U.S. PIAAC

Commissioned Paper
December 2022

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Suggested Citation: Fernandez, F. (2022). *Using PIAAC to Examine Characteristics and Numeracy Skills of Adults Who Do Not Complete Degree or Certificate Programs.* 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 the combined 2012/2014/2017 Restricted Use PIAAC data released in December 2019. 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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Using PIAAC to Examine Characteristics and Numeracy Skills of Adults Who Do Not Complete Degree or Certificate Programs

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Abstract

This paper examines the prevalence of incomplete educational qualifications and consider the importance of both background characteristics and numeracy skills as predictors of non-completion. The paper analyzes data from the Program for the International Assessment of Adult Competencies (PIAAC) to address the following research questions: *How does not completing educational qualifications vary by numeracy proficiency levels? Which background characteristics are related to not completing educational qualifications? Do relationships between background characteristics and non-completion vary by numeracy proficiency levels?* Findings show that adults with high numeracy proficiency are more likely to drop out of degree or certificate programs without completing new qualifications, while less-educated adults are not only underrepresented in degree or certificate programs, but they also have much higher odds of not completing those qualifications.

Using PIAAC to Examine Characteristics and Numeracy Skills of Adults Who Do Not Complete Degree or Certificate Programs

Economic growth is hampered by inequities in educational outcomes. According to Carnevale et al. (2021), the U.S. economy loses out on an estimated $956 billion per year because too few people complete higher education. Even when four-year degrees are unnecessary or unattainable, supporting two-year degree and certificate completion would lead to widespread individual and societal economic benefits (Carnevale et al., 2020). Many Americans want to complete higher education or lifelong learning opportunities to improve skills, and ultimately get better jobs or higher pay. However, too few carry out their learning intentions (American Institutes for Research, n.d.). Ironically, Americans with higher levels of education and greater income are more likely to participate in lifelong learning. Less-educated and lower income adults who would likely benefit most from further learning are the least likely to engage in lifelong learning (Horrigan, 2016).

Prior research demonstrates that adults with higher skills earn higher wages and have better opportunities for employment (Hampf et al., 2017). Additional research suggests education improves skills (Smith & Fernandez, 2015). Although there are many low-skilled adults who could benefit from new credentials, the demands on adult life often prevent them from beginning or completing new degree or certificate programs (American Institutes for Research, n.d.).

The purpose of this paper is to consider how to support adults who began but did not complete educational qualifications. Specifically, this paper moves beyond descriptive data to consider the importance of both background characteristics and numeracy skills as predictors of non-completion. This paper analyzes data from the Program for the International Assessment of Adult Competencies (PIAAC) for working adults ages 20-65 to address the following research

questions: *How does not completing educational qualifications vary by numeracy proficiency levels? Which background characteristics are related to not completing educational qualifications? Do relationships between background characteristics and non-completion vary by numeracy proficiency levels?* Findings help identify groups (both in terms of background demographics and assessed skill levels) that could benefit from additional assistance in completing educational qualifications. Findings from this study could be used to target lifelong learning opportunities to adults who would like, but are unable, to complete degree or certificate programs to improve their skills and job opportunities.

Literature Review

The U.S. has a relatively inclusive system for higher education and lifelong learning, including over one thousand community colleges, many broadly accessible universities, and multiple types of training or professional development programs (Kirst & Stevens, 2015). However, even countries with inclusive educational systems see broad disparities in who participates in lifelong learning. Across the Organization for Economic Cooperation and Development (OECD), adults with lower skill levels participate less frequently in pursuing educational credentials than those with higher skill levels (OECD, 2019). Internationally, less than 7% of adults with basic numeracy proficiency participate in education programs, while almost 16% of highly proficient adults participate in the same (Grotlüschen et al., 2016). Similarly, adults who already have higher educational attainment tend to seek out additional education more so than those with less schooling (Cincinnato et al., 2016) Although there are many low-skilled adults who could benefit from new education, the demands on adult life often prevent them from beginning or completing educational qualifications (American Institutes for Research, n.d.).

Much of the research on relationships among prior education, skills, and participation in education programs focuses on international or comparative contexts. However, the studies are still useful for considering the ways that differently skilled U.S. adults participate in degree or certificate programs. Toward the end of the literature review, this paper notes ways that prior research has limited generalizability to the U.S. and suggest opportunities for the current study to offer new contributions for education research and policy.

Relationships Among Skills, Prior Schooling, and Voluntary Participation in Education

Adults with higher skills tend to have better odds of being employed (Yamashita et al., 2018b) and to earn more when they were employed (e.g., Liu et al., 2019). Skill levels were also important predictors of voluntary participation in education programs. Across OECD countries adults with low literacy proficiency participated less frequently than highly skilled adults in either formal or nonformal education. When researchers controlled for background characteristics and employment factors, the participation gap between low- and high-skilled adults narrowed—and completely closed in Norway. However, sizable participation gaps remained between the least and most skilled adults in most countries even after controlling for adults' gender, age, parental education, prior schooling, socio-economic status, first language, employment status, and occupation (Grotlüschen et al., 2016).

In the U.S., specifically, 28% of adults with low numeracy proficiency wanted to complete some sort of voluntary education but did not (Grotlüschen et al., 2016). Conversely, adults with the highest levels of literacy skills were extremely likely to participate in educational programs. The predicted probability that adults with the highest literacy proficiency participated in education was 0.79, but the same statistic for the least proficient adults was 0.24. While some countries (i.e., the Netherlands, New Zealand, Norway, Sweden, Chile, Denmark) have had more

success at encouraging low-skilled adults to participate in education programs, the U.S. was not one of them (DesJardins, 2020).

Prior schooling has also positively predicted participation in education. When Cincinnato and colleagues (2016) compared adults' social background (parental education), personal capital (educational attainment), and readiness to learn (a proxy for embodied cultural capital), they found that educational attainment was the most important predictor of participation in educational programs. In other words, across 23 OECD countries, adults with more schooling tended to participate more frequently in voluntary education than less educated adults (Cincinnato et al., 2016). Another study focused on six countries with varying participation rates in adult education. Across high- and low-participation countries, demand for adult education was influenced by prior educational attainment. Although general interest in adult education was higher in high-participation countries and lower in low-participation countries, there was a consistent pattern that people who had completed more schooling were more likely to want additional adult education or training (Hovdhaugen & Opheim, 2018).

From one perspective, prior findings were counterintuitive; presumably, the least skilled and educated adults stood the most to gain from additional education. Yet, research indicates that more skilled and more educated adults tend to disproportionately pursue adult education. This may be because less-proficient adults or adults with less schooling discount potential returns to additional schooling because prior educational disadvantages left them less prepared to pursue additional learning (e.g., Anders, 2012; Carneiro & Heckman, 2002; Chowdry et al., 2013).

Additional Factors Influencing Voluntary Participation in Education: Background and Workplace Characteristics

Beyond education and skills, “non-participation in lifelong learning is determined by a complex set of diverse barriers and inhibitions” (Baert et al., 2006, p. 94). People have often developed learning intentions but not gone on to complete their intentions. Baert and colleagues proposed that non-completion could be explained by a variety of individual and social factors, including workplace experiences or conditions. What Baert et al. (2006) outlined conceptually, others have since supported empirically. For instance, DesJardins (2020) found that employer support mattered and that it could be manifested in multiple ways. Employers were more likely to support employees in engaging in educational programs if those workers already have prior schooling; that is, employers do not often support workers with low education levels in pursuing further education. Employers have also been more likely to support native-born (i.e., not immigrant) and younger employees in their educational pursuits. Finally, workers who were better paid were more likely to participate in voluntary education (DesJardins, 2020).

Some scholars have examined whether the ways people approach their jobs influences their learning intentions. One study examined original survey data from workers with low educational attainment and tested whether workers’ self-directedness and perceptions of task variety predicted learning intentions. The authors found that self-directedness had a statistically significant, positive relationship with learning intentions (Kyndt et al., 2013). Similar to Kyndt and colleagues’ (2013) concept of self-directedness, Liu (2020) used PIAAC data to show that motivation to learn was a statistically significant predictor of voluntarily participating in education in the U.S., as well as Germany and South Korea. Prior research with PIAAC has shown that motivation to learn may have differential effects depending on workers’ education levels (Fernandez & Liu, 2019; Yamashita et al., 2022).

Apart from workplace characteristics, researchers have looked to individuals' background characteristics to better understand why adults may not pursue their learning intentions or why they may begin education programs but leave before completing their learning intentions. Grotlüschen and colleagues (2016) reported that many PIAAC respondents list factors that limit their participation in education, including lack of time or balancing multiple responsibilities and affording the cost of educational programs. Barriers to completing learning intentions often relate to background characteristics, such as gender, age, immigrant status, work responsibilities, and caring for dependents (Patterson, 2018). Additionally, background characteristics, such as parental education, were especially important in the U.S. context relative to other OECD countries like Denmark and Sweden. In the U.S., adults with college-educated parents were significantly more likely to pursue education, relative to adults whose parents only completed high school (DesJardins, 2020). Some groups are persistently underrepresented in voluntary education, including low-educated women and immigrants, even though they could achieve significant monetary and social benefits from further education (e.g., Iñiguez-Berrozpe et al., 2020; Krupar et al., 2017; Smith & Fernandez, 2017).

On top of common inequities that seem inherent in educational systems across the OECD, the U.S. has persistent, documented racialized barriers to voluntary education. Many Black men and women do not participate in, or complete, degree or credential programs, and their non-completion cannot only be explained by issues related to program cost or balancing multiple commitments like work and childcare. Black college-educated students have found that "their position in society is replicated in the educational environment" when "their respective programs supported a culture of racism" (Aiken et al., 2001, p. 317). Some scholars suggest that in the U.S., Black students pursuing voluntary education must deal with "prevailing negative

stereotypes," so that racism is "further compounded by prejudicial treatment as low-literacy persons" (Drayton et al., 2014, p. 90). While other studies have addressed background characteristics that are comparable across national contexts, prior literature suggests that U.S. study should examine race, and potentially the interaction between race and literacy proficiency, as an important factor in whether students complete their learning intentions.

In the next section, the paper introduces a conceptual lens for framing this study that helps select variables that represent multiple contextual factors that influence decisions about pursuing voluntary education. While Grotlüschen and colleagues focused on adults with low proficiency in numeracy and literacy skills, they did not examine other equity issues around not completing educational qualifications. For example, they did not include breakdowns of non-completion of learning intentions by immigrant status or race. In the U.S., these social identities have historically shaped how students are stratified or excluded from educational opportunities (Astin & Oseguera, 2004; Posselt et al., 2012).

Conceptual Framework

To select variables for the analysis, the paper draws upon DesJardins' (2014) model of factors related to participation in adult education/training. DesJardins developed the model based on his analysis of data from PIAAC's predecessor assessment, the Adult Literacy and Lifeskills Survey (ALLS). ALLS was administered between 2003 and 2007 in 10 countries, but the model was based on analyses of ALLS data from eight countries, including the U.S.

DesJardins' full model considered skill matching or undermatching (that is, whether workers had a level of literacy skills that matched the level of skill needed in their current jobs). Additionally, because the full model was used to analyze cross-national data, it accounted for "broader structural characteristics" at the country level. To operationalize DesJardin's (2014)

model for this analysis, the paper omitted the skill mismatch and country-level elements. Based on the review of the literature, the model also collapsed the "Job characteristics" and "Organizational/workplace characteristics" parts of the model. The modified model is presented in Figure 1.

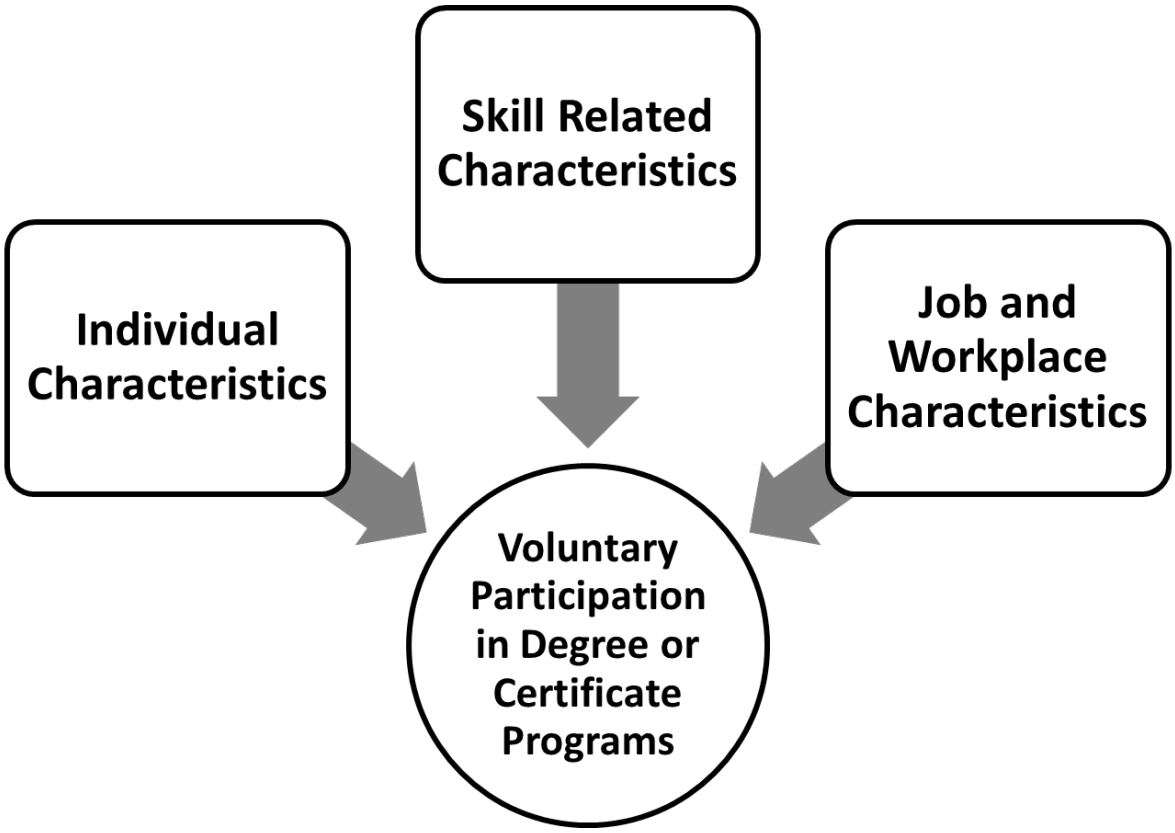

Figure 1. Hypothesized factors related to completing educational qualifications (framework based on DesJardins, 2014).

Although DesJardins (2014) focused on literacy skills, this paper uses numeracy proficiency to measure the skill related characteristics part of the model. In the 21st century, numeracy skills are understudied but increasingly important as information is more commonly presented in numeric terms, such as using frequencies and percentages to inform about medication risks (e.g., Sinayev et al., 2015). In fact, numeracy skills are related to understanding how to use medicines (e.g., Pires et al., 2016) and to broader health and wellness outcomes

(Yamashita et al., 2018a). Across PIAAC countries, higher percentages of respondents scored at or below Level 1 in numeracy proficiency compared to literacy proficiency. Numeracy and literacy are highly correlated (Liu, 2018), and across PIAAC countries, many of the adults who scored at or below Level 1 in numeracy also scored at or below Level 1 in literacy. Among those who scored low in a single skill domain, twice as many adults scored low in numeracy alone compared to literacy alone (Grotlüschen et al., 2016).

When compared to other PIAAC countries, the U.S. had higher percentages of adults with low numeracy proficiency, which was evident across occupational categories (American Institutes for Research, n.d.). Therefore, in the U.S. context, it is important to focus on adults with low numeracy skills because focusing on literacy skills would omit a substantial percentage of U.S. adults with low skills. PIAAC data offer a unique opportunity to provide implications for policymakers who seek to support adults with low numeracy proficiency in completing their learning intentions.

Data and Methods

Data

I analyzed PIAAC data to address the research questions. PIAAC is an international effort to assess adults' numeracy, literacy, and digital problem solving skills. The United States collected three samples in PIAAC Cycle 1 (Krenzke et al., 2019). The paper analyzed the combined PIAAC Cycle 1 data file, which included pooled household samples from the 2012 main study, the 2014 national supplement, and the 2017 wave of data collection (U.S. National Center for Education Statistics, n.d.).[2] Using the pooled sample increased the number of observations with minoritized social identities, such as immigrant status, which can be much

[2] I did not include the 2014 sample of incarcerated individuals.

smaller when only using a portion of the PIAAC Cycle 1 data (see, e.g., Smith & Fernandez, 2017).

PIAAC was an ideal dataset for this study. Boeren (2018) reviewed more than 1,000 articles that were published in leading journals in the field of adult education. After her systematic review, she found that PIAAC is "one of the major data sets of interest" to studying adult and lifelong education (Boeren, 2018, p. 73). Since her review, scholars have frequently used PIAAC in published research to better understand relationships among adults' background characteristics, numeracy or literacy skills, education, and occupational outcomes (e.g., Iñiguez-Berrozpe, 2020; Lopes et al., 2020).

Sample

The paper examines a limited PIAAC sample of working adults ages 20-65. Age groups with low labor force participation rates were excluded because they tended to fall outside the scope of the study. In 2019, a significant majority of adults in the 20-65 age range participated in the civilian labor force. However, only about 35% of adults under the age of 20 participated in the labor market, and only about 28% of adults between the ages of 65 and 74 (and only about 9% of adults older than 74) participated in the labor market (U.S. Bureau of Labor Statistics, 2020). In total, 2,270 cases were removed from the analytic sample because they fell outside the 20-65 age range.

I also removed cases for respondents who never held a job or had been out of the labor market for a long period (i.e., if they are still in compulsory schooling or they are retired). PIAAC did not include occupational context data for respondents who never had jobs or were long-term unemployed. Specifically, respondents were removed if they were unemployed (n = 1,270), out of the labor force (n = 1,740), or whose employment status was unknown (n = 320).

For all other variables in the analysis, the analysis relies on listwise deletion to address missing data.[3] Appendix B reports the number of cases that were missing data for each variable. The final analytic sample included 3,820 respondents.

Variables

Most of the variables for the study were drawn from PIAAC's background questionnaire. Additionally, the analysis used PIAAC's numeracy assessment data to create discrete numeracy proficiency levels (discussed more below). Because DesJardins' (2014) model was developed using a prior international assessment that was the foundation for PIAAC, the dataset contained variables that fit elements of the conceptual framework. Appendix B reports the original PIAAC variable names and labels for study variables described below.

Based on the research questions, the analysis used a single outcome for all analyses. *Incomplete Qualification* was a dichotomous variable (1 = had an incomplete qualification; 0 = did not have an incomplete qualification). This variable was drawn from an item in the PIAAC background questionnaire, which asked: "Did you ever begin a program of study for a degree or certificate, but leave before completing it?" Among the study population, 31.23% of respondents stated that they had an incomplete qualification.

Independent Variables

Skill related characteristics. Prior literature showed that participation in educational opportunities varies among differently skilled adults (e.g., Grotlüschen et al., 2016). PIAAC included a computer adaptive test to administer a selection of items that assessed respondents'

[3] Allison (2002) details that "listwise deletion is the method that is *most* robust to violations of MAR [missing at random] among *independent* variables in a regression analysis" (p. 6, italics in original). Finally, Allison (2002) shows that "for logistic regression, listwise deletion gives valid inferences under even broader conditions" (p. 7) than for other types of regression models. See also Little (1992) and Jones (1996).

numeracy skills. The assessment data were then used by PIAAC to generate ten plausible values for numeracy skills using an item response theory approach. The continuous numeracy scores ranged from 0-500. For this paper, the analysis relies on discrete proficiency levels for the ten plausible values for PIAAC's numeracy assessment scores (PVNUM1 – PVNUM10). Stata's **repest** command was used to include the ten proficiency level variables in the analyses, while only reporting a single set of estimates.

I used the NCES Description of PIAAC Numeracy Discrete Achievement Levels[4] to transform the plausible value scores into mutually exclusive categories for a *Numeracy Proficiency* variable (1 = Low; 2 = Moderate; 3 = High). Some of the NCES achievement level and score ranges had relatively small numbers of respondents, so those categories were collapsed. The low proficiency category included respondents with numeracy scores ranging from 0 – 225 (combining NCES' Below Level 1 and Level 1). The moderate proficiency category included respondents with numeracy scores ranging from 226 – 275 (NCES' Level 2). The high proficiency category included respondents with numeracy scores ranging from 276 – 500 (combining NCES' Level 3, Level 4, and Level 5). Approximately 23.41%, 32.67%, and 43.92% of observations were grouped in the low, moderate, and high numeracy proficiency categories, respectively.

Individual characteristics. Based on prior literature (Aiken et al., 2001; Drayton et al., 2014; Iñiguez-Berrozpe et al., 2020; Krupar et al., 2017; Patterson, 2018; Smith & Fernandez, 2017) and the conceptual framework (DesJardins, 2014), the analysis included variables for individual characteristics in the analysis. These included *Woman* (1 = self-identified as female; 0 = self-identified as male), *Immigrant* (1 = self-identified as not born in the U.S.; 0 self-identified

[4] https://nces.ed.gov/surveys/piaac/numproficiencylevel.asp

as born in the U.S.), *English Language Learner* (1 = yes; 0 = no), and a vector of dichotomous race categories that record whether participants self-identified as one of several racial groups (*Black*, *Hispanic*, *Other*, *White*). Additionally, the models included a variable for *Age* (coded continuously) and an indicator variable (*Parent*) for whether the respondent had children.

In terms of preparation for degree and certificate programs, the models included variables for prior schooling and parental education (e.g., Cincinnato, 2016; DesJardins, 2020). *Highest Credential* recorded the highest completed level of education (1 = High school diploma; 2 = Some college; 3 = Baccalaureate degree; 4 = Master's degree or above). The models also included a *Parental Education* variable that recorded whether either parent earned a college degree (1 = At least one parent was a college graduate; 0 = neither parent was a college graduate). Finally, the analysis included a self-reported scale score measure of respondents' *Readiness to Learn* (continuous), which is a habit or disposition that is positively related to education and employment outcomes (Fernandez & Liu, 2019; Liu et al., 2019).

Job and workplace characteristics. There were several types of variables that fit this element of the conceptual framework (e.g. Baert et al., 2006; DesJardins, 2020; Kyndt et al., 2013). First, the analysis included individual-level variables. These included *Earnings* (logged transformation of inflation-adjusted monthly earnings) and a categorical *Job Satisfaction* variable (1 = Extremely dissatisfied; 2 = Dissatisfied; 3 = Neither satisfied nor dissatisfied; 4 = Satisfied; 5 = Extremely satisfied). Second, the analysis included employer characteristics. Employer characteristics categorically measured firm or organizational factors, such as *Number of Employees* (1 = Between 1 and 10 people; 2 = Between 11 and 50 people; 3 = 51 to 250 people; 4 = 251 to 1000 people; 5 = More than 1000 people) and *Occupational Field* (1 = Legislators, senior officials and managers; 2 = Professionals; 3 = Technicians and associate

professionals; 4 = Clerks; 5 = Service workers and shop and market sales workers; 7 = Craft and related trades workers; 8 = Plant and machine operators and assemblers; 9= Elementary occupations).

I also included respondents' perceptions of how demanding their jobs were in terms of skill use. First, the analysis included self-reported measures of how frequently respondents could choose their own tasks (*Task Discretion*; measured continuously). Then the models included a categorical variable of the frequency with which they use *Problem Solving* skills to resolve complex challenges (1 = Never; 2 = Less than once a 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), and respondents' perceptions of whether they *Needed More Training* (1 = Yes; 0 = No). See Table 1 for descriptive statistics for variables used in the analysis.

Table 1

Descriptive Statistics for Derived Variables

Variable	%	Mean	SE
Dependent Variable			
Incomplete Qualification			
Yes	31.89		
No	68.89		
Independent Variables: Individual Characteristics			
Numeracy Proficiency			
Low	23.41		
Moderate	32.67		
High	43.92		
Woman			
Yes	48.12		
No	51.88		
Immigrant			
Yes	15.25		
No	84.75		
English Language Learner			
Yes	17.07		
No	82.93		
Race			

Hispanic	14.44		
White (alone)	65.90		
Black	11.84		
Other	7.81		
Age		41.24	0.11
Parent			
Yes	68.23		
No	31.77		
Highest Credential			
High school	54.67		
Some college	10.97		
Baccalaureate	21.20		
Master's degree or above	13.16		
Parental Education			
At least one parent was a college graduate	42.09		
Neither parent was a college graduate	57.91		
Readiness to Learn		2.53	0.01
Control Variables: Occupational Contexts			
Earnings (log)		7.99	0.01
Job Satisfaction			
Extremely satisfied	28.66		
Satisfied	50.91		
Neither satisfied nor dissatisfied	13.27		
Dissatisfied or extremely dissatisfied	7.16		
Number of Employees			
1 to 10	20.11		
11 to 50	28.12		
51 to 250	24.83		
251 to 1000	14.36		
More than 1000	12.59		
Occupational Field			
Legislators, senior officials and managers	11.16		
Professionals	22.55		
Technicians and associate professionals	18.40		
Clerks	6.74		
Service workers and shop and market sales workers	19.41		
Craft and related trades workers	8.13		
Plant and machine operators and assemblers	5.79		
Elementary occupations	7.82		
Task Discretion		1.98	0.01
Problem Solving Skills			

Never	14.20
Less than once a month	18.80
Less than once a week but at least once a month	19.64
At least once a week but not every day	31.78
Every day	15.58
Needed More Training	
Yes	23.11
No	76.89

Note. Descriptive statistics calculated using Stata's **repest** command to obtain weighted estimates. Two occupational fields were dropped because of small sample sizes (armed forces, skilled agricultural and fishery workers).

Methods of Analysis

I used Stata to calculate descriptive statistics and estimate regression models to analyze the PIAAC data. Stata's **repest** command not only facilitated analysis of plausible values, it also accommodated PIAAC's complex design features (e.g., sampling weights jackknife replicate weights) for all analyses. The first research question (*How does not completing formal educational qualifications vary by numeracy proficiency levels?*) was addressed by calculating crosstabulations and using chi-square tests to examine *Incomplete Qualification* by each numeracy proficiency level.

For the second research question (*Which background characteristics are related to not completing formal educational qualifications?*), percentages of adults with incomplete qualifications were calculated for various groups (adults with different levels of education, gender, immigrant status, race). Then, a logistic regression model was estimated for the *Incomplete Qualification* outcome variable. This multivariate analysis included covariates that were introduced in the Skill Related Characteristics, Individual Characteristics, and Job and Workplace Characteristics sections above. Results from the logistic regression models were calculated as odds ratios, which were exponentiated into inverse odds ratios if odds ratios were less than one (DesJardins, 2001). Statistically significant ($p < 0.05$) results are reported below.

For the third research question (*Do relationships between background characteristics and non-completion vary by numeracy proficiency levels?*), interaction terms were specified between the Individual Characteristics variables and the Skill Related Characteristics (i.e., numeracy proficiency levels). Interaction terms were added to the logistic regression model from the second research question to test whether relationships between background characteristics and *Incomplete Qualification* varied by numeracy proficiency.

Findings

At the descriptive level, there were sizable differences in the percentage of working adults who had not completed formal qualifications across numeracy proficiency groups. Less than 29% of working adults with low numeracy proficiency had incomplete qualifications, compared to upwards of 34% and 30% of working adults with moderate and high numeracy proficiency, respectively (see Table 2). To test whether the differences in percentages were statistically significant, a series of logistic regression models were estimated with different reference categories. Those models indicated there were not statistically significant differences between the moderate and high proficiency groups, but the low proficiency group had lower odds of having an incomplete qualification, relative to the moderate proficiency group. Relative to the low proficiency group, moderate proficiency adults had about 28% higher odds of having an incomplete qualification (OR = 1.28, $p < 0.05$).

Table 2

	Incomplete Qualification	
Numeracy Proficiency	%	SE
Low	28.80	0.02
Moderate	34.10	0.01
High	30.12	0.01

Note. Means for *Incomplete Qualification* calculated for each *Numeracy Proficiency* level using Stata's **repest** command to obtain weighted estimates. A series of logistic regression models with different reference

categories indicated there were not statistically significant differences between the moderate and high proficiency groups, but the low proficiency group had consistently lower odds of having an uncompleted formal qualification (relative to the other two groups).

In the multivariate analysis, working adults with low numeracy proficiency had lower odds of having an incomplete qualification relative to those with moderate numeracy proficiency. In other words, relative to low-skilled adults, moderately skilled adults had 1.5 times greater odds of having incomplete qualifications. Accounting for other variables also revealed a statistically significant difference in odds of having incomplete qualifications between moderately and highly skilled adults. Compared to moderately-skilled adults, highly-skilled adults had approximately 30% higher odds of having incomplete qualifications. When the reference category was changed, moderately skilled adults had 53% higher odds of having incomplete qualifications than low skilled adults. Similarly, highly skilled adults had odds of having incomplete qualifications that were approximately 2.0 times higher than low skilled adults.

Beyond skill levels, there were substantive differences in percentages of adults with incomplete qualifications for multiple groups. PIAAC respondents with the lowest level of education had the highest percentage of incomplete credentials—nearly 40%. Slightly more than one-third of the sample (approximately 35%) that completed "some college" had an incomplete credential. Smaller percentages of four-year degree and graduate degree holders had incomplete credentials (19% and about 13%, respectively). Relatively even shares of women and men had incomplete qualifications (around 30%). A larger percentage of U.S. born adults had incomplete qualifications (nearly one in three) compared to immigrant adults (closer to one in four). Across racial groups, Black Americans had the highest percentage of incomplete qualifications (nearly 38%), compared to about 32% of Hispanics and 30% of White Americans. See Table 3.

Table 3

Percentages of Demographic Groups with Incomplete Credentials

Variable	%
Educational Levels	
High School Diploma or Less	39.66
Some College	35.41
Baccalaureate	19.02
Graduate Degree	12.90
Gender	
Woman	30.53
Man	31.74
Immigrant	
Born in U.S.	32.44
Born outside U.S.	23.86
Race	
Hispanic	32.72
White	30.05
Black	37.50
Other	27.42

Multivariate analyses confirmed descriptive findings in Table 3 and revealed that, after controlling for skill and background characteristics, less educated adults have higher odds of not completing formal qualifications. Compared to adults with a master's degree or higher, those with a baccalaureate had 88% higher odds of not completing formal qualifications. Those with some college had odds that were more than 400% higher of having incomplete qualifications than the odds for those who earned a master's degree or higher. High school graduates had odds of having incomplete qualifications that were more than 800% higher than the most educated adults.

Black adults were the only racial group that had statistically significantly different odds of having incomplete qualifications, relative to White adults. Black adults, who were about 12% of the weighted sample, had approximately 39% higher odds of having incomplete qualifications

than White adults.. Immigrants had lower odds of having incomplete qualifications than non-immigrants. Parental education was positively related to having an uncompleted formal qualification. After accounting for skills, education, and other background characteristics, PIAAC respondents with higher *Readiness to Learn* scores had higher odds of having incomplete qualifications.

In terms of occupational contexts, the least satisfied workers had 49% higher odds of having incomplete qualifications, relative to employees who were extremely satisfied with their jobs. Similarly, workers who were neither satisfied nor dissatisfied with their jobs had 29% higher odds of having an incomplete qualification than extremely satisfied workers. Finally, odds of having uncompleted formal qualifications varied across occupational fields. Workers in low-skill occupations (craft and related trades workers, plant and machine operators and assemblers, elementary occupations) tended to have lower odds of having incomplete qualifications, relative to a highly-skilled occupational category (Legislators, senior officials and managers). See Table 4 for full results.

Table 4

Estimated Odds of Having Incomplete Qualification

Variable	Coef.		SE	OR	IOR
Individual Characteristics					
Numeracy Proficiency (Reference: Moderate)					
Low	-0.43	**	0.13	0.65	1.53
High	0.26	*	0.13	1.30	
Woman	0.07		0.09		
Immigrant	-0.45		0.20	0.64	1.57
English Language Learner	0.10		0.26		
Race (Reference: White)					
Hispanic	0.22		0.18		
Black	0.33	***	0.13	1.39	
Other	0.32		0.22		
Age	0.00		0.00		
Parent	-0.08		0.08		

Highest Credential (Reference: Master's degree or above)					
High school	2.25	***	0.19	9.53	
Some college	1.70	***	0.19	5.45	
Baccalaureate	0.63	**	0.17	1.88	
Parental Education	0.20	***	0.05	1.22	
Readiness to Learn	0.24	**	0.09	1.28	
Occupational Contexts					
Earnings (log)	-0.02		0.09		
Job Satisfaction (Reference: Extremely satisfied)					
Satisfied	0.17		0.10		
Neither satisfied nor dissatisfied	0.26	*	0.13	1.29	
Dissatisfied or extremely dissatisfied	0.40	*	0.18	1.49	
Number of Employees (Reference: More than 1000)					
1 to 10	-0.07		0.18		
11 to 50	-0.19		0.15		
51 to 250	-0.23		0.15		
251 to 1000	0.01		0.18		
Occupational Field (Reference: Legislators, senior officials and managers)					
Professionals	-0.11		0.16	0.89	
Technicians and associate professionals	-0.11		0.16		
Clerks	0.12		0.21		
Service workers and shop and market sales workers	-0.11		0.20		
Craft and related trades workers	-0.57	*	0.24	0.57	1.77
Plant and machine operators and assemblers	-0.90	***	0.22	0.41	2.46
Elementary occupations	-0.52	*	0.23	0.60	1.68
Task Discretion	0.01		0.05		
Problem Solving Skills (Reference: Every day)					
Never	0.03		0.15		
Less than once a month	-0.05		0.14		
Less than once a week but at least once a month	-0.14		0.13		
At least once a week but not every day	0.06		0.13		
Need More Training	0.15		0.10		
Constant	-2.76		0.87		

Note. Logistic regression model calculated using Stata's **repest** command to account for plausible values, sampling weights, and jackknife replicate weights. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To address the third research question, interaction terms were added to the model. When the model was re-estimated with interaction terms, there were not any statistically significant

interactions between numeracy proficiency and individual characteristics. Thus, these analyses suggest that the relationships between background characteristics and incomplete qualifications do not vary across numeracy proficiency levels.

Limitations

There were several empirical limitations that are inherent to the use of secondary data. PIAAC is a rich dataset with unique skill assessments and a thorough background questionnaire. However, PIAAC contains limited information about incomplete qualifications. For instance, a single item was used as the outcome variable, which aggregated degrees and certificates without distinguishing between subbaccalaureate, baccalaureate, or graduate credentials. Further, because of the survey's skip logic, it was impossible to consider whether respondents previously began a degree or certificate program and whether they completed; that is, PIAAC did not contain a set of mutually exclusive outcomes (non-participation; participation and completion; participation and noncompletion). Future research could use PIAAC's extensive background questionnaire to examine other opportunities for informal education and training. Researchers could also examine the broader PIAAC sample, including unemployed adults (though that would necessitate omitting variables related to occupational contexts).

Although the analyses in this paper focus on a single outcome variable, that variable reveals substantial disparities across subgroups of U.S. adults. Under old human capital assumptions, scholars could argue that more information is needed about why adults do not complete learning intentions, with the implication being that learners should have a "right to fail." More recent research has critiqued such a perspective and its implications for policy and practice. When considering educational disparities by race or background characteristics, the "right to fail" mentality absolves educational providers of responsibility for students' success and

places the fault for incompletion on already underserved students (e.g., Wood, 2012). Thus, the single survey question offered a useful dependent variable for examining disparities in which groups of adults do not complete degree or certificate programs.

Additionally, due to small sample sizes, Asian/Pacific Islander respondents could not be analyzed as their own racial category. Additionally, the U.S. administration of PIAAC did not include personality measures that other countries have used and which have been found to positively relate to educational attainment and participation in continuing education (e.g., Rammstedt et al., 2017). Nevertheless, the analyses included many variables that were not included in prior research (e.g., Grotlüschen et al., 2016) and data were weighted to provide a nationally representative snapshot specific to the U.S. context.

Discussion and Conclusion

The purpose of this paper was to better understand which groups of adults begin, but do not complete, voluntary education programs. Prior literature and DesJardins' (2014) model provided insights for studying factors related to pursuing additional degrees or credentials. PIAAC was used to test whether assessed numeracy proficiency, prior schooling, background characteristics, and occupational contexts were related to non-completion of formal qualifications. The results added by prior literature by showing that patterns that apply to participation do not hold for non-completion in education programs. Additionally, findings offer insights about specific groups that may benefit from targeted policies and practices that support them in completing educational qualifications.

Prior literature shows that adults with higher skills and prior education were more likely to participate in voluntary, lifelong education (e.g., DesJardins, 2020; Grotlüschen et al., 2016). This study shows that highly skilled adults and less educated adults were more likely to drop out

of educational programs without completing their intentions and earning new qualifications. It was outside the scope of this study to examine whether adults with high numeracy skill pursued other types of learning rather than traditional certificates and credentials. However, prior studies that analyze PIAAC data suggest that highly-skilled adults may find alternate opportunities to upskill—for example, through job-related lifelong learning (e.g., Desjardins & Rubenson, 2011; Tikkanen & Nissinen, 2016). Prior research also suggests that, although numeracy skill is related to an array of social outcomes, it is not a fixed construct over time. Workers can gain or lose skill depending on skill use and participation in formal or informal lifelong learning (e.g., Vera-Toscano et al., 2017). Future research and policy efforts may focus on public-private partnerships to help high-skilled workers prevent skill loss and benefit from lifelong learning on the job.

While less-educated adults are underrepresented in voluntary educational programs, they also have much higher odds of not completing formal qualifications, compared to adults with a master's degree or higher. These findings are consistent with prior literature that suggests that, even though they may stand the most to gain, less skilled and less educated students were not equitably treated by formal educational systems in the past; thus, they are less prepared to succeed and choose not to complete education that is not compulsory (e.g., Anders, 2012; Carneiro & Heckman, 2002; Chowdry et al., 2013).

These findings suggest that, beyond participation, the U.S. is inefficient at helping adults complete degree and certificate programs. Highly skilled adults are more likely to participate than lower skilled adults, but the highly-skilled adults then tend to drop out at higher rates. Adults with low educational credentials would benefit most from earning new qualifications, but

after controlling for skills, less-educated adults are *far* more likely to drop out of formal educational programs than highly-educated adults.

Since 2020, groups like Black Americans and immigrants, were disproportionately affected by the COVID-19 pandemic, and they were generally less likely to enroll in education programs (e.g., Kochhar, 2020; Patterson, 2018). Women or parents were not statistically more or less likely to have incomplete qualifications. Unlike prior literature, which suggested that there might be interactions between gender and skill proficiency (e.g., Iñiguez-Berrozpe) or between race and skill proficiency (Drayton et al., 2014), there were not any statistically significant interactions between worker's numeracy proficiency and background characteristics.

While there are some countries (i.e., the Netherlands, New Zealand, Norway, Sweden, Chile, Denmark) that have more success at encouraging low-skilled adults to voluntarily participate in lifelong education, the U.S. is not one of them (DesJardins, 2020). This study shows that, in addition to expanding adults' participation in educational opportunities, policymakers must consider how to improve completion of degree and certificate programs. However, policymakers should be cautious about using incentives to improve completion and ensure accountability and oversight of education. Grotlüschen et al. (2016) argue that funding for adult education for low-qualified workers should not be tied to outcomes in a way that encourages unintended consequences, such as restricting admissions to only enroll students who are likely to complete programs. Similarly, studies of performance-based funding at the university level show that incentive funding tends to restrict admissions without improving outcomes (Umbricht et al., 2017). Policymakers need to encourage broad access *and* support continued participation to completion.

This study also shows a need to probe for underlying inequities based on socially constructed identities. After accounting for skills, prior schooling, and occupational contexts, Black Americans had significantly higher odds than White Americans of beginning but not completing degree and certificate programs. Black Americans were particularly affected by mass unemployment during the COVID-19 pandemic (Kochhar, 2020), and more efforts need to be made to ensure their success (Drayton et al., 2014). Many studies that use PIAAC focus on analyzing background characteristics that are relatively comparable across countries. Future research on adult education and skill formation should investigate inequities that exist based on multiple, minoritized identities—and for which low skills and education do not serve as proxies.

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Appendix A

Table 1A

Missing Data in Analytic Sample

Variable	Missing Values	Non-Missing Values
Dependent Variable		
Incomplete Qualification	1,807	4,925
Independent Variables: Individual Characteristics		
Numeracy Proficiency	0	6,732
Woman	0	6,732
Immigrant	4	6,728
English Language Learner	0	6,732
Race	0	6,732
Age	0	6,732
Parent	7	6,725
Highest Credential	19	6,713
Parental Education	53	6,679
Readiness to Learn	4	6,728
Control Variables: Occupational Contexts		
Earnings	659	6,073
Job Satisfaction	6	6,726
Number of Employees	902	5,830
Occupational Field	148	6,584
Task Discretion	130	6,602
Problem Solving Skills	11	6,721
Needed More Training	5	6,727

Appendix B

Table 1B

Mapping of Study Variables and PIAAC Codebook Variable Names and Labels

Derived Variable Name	PIAAC Variable Name	PIAAC Variable Label
Dependent Variable		
Incomplete Qualification	B_Q03A	Education – Uncompleted qualification
Independent Variables: Individual Characteristics		
Numeracy Proficiency	PVNUM1 - PVNUM10	Numeracy scale score - Plausible value 1-10
Woman	GENDER_R	Person resolved gender from BQ and QC check
Immigrant	J_Q04A	Background - Born in country
English Language Learner	NATIVESPEAKER	Respondent is a native speaker
Race	RACETHN_4CAT	Background - race/ethnicity (derived, 4 categories)
Age	AGE_R	Person resolved age from BQ and QC check
Parent	J_Q03A	Background - Children
Highest Credential	B_Q01A_ISCED11	Education - Highest qualification - Level, ISCED 2011
Parental Education	J_Q06B; J_Q07B	Background - Mother/female guardian - Highest level of education; Background - Father/male guardian - Highest level of education
Readiness to learn	READYTOLEARN	Index of readiness to learn
Control Variables: Occupational Contexts		
Earnings	EARNMTHALLPPPUS_C	Mnthly earn. incl. bonuses for wage and salary earners and self-employed, PPP corr. $US (topc.) (der. frm EARNMTHALLPPP)
Job Satisfaction	D_Q14	Current work - Job satisfaction
Number of Employees	D_Q06a	Current work - Amount of people working for employer
Occupational Field	ISCO1C	Occupational classification of respondent's job at 1-digit level (ISCO 2008)
Task Discretion	TASKDISC	Index of use of task discretion at work
Problem Solving Skills	F_Q05b	Skill use work - Problem solving - Complex problems
Needed More Training	F_Q07b	Skill use work - Need more training