Commissioned Paper
November 2018

Associations Between Adults' Numeracy Skills and Employment Status: An Analysis of PIAAC's U.S. Dataset

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Suggested Citation: Saal, L.K., Gholson, M., Machtmes, K., and Machtmes, R. (2018). *Associations Between Adults' Numeracy Skills and Employment Status: An Analysis of PIAAC's U.S. Dataset*. Retrieved [insert date] from PIAAC Gateway website: [insert link]. Washington, DC.

This project has been funded by the American Institutes for Research through a contract with the National Center for Education Statistics (NCES) of the U.S. Department of Education. This report is based on 2012/2014 PIAAC data released in March 2016. The views expressed in this paper do not necessarily reflect the views or policies of the American Institutes for Research, National Center for Education Statistics, or the U.S. Department of Education, nor does mention of trade names, commercial products, or organizations imply endorsement of same by the U.S. Government.

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Associations Between Adults' Numeracy Skills and Employment Status: An Analysis of PIAAC's U.S. Dataset

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This project has been funded by the American Institutes for Research through a contract with the National Center for Education Statistics (NCES) of the U.S. Department of Education.

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Abstract

While many U.S. adult education programs and policies (including the Workforce Innovation and Opportunity Act (WIOA)) focus on low literacy skill as a barrier to employment, this study recognizes the role of increasing numeracy skill as critical in reducing the probability of unemployment. This study used a series of regression analyses to examine the relationship between numeracy skills and practices and employment status across four categories (currently employed, no experience with paid work, short-term unemployment, and long-term unemployment). Variables investigated included: participants' scale scores on literacy, numeracy, and PS-TRE assessments and selected demographic characteristics.

Methods and Data Source: We ran several sets of analyses on the 2012/14 PIAAC U.S. public-use data files using Stata 13. In order to answer our research questions, descriptive statistics for all variables as well as a series of multinomial logistic regression models were run utilizing numeracy, literacy, and problem solving in technology-rich environments as the independent variables and employment status/work history as the dependent variable. The initial logistic regression model was first run using only the independent and dependent variables. Next, a model was run including additional control variables with the exception of the six numeracy skill use in everyday life variables. Finally, a model isolating numeracy skill as assessed by PIAAC, the six numeracy skill use in everyday life variables, employment status, and all control variables was run.

Key Results: Only increases in numeracy skills were protective of the (un)employment categories of no experience with paid work and long-term unemployment after all variables were added to the model. The study's results point to the centrality of advanced numeracy skills as protective of continued employment for marginalized groups in the U.S. like women, older adults, and some people of color. Further, some numeracy related everyday life skills were related to employment status.

Significance: This study's findings on the importance of numeracy as protective of employment are particularly relevant to those interested in programming related to adult education and workforce development as outlined by the Workforce Innovation and Opportunity Act (WIOA) of 2014. This study demonstrates the need for:

- Expanding offerings in numeracy programing and curricula for adult education and workforce development programs.
- Expanding professional development/training on instructional practices for teaching numeracy skills for adult education and workforce development professionals.
- Including "low levels of numeracy" as one of the pre-identified "employment barriers" by WIOA similar to "low levels of literacy."
- Connecting adult education and workforce development programs with regional workforce agencies to better understand the required numeracies of specific local industries.

Associations Between Adults' Numeracy Skills and Employment Status: An Analysis of PIAAC's U.S. Dataset

Introduction

This study examined the 2012/2014 Programme for the International Assessment of Adult Competencies (PIAAC) data to examine literacy, numeracy and technology skills for U.S. adults in relationship to employment status. Based on a review of the literature, we theorized that numeracy skills of U.S. adults as measured by the PIAAC are more strongly related to employment outcomes than other skill areas (Goodman, Finnegan, Mohadjer, Krenzke, & Hogan, 2013; Rampey et al., 2016). In addition, we sought to determine if the relationship between numeracy skills as assessed by the PIAAC and employment status for U.S. adults varies by self-reported use/practice of numeracy information-processing skills in everyday life.

The analyses for this study are possible as a result of the 2014 U.S. PIAAC National Supplement to the 2012 PIAAC administration. The (2014) Supplement conducted a second round of data collection where an additional 3,660 adults were surveyed adding three subgroups: 1) unemployed adults (age 16-65), 2) young adults (age 16-34), and 3) older adults (age 66-74) (Rampey et al., 2016). Initial results from the U.S. data files from the Program for International Assessment of Adult Competencies were published in March 2016; however, "complex interactions and relationships among [the variables had] not been explored… [and the] report [was] intended to encourage more in-depth analysis of the data using more sophisticated statistical methods" (Rampey et al., 2016, p. 4). Specifically, this study focuses on a more in-depth analysis of the relationships across employment status, including the short and long-term unemployed, information-processing skills, and self-reported numeracy skills use.

A person's employment status, or whether or not they hold a job, is a predictive indicator of social and economic outcomes for individuals (Aaronson, Mazumder, & Schechter, 2010; Linn, Sandifer, & Stein, 1985). According to the 2015 American Community Survey Estimates, the current unemployment rate in the U.S. for adults aged 25-64 is 5.2%. However, when disaggregated by educational attainment, the unemployment rate varies from 2.9% for those with a bachelor's degree or higher to 9.6% for those who lack a high school diploma. Government/intergovernmental research organizations, policy makers, and adult education researchers have long touted educational attainment as predictive and protective of employment status (Hanushek, Schwerdt, Woessmann, & Zhang, 2017; Parsons, & Bynner, 1997; U.S. Bureau of Labor Statistics, 2015). However, there are only a few PIAAC studies which explored how academic proficiencies and self-reported skill use are associated with employment status in combination with other factors (Grotluschen et al., 2016; OECD, 2015). Specifically, the PIAAC assessment makes possible a move beyond proxy measures for skill proficiencies (that is educational attainment) and skill practices to better understand how U.S. residents leverage their skills to achieve their employment goals.

If certain informational-processing skills, particularly numeracy skills, are more predictive of earnings (Holzer, & Lerman, 2015) and particular categories of employment, then there are substantial implications for workforce development and adult education policy and program design/delivery. Particularly, there are significant policy and programmatic implication for U.S.

subpopulations who are vulnerable to unemployment, like those with lower educational attainment, the disabled, older adults, those who acquired English as an additional language, immigrants, or those living in poverty (US Census Bureau, 2015). For these reasons, isolating specific "employment privileged skills," or specific information-processing skills associated with employability could improve the effectiveness of adult education and workforce development policy and programs by encouraging the integration of those skills into curricula. Moreover, an examination of how skill use in everyday life further impacts employment outcomes is important for adult education and workforce policy makers and program administrators to determine if targeting specific skill use in numeracy skill practices, like using charts and graphs more frequently, within programs can increase participants' chances of landing or retaining a job.

Literature Review

An Overview of PIAAC

The 2012/14 Program for the International Assessment of Adult Competencies (PIAAC) U.S. Assessment of Adult Skills is a cyclic, large-scale study created in association with Organization for Economic Cooperation and Development (OECD) to assess and compare how adults' skills and competencies are gained and lost over the course of the lifespan. The assessment consists of cognitive and workplace skills necessary for participants to meaningfully engage in our 21st-century global economy and society (OECD, 2012, 2013, 2016). To this end, the Survey of Adult Skills also investigates how skills and competencies are related to participation in the economic, social, personal, and political spheres of adult life.

There are three key information-processing skills, literacy, numeracy, and problem solving in technology rich environments, which are formally assessed in the PIAAC (OECD, 2013, 2016). These three discrete skill sets are viewed as necessary, transferable, and learnable; however, these skills are also highly correlated (OECD, 2013). For example, the correlation between proficiency in literacy and numeracy for the United States sample ages 15-17 is 0.89, which is the second highest among all the countries assessed by the PIAAC (OECD, 2013). However, "the strength of the relationships with other outcomes, such as employment and wages varies" (OECD, 2013, p. 85). In the U.S., Holzer and Lerman (2015) found a close connection between skill proficiency and earnings/wages. Being considering proficient in numeracy added $1000 to one's monthly earnings and high numeracy proficiency added nearly $2000. Conversely, the literacy skills of U.S. adults did not help predict full-time employment in Fernandez and Umbricht's (2016) study.

Defining Numeracy

For the purpose of this study, we borrow the definition of numeracy from the PIAAC. The "concept of numeracy is 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, 2013, p. 59). Participants on the PIAAC respond "to mathematical context, information, or ideas represented in multiple ways" across multiple contexts in order to authentically solve problems (OECD, 2013, p. 59). While other studies and researchers have defined numeracy in other ways as exemplified in the other research cited below, we appreciate the contextualized and multidimensional perspective on numeracy outlined by OECD. We find the

definition supportive of the goal of developing life-long 21st century learners who are actively engaged in a global society.

Employment Status and Life Outcomes

A person's employment status, or whether or not they hold a job, is a predictive indicator of social and economic outcomes for individuals (Aaronson, Mazumder, & Schechter, 2010; Linn, Sandifer, & Stein, 1985). Unemployment has many costs, only some of which are economic. While the loss of a job can leave families unable to pay their bills or meet their other financial obligations, other impacts can include negative health consequences (Linn, Sandifer, & Stein, 1985; Sullivan, & von Wachter, 2009).

Length of unemployment is a significant variable to be considered in any study investigating job loss and skills. We focus our analysis on two categories of unemployment: short-term unemployment, which is defined as unemployment for less than one year, and long-term unemployment, which is defined as unemployment for longer than one year. While short-term unemployment has significant and lasting impact on a family's outcomes, long-term unemployment, or unemployment for longer than one year, has even greater impact. Unfortunately, long-term displaced workers face further disadvantages beyond economics including: higher rates of poverty, increased likelihood of divorce, and further deterioration of physical and mental health (Krueger, Cramer, and Cho, 2014; Nichols, Mitchell, and Lindner, 2013; Van Horn, Zukin, and Kopicki, 2014). Moreover, the longer a worker is unemployed the more likely they are to remain unemployed.

While researchers' definitions of unemployment vary, unemployment, and particularly long-term unemployment, impacts future employment opportunities. Krueger, Cramer and Cho (2014) found length of unemployment is connected to employer bias in hiring practices. Edin and Gustavsson (2008) recognized the impact of unemployment in declining workplace skills. Understanding the impact of information-processing skills on categories of unemployment (never having worked, short-term unemployment, and long-term unemployment) is important as parts of U.S. population seek to regain entry into the labor market following the Great Recession of 2007-2010 (Hamilton, 2017).

Employment Status and Skill Proficiencies

Information-processing skill proficiencies are related to a person's labor market participation– explicitly the ability to get and keep a job (Bynner & Parsons, 2001; OECD, 2016; Rampey et al., 2016; Reder, & Bynner, 2009). Research has examined cognitive skills as a predictor of earnings and differences in economic growth across countries (Hanushek & Woessmann, 2008, 2012; Holzer & Lerman, 2015). While higher skills across all domains (literacy, numeracy, and problem solving in technology rich environments) are related to higher earnings, higher numeracy skills indicate higher earnings for older workers and US born workers (Holzer & Lerman, 2015).

Particularly, literacy and numeracy are basic skills identified as impacting employment (Bynner, 2008; Charette & Meng, 1998; Lundetræ, Gabrielsen, & Mykletun, 2010; Rivera-Batiz, 1992).

For all PIAAC participating countries, on average, "an adult who scored 48 points higher on the literacy scale is .8 percentage point more likely to be employed" even after controlling for other demographic and educational variables (OECD, 2016, p. 27). Further, in the 2016 report, *Skills of the U.S., Unemployed, Young, and Older Adults in Sharper focus,* Rampey et al. found that "15 percent of employed adults age 16-65 performed at the top proficiency level (4/5), while in numeracy 12 percent of employed adults reached this level. In both cases, the percentage of employed adults at the top proficiency level was larger than that of unemployed adults (7 percent in literacy and 4 percent in numeracy) and adults who were out of the labor force (9 percent in literacy and 6 percent in numeracy)" (p. 5). Further, a larger percentage of people who were unemployed performed at or below the lowest level of skill proficiency across as measured by the PIAAC across all skill levels when compared to the employed (Rampey et al., 2016).

Numeracy as Protective of US Employment?

Nearly a third of U.S. adults have weak numeracy skills (U. S. Department of Education, 2013). Several studies have established a strong correlation between numeracy and employability. Geary, Hoard, Nugent & Bailey's (2013) study identified numeracy skills directly related to employability as: multi-step word problems, computational arithmetic, computational fractions, and fractions concepts scores. Further, in Hoyles, Wolf, Molyneux-Hodgson and Kent's (2002) examination of numeracy skills in the workplace, they found that numeracy skills were increasingly extended and required throughout the workforce at all levels. For example, with pressures for increases in business goals and productivity and the introduction of information technology, "data collection and first level analysis [of numerical data] are increasingly the responsibility of shop floor workers, [which] allow[s] managers to undertake more analysis of a strategic nature" (p. 13).

Bynner's (2004) study examined the relationship between literacy, numeracy and employability and found significant predictors of likely unemployment included number of jobs and the level of numeracy skills. Further, Parsons and Bynner's (2005) study found numeracy skills related to literacy and economic outcomes, yet level of numeracy skill was found to be more predictive of economic outcomes. The study further identified men with lower numeracy scores as being less likely to be employed and more likely to be arrested. Women were found to be more likely to be part of a non-working home and have poor health and increased depression (Parson & Bynner, 2005). However, most of these studies were conducted in the United Kingdom versus a U.S. context and most did not use the PIAAC dataset nor definition of numeracy.

Adults' Everyday Life/Authentic Numeracy Skill Use and Employment

Numeracy skills are not only essential for work but also essential and practiced in everyday life. Paulos (1988) recognized the impact numeracy skill has on daily life and theorized that mathematical innumeracy in both academic settings and everyday life was detrimental to the individual economically, psychologically, and socially. Ginsberg, Manly and Schmidt (2006) reviewed a variety of adult numeracy frameworks to examine how numeracy skill impacts the daily life experiences within a variety of personal and social contexts. They divided numeracy skills into four contexts: family or personal, workplace, community, and further learning. Interestingly, they found that "real world" or personal/family and/or community contexts for

numeracy bore little resemblance to numeracies of the workplace or learning contexts. For example, in everyday life numeracies, "calculations tend to be less error-prone, people focus on the meaning more often, and the resources that people turn to [to solve problems] are more varied" (Ginsberg, Manly, & Schmidt, 2006, p. 9).

Bynner and Parson (1998) were also interested in the intersection of skills and everyday life contexts. They studied the impact of unemployment on adults' literacy and numeracy skills. They found that unemployed adults' numeracy skill proficiencies declined at a significantly more rapid rate than their literacy skills. They hypothesized that, since reading/literacy skills are frequently used in everyday life and numeracy skills are less frequently used in everyday life in the same context, unemployment had a greater impact on adults' numeracy skills (Bynner & Parson, 1998).

Practice Engagement Theory

In this study, we are applying Reder's 1994 *Practice Engagement Theory,* which posits that adults' practices, or their engagement in literacy and numeracy events in their everyday lives, impact adults' proficiencies, or their performance on information-processing skills as measured by standardized assessments (like PIAAC) (Reder, 2009). Increased work-related information-processing practices and information-processing proficiencies have been shown to lead to improved economic outcomes (Desjardins & Rubenson, 2011). For our paper, we were interested in the six "outside of work" or everyday life numeracy practices investigated in the PIAAC background questionnaire. These "everyday life" prompts allow a unique opportunity to investigate the intersection of proficiencies and employment and possible relationships with social practices or skill use (Barton, Hamilton, & Ivanic, 2000; Street, 1993; Purcell-Gates, Degener, Jacobson, & Soler, 2000). Research has articulated that increased skill use (or social practices) is strongly associated with higher income levels (OECD, 2013). The ability to analyze skill proficiencies, skill use, and categories of employment along with related variables is novel and merits study (Grotlüschen, Mallows, Reder, Sabatini, 2016).

Methodology

Research Questions

1. What is the relationship between numeracy skills and employment status compared to the relationship between the other skills measured in PIAAC (literacy and problem solving in technology-rich environments) among U.S. adults?
2. What is the relationship between numeracy-related skills used in everyday life and employment status for U.S. adults?

In order to answer our research questions, we completed a secondary analysis of the 2012/2014 PIAAC U.S. data files.

Sample/Data Source

For our analysis, we used the 2012/14 PIAAC U.S. public-use data files. In the United States, the PIAAC assessment is only administered in English; however, background questions are available in both English and Spanish. The United States' first round, the U.S. PIAAC Main Study (2012), was supplemented by a second round of national data collection in 2013-14, known as the U.S. National Supplement (NCES, 2013).

The merged national sample contains approximately 8,700 adults and allows for "more accurate and reliable national estimates as well as estimates for groups not previously available in the PIAAC dataset" (NCES, 2013; Rampey et al., 2016). For the purposes of our research questions and subsequent analysis, we were particularly interested in the numeracy skill proficiencies and numeracy skill practices/skill use of the oversampled population of unemployed adults ages 16-65. The sections below highlight the variables employed. For a full list of variables and corresponding codes, see Appendix A.

Dependent Variable

Current Employment Status/Work History (C_D09) was our dependent variable. This derived variable corresponds to the survey respondents' current status/work history and contains the six categories: Not Stated or Inferred, Currently Working (paid or unpaid), Recent Work Experience in Last 12 Months (short-term unemployment), Left Paid Work Longer Than 12 Months Ago (long-term unemployment), No Work Experience, and Status Unknown. In this study, cases with low numbers-in-category including "Not Stated or Inferred" and "Status Unknown" employment status were excluded from analysis due to low numbers-in-category. Further, we renamed the category "Recent Work Experience in Last 12 Months" as "Left Paid Work Less Than 12 Months Ago" for consistency within this paper and for connotation and clarity in reporting results.

We selected this variable because we wanted to further explore the associations between information-processing skills (numeracy, literacy, and problem solving in technology rich environments) and Employment Status by levels of (un)employment. Therefore, our reference category was "Currently Working" or employed.

Independent Variables

Our main independent variables were the participants' scale scores on literacy, numeracy, and PS-TRE assessments. Literacy, for PIAAC, is described as "the ability to understand, evaluate, use and engage with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential" (OECD, 2103, p. 59). Receptive literacy skills were assessed using word level skills of decoding words and sentences to critical comprehension inclusive of "the interpretation and evaluation of complex texts" across multiple contexts (OECD, 2013, p. 59). Of note, the PIAAC does not assess expressive language skill (writing) within the literacy assessment.

Numeracy, for PIAAC, is outlined 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, 2013, p. 59). Numeracy skills assessed involved participants "responding to mathematical context, information, or ideas represented in multiple ways" across multiple contexts in order to authentically solve problems (OECD, 2013, p. 59).

Finally, problem solving in technology-rich environments (PS-TRE) is "defined as the ability to use digital technology, communication tools and networks to acquire and evaluate information, communicate with others, and perform practical tasks" (OECD, 2013, p. 59). PS-TRE skills assessed include the capacity to "solve problems for personal, work, and civic purposes" by goal setting, accessing, and utilizing information through computers and networks (OECD, 2013, p. 59). Of note, the PIAAC only assesses PS-TRE using computers and does not assess PS-TRE using mobile devices or tablets, further those participants who did not take the computer-based assessment would not have scores for the PS-TRE assessment.

PIAAC results are reported as average scores (OECD, 2013). There are six defined proficiency levels for literacy and numeracy (Levels 1 through 5 and "below Level 1") and four defined proficiency levels for problem solving in technology-rich environments (Levels 1 through 3 and "below Level 1"). Proficiency levels for the PIAAC are descriptive, and, therefore, "suggest what adults with particular proficiency scores in a particular skills domain can do" (OECD, 2013, p. 61). Tasks are mapped to particular proficiency levels, with an average person likely to complete the task successfully approximately two-thirds of the time (OECD, 2013). For the purposes of this paper, we chose to use the average scores in the three domains of information-processing skills (literacy, numeracy, and PS-TRE) (PIAAC 2012/2014). Participants were not administered every literacy, numeracy, and problem-solving question in the PIAAC 2012/2014; instead, they responded to a small portion of the entire assessment (OECD, 2012). Therefore, plausible values were computed as an approximation of consistent estimates of respondents' individual test scores. We used the analytical techniques for plausible values and weights as outlined by Pokropek and Jakubowski in 2013 in Stata 13.

Finally, in order to apply Reder's (1994) Practice Engagement Theory by exploring numeracy skill use/practices in association with numeracy skill proficiencies for our sample, we included six variables related to six questions/numeracy skills from the Background Questionnaire about participants' self-reported numeracy skill use in everyday life (at home). These skills included: 1) calculating costs or budgets, 2) calculating fractions or percentages, 3) use of calculator, 4) preparing charts, graphs or tables, 5) using simple algebra, and 6) using advanced math or statistics. For each of the six questions on numeracy skill use, participants were asked to respond with "how often" or how frequently they performed the outlined numeracy skill in everyday life. For example, "In every day life, how often do you usually use a calculator - either hand-held or computer based?" (H_Q03D). Participants had five outcome choices, 1) Never, 2) Less than once per month, 3) Less than once a week but at least once a month, 4) At least once a week but not every day, 5) Every day. These five outcome choices were analogous for all six every day life numeracy skill questions. Although the Background Questionnaire also uses the same six numeracy skill questions in reference to "use at work," we did not include those variables in our analysis as members of our sample of most interest were not working, and, therefore, had not answered this question set.

Control Variables

Other demographic variables of interest included: educational attainment, age (from 16-65), nativity, gender, English language acquisition, race, health status, having a learning disability, vision disability, hearing disability, number of books in the home at age 16, and parental education. We treated both age and health status as categorical, ordinal variables. As we could not establish "net earnings" as a variable for socioeconomic status (SES) because our sample included the unemployed, we used parental educational attainment as a proxy for SES (OECD, 2013).

Analytic Approach

In order to answer our research questions, descriptive statistics for all variables as well as a series of multinomial logistic regression models were run utilizing numeracy, literacy, and problem solving in technology-rich environments as the independent variables and employment status/work history as the dependent variable. The initial logistic regression model was first run using only the independent and dependent variables. Next, a model was run including additional control variables with the exception of the six numeracy skill use in everyday life variables. Finally, a model isolating numeracy skill as assessed by PIAAC, the six numeracy skill use in everyday life variables, Employment Status, and all control variables was run.

Assumptions underlying the procedure of logistic regression were met. While independence of observations was assured and care with inclusion of predictor variables was taken, literacy, numeracy, and PS-TRE skills are very highly correlated. However, in order to answer Research Question 1, all three skills were included in the same model despite risk of multicollinearity (Silvey, 1969). Further, because the coefficients of logistic regression can be difficult to conceptually apply to policy or practice contexts, we chose to additionally calculate and report the adjusted odds ratios, which "estimate the multiplicative change in the odds of membership in the targeted group for every one-unit increase in the predictor variable while statistically controlling for the other predictor variables" (Hatcher, 2013, p. 330). Logistic regression methods predict the probability or likelihood of particular outcomes which is helpful for interpretation of the study findings and supports interpretation for policy and practice (Bruin, 2011; Long & Freese, 2014). By examining odds ratios across employment membership categories in each of the three skill areas, we are better able to determine the relationship across each skill and membership within employment categories (Hosmer & Lemeshow, 2000; Winship & Mare, 1984).

Results

Overall results for research question one found the adjusted odds ratios for numeracy are significantly negatively associated with two categories of (un)employment status: unemployed (No Experiences with Paid Work) and long-term unemployment (Left Paid Work Longer than 12 Months). In other words, only increases in numeracy skills were statistically protective of employment after all variables were added to the model. Problem solving in technology rich environments (PS-TRE) was also significantly associated with long-term unemployment (Left Paid Work Longer than 12 Months); however, this relationship was slightly positive.

Results for research question two found significance between numeracy averages (performance as assessed by PIAAC) across all three domains of unemployment once the other information-processing skills were removed from the model. Further, several of the self-reported numeracy practices in every day life were significant across disparate (un)employment categories including use of Costs or Budgets, Use of Calculator, and Charts and Graphs.

Descriptive statistics for the variables included in our models and results from the inferential statistics and subsequent analysis are presented in the following sections.

Descriptive Statistics

Descriptive statistics for employment status/work history, literacy, numeracy, problem solving in technology-rich environments, and all of our control variables are presented in Table 1. The values and corresponding calculations reported for literacy and numeracy information-processing skill variables were computed using a sample size of N=7,921. The values and corresponding calculations reported for PS-TRE were computed using a sample size of N=6,813. For our study focusing on employment status/work history of the 16-65 aged population, the variable of age includes categories of age ranges beginning at age 16-19 and continuing every five years through age 65. The largest group of participants were ages 20-24, 25-29, and 30-34 respectively (13.7 %, 13.2% and 13.3%) which comprise a large cluster towards the younger end of the sample (40.2%). The lowest percent of participants was the range category of ages 55-59 (7.5%).

35.2% of people in the 16-19 age category are employed according to the U.S. Bureau of Labor Statistics (2017). Over one-third of the age 16-19 age category are working. Based on our analysis and similar to previous research (Rampey et al., 2016), younger U.S. adults in our sample have relatively higher digital skills than older adults. Further, similar to previous research (Provasnik & Xie, 2018), we found in our sample that young adults (age 16-19) also are a higher proportion of the (un)employed, No Experience with Paid Work category than older adults. This status could overlap with either their transitional role as students or as people who are unemployed but seeking employment. However, given that this age group marks the entrance into the job market for some U.S. adults and over a third of this age group are working, they were included in the analysis. Because our research questions and analysis focus on employment outcomes, we intentionally excluded the data from the 66-70 and 70 plus age ranges as the majority (80.7%) of people older than 65 are outside of the labor force according to the U.S. Bureau of Labor Statistics (2017). See Table B.1 in the Appendix for further information on the sample by age cohort.

Employment status/work history, the dependent variable, includes the categories of Currently Working (employed), and three (un)employed categories: unemployed (no experience with paid work), short-term unemployment (Left Work Less Than 12 Months Ago), and long-term unemployment (Left Work Longer than 12 Months Ago). Most participants (age 16-65) in this study were Currently Working (73.8%). The largest percent (14.2%) of unemployed participants were long-term unemployed and 8.1% were short-term unemployed. The smallest percent of participants reported having no work experience (4.0 %).

In terms of information-processing skill proficiencies, the independent variables, the PIAAC literacy and numeracy are divided into five levels of proficiency which outline what a person with

a particular score can do at each level of proficiency (OECD, 2016). The literacy scores for this study ranged from 100 to 429 with an average score of 272. Individuals who obtain the average literacy score are able to do the following skills: make matches between texts, paraphrase, and make low level inferences (OECD, 2013). Numeracy scores for this study ranged from 57 to 429, with an average score of 257. Individuals who fall within this average can apply two or more steps involving calculations with whole numbers, decimals, percent, and fractions (OECD, 2013). Participants with an average score would be able to do simple measurement and interpret simple data and statistics in texts, tables and graphs (OECD, 2013). The average scores fall within level two proficiency for both literacy and numeracy. This includes scores ranging from 226 to 275. The problem-solving in technology rich environments scores range from 101 to 417, with an average score of 273. Problem solving contains three levels of proficiency. The average score translates to level one, with a range of scores from 241 to 290. At level one, most participants would be able to complete tasks on well-defined problems, where few steps are required, and tasks include familiar technology.

For the control variables included in the model, the variable educational attainment included six categories: lower secondary or less (14.0 %), upper secondary (for the U.S. sample this would be those with a high school diploma or equivalency) (40.8%), post-secondary, non-tertiary (8.8%), tertiary-professional degree month (9.0 %), tertiary bachelor's degree (17.0 %) and tertiary-master/research degree (10.4 %). Over half of the U.S. sample ages 16-65 has, at most, a high school diploma or equivalency. About half of our sample is female (50.8%). While most respondents learned English as a first language (84.3 %), respondents who acquired English as a second (or later) language were categorized into two groups. The first group is those who learned English when age 15 or younger (11.4%), and the second is those who learned English when age 16 or older (4.2%). The variable of race includes four categories: White (65.1%), Hispanic (14.8%), Black (12.7%) and other race (7.5%). Participants who are foreign born comprised (14.5%) of the sample. Respondents in the sample who self-reported as having disabilities are those with a learning disability (8.01%), hearing problems (8.9%) and vision problems (11.4%). Health categories include a range from excellent (23.5%), very good (33.2%), good (28.3%), fair (11.5%) and poor (3.6%). Most participants in our sample rated their health as good, very good or excellent (85.0%).

The variable in the Background Questionnaire for the number of books at home at age 16 was used to further explore possible exposure to materials impacting long-term academic/information-processing outcomes (Cunningham, & Stanovich 1997). The range of books included numbers of books in six categories. The most frequent number selected was 26 to 100 books (31.9%); the next highest range was 11-25 books (19.0%), 10 books or less (19.0%), 101 to 200 books (15.5%); 201 to 500 books (9.6%) and more than five hundred books (5.0%). Three parental educational attainment categories were used including: (1) neither parent has attained upper secondary (17.4%), (2) at least one parent has attained secondary and post-secondary, non-tertiary (43.7%), and (3) at least one parent has attained tertiary (38.9%).

Finally, descriptive statistics were calculated for the six self-reported use of numeracy in everyday life skills including: costs or budgets; fractions or percentages; use of calculators; charts, graphs and tables; simple algebra or formula; and advanced math or stats. Almost three out of four (73.0%) of participants report using a calculator while only 27.0% report *never* using a calculator. Findings

for variables with a high percentage of skills *never* used were advanced math or stats (81.6%), charts, graphs, tables (53.9%), simple algebra or formulas (52.4%) and costs or budgets (42.1%). Interestingly, skill use reported by participants of fractions or percentages was conflicted as some reported never using the skill (33.2%) yet others self-reported using the skill at every day (35.8%).

Table 1

Descriptive Statistics for Employment Status, Literacy, Numeracy, PS-TRE, and Control Variables

Dependent Variable		Percent (SE)		
Employment Status/Work History				
Employed (Currently working) (ref)		73.76 (.006)		
Short-Term Unemployment (Left paid work less than 12 months ago)		8.05 (.003)		
Long-Term Unemployment (Left paid work longer than 12 months ago)		14.16 (.005)		
Unemployed (No work experience with paid work)		4.01 (.003)		
Independent Variables Information-Processing Skills	Mean (SD) (SE)	Percent (SE)	Minimum	Maximum
Literacy	272 (47.95) (0.950)		100.2	429.95
Numeracy	257 (54.41) (1.07)		57.18	429.04
PS-TRE	274 (42.87) (1.13)		101.89	417.47
Control Variables		**Percent (SE)**		
Education Attainment				
Lower secondary or less		13.96 (.002)		
Upper secondary		40.84 (.004)		
Post-secondary, non-tertiary		8.79 (.004)		
Tertiary - professional degree		8.99 (.004)		

Tertiary - bachelor degree		17.00 (.005)		
Tertiary - master/research degree		10.41 (.005)		
Gender Female Male		 50.82 (.000) 49.18 (.000)		
English language status				
Learned English as the first language (ref)		84.34 (.007)		
Learned English when age 15 or younger		11.42 (.007)		
Learned English when age 16 or older		4.24 (.003)		
Race				
White (ref)		65.05 (.008)		
Hispanic		14.77 (.004)		
Black		12.72 (.004)		
Other race		7.47 (.007)		
Nativity				
Native born Foreign born		85.49 (.004) 14.51 (.004)		
Age				
16-19		12.07 (.002)		
20-24		13.66 (.003)		
25-29		13.17 (.004)		
30-34		13.34 (.003)		
35-39		7.98 (.003)		
40-44		7.84 (.003)		
45-49		7.99 (.004)		
50-54		8.43 (.004)		
55-59		7.45 (.004)		
60-65		8.07 (.003)		
Diagnosed or Identified with Learning Disability Yes No		 7.98 (.004) 92.02 (.004)		

Difficulty with Hearing Yes No		8.92 (.004) 91.08 (.004)		
Difficulty with Vision Yes No		11.40 (.004) 88.60 (.004)		
Number of books at home				
10 books or less		18.94 (.005)		
11 to 25 books		18.95 (.006)		
26 to 100 books		31.91 (.007)		
101 to 200 books		15.53 (.006)		
201 to 500 books		9.63 (.005)		
More than 500 books		5.04 (.003)		
Parental Educational Attainment				
Neither parent has attained upper secondary		17.40 (.007)		
At least one parent has attained secondary and post-secondary, non-tertiary		43.74 (.010)		
At least one parent has attained tertiary		38.86 (.009)		
Health				
Excellent		23.48 (.007)		
Very good		33.16 (.007)		
Good		28.27 (.007)		
Fair		11.50 (.005)		
Poor		3.59 (.002)		
Numeracy Skill Use in Every Day Life Variables		**Percent**		
Costs or budgets				
Never		42.12 (.007)		
Less than once a month		9.96 (.005)		
Less than once a week but at least once per month		7.88 (.004)		
At least once a week but not every day		10.89 (.006)		
Every day		29.16 (.007)		

Fractions or Percentages				
Never		33.21 (.006)		
Less than once a month		9.33 (.005)		
Less than once a week but at least once per month		7.91 (.005)		
At least once a week but not every day		13.79 (.006)		
Every day		35.77 (.008)		
Use of Calculator				
Never		26.99 (.005)		
Less than once a month		7.42 (.004)		
Less than once a week but at least once per month		8.98 (.005)		
At least once a week but not every day		17.07 (.006)		
Every day		39.53 (.008)		
Charts, graphs, tables				
Never		53.66 (.007)		
Less than once a month		14.21 (.006)		
Less than once a week but at least once per month		11.33 (.006)		
At least once a week but not every day		11.60 (.005)		
Every day		9.21 (.004)		
Simple algebra or formula				
Never		52.37 (.006)		
Less than once a month		10.58 (.005)		
Less than once a week but at least once per month		8.20 (.005)		
At least once a week but not every day		10.66 (.006)		
Every day		18.19 (.006)		
Advanced math or stats				
Never		81.64 (.006)		
Less than once a month		7.82 (.004)		
Less than once a week but at least once per month		3.91 (.003)		
At least once a week but not every day		3.58 (.003)		
Every day		3.05 (.003)		

Note: Means and standard deviations for literacy, numeracy, and PS-TRE were calculated using the PV and Repest commands in Stata to account for weights and plausible values. The sample size fluctuates depending on the variable. Percentages are based on the specific data reported. N = 7,921 inclusive of Age 16-65 for Literacy and Numeracy. All values are weighted

Research Question 1

In order to answer our first research question, "*What is the relationship between numeracy skills and employment status compared to the relationship between the other skills measured in PIAAC (literacy and problem solving in technology-rich environments) among U.S. adults?,"* we completed a multinomial logistic regression analyses predicting employment status from numeracy, literacy, and technological problem solving. These findings are presented in Table 2. Table 2 presents the adjusted odds ratios for the predictor variables before accounting for any control variables. The three models demonstrate that the adjusted odds ratios for numeracy, literacy, and problem solving in technology rich environments (PS-TRE) are all significantly associated (see corresponding significance levels) with each category of (un)employment status (No Experiences with Paid Work, short-term unemployment (Left Paid Work Less Than 12 Months), long-term unemployment (Left Paid Work Longer than 12 Months) with one exception. The adjusted odds ratio for PS-TRE associated with the Left Paid Work Less Than 12 Months (un)employment status was .998. The 95% Confidence Interval (CI) included the value of 1.0, indicating that the adjusted odds ratio was not statistically significant.

Specifically, a ten-point increase on the numeracy assessment is associated with a 2% less likelihood of being unemployed (No Experience with Paid Work), a .5% less odds of short-term unemployment (Left Paid Work Less Than 12 Months Ago), or a .8% less odds of having long-term unemployment (Left Paid Work Longer than 12 Months Ago). A ten-point increase on the literacy assessment is associated with .1%, .4% and .8% less odds, correspondingly with each of the categories of (un)employment. Finally, ten-point increases on the PS-TRE assessment is associated with .6%, less odds of No Experience with Paid Work and long-term unemployment (Left Paid Work Longer than 12 Months Ago).

Table 2

Results of Logistic Regressions Before Accounting for Control Variables

Information-Processing Skills	**Unemployed (No Experience with Paid Work)**			**Short -Term Unemployment (Left Paid Work Less Than 12 Months Ago)**			**Long-Term Unemployment (Left Paid Work Longer Than 12 Months Ago)**		
	OR	SE	95% CI	OR	SE	95% CI	OR	SE	95% CI
Literacy	.99***	.0001	.98-99	.996**	.0001	.994-.998	.992***	.001	.99-.994
Numeracy	.98***	.0001	.98-.99	.995***	.0001	.993-.997	.992***	.0001	.99-.994

PS-TRE	.994**	.0001	.99-.998	.998	.0001	.995-1	.994**	.001	.99-.996

Note: Currently Working is the reference group (base group). For every 10-point score increase, we predict a % change in employment in that category based on the odds ratio for that category. Each category is compared to our reference category "current working."
**p<.01; weighted; two-tailed tests
***p<.001; weighted; two-tailed tests
N Literacy & Numeracy (7,584)
N PS-TRE (6,813)

As indicated in the review of previous scholarship, there are other characteristics that may be associated with both employment status and information-processing proficiencies in literacy, numeracy, and PS-TRE. Therefore, control variables are included in the model outlined in Table 3. After introducing the control variables outlined in Table 3, the adjusted odds ratios for literacy are no longer significant across any of the (un)employment categories. However, numeracy odds ratios are still significantly negatively associated with two categories of (un)employment status: No Experiences with Paid Work and long-term unemployment (Left Paid Work Longer than 12 Months). In other words, increases in numeracy skills were statistically protective of employment after all variables were added to the model. Problem solving in technology rich environments (PS-TRE) was also significantly associated with long-term unemployment (Left Paid Work Longer than 12 Months); however, this relationship was slightly positive. Further, for all three relationships which remained significant, the strength of the relationships was reduced.

For example, a 10-point increase on the numeracy assessment, which is approximately 1/5 of a standard deviation, is associated with .2% less likelihood of being unemployed (No Experience with Paid Work) and a .1% less likelihood of having long-term unemployment (Left Paid Work Longer Than 12 Months Ago) after controlling for additional variables within the model. A 10-point increase on the PS-TRE assessment is related to a .1% increased likelihood of having long-term unemployment (Left Paid Work Longer Than 12 Months Ago). Yet, of the literacy, numeracy and PS-TRE assessments, none significantly predict the (un)employment category of short-term unemployment (Left Paid Work Less Than 12 Months Ago) when control variables are added into the model.

Moreover, some of the control variables presented in Table 3 were much more strongly associated with Employment Status than were numeracy information-processing skills after controlling all variables. For example, educational attainment was more negatively associated with the Employment Status' across all (un)employment categories than numeracy. For every unit increase in education, participants were 54.0%, 22.0%, and 15.0% less likely to be assigned to the (un)employment categories of unemployed (No Experience with Paid Work), short-term unemployment (Left Paid Work Less Than 12 Months Ago), or long-term unemployment (Left Paid Work Longer than 12 Months Ago) respectively.

Perhaps unsurprisingly, age is more strongly associated with Employment Status than numeracy information-processing skills within the model. The relationship is negative for the unemployed

(No Experience with Paid Work) and the short-term (Left Paid Work Less Than 12 Months Ago) (un)employment categories. Correspondingly, a participant is 46.0% less likely to be in the unemployed (No Experience with Paid Work) category and 15.0% less likely to be in the short-term (Left Paid Work Less Than 12 Months Ago) (un)employment category. Conversely, the relationship between age and employment status within the model is positive for the long-term (Left Paid Work Longer than 12 Months Ago) (un)employment category where a participant is 12.0% more likely to fall in the long-term (Left Paid Work Longer than 12 Months Ago) (un)employment category. To better understand these results, we analyzed the distribution of our sample across the (un)employment categories by the 10 age bands. See Table B.2 in the Appendix. Based on our review of the data, we note that, similarly to previous scholarship, some sample sizes across the employment categories by age are too small to support the same depth of analysis (Provasnik & Xie, 2018).

Additionally, gender was more strongly associated with the Employment Status' across (un)employment categories than numeracy. There is a strong positive relationship between the female gender and several (un)employment categories. In the numeracy model including control variables, a female is 68.0% more likely than males to be in the No Experience with Paid Work (un)employment category and 103.0% more likely than males to be in the long-term (Left Paid Work Longer than 12 Months Ago) (un)employment category.

Further, we found that the adjusted odds ratio for students who learned English as a second language at 15 years or younger associated with the long-term unemployment (Left Paid Work Longer Than 12 Months Ago) category was 1.72. The 95% Confidence Interval (CI) for this relationship did not include the value of 1.0, indicating that the adjusted odds ratio was statistically significant. In other words, there is a statistically positive relationship between a young age of English as a second language literacy development, or English language acquisition, and the long-term unemployment category (Left Paid Work Longer Than 12 Months Ago) within the model. However, interestingly, there is no relationship (positive or negative) between an older age of English as a second language literacy development, or English language acquisition, and (un)employment categories within the numeracy model.

Several of the adjusted odds ratios across racial(ethnicity) categories were also statistically significant. For participants who selected Hispanic as their racial/ethnic category, the adjusted odds ratio of .48 within the category of long-term unemployment (Left Paid Work Longer than 12 months ago). This indicates that members of Hispanic population are 42.0% less likely to be in the category of long-term unemployment (Left Paid Work Longer than 12 months ago) category when compared to Whites. For Black participants, they are 79.0% more likely to have No Experience with Paid Work than Whites.

Other control variables of interest within the model include health, disability status (hearing and vision), and number of books in the home. For health, the category of long-term unemployment (Left Paid Work Longer than 12 months ago) was positively significant. For those who reported not having difficulty with hearing or vision, they were 44.0% and 47.0% respectively less likely to be in the category of long-term unemployment (Left Paid Work Longer than 12 months). Finally, there is a positive relationship between the number of books in a home at age 16 and short and long-term unemployment categories.

Table 3

Results of Logistic Regression Including Control Variables

Employed (Currently Working) (ref)	Unemployed (No Experience with Paid Work)			Short-Term Unemployment (Left Paid Work Less Than 12 Months Ago)			Long-Term Unemployment (Left Paid Work Longer Than 12 Months Ago)		
	OR	**SE**	**95% CI**	**OR**	**SE**	**95% CI**	**OR**	**SE**	**95% CI**
Literacy	1.01	.01	.99-1.04	1.00	.00	1.00-1.01	.99	.00	.98-1.00
Numeracy	0.98*	.01	.97-.997	1.00	.00	.99-1.00	.99*	.00	.99-1.00
Digital Problem Solving	1.00	.01	.85-1.01	1.00	.00	.99-1.01	1.01*	.01	1.00-1.02
Education Attainment	.46***	.16	.34-.64	.78***	.05	.71-.85	.85***	.05	.77-.93
Age	.54***	.10	.45-.66	.85***	.03	.81-.90	1.14***	.03	1.09-1.21
Born out of the Country	1.71	.35	.45-3.38	1.08	.30	.61-1.93	.81	.27	.47-1.38
Female	1.68**	.17	1.2-2.3	1.17	.10	.96-1.43	2.03***	.12	1.62-2.55
Learned English as the first language (ref)	-----	-----	-----	-----	-----	-----	-----	----	-----
Learned English when age 15 or younger	1.67	.38	0.79-3.53	1.01	.28	.59-1.74	1.72*	.23	1.10-2.69
Learned English when age 16 or older	.34	.94	.05-2.14	.58	.55	.20-1.72	2.02	.44	.86-4.73
White (ref)	-----	-----	-----	-----	-----	-----	-----	----	-----
Hispanic	1.81	.34	.94-	1.01	.16	.74-	.48**	.25	.29-

			3.50			1.39			.79
Black	1.79*	.25	1.09-2.93	1.37	.18	.96-1.96	.85	.16	.63-1.16
Other Race	1.90	.43	.83-4.37	1.46	.21	.96-2.23	.90	.25	.55-1.48
Health	1.00	.08	.86-1.17	1.06	.06	.94-1.20	1.52***	.06	1.37-1.70
Learning Disability (do not have issue)	.68	.22	.44-1.03	.82	.15	.62-1.10	.85	.20	.57-1.26
Hearing (do not have issue)	1.01	.41	.44-2.21	1.28	.23	.82-2.01	.66**	.15	.49-.88
Vision (do not have issue)	.83	.39	.39-1.80	.83	.21	.55-1.27	.63**	.18	.44-.89
Number of Books	1.14	.09	.96-1.36	1.14**	.04	1.04-1.24	1.21***	.04	1.11-1.31
Parental Education (SES)	1.00	.14	.76-1.31	1.04	.08	.88-1.21	.86	.09	.72-1.01

*p<.05; weighted; two-tailed tests
**p<.01; weighted; two-tailed tests
**p<.01; weighted; two-tailed tests
N=Literacy and Numeracy (7,584) N=PS-TRE (6,813)
Bonferroni corrections used for Type I protection (.05/number of tests for category has more than two levels. (such as Race, Language etc.)

Research Question 2

Another logistic regression model was run to determine the relationship between self-reported numeracy skill use in everyday life, numeracy proficiencies as assessed by the PIAAC , and employment status. The odds ratios and confidence intervals for the model assessing the relationship between the numeracy in everyday life variables and numeracy scores by employment status are reported in Table 4. All control variables previously included in the original logistic regression models were also controlled for in the second model. Participants' performance on the PIAAC's numeracy assessment averages in the second model was predictive of the category of No Experience with Paid Work, the Left Paid Work Less than 12 Months Ago, and Left Paid Work Longer than 12 Months ago. Significant relationships were also found for Cost or Budgets, Use of Calculator, and Charts, Graphs, and Tables for Left Paid Work Longer Than 12 Months. We also found a significant relationship for long-term unemployment (Left Paid Work Less Than 12 Months Ago) and Use of Calculator. See Table B.2 in the Appendix for further results reporting across control variables by (un)employment categories.

Table 4

Odds Ratios and 95% Confidence Interval for Regression Model Assessing Numeracy Everyday Life Variables and Numeracy on Work Status in Comparison to Full-time Employed

Independent Variables	Unemployed (No Experience with Paid Work)			Short-Term Unemployment (Left Paid Work Less Than 12 Months Ago)			Long-Term Unemployment (Left Paid Work Longer Than 12 Months Ago)		
	OR	SE	95% CI	OR	SE	95% CI	OR	SE	95% CI
Numeracy Averages	0.99**	.003	.98-.995	0.997*	.001	.995-0.9999	0.996**	.001	0.993-0.998
Costs or budgets	0.91	.061	.80-1.03	1.07	.036	0.99-1.15	1.37***	.039	1.27-1.48
Fractions or Percentages	1.23**!	.068	1.08-1.40	1.08	.049	0.98-1.18	1.05	.040	0.97-1.13
Use of Calculator	0.95	.074	.82-1.10	0.89*	.055	0.80-0.998	0.80***	.037	0.74-0.86
Charts, graphs, tables	1.18*!	.082	1.01-1.39	1.08	.044	0.99-1.18	1.29***	.06 0	1.15-1.45
Simple algebra or formula	1.09	.088	.91-1.29	1.05	.047	0.95-1.15	0.99	.044	0.91-1.08
Advanced math or stats	0.92	.071	.80-1.06	1.06	.054	0.96-1.18	1.10	.063	0.97-1.24

Note: p*** < .001, p** < .01, p* < .05; ! = Interpret data with caution. The coefficient of variation (CV) for this estimate is between 30 and 50 percent.

Discussion

Research Question 1

PIAAC's defines numeracy 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, 2012, p.36). Numeracy is important to the functioning of adults and has an impact on personal and economic life. The PIAAC assessment of numeracy goes beyond the use of a disparate mathematic skill requiring not only numeric ability but judgement and application. The United States significantly underperforms in comparison to other countries (U.S. Department of Education, 2013). The average numeracy score on the PIAAC in the U.S. corresponds to a Level 2 performance. Individuals performing at level 2 can apply two or more steps or processes involving calculation with whole numbers. This national underperformance raises concerns. Within the United States, adults with better numeracy skills have higher wages (OECD, 2012), and, based on the results outlined above and previous research (Geary et al., 2013; Hoyles et al., 2002) numeracy proficiency is increasingly important to and protective of employability in a 21st century global economy.

In this study, after including control variables into the models, we found that the relationships between numeracy and employment status was negatively significant for two categories of (un)employment. For every 10-point increase in average numeracy score, the likelihood of being

unemployed (No Experience with Paid Work) and long-term unemployment (Left Paid Work Longer than 12 Months ago) goes down significantly. This is an impactful finding regarding the importance of numeracy skill as protective of two of the most challenging forms of unemployment.

Intriguingly, of the literacy, numeracy and PS-TRE assessments, none significantly predict the (un)employment category of short-term unemployment (Left Paid Work Less Than 12 Months Ago) when control variables are added into the models. This finding seems to indicate how various and disparate factors not captured within the current model impact short-term unemployment (Left Paid Work Less than 12 Months Ago). Other variables, for example short term health concerns or family obligations, could impact short-term unemployment and are innumerable. We assume outside environmental factors are impacting short-term unemployment. Therefore, the potential modest effect of information processing skills on unemployment are suppressed once controls are added to the model.

Policymakers and practitioners should note these findings as they merit the inclusion of numeracy when designing the types of programs and curricula offered to/for adult learners. This study's findings on the importance of numeracy as protective against long-term unemployment are particularly relevant to those interested in programming related to workforce development and employment as outlined by the Workforce Innovation and Opportunity Act (WIOA). To meet the WIOA and College and Career Readiness Standards (CCRS) requirements of deep conceptual understanding of mathematics in adult education programs and curricula, many teachers may need additional training as "they may not have that [type] of conceptual understanding themselves" (Ginsburg, 2017, p. 57). In fact, a 1994 study by Gal and Schuh (as cited in Ginsburg, 2017) found that only 5% of adult education teachers have the credentials to teach math. The results of this paper, coupled with Ginsburg's assertions, demonstrate the need for continued training for in-service adult education professionals in order to foster the development of adults' numeracy skills.

Additionally, WIOA dictates what types and kinds of services U.S. adult and workforce education programs can provide under Title II funding. Based on the delivery of these services, WIOA requires that each state produce a *Statewide Performance Reports.* These standardized reports require demographic descriptions of participants/clients served as well as participants/clients "employment barriers" by pre-identified categories. One specific recommendation, based on this research, would be to include "low levels of numeracy" as one of the pre-identified categories of "employment barriers" by WIOA on the standardized reports similar to the existing category of "low levels of literacy." See Appendix C for Exemplar Statewide Performance Report - WIOA Title II Adult Education Program. The addition of "low levels of numeracy" would both emphasize the collection of data at the state level around this issue and also spur new assessments and programming to meet this pre-identified need. For example, the U.S. Department of Labor's American Job Centers (One-Stop Centers) could assess numeracy skills of clients/job seekers and collaborate with local providers (adult education programs, workforce development programs, community and technical colleges, and libraries) to offer targeted numeracy programing.

Of note, similar to Fernandez and Umbricht's (2016) study, the relationships between literacy and employment status was no longer significant (positive or negative) for any (un) employment category. We caution that the lack of statistical significance does not mean that no relationship

exists. Prior research has extensively established the importance of literacy skill as indicative of better life outcomes for adults and families - socially and economically.

Finally, PS-TRE was positively significant with long-term unemployment (Left Paid Work Longer than 12 Months Ago). Interestingly, this seems to reinforce the concept that those who are younger had an impact on the (un)employment categories. A consideration for younger age categories is whether or how their recent participation in formal education impacts their PS-TRE skills and, in turn, their participation in the labor market.

While all the information-processing skills were significant in isolation across categories of (un)employment, once control variables were added, they had a large impact on the model. For those significant relationships which remained significant following the control variable's inclusion in the model, the strength of the relationships was reduced – evidence of the impact of the control variables on the model. Further discussion of the control variables within the model follows.

In keeping with previous research, age was relevant to (un)employment status and has significant policy implications for equitable opportunities. Older people are particularly at risk for long-term unemployment. Further and more nuanced examination of the effects of aging across the (un)employment are important for older people to receive opportunity and access to employment. These results around long-term unemployment of older adults mirror Rampey et al.'s (2016) findings around employment challenges for older adults with lower numeracy proficiencies.

Educational attainment was more negatively associated with the Employment Status' across all (un)employment categories than numeracy. The higher level of education a participant has, the less likely they are to be in one of the (un)employment subcategories (status). This finding is similar to previous scholarship (Grotluschen et al., 2016; OECD, 2015), yet our results are specific to the U.S. context and also additionally outlines the impact of educational attainment and skills across employment status beyond the dichotomous (employed v. unemployed).

Gender was also more associated with employment status across all employment categories than numeracy. The need to address the gender gap in labor force participation is apparent and pressing. In the numeracy model including control variables, females are 68.0% more likely than males to be in the No Experience with Paid Work (un)employment category and 103.0% more likely than males to be in the long-term unemployment (Left Paid Work Longer than 12 Months) category. As indicated by previous scholarship and reinforced in the current study, females are much more likely than males to be out of the workforce long-term and have a much greater likelihood of having no experience in the workforce at all. In addition, the examinations contrasting the kinds of employment options between genders and inequities such as access to skill training and advancement for women in the workplace are well known (Arora & Pawlowksi, 2017). Overall, these findings represent a huge opportunity gap for women in the U.S. labor market.

Although the literacy information-processing skills were not significant across (un)employment categories for this study, we found a strong positive relationship between learning English as a second language at a young age (15 or younger) and one (un)employment category within the numeracy model. People who learned English as a second language before age 15 had a 72.0%

higher chance of being long-term unemployed compared to those who learned English as a first language. However, interestingly, there is no relationship (positive or negative) between an older age of English language acquisition and (un)employment categories within the numeracy model. We caution that the lack of statistically significance does not mean that no relationship exists. The smaller numbers in this subcategory could influence the model. The relationship between younger English Language Learners and (un)employment outcomes is further analyzed below.

One possible explanation for these results is that language acquisition programs for U.S. children are primarily in one-way English immersion programs, where home language skills are not reinforced (Nieto, 2018). Yet, this is contrary to how languages are most effectively learned (Lightbrown, & Spada, 2013). Second languages (L2) are acquired most effectively by children (Lightbrown, & Spada, 2013) and adults (NRC, 2012) when learners have well developed home (L1) languages. Therefore, there is one plausible (and research based) explanation for why children who learned English as a second or other language have higher likelihoods of long-term employment when compared to people who learned English as children. The hypothesis is that when the development of language skills in a child's L1 is not continued, and that child learns English at a young age, he/she is not well positioned to attain high levels of proficiency in English - and may be more susceptible to long-term unemployment as adults. However, it should be noted that well-developed bilingualism is increasingly seen as a commodifiable asset across industries in the U.S. labor market (Callahan & Gándara, 2014). This study's results point to an additional rationale why U.S. schools should consider changing to a two-way model of bilingual education programming. However, a higher sampling of adults who learned English after age 15 would be necessary to further explore this line of inquiry.

In our models, race variables continued to identify inequities in employment opportunities for Black workers (Rampey et al., 2016). In our numeracy model, Black participants were 79.0% more likely to have No Experience with Paid Work when compared to Whites at the same level of proficiency. In previous research, the over representation of race in the unemployment categories for both Black (31.0%) and Hispanic (37.0%) when compared to White (22.0%) at the bivariate level demonstrates an employment equity gap in America along racial lines (Rampey et al., 2016). Interestingly, when control variables were added to our numeracy model which also integrated more levels of employment status, almost all of these significant relationships identified in the Rampey et al. models were mitigated.

In contrast, in our model, people who identified as Hispanic were 62% *less* likely than Whites to be long-term unemployed. This unique finding for the Hispanic population was further explored by looking at the descriptive statistics across race by current work and type of contract within our sample. Within the Hispanic group, 60.0% of people in our sample who work currently have no contract, which was higher percentage than for any other racial/ethnic group. This "no contract" employment context may be an indication that Hispanic people are more likely to be employed part-time and/or without contract which may impact their long-term unemployment.

Across the health variables, we found similar results to previous researchers (Prins, Monnat, Clymer, & Toso, 2015). In our study, participants that self-reported health-related issues and difficulties with hearing and vision were more likely to be long-term unemployed.

Finally, the Number of Books in the Home at Age 16, which provides some insight into educational materials impacting information processing, was positively related to both the short-term (Left Paid Work Less Than 12 Months Ago) and long-term (Left Paid Work More Than 12 Months Ago) categories. Given the positive direction of the relationship, this finding is unexpected and merits further exploration in future analysis particularly for those in the younger age bracket (16-19).

Research Question 2

Practice Engagement Theory (Reder, 2009; 2014) outlines the argument that skill proficiency (as assessed by the PIAAC) and self-reported skill use should interact and mutually reinforce one another. Further, engaging in skill use develops proficiency. To give a concrete example, using numeracy skills in your everyday life, like budgeting, more frequently should reinforce your skill proficiency in numeracy as assessed on a formal measure. Moreover, based on our analysis for Research Question 1, the higher a numeracy score proficiency the more likely you are to be employed. As mentioned above, the PIAAC assessment is the first time this framework has been able to be used to investigate not only the relationship of skill proficiency and skill use, but how that relationship may impact a social outcome (like employment).

Similar to the work of Desjardins & Rubenson (2011), we found that some increased everyday life numeracy information-processing practices and numeracy information-processing proficiencies lead to improved economic outcomes. However, not all relationships across everyday life numeracy skills or numeracy proficiencies as measured by PIAAC were related to employment status.

In analyzing the results of Research Question 2, the negative relationship between calculator skills and long-term unemployment is an indicator that many adults seek ways to solve problems within their world. The ability to go beyond basic functions on a calculator and knowledge to apply the skills across a variety of contexts has utility in the lives of individuals. For example, the use of a calculator and knowledge of financially-related literacies can significantly impact and individual's financial stability and long-term economic outcomes. Similarly to our findings on use of a calculator, Ginsberg, Manly, & Schmidt, (2006) found that "people focus on the meaning more often, and the resources that people turn to [to solve problems] are more varied" (p. 9). Therefore, one possible explanation for our finding on calculator use is that closer that an everyday life skill is to an authentic workplace skill the more likely the skill will impact employment.

Interestingly, positive relationships across increased use of costs or budgets and increased use of charts, graphs, and tables were identified with the Left Paid Work Longer than 12 Months ago, or the long-term unemployment category. These unique findings were further explored by running a cross tabulation with the EDWORK variable. This cross tabulation shows that over 12.0% of the long-term unemployed are in education and 18.0% were not in education or work but has participated in education or training in last 12 months. This ongoing or recent education or training for those long-term unemployed, who are also targets for "employment barrier" workforce development programming, may be impacting this model.

Although several everyday life numeracy skills were not found to be statistically significant in our model, this lack of statistical significance does not necessarily mean that no relationship exists. For example, in the sample, a high percentage of skills *never* used were advanced math or stats (81.6%), charts, graphs, tables (53.9%), simple algebra or formulas (52.4%) and costs or budgets (42.1%). All of these every day life skills are related and complex numeracy skills and are indicative of performance on the information-processing numeracy assessment of the PIAAC. Research has reiterated consistently that these kinds of complex numeracy skills are imperative for employment in the 21st century workforce and, unfortunately, many people in the U.S. are not able to perform these skills or practice them regularly.

Limitations

One limitation of this study's findings is the categorization of data from the survey. For example, the disability category seeks sensitive/personal information and is therefore likely to be underreported. The disability category is operationalized as learning, vision, and hearing. Clearly, more nuanced definitions of disability are warranted, and results are constrained by this limited definition. Future iterations of the questionnaire should consider improved and nuanced disability definitions that reflect the U.S. context and existing language used by rehabilitation and/or disability services agencies. In another example of limited categorization, all English language learners are categorized under a single variable, yet research recognizes this is not a homogenous population. Depending on the language of the participant, participants may not have equitable access to language support in responding to survey questions or, more broadly, in the educational and workforce context. Such limitations should be considered when applying any of the findings to practice or policy.

Another example of a limitation of the findings as a result of the survey's construction is around immigration status. Although the PIAAC Background Questionnaire includes questions about nativity, data around immigration status is not included. Therefore, we cannot perform analysis on how certain statuses, like being undocumented, a refugee, or on Temporary Protective Status (TPS), for example, impacts or effects findings. This is a significant concern when exploring employment in the U.S. context because immigration status distinctively impacts employment outcomes (Baran, Valcea, Porter, and Gallagher, 2018).

Caution should be applied when interpreting the results on numeracy skill practices in/for every day life. One limitation of this study is that many of the skills for "every day life" are not authentic social practices of skills. Instead, the questions/skills for "every day life" section were explicitly repeated from those identified as "workplace skills." This list of workplace skills was garnered from an analysis of job skills in an information-processing area with measurable importance to a respondent's job. In the PIAAC's Background Questionnaire, only the prompt indicating the location of skill use changed. While the PIAAC holds promise for examining social practices or everyday life skills on a large scale, the actual items may not be the most accurate for this purpose.

Suggestions for Future Research

This study expanded the investigation of employment beyond the dichotomous categories of employed and unemployed, and future studies should examine the differences in the kinds/types

of employment including the concept of underemployment as it relates to information-processing skills. The topic of "underemployment" is particularly important for marginalized populations including but not limited to immigrants and migrant workers who often are willing to take lower paying jobs or jobs outside of the traditional labor market. According to the U.S. Department of Labor (2017), "the median usual weekly earnings of foreign-born full-time wage and salary workers were $715 in 2016, compared with $860 for their native-born counterparts." Researchers have used census data to examine underemployment, particularly for immigrant populations across OECD Countries (Docquier, Ozden, & Peri, 2014). Future research should include the use of the PIAAC dataset as an avenue for further exploration of "brain waste" (Mattoo, Neagu, & Ozden, 2008), or underemployment of immigrant populations based on their credentials, level of experience, in the U.S. context.

Likewise, future studies of the U. S. PIAAC in the area of information-processing skills and employment status should utilize the NCES created *student and employment status* variable (Provasnik & Xie, 2018). The NCES "variable [will] allow policymakers and others interested in issues related to young adults transitioning into the labor force to analyze PIAAC data simply and efficiently" (Provasnik & Xie, 2018, p.7). Such analyses are important beyond the study of young adults, because the impact of education (or student status) is relevant to all studies of (un)employment and skills.

Future research explorations should investigate numeracy skill use in every day life variables and workplace variables using a more refined examination of the individual skills themselves. This entails an examination of all of the numeracy-related variables included on the survey instrument. Given that "different jobs and industries require particular bodies of mathematical content knowledge and may have particular ways of applying that knowledge" (Ginsburg, 2017, p.59) an understanding of how self-reported workplace skill use and everyday life skill use variables overlap or do not overlap with the needs of U.S. employers is pressing.

Adult education and workforce development programs should also consider prolonged connections with regional workforce agencies to better understand the required numeracies of specific local industries (Ginsburg 2017) in order to meet WIOA requirements. Transferable knowledge and skills are critical concepts for future investigations in a rapidly changing world where individuals may have multiple jobs within their lives. Future studies should examine numeracy skill use as assessed by the PIAAC in relationship to transferable knowledge. Future assessment instruments could consider skill use in ways that address employer targeted numeracy skills and transferable numeracy skills as critical for studies of unemployment.

Conclusions

According to the U.S. Department of Labor, the "total nonfarm payroll employment rose by 148,000 in December" (USDL, 2018, p. 2). The health care, construction, and manufacturing industries experienced the largest growth in jobs. As the U.S. economy rebounds and job opportunities expand, it is essential to prepare workers, especially those who have been long-term unemployed, to take advantage of growth in these industries and related sectors. Our results indicate how numeracy skills are necessary and protective of employment, particularly long-term unemployment. Further, these results demonstrate the need for continued training and development

of adults' numeracy skills to prepare them for employment in industries where discrete numeracy skills have relevant applications. Adult education programs and workforce development programs, including One Stops, should consider the content and the rigor of the program in relationship to the likelihood that content supports transferable skills to the workplace if employment outcomes are to be achieved or sustained.

Finally, our results point to the centrality of advanced numeracy skills as protective of continued employment particularly for marginalized groups like women, older adults, and some people of color. While many adult education programs and policies (including WIOA) focus on low literacy skill as a barrier to employment, this study recognizes the role of increasing numeracy skill as critical in reducing the probability of unemployment, particularly the vexing issue of long-term unemployment.

References

Aaronson, D., Mazumder, B, & Schechter, S. (2010). What is behind the rise in long-term unemployment?. *Economic Perspectives, 34*(2), p. 28-51.

Agresti, A. (2002). Categorical Data Analysis (2 ed.). Hoboken, New Jersey: John Wiley & Sons.

Arora, A. and Pawlowksi, E. (201 7). Examining Gender Differences in the Mathematical Literacy of 15-Year-Olds and the Numeracy Skills of the Age Cohorts as Adults. Retrieved from https://static1.squarespace.com/static/51bb74b8e4b0139570ddf020/t/588a18c13a04118a0c68116e/1485445313820/Arora_Pawlowski_PIAAC_2017.pdf

Ashton, D., Davies, B., Felstead, A., and Green, F. (1999). 'Work Skills in Britain', SKOPE, Oxford and Warwick Universities.

Baran B. E., Valcea, S., Porter, T. H. and Gallagher, V. C. (2018). Survival, expectations, and employment: An inquiry of refugees and immigrants to the United States. *Journal of Vocational Behavior, 105*, 102-115.

Barton, D., Hamilton, M., & Ivanic, R. (2000). Situated literacies: Reading and writing in context. New York, NY: Routledge.

Bruin, J. 2006. newtest: command to compute new test. UCLA: Statistical Consulting Group. https://stats.idre.ucla.edu/stata/ado/analysis/

Bynner, J. (2004). Literacy, numeracy and employability: Evidence from the British birth cohort studies. *Literacy & Numeracy Studies*, *13*(1), 31–48.

Bynner, J. (2008). Illuminating disadvantage. *Literacy Today, June 2008*(55): 26-28.

Bynner, J., & Parsons, S. (2001). Qualifications, basic skills and accelerating social exclusion. *Journal of Education and Work*, *14*(3): 279–91.

Callahan, R. M. & Gándara, P. C. (2014). *The bilingual advantage: Language, literacy and the US labor market.* Retrieved from ERIC database. (ED 581559)

Charette, M. F., & R. Meng (1998). The determinants of literacy and numeracy, and the effect of literacy and numeracy on labour market outcomes, *Canadian Journal of Economics, 31*(3), 495-517.

Cunningham, A. E., & Stanovich, K. E. (1997). Early reading acquisition and its relation to reading experience and ability 10 years later. *Developmental Psychology, 33*(6), 934-945.

Custer, R. L., Schell, J. W., McAlister, B., Scott, J., & Hoepfl, M. (2000). *Using authentic assessment in vocational education*. Retrieved from ERIC database. (ED440293)

Desjardins, R., & Rubenson, K. (2013). Participation patterns in adult education: The role of Institutions and public policy frameworks in resolving coordination problems. *European Journal of Education*, *48*(2), 262-280.

Docquier, F. Ozden, C., & Peri, G (2014). The labour market effects of immigration and emigration in OECD Countries, *The Economic Journal*, 124(579), 1106-1145.

Edin, P., & Gustavsson, M. (2008). Time out of work and skill depreciation. *ILR Review, 61*(2), 163-180.

Fernandez, F. and Umbricht, Mark R. (2016). Education and Work in the 21st Century: Credential Inflation or Transformation? Retrieved 10/24/16, from https://static1.squarespace.com/static/51bb74b8e4b0139570ddf020/t/5792334be58c62972613ae78/1469199180259/Fernandez_Umbricht_PIAAC.pdf. Washington DC.

Geary, D. C., Hoard, M. K., Nugent, L., & Bailey, D. H. (2013) Adolescents' Functional Numeracy Is Predicted by Their School Entry Number System Knowledge. *PLoS ONE, 8*(1): e54651. doi:10.1371/journal.pone.0054651

Ginsburg, L. (2017). What's an adult numeracy teacher to teach?: Negotiating the complexity of adult numeracy instruction. *Journal of Research and Practice for Adult Literacy, Secondary, and Basic Education, 6*(1), 57-61.

Ginsburg, L., Manly, M., & Schmitt, M. J. (December 2006), The components of numeracy. (NCSALL Occasional Paper). Harvard Graduate School of Education, Cambridge, MA: National Center for the Study of Adult Learning and Literacy. Online: www.ncsall.net/

Goodman, M., Finnegan, R., Mohadjer, L., Krenzke, T., and Hogan, J. (2013). *Literacy, Numeracy, and Problem Solving in Technology-Rich Environments Among U.S. Adults: Results from the Program for the International Assessment of Adult Competencies 2012: First Look* (NCES 2014-008). U.S. Department of Education. Washington, DC: National Center for Education Statistics. https://nces.ed.gov/pubs2014/2014008.pdf

Green, F. (1998). The value of skills, *Studies in Economics, No 98/19,* University of Kent at Canterbury.

Grotlüschen, A. et al. (2016), "Adults with Low Proficiency in Literacy or Numeracy", OECD Education Working Papers, No. 131, OECD Publishing, Paris. http://dx.doi.org/10.1787/5jm0v44bnmnx-en

Hamilton, J. (2017), Dates of U.S. recessions as inferred by GDP-based recession indicator [JHDUSRGDPBR], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/JHDUSRGDPBR

Hanushek, E. A., & Woessmann, L. (2008). The role of cognitive skills in economic development. *Journal of Economic Literature, 46*(3), 607-668.

Hanushek, E. A., Schwerdt, G., Wiederhold, S. & Woessmann, L (2015). Returns to skills around the world: Evidence from PIAAC**.** *European Economic Review. 73,* 103-130.

Hanushek, E. A., Schwerdt, G., Woessmann, L. & Zhang, L. (2017). General education, vocational education, and labor-market outcomes over the lifecycle. *Journal of Human Resources, 52*(1), 48-87.

Holzer H. J., & Lerman R. I. (2015). Cognitive skills in the U.S. labor market: For whom do they matter? Retrieved 10/24/16, from https://static1.squarespace.com/static/51bb74b8e4b0139570ddf020/t/54da7582e4b0cb4c49fc0d9d/1423603074704/Holzer_Lerman_PIAAC.pdf

Hosmer, D. W., Jr. & Lemeshow, S. (2000). Applied Logistic Regression. 2nd Ed. New York: John Wiley & Sons.

Hoyles, C., Wolf, A., Molyneux-Hodgson, S., & Kent, P. (2002), Mathematical skills in the workplace. London: Science, Technology and Mathematics Council. Online: http://eprints.ioe.ac.uk/1565/1/Hoyles2002MathematicalSkills.pdf

Krueger, A. B., Cramer, J., & Cho, D. (2014). Are the long-term unemployed on the margins of the labor market? *Brookings Papers on Economic Activity, Spring 2014*, 229-299.

Lightbrown, P. M., & Spada, N. (2013). *How languages are learned.* Oxford, UK: Oxford University Press.

Linn, M. W., Sandifer, R., & Stein, S. (1985). Effects of unemployment on mental and physical health. *American Journal of Public Health*, *75*(5), 502–506.

Long, J. S., & Freese, J. (2014). Regression Models for Categorical Dependent Variables Using Stata. 3rd ed. College Station, TX: Stata Press.

Lundetræ, K., Gabrielsen, E., & Mykletun, R. (2010). Do basic skills predict youth unemployment (16- to 24-year-olds) also when controlled for accomplished upper-secondary school? A cross-country comparison, *Journal of Education and Work, 23*(3), 233-254.

Mattoo, A., Neagu, I.C. & Ozden, C. (2008). Brain waste?: Educated immigrants in the US labour market, *Journal of Development Economics, 87*(2), 255-269.

Nichols, A., Mitchell, J., & Lindner, S. (2013). *Consequences of long-term unemployment.* Retrieved from the Urban Institute website: http://www.urban.org/sites/default/files/publication/23921/412887-Consequences-of-Long-Term-Unemployment.pdf

National Research Council. (2012). *Improving Adult Literacy Instruction: Options for Practice and Research.* Committee on Learning Sciences: Foundations and Applications to Adolescent and Adult Literacy, A.M. Lesgold and M. Welch-Ross, (Eds. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Nieto, S. (2018). *Language, culture, and teaching: Critical perspectives* (Third Edition). New York, NY: Routledge.

Oreopoulos, P., Page, M., & Stevens, A. H., (2008). The intergenerational effects of worker displacement, *Journal of Labor Economics, 26*(3), 455–483.

Organization for Economic Cooperation and Development. (2012). *Literacy, Numeracy, and Problem Solving in Technology-Rich Environments: Framework for the OECD Survey of Adult Skills*, OECD Publishing. http://www.oecd-ilibrary.org/education/literacy-numeracy-and-problem-solving-in-technology-rich-environments_9789264128859-en

Organization for Economic Cooperation and Development. (2013). OECD Skills Outlook 2013: First Results from the Survey of Adult Skills, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264204256-en

Organization for Economic Cooperation and Development. (2016), Skills Matter: Further Results from the Survey of Adult Skills, OECD Skills Studies, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264258051-en

Parsons, S., & Bynner, J. (1997). Numeracy and employment. *Education + Training*, *39*(2), 43-51.

Parsons, S., & Bynner, J. (1998). *Use it or lose it: The impact of time out of work on literacy and numeracy skills.* Retrieved from ERIC database. (ED430160)

Parsons, S., & Bynner, J. (2005). Does numeracy matter more?, National Research and Development Centre for Adult Literacy and Numeracy (NRDC), London. http://eprints.ioe.ac.uk/4758/1/parsons2006does.pdf

Paulos, J. (1988). *Innumeracy: Mathematical illiteracy and its consequences.* New York: Hill and Wang.

Pellegrino, J. W., & Hilton, M. L., EDS. (2012). Education for life and work: Developing transferable knowledge and skills in the 21st century. Washington: The National Academy Press.

Prins E., Monnat S., Clymer C., & Toso B. (2015). Examining Associations between Adult Health and Literacy, Numeracy, Technological Problem-Solving Skills, and Post-Initial Learning in the U.S. Retrieved April 21, 2015, from http://piaacgateway.com/researchpapers/#2015papers

Provasnik, S. & Xie, H. (2018). *Analyzing U.S. Young Adults' Skills by Student and Employment Status: Methodology for a New PIAAC Variable with Initial Results* (NCES 2018-122). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2018122

Purcell-Gates, V., Degener, S., Jacobson, E. & Soler, M. (2001). Taking literacy skills home. *Focus on the Basics: Connecting Research and Practice, 4*(D), from http://www.ncsall.net/index.html@id=771&pid=286.html

Pokropek, A., & Jakubowski, M. (2013). PIAACTOOLS: Stata® programs for statistical computing using PIAAC data. Retrieved from http://www.oecd.org/site/piaac/PIACTOOLS_16OCT_for_web.pdf

Rampey, B. D., Finnegan, R., Goodman, M., Mohadjer, L., Krenzke, T., Hogan, J., and Provasnik, S. (2016). *Skills of U.S. Unemployed, Young, and Older Adults in Sharper Focus: Results From the Program for the International Assessment of Adult Competencies (PIAAC) 2012/2014: First Look* (NCES 2016-039rev). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved from: http://nces.ed.gov/pubsearch

Reder, S. (2009). Scaling up and moving in: Connecting social practices views to policies and programs in adult education. *Literacy & Numeracy Studies, 16*(2), 35-50.

Reder, S. (2014). *The impact of ABS program participation on long-term literacy growth*. Washington, DC: U.S. Department of Education, Office of Career, Technical and Adult Education.

Reder, S., & Bynner, J. (2009). *Tracking adult literacy and numeracy skills: Findings from longitudinal research.* New York, NY: Routledge.

Rivera-Batiz, F. L. (1992), Quantitative literacy and the likelihood of employment among young adults in the United States, *The Journal of Human Resources 27*(2), 313-332.

Silvey, S.D. (1969). Multicollinearity and Imprecise Estimation, *Journal of the Royal Statistical Society,* Series B (3) 539-552.

Street, B. (1993). *Cross-cultural approaches to literacy.* New York, NY: Cambridge University Press.

Sullivan, D. G., & von Wachter, T. (2009) Job displacement and mortality: An analysis using administrative data, *Quarterly Journal of Economics, 124*(3), 1265–1306.

U.S. Census Bureau. (2015). 2015 American Community Survey 1-Year Estimates [Data Table]. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

U.S. Department of Education, National Center for Education Statistics. (2012) *Literacy, numeracy, and problem-solving technological domain*. Washington, D. C.: Author. http://nces.ed.gov/surveys/piaac

U.S. Department of Education, Office of Career, Technical, and Adult Education. (2015, February). *Making Skills Everyone's Business: A Call to Transform Adult Learning in the United States*. Washington, D.C.: Author. Retrieved from http://www2.ed.gov/about/offices/list/ovae/pi/AdultEd/making-skills.pdf

U.S. Department of Labor, Employment Projections Program, U.S. Bureau of Labor Statistics. (2017, October). Civilian labor force participation rate, by age, sex, race, and ethnicity. Washington, D. C.: Author. Retrieved from https://www.bls.gov/emp/tables/civilian-labor-force-participation-rate.htm

U.S. Department of Labor, Bureau of Labor Statistics (2017). Foreign-born Workers: Labor Force Characteristics Summary, *TED: The Economics Daily.* Washington, D. C.: Author. Retrieved from https://www.bls.gov/news.release/forbrn.nr0.htm

U.S. Department of Labor, Bureau of Labor Statistics (2015). Unemployment rates by educational attainment in August 2015, *TED: The Economics Daily.* Washington, D. C.: Author. Retrieved from https://www.bls.gov/opub/ted/2015/unemployment-rates-by-educational-attainment-in-august-2015.htm

Van Horn, C. E., Zukin, C. & Kopicki, A. (2014) *Left Behind: The long-term unemployed struggle in an improving economy*. New Brunswick, NJ: John J. Heldrich Center for Workforce Development, Rutgers University.

Webb, N. (1997). Criteria for alignment of expectations and assessments on mathematics and science education (Research Monograph No. 6). Washington, DC: CCSSO.

Winship, C. & Mare, R.D. (1984) Regression models with ordinal variables. American Sociological Review, 1984, Vol. 49 (August 512-525).

Appendices

Appendix A. Variables and Codes

Variable description	Variable ID in the Dataset
IVS/DVS	
Employment Status/Work History (DV)	C_D09
LIT (IV)	PVLT
NUM (IV)	PVNUM
PSTRE (IV)	PSPSL
Demographic Variables	
Education Attainment	EDCAT6
Age	AGEG5LFS
Nativity	J_Q04A
ELL	LANGUAGE
Gender	GENDER_R
RACE	RACETHN_4CAT
Health	I_Q08
Learning Disability	I_Q08USX3
Hearing	I_Q08USX2
Vision	I_Q08USX1
Number of Books in the Home (SES Proxy)	J_Q08
Numeracy Everyday Life Variables	
Costs or budgets	H_Q03B
Fractions or Percentages	H_Q03C
Use of Calculator	H_Q03D
Charts, graphs, tables	H_Q03G
Simple algebra or formula	H_Q03F
Advanced math or stats	H_Q03H

Appendix B. Supplemental Tables

Table B. 1

Distribution of Age Bands by Categories Of (Un)Employment

Age in 5 Year Bands (derived)	Currently Working	No Experience with Paid Work	Left Paid Work Less Than 12 Months Ago	Left Paid Work Longer Than 12 Months Ago
Aged 16-19	336	325	213	72
Aged 20-24	613	69	254	121
Aged 25-29	723	26	151	122
Aged 30-34	727	20	129	152
Aged 35-39	415	15	92	96
Aged 40-44	410	14	67	117
Aged 45-49	428	9	67	114
Aged 50-54	449	12	62	132
Aged 55-59	359	7	46	162
Aged 60-65	323	7	73	223
Total	4,783	504	1,154	1,311

Note: Two of the categories (Not Stated or Inferred and Status Unknown) of the Current Employment/Work History (C_D09) Variable were not included in this

Table B. 2

Odds Ratio and 95% Confidence Interval for Controls in Regression Model Assessing Numeracy Everyday Life Variables and Numeracy on Work Status in Comparison to Full-time Employed

Control Variable	No Experience with Paid Work			Left Paid Work Less Than 12 Months Ago			Left Paid Work Longer Than 12 Months Ago		
	OR	SE	95% CI	OR	SE	95% CI	OR	SE	95% CI
Education Attainment									
Lower secondary or less (ref.)									
Upper secondary	0.33***	.311	.18-0.60	0.88	.181	0.62-1.26	0.68*	.158	0.50-0.93
Post-secondary, non-tertiary	0.16***	.514	0.06-0.44	0.64	.241	0.40-1.03	0.50**	.219	0.32-0.76
Tertiary - professional degree	0.42	.544	0.15-1.23	0.68	.248	0.56-1.10	0.53**	.193	0.37-0.78
Tertiary - bachelor degree	0.26**!	.487	0.10-0.67	0.48**	.249	0.30-0.78	0.45**	.244	0.28-0.73
Tertiary - master/research degree	0.06***	.677	0.02-0.22	0.44**	.296	0.24-0.78	0.27***	.281	0.15-0.46
Gender Female Male (ref.)	2.10***	.171	1.50-2.93	1.27*	.094	1.06-1.53	1.98***	.098	1.63-2.40
English language status									
Learned English as the first language (ref)	-	-	-	-	-	-	-	-	-
Learned English when age 15 or younger	1.67	.396	0.77-3.63	1.08	.258	0.65-1.80	1.93**	.230	1.23-3.02
Learned English when age 16 or older	0.96	.550	0.33-2.83	0.71	.388	0.33-1.52	1.81	.417	0.80-4.10
Race									
White (ref.)	-	-	-	-	-	-	-	-	-
Hispanic	1.63	.349	0.82-3.23	0.97	.158	0.71-1.32	0.54**	.214	0.36-0.82
Black	2.06**	.245	1.28-3.33	1.40*	.169	1.01-1.96	0.87	.147	0.65-1.16
Other race	1.47	.488	0.56-3.83	1.33	.241	0.83-2.13	0.91	.231	0.58-1.44
Nativity									
Native born (ref.) Foreign born	2.11*	.377	1.01-4.42	1.01	.261	0.60-1.68	0.55*	.257	0.33-0.91

Age									
	16-19 (ref.)	-	-	-	-	-	-	-	-	-
	20-24	0.19***	.260	0.12-0.32	0.68	.218	0.44-1.04	1.22	.335	0.63-2.36
	25-29	0.06***	.394	0.05-0.14	0.35***	.247	0.21-0.57	0.83	.329	0.44-1.58
	30-34	0.06***	.267	0.04-0.10	0.25***	.257	0.15-0.41	1.40	.310	0.77-2.58
	35-39	0.07***	.386	0.03-0.15	0.29***	.204	0.19-0.43	1.19	.326	0.63-2.25
	40-44	0.04***	.544	0.01-0.10	0.20***	.231	0.13-0.32	1.72	.300	0.96-3.10
	45-49	0.04***	.537	0.01-0.12	0.26***	.258	0.15-0.42	1.26	.303	0.69-2.28
	50-54	0.07***	.583	0.02-0.21	0.22***	.291	0.12-0.38	1.35	.328	0.71-2.56
	55-59	0.05***	.417	0.02-0.12	0.20***	.305	0.11-0.36	3.01**	.328	1.58-5.72
	60-64	0.08***	.522	0.03-0.24	0.61*	.234	0.39-0.96	5.79***	.268	3.42-9.79
Parental Education Level									
	Neither parent has attained upper secondary education (ref.)	-	-	-	-	-	-	-	-	-
	At least one parent has attained upper secondary education	1.31	.340	0.68-2.56	0.99	.162	0.72-1.36	0.82	.154	0.61-1.11
	At least one parent has attained tertiary education	0.88	.339	0.45-1.70	1.04	.170	0.74-1.45	0.77	.172	0.55-1.08
Health									
	Excellent (ref.)	-	-	-	-	-	-	-	-	-
	Very good	1.02	.264	0.59-1.65	1.07	.151	0.79-1.43	0.73*	.155	0.54-0.99
	Good	1.11	.193	0.76-1.62	0.98	.179	0.69-1.39	1.21	.138	0.93-1.59
	Fair	1.11	.293	0.63-1.98	1.58*	.219	1.03-2.42	2.46***	.164	1.78-3.40
	Poor	3.52	.720	0.86-14.42	1.77	.371	0.86-3.66	13.36***	.270	7.63-22.67
Diagnosed or Identified with Learning Disability Yes (ref.) No		0.37***	.246	0.23-0.59	0.77	.147	0.58-1.02	1.17	.163	0.62-1.17
Difficulty with Hearing Yes (ref.) No		1.15	.437	0.49-2.70	1.39	.204	0.93-2.08	0.84	.148	0.63-1.12

Difficulty with Vision Yes (ref.) No	1.29	.312	0.70-2.38	0.96	.212	0.63-1.46	0.72	.170	0.52-1.00
Number of books at home									
10 books or less (ref.)	-	-	-	-	-	-	-	-	-
11 to 25 books	1.69*	.234	1.07-2.67	0.85	.169	0.61-1.19	1.07	.142	0.81-1.41
26 to 100 books	1.55	.304	0.85-2.81	1.08	.148	0.81-1.44	1.21	.143	0.92-1.60
101 to 200 books	0.94	.322	0.50-1.76	1.52*	.165	1.10-2.10	1.48**	.146	1.11-1.97
201 to 500 books	1.79	.410	0.80-3.99	1.10	.207	0.73-1.65	1.67*	.207	1.11-2.50
More than 500 books	1.66	.542	0.57-4.81	1.19	.291	0.67-2.10	1.73	.297	0.97-3.09

Note: $p^{***} < .001$, $p^{**} < .01$, $p^{*} < .05$; ! = Interpret data with caution. The coefficient of variation (CV) for this estimate is between 30 and 50 percent.

Appendix C. Exemplar Statewide Performance Report

OMB Control Number 1205-0526 Expiration Date: 06-30-2019

ETA-9169

Statewide Performance Report - WIOA Title II Adult Education Program PY 2016

PROGRAM	TITLE (select one):			
STATE: MARYLAND **REPORTING PERIOD COVERED (Required for current and three preceding years.)** Title I Local Area: From (07/01/2016): To (06/30/2017):	Title I Adult Title I Dislocated Worker Title I Youth Title I and Title III combined	☐ ☐ ☐ ☐	Title II Adult Education Title III Wagner-Peyser Title IV Vocational Rehabilitation	☒ ☐ ☐

SUMMARY INFORMATION

Service	Participants Served (Cohort Period: 07/01/2016 - 06/30/2017)	Participants Exited (Cohort Period: 07/01/2016 - 03/31/2017)	Funds Expended (Cohort Period: 07/01/2016 - 06/30/2017)	Cost Per Participant Served (Cohort Period: 07/01/2016 - 06/30/2017)
Career Services				
Training Services				

Percent training-related employment1:	Percent enrolled in more than one core program:	Percent Admin Expended1:

BY PARTICIPANT CHARACTERISTICS

	Total Participants Served (Cohort Period: 07/01/2016 - 06/30/2017)	Total Participants Exited (Cohort Period: 07/01/2016 - 03/31/2017)		Employment Rate (Q2)2 (Cohort Period: N/A)		Employment Rate (Q4)2 (Cohort Period: N/A)		Median Earnings (Cohort Period: N/A)	Credential Rate3 (Cohort Period: N/A)		Measurable Skill Gains3 (Cohort Period: 07/01/2016 - 06/30/2017)	
				Num	Rate	Num	Rate	Earnings	Num	Rate	Num	Rate
Total Statewide	28,797	24,400	Target								9,616	36.00%
			Actual								10,887	37.81%
Female	15,053	12,993									5,679	37.73%
Male	13,744	11,407									5,208	37.89%
< 16	N/A	N/A									N/A	N/A
16 – 18	2,061	1,818									712	34.55%
19 – 24	5,744	4,925									2,282	39.73%
25 – 44	15,556	13,243									5,958	38.30%
45 – 54	3,396	2,794									1,236	36.40%
55 – 59	995	793									326	32.76%
60+	1,045	827									373	35.69%
American Indian or Alaskan Native	149	125									38	25.50%
Asian	2,321	1,973									939	40.46%
Black or African American	9,863	8,050									3,688	37.39%
Hispanic or Latino	12,286	10,742									4,635	37.73%
Native Hawaiian or Other Pacific Islander	58	47									16	27.59%
White	3,848	3,231									1,498	38.93%
Two or More Races	272	232									73	26.84%

PY 2016 Statewide Performance Report - WIOA Title II Adult Education Program - MARYLAND 1 of 2

Ethnicity/Race Age Sex

BY EMPLOYMENT BARRIER4 PY 2016 Statewide Performance Report continued for MARYLAND													
	Total Participants Served (Cohort Period: 07/01/2016 - 06/30/2017)	Total Participants Exited (Cohort Period: 07/01/2016 - 03/31/2017)		Employment Rate (Q2)2 (Cohort Period: N/A)		Employment Rate (Q4)2 (Cohort Period: N/A)		Median Earnings (Cohort Period: N/A)	Credential Rate3 (Cohort Period: N/A)		Measurable Skill Gains3 (Cohort Period: 07/01/2016 - 06/30/2017)	
				Num	Rate	Num	Rate	Earnings	Num	Rate	Num	Rate
Total Statewide	28,797	24,400	Target								9,616	36.00%
			Actual								10,887	37.81%
Displaced Homemakers	68	53									20	29.41%
English Language Learners, Low Levels of Literacy, Cultural Barriers	6,162	5,049									2,694	43.72%
Exhausting TANF within 2 years (Part A Title IV of the Social Security Act)	~	~									~	~
Ex-offenders	147	121									34	23.13%
Homeless Individuals / runaway youth	189	158									48	25.40%
Long-term Unemployed (27 or more consecutive weeks)	138	103									45	32.61%
Low-Income Individuals	339	266									105	30.97%
Migrant and Seasonal Farmworkers	33	27									8	24.24%
Individuals with Disabilities (incl. youth)	376	290									84	22.34%
Single Parents (Incl. single pregnant women)	1,440	1,276									397	27.57%
Youth in foster care or aged out of system	~	~									~	~

1Applies to Title I only.
2This indicator also includes those who entered into a training or education program for the Youth program. 3Credential Rate and Measurable Skill Gains do not apply to the Wagner-Peyser program.
4Barriers to Employment are determined at the point of entry into the program.
~ Data were suppressed to protect the confidentiality of individual participant data.

PY 2016 Statewide Performance Report - WIOA Title II Adult Education Program - MARYLAND 2 of 2