associated metrics (where available) for each category are also reported for the Black adult population of the U.S. to provide both rationale and context for the study’s models and findings.

### **Associated Demographic, Household, Background, and Language Characteristics**

Demographic variables (age and gender), household variables (household membership and number of children), background variables (nativity and parents’ educational attainment), and language spoken at home all have strong associations with information processing skill proficiencies in the U.S. adult population (Goodman et al., 2013; Office of Career, Technical, and Adult Education., 2015; Rampey et al., 2016; Reder

& Bynner, 2009). The U.S. Black population is young and approximately 52.2% of the population is female (United States Census Bureau, 2019). The median age of Black people in 2019 was 32 (United States Census Bureau, 2019). “Roughly 30% of the entire Black population is below the age of 20 and 11% are 65 or older” (Tamir et al, 2021, Age Structure section). Twelve percent of Black adults in the U.S. were born in another country and an additional nine percent were born in the U.S. and have at least one foreign-born parent (Tamir, 2022).

Thirty-eight percent of Black households are headed by married couples, 32% of Black household heads are female, six percent live in male-headed households, and 24% of Black adults are part of households identified as non-family, or those which include people who are not related by birth, marriage, or adoption (Tamir et al., 2021), and the fertility rate for Black females is 1.775 (Martin et al., 2019). Most of the Black population, or 89%, speak only English at home (Tamir et al., 2021). Other languages spoken by Black households at home include “Spanish (3%), French or Haitian Creole (2%) and Amharic and other Ethiopian languages (1%)” (Tamir et al., 2021, Languages section).

### **Associated Educational Participation Characteristics**

Education participation and achievement is a significant success factor for a population’s and individual’s personal and professional development (Reder & Bynner, 2009). Research has established several significant relationships between increased educational participation including educational attainment, total years of education, along with recent participation in formal and informal education and higher information processing skill proficiencies in the U.S. adult population (Goodman et al., 2013; Mamedova et al., 2017; Office of Career, Technical, and Adult Education., 2015; Reder & Bynner, 2009).

Recent research highlights significant gains in formal educational attainment for the Black population in the U.S. and has established the importance of continued education particularly for young adults. “The period between the end of compulsory schooling and young adulthood is generally marked by a rapid increase in foundation skills” (OECD, 2021, Executive Summary section). While Goings and Shi (2018) identified that

educational attainment for Black male adults can be predicted by their parents' educational attainment and socioeconomic status, according to Day (2020), 88% of Black adults in the U.S. have attained a high school diploma - a significant increase over the last 50 years. Further, 33% of Black adults (ages 25 and older) have completed some college (Tamir et al., 2021). In 2016, 36% of Black young adults in the U.S. were enrolled in some form of post-secondary education and the six-year graduation rate for "first-time, full-time undergraduate students who began their pursuit of a bachelor's degree at a 4-year degree-granting institution in fall 2010" was 40% (de Brey et al., 2019, vi). In the last twenty years, the number of Black adults with a college degree or more education has more than doubled as 23% of all Black adults ages 25 and older have a bachelor's degree or higher level of educational attainment (Tamir et al., 2021).

Between the years of 2000 and 2016, postbaccalaureate enrollment for the Black population constituted a 100 percent increase – going from 181,000 to 363,000 (de Brey et al., 2019). However, a significant gap between Black female and male postbaccalaureate enrollment was identified (70 vs. 30 percent) (de Brey et al., 2019). Black adults also report high levels of recent educational participation. According to Horrigan (2016), 64% Black adults in the U.S. pursue personal learning activities over a year span and 59% of Black adults in the U.S. pursue professional learning activities over the course of a year. Punksungka et al. (2021) analyzed the 2012/2014 PIAAC public use file and found that Black adults participate more in all forms of adult education and training when compared to other racial groups.

### **Associated Employment Characteristics**

Previous research has identified several associations between employment, its associated income, and higher information processing skill proficiencies (OECD, 2021; Pena, 2018; Rampey et al., 2016; Saal et al., 2018). For Black adults in the United States, higher educational attainment is associated with an increased likelihood of labor force participation (Brundage, 2020). Seventy-eight percent of Black adults with a master's, professional, or doctoral degree and 77% of Black adults with a bachelor's degree participate are employed (Brundage, 2020, Labor force section). Correspondingly, 59% and 37 % of Black adults with a high school

diploma or less than a high school diploma respectively are employed (Brundage, 2020). Black adults are well represented in labor participation in the education and health fields (28% of those employed among all Black adults), retail (10% of employed Black adults), and leisure and hospitality (10% of employed Black adults) (Brundage, 2020). However, Black adults are underrepresented in labor participation in STEM fields despite predictions that the jobs and skills associated with these fields are expected to outpace non-STEM occupations (Fry et al., 2021; OECD, 2021). For example, Black adults make up 9% of the STEM workforce despite constituting 11% of the total labor force (Fry et al., 2021).

Black adults with higher levels of educational attainment typically have higher incomes in the U.S. “Among full-time wage and salary workers, median weekly earnings of Black [adults] with an advanced degree (\$1,284) were more than twice the earnings of Black high school graduates with no college education (\$635) in 2019” (Brundage, 2020, Earnings increase section). For Black adults in the U.S., the median household income is \$44,000 (Tamir et al., 2021). Almost half of Black households (46%) have median incomes of \$50,000 or more. Of these households, 28% make \$75,000 or more and 18% make \$100,000 or more (Tamir et al., 2021). Research has identified the link between assessed performance in literacy and math of Black males and family’s permanent income (Dixon-Román, 2012).

### **Associated Health Characteristics**

Decades of research have identified education as predictive of health outcomes and this association has intensified over the last forty years (Goldman & Smith, 2011; Olshansky et al., 2012). Problem-solving ability and self-efficacy can mediate the relationship between education and health (Mirowski & Ross, 2005) and literacy, numeracy, and problem-solving skills are social determinates of health (Prins et al., 2015). Annual exams, such as those for vision and dental care, and vaccines, like the flu shot, serve as preventative measures which can reduce the risk for disease, disability, and death (Borksy et al., 2018) and utilizing these types of preventative measures are often associated with educational level (Zhang et al., 2012). For some populations, literacy and numeracy proficiencies are also associated with utilizing different health information sources to

make health related decisions like whether to buy insurance, receive a vision check, vaccine, or see a dentist (Saal, 2021; Yamashita et al., 2020). Almost 86% of the Black adult population in the U.S. (ages 19-65) is insured (Baumgartner et al., 2021).

In 2020, the life expectancy for Black people in the U.S. is 77 years old (79 for women and 74 for men) and 89.9% were insured (Office of Minority Health, 2021). According to the U.S. Department of Health and Hospitals' Office of Minority Health (2021), 41.2% of Black adults (over 18) received the flu shot in the 2019-2020 season. However, dental insurance and associated care is a persistent problem, Black adults are 40% more likely than other population groups to have untreated oral disease because of a lack of annual examinations (Center for Disease Control, 2021). Further, 47% of Black adults' self-report annual eye care visits or vision exams (Zhang et al., 2012).

### **Social Trust, Civic Engagement, and Political Efficacy**

Higher levels of social trust, civic engagement, and political efficacy are also all identified in research as related to higher information processing skills for adults (Dinis da Costa et al., 2014; Rose et al., 2019; Saal et al., 2020). In 2020, the most recent U.S. national election, 64.5% of the Black, eligible population was registered to vote and 58.5% voted (U.S. Census Bureau, 2021). According to the most recent report on volunteering by the Bureau of Labor Statistics (2016), 19.3% of the Black population also civically engages through volunteering each year. Walton et al. (2017) note that, for the Black community, their social trust and political engagement are impacted by their perception of responsiveness of the current government to their needs and interests, especially the protection of civil rights. According to Shaw et al. (2018), U.S. minority groups, particularly Black adults, dependably self-report distrust in government which political scientists and historians accredit to over a century of deliberate and continuing disenfranchisement and voter suppression. For example, Cohen (2010) used results from Black Youth Project to articulate how Black youth often: have a profound lack of trust in the government and political community; feel treated as second class citizens in their own , and do not feel equality exists.

### **Research Question**

After an extensive review of literature, the following research question was developed for exploratory analysis.

- Do known associations between information processing proficiencies, demographic characteristics, education, employment, health, social trust, civic engagement, and political efficacy vary within the Black adult population in the U.S. by information processing skill levels?

### **Methods**

This exploratory analysis documents and examines the differences in the information processing skill proficiencies (low, mid, vs. high levels) of Black adults in the U.S. (ages 16-74) by larger categories of key demographic and personal characteristics (see Table 1) that have been identified in the literature. Specifically, we classify the samples of Black adults by the three literacy, numeracy, and digital problem-solving skill proficiency levels, and compute basic characteristics for all levels. For example, we analyze the age distribution for low, mid, and high proficiency levels across the Black adult population. Additionally, we computed the mean skill proficiency scores (0-500 points) by each of the characteristics.

We hypothesized that the levels of information processing skills would vary across demographic and socioeconomic characteristics among Black adults. Also, given previous research on the larger U.S. adult population, we hypothesized that greater information processing skills would be associated with more positive life outcomes including higher levels of education, socioeconomic status (i.e., employment, income), better health, and more active social trust and participation among Black adults.

### **Sample**

This study utilizes the 2012/2014/2017 Program for International Assessment of Adult Competencies (PIAAC), U.S. Restricted-Use File (RUF) data (National Center for Education Statistics, 2019b). PIAAC is an ongoing large-scale assessment with repeated cross-sectional data and a complex sampling design. PIAAC assessed literacy, numeracy, and digital problem-solving skills. The skill

proficiencies are recorded in a set of 10 plausible values<sup>3</sup>, ranging from 0 to 500 points. A PIAAC RUF data license (#17080026) was obtained from the Institute of Education Sciences (IES) and all analyses complied with the IES data security policies. Before the 2012/2014/2017 RUF was released in early 2020, the sample sizes for all racial/ethnic minorities in the U.S. were limited and estimations by skill proficiency levels for sub-populations were somewhat restricted. With additional sample from the 2012/2014/2017 RUF data, more detailed analyses by skill proficiency levels and the larger categories of key demographic and personal characteristics, such as in this report, are achievable.

The 2012/2014/2017 U.S. RUF has a sample size of 12,330 with the associated sampling weights and replicate weights to generate nationally representative estimates. The PIAAC RUF combined data can be analyzed as a large cross-sectional data file. According to the 2012/2014/2017 U.S. RUF file utilized for this analysis, approximately 17.5% of the U.S. PIAAC sample (2,160 cases) self-identified as Black. The information processing skill proficiency levels were classified as follows: below level 1 – level 5 for literacy and numeracy, below level 1 – level 3 for digital problem-solving skills, in PIAAC. Per the classification used in the previous national reports (e.g., NCES, 2020), we used a three-level classification: low (below level 1 and level 1), mid (level 2), and high (level 3, 4 and 5) for literacy and numeracy information processing skill proficiency, and low (below level 1 and level 1), mid (level 2), and high (level 3) for digital problem-solving skills.

Due to the design of the basic computer skill screening for the PIAAC assessment, a portion of the respondents did not take the digital problem-solving assessment. In this study, the missing rate of the digital problem-solving skills sample is about 24% based on the total Black samples available for literacy and numeracy information processing skills. Yet, in terms of sub-groups of interest [e.g., age (16-74) by groups (6 groups), gender (women vs. men), education levels (3 levels)], the sample size

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<sup>3</sup> Plausible values are the statistically imputed set of proficiency score (0-500 points) based on the assessment result, and are necessary to correctly estimate nationally representative figures and their standard errors.

meets the suggested guidelines (minimum sample size for a sub-group  $\geq 62$ ) when plausible values are involved (AIR PIAAC Team, n.d.).

The power analysis was conducted to ensure sufficient statistical power for all analyses given the variables and sub-samples of interest in this study. The results for the bivariate significance test show that the required sample size, with the small to medium effect size assumption, is 63 to 393 (Champely, 2020). Across all bivariate analyses with the assumption of medium effect size, the requisite minimum sample sizes are satisfied ( $n > 393$ ).

### **Variables**

Based on the review of related literature, we analyzed the variables in the dataset related to literacy, numeracy, and digital problem-solving proficiencies of Black adults as well as the larger key clusters of personal variables including associated 1) demographic, household, background, and language characteristics, 2) educational characteristics, 3) employment characteristics, 4) health characteristics, and 5) social outcome characteristics inclusive of social trust, civic engagement, and political efficacy for our exploratory analysis. We operationalized industries as STEM or Non-STEM according to the ISCO-08 classifications and those identified in research (Cedefop, 2014; European Commission, 2015; Koonce, et al. 2011; Shapiro et al, 2020). We included: science & technology professionals, health professionals, information and communication technology professionals, science and engineering associate professionals, health associate professionals, and information and communication technicians in our STEM classification.

Table 1

*Variables Clustered by Theme*

Variable name	Description	Value range
<b>Skill Proficiencies<sup>a</sup></b>		
PVLIT1-10	Literacy plausible values (The numbers represent the plausible value scores)	Below 1 (0 - 175) 1 (176 – 225) 2 (226 – 275) 3 (276 – 325) 4 (326 – 375) 5 (376 – 500) * Low (below level 1 and level 1), mid (level 2), and high (level 3, 4 and 5)
PVNUM1-10	Numeracy plausible values (The numbers represent the plausible value scores)	Below 1 (0 - 175) 1 (176 – 225) 2 (226 – 275) 3 (276 – 325) 4 (326 – 375) 5 (376 – 500) *Low (below level 1 and level 1), mid (level 2), and high (level 3, 4 and 5)
PVPSL1-10 <sup>b</sup>	Digital problem solving skills plausible values (The numbers represent the plausible value scores)	Below 1 (0 - 240) 1 (241-290) 2 (291-340) 3 (341-500) * Low (below level 1 and level 1), mid (level 2), and high (level 3)
<b>Demographic Variables</b>		
AGE_R	Age	Age in years
GENDER_R	Gender	1=Male; 2= Female
RACETHN_4CAT	Race	1=Hispanic; 2=White; <b>3=Black</b> ; 6=Other race
<b>Household Variables</b>		
J_Q02A	Living with spouse or partner	1 = Yes; 2 = No
J_Q01	Number of household members	Count
J_Q03A & J_Q03B	Number of children	1 = Yes; 2 = No * & Count *The number of children variable [range from 0 to 7 (top-coded)] that is analyzed in this study are derived from the two variables -- J_Q03A & J_Q03B.

<b>Background Variables</b>		
J_Q04A	Nativity – born in the United States	1 = Yes; 2 = No
PARED	Parents' educational attainment	1=Less than high school; 2=High school diploma; 3=College degree or higher
<b>Language</b>		
LNG_HOME	Primary language spoken at home is English	English v. Non-English
<b>Education</b>		
B_Q01AUS_C	Educational attainment	College or higher v. Less than College
YRSQUAL	Total years of education	Total years of formal education
FE12	Participated in Formal Education in last 12 months	1 = Yes; 2 = No
NFE12	Participated in Non-formal Education in last 12 months	1 = Yes; 2 = No
<b>Employment</b>		
C_D05	Employment status	1=Employed; 2=Unemployed; 3=Not in Labor Force
ISCO2C	If employed, STEM v. Non-STEM	STEM v. Non-STEM
EARNMTHALLDCL <sup>c</sup>	Income quintile	0=No income (not employed); 1 = first quintile; 2 = second quintile; 3 = third quintile; 4 = fourth quintile; 5 = fifth quintile
<b>Health</b>		
I_Q08	Self-rated health	1=Excellent, Very Good, Good 2=Fair, Poor
I_Q10BUSX1	Health insurance status	1 = Yes; 2 = No
I_Q10BUSX3A	Flu shot in last year	1 = Yes; 2 = No
I_Q10BUSX3H	Visit to dentist in last year	1 = Yes; 2 = No
I_Q10BUSX3E	Visit to check vision in last year	1 = Yes; 2 = No

Social Trust, Civic Engagement, & Political Efficacy		
I_Q07A & I_Q07B	Social trust	1-5: Strongly agree – Strongly disagree
I_Q05F	Civic engagement – volunteering	1-5: Never – Everyday
I_Q06A	Political efficacy – no influence on the government	1-5: Strongly agree – Strongly disagree
Notes: *a Converted to levels *b Approximately 20% of data are missing in the total sample *c Only reflects income from employment		

## Analytic Approach

To answer our research question, we utilized the STATA macro program, REPEST, to incorporate all 10 plausible values for each skill information processing skill domain (literacy, numeracy, and digital problem-solving) and the associated sampling (SPFWT0) and replicate weights (SPFWT1-80) into all analyses (Avvisati & Keslair, 2014). First, to complete our analysis of information processing skills for the Black adult population of the U.S. by proficiency level (low, mid, vs. high; and all levels combined), a series of weighted descriptive statistics for all outlined variables of interest were estimated. Next, to conduct a bivariate significance test for all combinations of the information-processing skill levels, the STATA command `mlogit` in the REPEST macro was used to run simple multinomial logistic regressions with the three proficiency levels as the outcomes and each variable of interest as the predictor. This analysis method is equivalent to simultaneously running bivariate tests for low vs. mid, low vs. high, and mid vs. high proficiency levels for each variable, and therefore, possible inflated Type I error rate is not concerning. The statistical significance for each association was evaluated at the alpha level of 0.05. All unweighted statistics as well as sub/sample sizes were rounded up to the nearest 10 according to the IES restricted data use guideline.

## Findings

In the following section, the findings from the bivariate significance tests for all combinations of information processing skill levels and the variables of interest are presented. The resultant descriptive summaries by literacy, numeracy and digital problem-solving skills are presented by previously outlined themes (see Tables 2-4) and significant findings are described below.

### Information Processing Skills of Black Adults by Proficiency Level

When reviewing the information processing skills for the combined sample of 2012, 2014, and 2017 PIAAC data for Black adults in the U.S., a more nuanced representation of heterogeneity is observed. For literacy and numeracy, the proficiency levels were categorized as low (below level 1 and level 1), mid (level 2) and high (level 3, 4 and 5). For literacy, the distribution of the weighted percentages of scores are as follows: about 35% of Black adults in the U.S. are categorized as low, 41.69% are categorized as mid-level, and 23.34% are categorized as high. The average scores for literacy by category are 193.33 (low), 251.00 (mid), and 301.75 (high). For numeracy, the distribution of the weighted percentages of scores are as follows. About 56.76% of Black adults in the U.S. are categorized low, 31.81% are categorized as mid-level, and 11.43% are categorized as high. The proficiency scores by category are 170.32 (low), 224.59 (mid), and 272.36 (high). For digital problem-solving, proficiency levels were categorized as below level 1 (low), level 1 (mid), and level 2 or above (high). The distribution of the weighted percentages for digital problem-solving are 43.37% (low), 40.98% (mid), and 15.64% (high). The average scores for digital problem-solving for Black adults in the US are 207.28 (low), 263.87 (mid), and 311.21 (high).

### Information Processing Skills and Associated Demographic, Household, Background, and Language Characteristics

In terms of the associated demographic, household, background, and language characteristics, the bivariate significance tests show numerous significant differences between skill groups (between low and mid, low and high, and mid and high groups). Specifically, age, number of children, nativity, parents' educational

attainment, and English as a home language are all significantly associated with processing skill level differences between one or more skill level groups. First, Black adults with mid or high skills in literacy tend to be younger than those whose skills fall in the low category. In fact, a lower age is associated with higher skills in literacy across all comparisons in the model (between low and mid, low and high, and mid and high groups). Next, when analyzing the relationships between numeracy and age and digital problem-solving and age, people with mid to high skills are younger when compared to those with low skills. Black adults with higher skill levels in literacy and numeracy in the dataset have fewer children than those with lower skills, while Black adults with mid and high skill levels in digital problem-solving have fewer children only in comparison to those in the low skill group.

Further, Black adults with high skills in digital problem-solving are more likely to be born in the U.S. when compared to those with lower skills. Black adults with higher skills in literacy and numeracy tend to have more educated parents – as higher skills in literacy and numeracy are associated with having parents whose educational attainment is college or higher across all combinations of levels (between low and mid, low and high, and mid and high groups). Analysis of relationships between problem-solving in digital environments and parent's tertiary education found that people with mid to high skills are more likely to have college educated parents than those with low skills. Finally, adults with high skills in literacy are more likely to have identified English as a home language when compared to those with low skills.

### **Information Processing Skills and Associated Educational Characteristics**

For educational characteristics, the bivariate significance tests for all combinations of information processing skill levels identified several significant differences between skill groups in the models (between low and mid, low and high, and mid and high groups). Here all four variables investigated (educational attainment, total years of education, and participation in formal and non-formal educational in the last 12 months) are identified as significantly associated with processing skill level differences between one or more skill groups. Across all combinations of levels (between low and mid, low and high, and mid and high groups),

an educational attainment of college or higher and total years of education are associated with higher skills in literacy, numeracy, and digital problem-solving. In other words, more formal education and, specifically having a college degree or higher level of educational attainment, are both related to higher skills across all three information processing skills. Yet, differences emerge when reviewing associations between information skills and proficiency levels and variables associated with educational participation in the last 12 months. Non-formal educational participation in the last 12 months is associated with higher skills in literacy and numeracy and is associated with higher skills in digital problem-solving for mid and high skill groups when compared to low skilled individuals. While formal educational participation in the last 12 months is associated with higher skills in literacy and digital problem-solving for both mid and high skill groups when compared to low, recent formal educational participation is only associated with higher skills in numeracy for the mid skill group when compared to the low.

### **Information Processing Skills and Associated Employment Characteristics**

When analyzing employment characteristics, the bivariate significance tests for all combinations of information -processing skill levels again identified several significant differences between skill groups (between low and mid, low and high, and mid and high groups). First, across all comparisons, Black adults in the U.S. with higher skills in literacy and numeracy are more likely to be employed. Yet, for digital problem-solving, only high skills are associated with employment when compared to those with low skills.

High level skill in literacy and numeracy are associated with employment in STEM when compared to both mid and low skill groups. Additionally, high level skill in digital problem-solving is associated with employment in STEM when compared to low skill groups. Finally, across all comparisons in our models (between low and mid, low and high, and mid and high groups), higher incomes are associated with higher skills in literacy and numeracy. Higher incomes are also associated with high skills in digital problem-solving when compared to those with low skills in this area.

**Information Processing Skills and Associated Health Characteristics**

When examining the available associated health characteristics which are part of the PIAAC dataset, the bivariate significance tests for all comparisons of information processing skill levels found several distinctions between skill groups (between low and mid, low and high, and mid and high groups). When reviewing literacy skill associations with health for Black adults, higher skills in literacy across all comparison groups are related to higher self-rated health. Higher skills in numeracy and digital problem-solving are associated with reporting higher self-rated health when compared to those whose skills are lower. Further, the group with higher skills in literacy are more likely to have seen a dentist in the last year when compared to those whose skills in literacy fall in the low category. Interestingly, high skills in literacy and numeracy are also associated with an increased likelihood of not receiving a flu shot.

**Information Processing Skills and Social Trust, Civic Engagement, and Political Efficacy**

Upon reviewing the bivariate significance tests across information processing skill levels and available variables on social trust, civic engagement, and political efficacy, several associations between skill groups (between low and mid, low and high, and mid and high groups) were identified. Black adults with high skills in literacy, numeracy, and digital problem-solving are less likely to feel that other people will take advantage of them when compared to those with low skills in these areas. Those with higher skills in literacy and numeracy are more likely to have volunteered in the last 12 months. Across all combinations of levels (between low and mid, low and high, and mid and high groups), higher skills in literacy are associated with higher political efficacy. Mid to high skill levels in numeracy are also associated with higher political efficacy when compared to Black adults with low skills. Finally, those with high skills in digital problem-solving have higher political efficacy than those whose skills fall within the low skill range.

**Table 2***Weighted Descriptive Statistics and Significance Tests Results by the Literacy Proficiency Levels*

Variables	All (n = 1,940) <sup>a</sup>	Low	Medium	High
	Mean or percentage (standard error)			
Percentage		34.97%	41.69%	23.34%
<b>Skill proficiency (0-500)</b>				
Literacy	242.67 (1.87)	193.33 (1.59)	251.00 (0.80)	301.75 (1.67)
Numeracy	216.75 (2.17)	170.32 (2.05)	224.59 (2.20)	272.36 (2.53)
Digital problem-solving	246.74 (2.05)	202.70 (2.99)	246.05 (2.02)	288.42 (2.86)
<b>Demographic variables</b>				
Age (years)	41.03 (0.10)	45.46 (0.77)	39.68 (0.64)*	36.79 (0.80)* †
Gender (women)	53.95% (0.25)	52.96% (2.46)	52.71% (2.31)	57.70% (3.47)
<b>Household variables</b>				
Living with spouse or partner (yes)	39.71% (1.59)	40.61% (2.78)	39.66% (2.33)	38.44% (3.31)
Number of household members	3.13 (0.61)	3.03 (0.10)	3.26 (0.10)	3.04 (0.13)
Number of children	1.69 (0.04)	2.00 (0.08)	1.66 (0.07) *	1.28 (0.09) * †
<b>Background variables</b>				
Nativity (born in the U.S.)	88.26% (1.73)	87.57% (2.52)	87.72% (2.29)	90.24% (2.21)
Parent's educational attainment (college or higher)	32.42% (1.37)	18.80% (2.47)	33.92 (2.76)*	47.03% (3.46)* †
<b>Language variables</b>				
Speak English at home (yes)	97.38% (0.56)	95.53% (1.12)	97.75% (1.10)	99.51% (0.39)*
<b>Education variables</b>				
Educational attainment (college or higher)	26.58% (0.81)	10.71% (1.92)	26.66% (2.05)*	50.13% (3.22)* †
Total years of education	12.72 (0.04)	11.49 (0.12)	12.77 (0.10)*	14.67 (0.20)* †
Formal education participation in the last 12 months	29.90% (1.10)	21.22% (2.38)	32.34% (2.26)*	38.55% (3.04)*
Non-formal education participation in the last 12 months	53.14% (1.77)	37.93% (3.03)	54.47% (3.08)*	73.26% (2.71)* †
<b>Employment variables</b>				
Employment status (employed)	66.26% (1.23)	55.74% (2.59)	67.66% (2.48)*	79.46% (2.92)* †
Employed in the STEM industry	8.01% (0.73)	4.54% (1.37)	7.84% (1.37)	13.51% (2.08)* †
Income quintile <sup>b</sup>			*	*†
0 (not employed/no income)	41.29% (1.42)	52.69% (2.75)	40.63% (2.67)	22.45% (3.078)
1	13.24% (0.91)	12.08% (1.64)	15.03% (1.86)	11.77% (2.10)
2	16.76% (0.87)	18.23% (2.08)	16.00% (1.86)	15.93% (2.31)
3	12.26% (0.97)	9.66% (1.68)	13.37% (1.95)	14.18% (2.73)

4	10.46% (0.78)	4.43% (1.32)	10.40% (1.66)	19.59% (2.46)
5	5.97% (0.74)	2.91% (0.94)	4.56% (1.23)	13.09% (2.42)
<b>Health variables</b>				
Self-rated health (Excellent, very good and good)	80.43% (1.31)	68.60% (2.60)	84.05% (1.91)*	91.69% (1.82)* †
Health insurance (insured)	81.02% (1.36)	78.57% (2.51)	80.99% (1.91)	84.78% (2.67)
Flu shot (yes) in the last year	38.80% (1.63)	42.97% (2.96)	37.57% (3.05)	34.75% (3.16)*
Seen a dentist in the last year	62.02% (1.13)	57.98% (2.83)	62.74% (2.25)	66.81% (2.98)*
Vision check in the last year	63.27% (1.42)	61.38% (2.82)	64.86% (2.58)	63.28% (2.98)
<b>Social trust, civic engagement, and political efficacy variables</b>				
Trust only few people (agree)	76.21% (1.73)	78.33% (2.72)	76.61% (3.04)	72.33% (3.33)
Other people take advantage of you (agree)	84.73% (1.40)	87.10% (2.22)	85.91% (2.05)	78.62% (2.89)* †
Volunteering in the last 12 months (yes)	29.88% (1.37)	24.80% (2.34)	31.46% (2.55)	34.68% (3.55)*
No influence on the government (agree)	37.28% (1.32)	47.77% (3.03)	35.94% (2.34)*	24.07% (3.18)* †
<p>*<math>p &lt; 0.05</math> (vs. low); †<math>p &lt; 0.05</math> (vs. mid)</p> <p>a. Unweighted sample sizes (rounded to the nearest 10 per the PIAAC RUF data use guideline)</p> <p>b. the category “0” includes no income (see the Methods section for more details). The income variable was described as the categorical variable to illustrate the detailed distribution but treated as the continuous measure in the significance test.</p> <p>Tables 2 and 3 have the sample samples while Table 4 has the different subset due to the availability in the digital problem-solving skill proficiency.</p> <p>Source: U.S. Department of Education, National Center for Education Statistics, Program for International Assessment of Adult Competencies, 2012/2014/2017 Restricted Use File Data.</p>				

**Table 3**

*Weighted Descriptive Statistics and Significance Tests Results by the Numeracy Proficiency Levels*

Variables	All (n = 1,940) <sup>a</sup>	Low	Mid	High
	Mean or percentage (standard error)	Mean or percentage (standard error)	Mean or percentage (standard error)	Mean or percentage (standard error)
Percentage		56.76%	31.81%	11.43%
<b>Skill proficiency (0-500)</b>				
Literacy	242.67 (1.87)	215.59 (1.99)	268.04 (1.96)	306.53 (3.87)
Numeracy	216.75 (2.17)	182.13 (1.62)	248.16 (1.02)	301.01 (2.07)
Digital problem-solving	246.74 (2.05)	221.19 (3.38)	261.55 (2.54)	297.89 (4.36)
<b>Demographic variables</b>				
Age (years)	41.03 (0.10)	43.02 (0.48)	38.69 (0.89)*	37.67 (1.15)*

Gender (women)	53.95% (0.25)	57.04% (1.64)	51.21% (2.55)	46.26% (4.69)
<b>Household variables</b>				
Living with spouse or partner (yes)	39.71% (1.59)	38.35% (0.25)	41.01% (3.25)	42.87% (4.30)
Number of household members	3.13 (0.61)	3.12 (0.07)	3.23 (0.12)	2.92 (0.16)
Number of children	1.69 (0.04)	1.88 (0.06)	1.55 (0.08)*	1.17 (0.13)* †
<b>Background variables</b>				
Nativity (born in the U.S.)	88.26% (1.73)	90.06% (1.95)	86.16% (3.06)	85.10% (3.71)
Parent's educational attainment (college or higher)	32.42% (1.37)	23.59% (1.85)	37.57% (3.04)*	56.79% (1.61)* †
<b>Language variables</b>				
Speak English at home (yes)	97.38% (0.56)	97.25% (0.74)	97.08% (1.37)	98.84% (1.03)
<b>Education variables</b>				
Educational attainment (college or higher)	26.58% (0.81)	15.16% (1.52)	33.72% (3.07)*	63.43% (4.68)* †
Total years of education	12.72 (0.04)	11.82 (0.08)	13.38 (0.18)*	15.52 (0.30)* †
Formal education participation in the last 12 months	29.90% (1.10)	26.46 (1.73)	34.00% (2.95)*	35.56% (5.26)
Non-formal education participation in the last 12 months	53.14% (1.77)	44.20% (2.46)	61.28% (2.97)*	73.99% (4.58)* †
<b>Employment variables</b>				
Employment status (employed)	66.26% (1.23)	58.45% (1.76)	72.99% (2.80)*	86.35% (3.57)* †
Employed in the STEM industry	8.01% (0.73)	6.31% (1.11)	8.36% (1.64)	15.56% (3.22)* †
Income quintile <sup>b</sup>			*	**†
0 (not employed/no income)	41.29% (1.42)	49.62% (1.92)	34.33% (3.03)	19.31% (3.48)
1	13.24% (0.91)	12.81% (1.17)	14.38% (1.89)	12.24% (3.53)
2	16.76% (0.87)	17.98% (1.38)	16.31% (2.15)	12.04% (3.34)
3	12.26% (0.97)	10.65% (1.20)	14.72% (1.95)	13.40% (3.05)
4	10.46% (0.78)	5.93% (1.04)	13.36% (1.95)	24.83% (4.20)
5	5.97% (0.74)	3.01% (0.77)	6.90% (1.59)	18.17% (4.09)
<b>Health variables</b>				
Self-rated health (Excellent, very good and good)	80.43% (1.31)	73.49% (1.95)	88.00% (1.99)*	93.85% (2.49)*
Health insurance (insured)	81.02% (1.36)	79.39% (1.95)	81.90% (2.49)	86.70% (3.57)
Flu shot (yes) in the last year	38.80% (1.63)	42.68% (2.19)	34.31% (3.48)	32.17% (4.68)*
Seen a dentist in the last year	62.02% (1.13)	59.66% (1.89)	63.62% (2.65)	69.34% (4.20)

Vision check in the last year	63.27% (1.42)	62.29% (2.17)	65.14% (2.65)	62.91% (4.79)
<b>Social trust, civic engagement, and political efficacy variables</b>				
Trust only few people (agree)	76.21% (1.73)	76.92% (2.16)	76.74% (2.82)	71.28% (4.81)
Other people take advantage of you (agree)	84.73% (1.40)	88.68% (1.75)	84.32% (2.43)	76.19% (5.16)*
Volunteering in the last 12 months (yes)	29.88% (1.37)	26.27% (1.91)	33.75% (3.31)	36.96% (4.69)*
No influence on the government (agree)	37.28% (1.32)	43.42% (2.05)	31.53% (3.06)*	22.87% (4.32)*

\*p < 0.05 (vs. low) †p < 0.05 (vs. mid)

a. Unweighted sample sizes (rounded to the nearest 10 per the PIAAC RUF data use guideline)

b. the category “0” includes no income (see the Methods section for more details). The income variable was described as the categorical variable to illustrate the detailed distribution but treated as the continuous measure in the significance test.

Tables 2 and 3 have the sample samples while Table 4 has the different subset due to the availability in the digital problem-solving skill proficiency.

Source: U.S. Department of Education, National Center for Education Statistics, Program for International Assessment of Adult Competencies, 2012/2014/2017 Restricted Use File Data.

**Table 4**

*Weighted Descriptive Statistics and Significance Tests Results by the Digital Problem-Solving Skill Levels*

Variables	All (n = 1,470) <sup>a</sup>	Low	Mid	High
	Mean or percentage (standard error)			
Percentage		43.37%	40.98%	15.64%
<b>Skill proficiency (0-500)</b>				
Literacy	252.20 (2.10)	220.25 (2.33)	265.71 (2.08)	305.34 (3.05)
Numeracy	226.12 (2.16)	193.96 (2.62)	238.80 (2.70)	282.04 (1.03)
Digital problem-solving	246.74 (2.05)	207.28 (1.88)	263.87 (0.90)	311.21 (2.13)
<b>Demographic variables</b>				
Age (years)	38.03 (0.32)	42.40 (0.86)	35.06 (0.73)*	33.71 (1.45)*
Gender (women)	55.36% (0.78)	54.26% (2.57)	57.17% (3.00)	53.55% (5.59)
<b>Household variables</b>				
Living with spouse or partner (yes)	39.70% (1.74)	46.29% (3.13)	35.33% (3.27)	32.88% (4.90)
Number of household members	3.35 (0.08)	3.22 (0.11)	3.36 (0.11)	3.01 (0.19)

Number of children	1.56 (0.04)	1.93 (0.09)	1.36 (0.08)*	1.02 (0.14)*
<b>Background variables</b>				
Nativity (born in the U.S.)	88.41% (1.68)	85.14% (0.25)	90.24% (2.35)	92.73% (2.26)*
Parent's educational attainment (college or higher)	37.33% (1.61)	25.61% (2.52)	42.81% (3.12)*	52.95% (4.94)*
<b>Language variables</b>				
Speak English at home (yes)	98.43% (0.40)	97.31% (0.94)	99.12% (4.31)	99.73% (0.31)
<b>Education variables</b>				
Educational attainment (college or higher)	33.00% (1.08)	22.33% (2.40)	35.37% (2.86)*	56.22% (5.19)* †
Total years of education	13.25 (0.07)	12.55 (0.14)	13.33 (0.17)*	15.02 (0.32)* †
Formal education participation in the last 12 months	35.76% (1.51)	28.23% (2.81)	40.81% (3.28)*	43.35% (5.29)*
Non-formal education participation in the last 12 months	61.98% (1.78)	52.48% (3.33)	67.47% (3.05)*	74.40% (4.30)*
<b>Employment variables</b>				
Employment status (employed)	72.21% (1.41)	68.53% (2.65)	72.59% (2.62)	81.36% (4.11)*
Employed in the STEM industry	9.35% (0.90)	6.01% (1.38)	10.06% (1.70)	16.72% (3.25)*
Income quintile <sup>b</sup>				*†
0 (not employed/no income)	35.35% (1.45)	42.11% (2.68)	33.03% (3.00)	22.78% (4.46)
1	14.12 (1.17)	12.74 % (2.16)	16.37% (2.03)	12.05% (3.49)
2	17.21% (1.04)	17.67% (2.09)	18.51% (2.23)	12.54% (3.60)
3	13.85% (.10)	14.60% (1.98)	13.34% (1.81)	13.04% (3.51)
4	12.74% (1.001)	9.08% (1.71)	12.00% (1.87)	23.04% (3.52)
5	67.00 (0.87)	3.80% (1.18)	6.75% (1.77)	16.42% (3.98)
<b>Health variables</b>				
Self-rated health (Excellent, very good and good)	85.41% (1.18)	79.25% (2.34)	89.11% (1.88)*	92.74% (2.57)*
Health insurance (insured)	81.30% (1.56)	80.15% (2.29)	80.50% (2.70)	86.49% (3.86)
Flu shot (yes) in the last year	37.88% (1.85)	41.41% (3.12)	32.26% (2.66)	34.92% (5.28)
Seen a dentist in the last year	65.26% (1.35)	64.73% (2.95)	65.25% (2.87)	66.68% (4.74)
Vision check in the last year	63.92% (1.62)	63.61% (3.10)	64.05% (2.87)	64.29% (4.45)
<b>Social trust, civic engagement, and political efficacy variables</b>				

Trust only few people (agree)	74.15% (1.89)	78.26% (2.69)	71.46% (2.70)	69.75% (1.45)
Other people take advantage of you (agree)	83.30% (1.49)	87.26% (2.19)	81.95% (2.48)	75.87% (4.55)*
Volunteering in the last 12 months (yes)	33.68% (1.68)	31.16% (2.47)	36.01% (3.01)	34.63% (4.68)
No influence on the government (agree)	33.34% (1.48)	37.54% (2.67)	33.43% (2.88)	21.52 (5.05)*
<p>*p &lt; 0.05 (vs. low) †p &lt; 0.05 (vs. mid)  a. Unweighted sample sizes (rounded to the nearest 10 per the PIAAC RUF data use guideline)  b. the category “0” includes no income (see the Methods section for more details). The income variable was described as the categorical variable to illustrate the detailed distribution but treated as the continuous measure in the significance test.  Tables 2 and 3 have the sample samples while Table 4 has the different subset due to the availability in the digital problem-solving skill proficiency.  Source: U.S. Department of Education, National Center for Education Statistics, Program for International Assessment of Adult Competencies, 2012/2014/2017 Restricted Use File Data.</p>				

## Discussion

To summarize, the purpose of this exploratory study was to explore the associations between levels of information processing proficiencies and demographic characteristics, education, employment, health, social trust, civic engagement, and political efficacy among Black adults in the U.S. In previous analyses of PIAAC data, researchers have often concluded that Black adults in the U.S. have low levels of information processing (NCES, 2014, 2016, 2019a; Pena, 2018; Rampey et al., 2016). However, our findings tell a more nuanced and contrarian story than previous research conducted using Black adults as a component of the national sample. While we also found that most Black adults in the in the U.S. sample have low numeracy skills, our findings indicate that most Black adults in the U.S. sample have mid-to-high levels of information processing skills in literacy and digital problem-solving. This finding can only be highlighted when conducting within group analysis and disaggregating the data according to information skill proficiency level. These findings are increasingly important as national policies must prioritize initiatives to support positive life, health, and economic outcomes for Black population.

These findings also highlight the need to incorporate more within group analyses to understand the context of differences in information processing skills for Black adults and other large heterogeneous

populations in the U.S. Furthermore, this finding signals the necessity for researchers to (re)consider how treating Black adults as a monolithic group has impacted previous research studies. Specifically, the current research findings highlight the need for using intersectionality theory (Crenshaw, 1990) as a lens through which future researchers must begin to explore within group analyses to gain more comprehensive picture of the relationship between information processing skill and various related outcomes across proficiency levels (low, mid, high). For example, there is a preponderance of evidence that suggests Black women and men experience society and various systems (e.g., healthcare, education, employment) differently based on their identities (Assari, 2018; Ireland et al., 2018; Williams et al., 2022). Therefore, these differences in access and experience may also impact information processing skill.

A second major finding from this study was the relationships between the demographic differences of Black adults who had more advanced information processing skills when compared to those with lower skills. Overall, our findings indicate that Black adults with more advanced skills in the sample are younger, have fewer children, have more educated parents, and are more likely to speak English as a home language than those participants who were in the low information processing group. The finding on the discrepancies between older and younger Black adults' skill proficiencies parallel the findings of Day (2020) and Tamir (2021) who both identified the rapid expansion in educational attainment by Black adults over the last two decades and could provide an explanation for the difference in corresponding skills across age groups.

Further, while we found that Black adults with higher skills are more likely to have fewer children than those with lower skills, we must also acknowledge that this may be a result of individuals with more children having to shift their focus from their own educational attainment to providing for their children or other family members. It must be noted that we most certainly do not want to pathologize the Black family which has been done in past research, but we want to highlight the challenges that Black adults may experience and overcome in their educational pursuits. Care work, or the work involved with caring for family or household members, both meets the definition of a job and is unequally distributed in society (Dozan, 2021). Over one fifth of Black

adults and almost one third of Black caregivers are part of what is known the “sandwich generation” where they take on the tasks and financial responsibilities of care for both children as well as older adults in the family (Bonello, 2020; Parker & Patton, 2013). Further, 57 percent of Black adult family caregivers are categorized as falling in the “high burden” caregiving bracket (those that provide an average of thirty hours per week of care to family members) (Bonello, 2020).

When examining the relationship between information processing skills and educational attainment, our findings largely parallel previous studies in this area with the general population as educational attainment, years of education, and participation in educational training are all associated with higher levels of skills. Our findings also reinforce the work Goings and Shi (2018) who identified that educational attainment for Black male adults can be predicted by their parents’ educational attainment and the deficit oriented and pervasive U.S. educational policy preference for monolingual English instruction in educational environments (International Literacy Association, 2019). We hypothesize that these findings on the relationships between Black adults’ skill proficiencies and educational characteristics, coupled with the findings on the relationships between age and information processing skill, parallel the forced opening of educational access as a result of community advocacy, judicial remedy, and associated public policies for the Black population in the U.S. over the past four decades.

Based on previous research by Punksungka et al. (2021) who found that Black adults participate more in all forms of adult education and training than other racial groups, we also must note not to interpret our findings as a signal that Black Americans who scored lower on information processing skills have an ‘oppositional stance’ (Fordham & Ogbu, 1986) to education or skill development. Instead, they may have life circumstances, like care work or financial hardship, that require their immediate attention rather than spending the time to acquire additional informational processing skills. Additionally, those Black adults with lower information processing skills may also be more likely to have sustained inadequate access to equitable and culturally sustaining educational spaces and systems (Paris & Alim, 2017).

When examining the relationship between information processing skills and employment our findings confirmed that Black adults with higher literacy and numeracy skills are more likely to be employed. This finding confirms prior research that suggests the importance of having a strong foundation in literacy and numeracy in Black students' ability to succeed academically (Brundage, 2020; Goings & Shi, 2018; Tatum et al., 2021). This report extends the findings (OECD, 2021; Pena, 2018; Rampey et al., 2016; Saal et al., 2018) on the impact higher information skill proficiencies on employment to Black adults. We also found that higher skills in literacy, numeracy, and digital problem-solving specifically correlated with Black adults having careers in STEM and earning a higher income when compared to low skill individuals.

Yet, only a minority of Black adults in the U.S. report that careers in STEM fields are "open" to Black people (Funk, 2022). Therefore, this finding also signals that, if the U.S. wants to increase the representation of Black adults in STEM disciplines (Fry et al., 2021), there must be increased opportunities for Black adults to have access to educational programs that will support them to develop the higher literacy, numeracy, and digital problem-solving skills needed to succeed. This need for STEM training has also been acknowledged by researchers. For example, Priemer et al. (2020) proposed a 13-step integrated STEM problem solving framework that STEM professionals can use to develop the problem-solving skillset needed to succeed in STEM. They argue that training is needed which integrates science, technology, engineering, and mathematics together given the complexity of the problems that need to be solved (Priemer et al, 2020). It should be noted that these findings need to be treated with caution due to the limitations (see the limitation section) and recent job-market trends (e.g., increasing number of the STEM jobs only requiring associate or postsecondary certificate) (Gonzalez et al., 2019).

Interestingly, our findings also signal possible connections between Black adults' information processing skill levels and self-reported health and health-related behaviors, but not always in ways analogous to the general U.S. population. Like Prins et al. (2015), we found that Black adults with higher information processing skills were more likely to report higher self-rated health. We also found a connection between higher

information processing skills and Black adults being more likely to have received a recent dental exam. However, unlike previous researchers (Prins et al, 2015; Saal, 2021; Yamashita et al., 2020), we found that, for Black adults, higher information processing skills were related to a decreased likelihood of receiving the flu shot.

We offer several possible hypotheses for this divergent result from this within group analysis. One possible explanation for this finding is that Black adults with higher skills, according to our own analysis, tend to be younger, and, therefore, government supported health systems and associated policies and interventions (like Medicare) are less often focused on preventative care (like the flu shot) for a younger, and presumed healthier, population. Further, given that individual health behaviors are often driven by the need, those with lower skills might have experienced other health problems and/or more interactions with health care providers who recommended the seasonal flu shot on site (Yamashita et al., 2020). Alternatively, government supported health systems and associated policies and interventions (like Medicaid) and other community health efforts may intentionally focus on those seen as the most vulnerable populations in the Black community - like those who are older and/or are socioeconomically depressed (Strully et al., 2022). Finally, these findings may also be contextualized by a recent Pew Research Center Survey (2022), which found that the majority of U.S. Black college graduates (over 50%) believed that: “less access to quality medical care where they live,” “health care providers [being] less likely to provide advanced care,” and “hospitals and medical centers [giving] lower priority to well-being” were all contributing factors to worse health outcomes for Black people (Funk, 2022). However, we recommend exercising caution when interpreting our findings -as our analysis is only bivariate and future research with more complex analysis is needed to verify the finding. Since our result is inconsistent with the skills and disease prevention behaviors in the general population, our study does magnify calls for additional research on the within-group differences in the understudied subpopulations (O’Halloran et al., 2021).

Lastly, these findings provide some insights into the civic engagement, social trust, and political efficacy of Black adults. Specifically, we found that Black adults with higher literacy, numeracy, and digital processing skills had higher levels of social trust (the belief that people will not take advantage of you) and had higher political efficacy. Our finding on political efficacy mirrors the findings of Saal et al. (2020) who used PIAAC data to explore the relationship between information processing skills and individuals' political efficacy and found adults with higher information processing skills had higher levels of political efficacy. However, findings here provide a more detailed account as that previous study looked at Black adults as an aggregate and did not explore the differences at each skill level. We must acknowledge that in Saal et al.'s (2020) analysis, they found that Black adults, overall, reported more political efficacy than other racial groups in the PIAAC dataset. However, this newer finding is important to note considering that the ongoing historical and systemic barriers that Black adults have and do face in the U.S. around political representation and the right to vote which may impact those Black adults with lower information processing skills disproportionately when compared to those with higher information processing skills.

In conclusion, through this research, we identified that the levels of information processing skills varied significantly across demographic and personal characteristics among Black adults. We were also able to ascertain that, in general, greater information processing skills, are associated with more positive life outcomes for Black adults including higher levels of education, employment, self-reported health, social trust, and political efficacy.

### **Limitations**

Several limitations should be noted. Understandings of the diverse experiences of Black adults is larger and more complex than the parameters of the PIAAC survey. For example, almost 80% of Black adults in the U.S. affiliate with a religious identity and many see the role of predominantly Black congregations and religion as key in the fight against racial injustice - although this pattern is shifting with younger generations (Mohamed et al., 2021). Yet, the PIAAC does not include questions about religion or service attendance. In a second

example, the PIAAC does not ask about the number of dependents nor the age of the respondents' children although both are significantly related to associated care work (Bonello, 2020). Therefore, this study is limited by the questions asked on the self-reported background questionnaire to examine sociocultural contexts of the findings. Additionally, as is true for most secondary data sources, in-depth analysis of the rationale for *why* participants provide certain answers is not included.

Importantly, as has been mentioned in the discussion above, the purpose of this study was an initial exploration of the information processing skill levels and a series of individual characteristics among the understudied population of Black adults in the U.S. Therefore, the findings and interpretations of these findings are limited by the bivariate comparisons. A more comprehensive analysis with a set of covariates (e.g., multiple regression) and qualitative analysis of interviews with open-ended prompts would provide more detailed explanations in future research as well as further isolate discrepancies in significance across skill comparisons. Finally, all three cycles of data collected for this report were gathered during President Obama's, the first Black U.S. President, terms (2009-2017). How President Obama's influence or resulting policies may have impacted the Black adult's educational experiences and perceptions of the role of government in the U.S. are contextual factors which cannot be adequately accounted for in this study..

### **Implications and Suggestions for Future Research**

Despite the limitations, the results of this exploratory study are applicable across several fields of social science, have significant implications for educational policy, and could lead to increasingly targeted and relevant educational curricula/methods, services, and programs at the local, state, and national levels.

### **Implications for Policy**

Over the last 40 years, American jobs have been shifting to skilled-services like those in the governmental, educational, business, financial, healthcare, leisure and hospitality, and personal sectors, and most will require some form of postsecondary education or corresponding levels of information processing skill (U. S. Chamber of Commerce, 2020). Further, information processing skills are consistently reinforced as a social determinate

of public health impacting a wide range of health, daily functioning, and quality-of-life factors (U.S. Department of Health and Human Services, 2022). Our findings highlight some of the existing educational policy successes originally meant to expand educational and health systems access and opportunity for the Black population of the U.S. and point to the importance of their continuation. For example, our report emphasizes the critical need for adult education programs to receive adequate funding. Our findings on the associations between education and information processing skill level for the Black adult population reinforce the importance of the continuance of policies which support equitable educational programs and practices for Black children and adults. While educational experiences for Black adults in the U.S. remain inequitable (Goings, 2018; U.S. Chamber of Commerce, 2020), given the disparate educational experiences of older and younger Black adults, we see that with the expansion of educational opportunity for the Black population came greater educational achievement, educational attainment, and economic outcomes.

Yet, our findings on the age-related skill discrepancies for the Black population also highlight the need for understanding the continuity (or discontinuity) of services and supports across K-12 and adult systems/programming for the Black adult population. Particularly local, state, and national policymakers should identify where changes to K-12 and adult educational policies, especially those related to desegregation and educational learning standards (like the Common Core State Standards), have intersected across various Black adult learners' lifetimes. Policymakers should compare and contrast these driving policy forces behind programming to identify gaps in information skill expectation and incentivize programming to address needed information skill expansion for targeted sub-groups of Black adult learners. Specifically, policies and associated funding reinforcing the importance of programming focused of numeracy skills is one area to consider a targeted expansion as these skills often undergird both the frameworks of STEM focused education as well as health systems. Longitudinal Equity Audits for K-12 and adult learning systems, described in the Implications for Practice section below, also hold promise for understanding the protracted repercussions of educational policies for Black adults in the U.S.

### **Implications for Practice**

Our findings also highlight some of the historical as well as contemporary institutional and contextual challenges that can and do serve as a barrier for some Black adults' acquisition of 21<sup>st</sup> century information processing skills. Below, we offer several implications and associated recommendations for practitioners of adult education in the U.S. across all adult education locales – community-based, workforce/employer-based, and even programs associated with higher education settings.

First, as mentioned in the introduction, the last known public school in the U.S. to integrate was in 2016, and educational access and equity are contemporary, not historic, concerns for some members of the Black adult population of learners. Therefore, given the policy context and the importance of age in our models, we first emphasize to practitioners that commonly held notions of legal segregation in educational settings and the associated repercussions as merely historical context for Black adult learners are incorrect. These understandings of the contemporary context of institutionally racist policies and practices in education are an often underemphasized point in initial and ongoing training for current and future adult learning instructors and administrators.

As we mention in the limitation sections above, this study is exploratory and merits additional data collection. Therefore, to begin to understand and create culturally sustaining and equitable adult educational programs (Paris & Alim, 2017) for Black adult learners in specific locales, programs should consider completing an Equity Audit of local educational systems (including their own) by using programmatic and publicly available data to better identify and redress contemporary disproportionalities in educational access and performance for the Black population (Skrla et al., 2009). This initial exploration should be followed by an Equity Audit of the associated curricula to isolate bridges and barriers to educational successes including skill development, program persistence, and program completion for Black adult learners in specific programs by information processing skill level. Last, to triangulate this data for the purposes of differentiating programming, intake assessments should expand beyond assessments of current information processing skill

level to also include a potential participant's educational experiences/history, adult learners' perceptions of these experiences, and attitude and interest inventories (Greenberg & Feineberg, 2019; Saal & Beckers, 2013; Saal & Sulentic Dowell, 2014). Gathering and systematically analyzing this information allows programs to create targeted programmatic and curricular interventions including modifications to policies and processes which inhibit educational equity and associated training and development of program staff. For example, given the results of this study and further equity associated data collection and analysis, contextualizing a program's adult education curricula by tailoring to the experiences of Black adult learners by age may be warranted.

Finally, given our preliminary findings on the demographic differences between those Black adults with higher and lower skills, there is a need for culturally sustaining, differentiated, and flexible educational programming to support adults across the lifespan who are balancing paid employment, care work, and educational responsibilities. Given the impact of social and historical context of institutional educational inequity for some members of the Black population, wrap-around program models for adult education programming are encouraged (ACTE, 2010; Mairs, 2019). In these models, education program advisors or professionals meet individually with potential learners to establish a "need-driven" approach to program participation. Learners are guided to identify their own goals, needs and strengths. Proactive supports and services are provided that both fit the learners' needs and cultural preferences. Common components of a wrap-around models are academic supports (such as access to academic advising, peer and industry mentoring, tutoring, and supplemental instruction) and health/wellbeing supports (such as access to mental health counseling, employment support, childcare/eldercare, and transportation). Wrap-around models leverage the community-based education, health, and employment services provided by governments, non-profits, and community-driven initiatives by making intentional connections and assisting learners with navigating these systems. For example, one possible barrier for Black adults' continued skill development and educational attainment as highlighted by Goings (2018) and others is care work. Where an identified need exists, programs for adult learners could consider partnerships with child and elder supportive care programs to mitigate this

barrier. These kinds of strategic partnerships could also serve as an integrated instructional training opportunity for program participants or others interested in education and other related professions (Perin, 2011).

While many of these overarching suggestions, like the need for contextualized training and programming, could be applied to other populations, these suggestions for practice are intended to capture the unique and heterogenous needs and perspectives of the Black adult learner population. They all (additional training, equity auditing, and even wrap around services) suggest a tailored approach to educational programming and practice based on the unique data collection on policy and practice at the specific locale and input from unique Black adult learners who may/do utilize these educational services.

### **Suggestions for Future Research**

Our initial exploratory analysis of the information processing skills of the Black adult population in the U.S. leads us to several suggestions for future research. Future research may examine more complex associations and intersections between Black adults' information processing skills and other characteristics reported by the PIAAC. For example:

- Studies focused on intersections across multiple individual characteristics are important areas of research (McCall, 2005). For example, more closely examining the complex intersectionality of gender, socioeconomic status, health, and skill levels among Black adults would be beneficial and important to better understand within group differences (e.g., skills levels may further vary by gender and income).
- Relatedly, given our findings, associations between aging and information processing skills among Black adults are still understudied. In the same respect, aging per se is unlikely to explain the differing skill levels among Black adults. The associations between age and skills should be contextualized across different demographic and socioeconomic characteristics.
- Finally, future research should also consider how to report out data on large and diverse populations like the Black adult population of the U.S. At minimum, when possible, researchers should consider using and reporting on measures of variability to better describe the distribution of data.

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