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The Effects of Social Characteristics of Jobs on the Cognitive Skills of Adults in the United States: A PIAAC Analysis

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Abstract

There is contrary research around whether collaboration at work fosters individual learning and skill development. This study's purpose was to examine the relationship between social characteristics of jobs on adults' cognitive skills as measured by the Program for the International Assessment of Adult Competencies (PIAAC). For select industry sectors, we used a linear regression model to predict scores for PIAAC scales—literacy, numeracy, and problem solving in technology-rich environments—based on the independent variables gender, education level, frequency of workplace collaboration, and frequency of sharing work-related information. Results showed level of collaboration at work is negatively associated with PIAAC scores, contradicting current thinking on the role of social interactions in the workplace. We conclude there may be an overemphasis on the social characteristics in job design in some industries and workplaces, leaving little support and time for other activities known to support workplace learning, like management support and time for reflection.

Keywords

workplace collaboration, workforce development, cognitive skills, PIAAC

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American employers have long warned about the economic consequences of the skills gap and continue to pressure policy makers and educators to develop new strategies to increase the workforce's fundamental skills (McDonough, 2017). As technology trends enable employers to automate low skilled and routine work (Arntz, Gregory, & Zierahn, 2016), secure jobs with career potential are likely to require workers with state-of-the-art technical skills, and the foundational literacy, numeracy, information, and communications technology skills required to continuously learn. Moreover, the increased reliance on workplace diversity and teamwork has led employers to also call for improved "soft skills," like cooperation and collaboration, among the workforce (U.S. Department of Education Office of Career, Technical, and Adult Education, 2014).

Some workplace learning scholars (Billett & Noble, 2017; Skule, 2014) suggest team configurations provide a supportive learning culture (Ellinger, 2005) to foster intensive learning required for many jobs today. Research purports that teams provide a trusting environment and a safe context for members to share knowledge and information as well as engage in behaviors that promote experimental learning (Edmondson, 2003). However, Sanner and Bunderson's (2015) meta-analysis on teams, psychological safety, and learning found safety was more strongly associated with learning in studies conducted in knowledge-intensive task settings, meaning in certain teams and even industries, no matter how comfortable team members may be with one another, learning is unlikely to occur.

Indeed, for the past three decades, empirical research has advanced varying opinions about whether teamwork and the collaboration teams are designed to foster can truly result in the learning it is assumed to accomplish. While many scholars have emphasized the social aspects of learning in teams (Zoethout, Wesselink, Runhaar, & Mulder, 2017) and the importance of trust in successful collaboration to learning (Carmeli, Tishler, & Edmondson, 2012; Dodgson, 1993), little is known about skill development and maintenance for individual learners who are a part of a team.

The problem motivating this study was this gap in understanding of the effects of social characteristics of jobs on individual learning and skill. Specifically, the problem is the lack of understanding of relationship between collaboration at work and the cognitive skills vital in today's workplaces. As society becomes more reliant on work and economic participation for social equity and inclusion, work structures and prevailing job characteristics serve as inequality regimes (Acker, 2006) that reproduce and reinforce broad patterns of gender, racial, and class discrimination and disadvantage. Adult educators with knowledge of the relationship between job characteristics and learning will have new options to foster individual learning at work and facilitate social change in the broader systems that reproduce societal disadvantage.

The Program for the International Assessment of Adult Competencies (PIAAC) data set represents a rare opportunity to examine these phenomena on a national scale. Therefore, *the purpose of this study was to investigate the extent to which cooperation/collaboration at work and sharing work-related information, considered here as two distinct activities, are associated with cognitive skills, as measured by the PIAAC 2012/2014 U.S. data set.* We next present a literature review and conceptual framework based on recent scholarship related to workplace learning and skills. We then describe

our methodology, multiple linear regressions, including an overview of the PIAAC data set, followed by results, discussion, and implications for adult education and workplace learning research and practice specific to the social characteristics of jobs.

Literature Review

Although formal learning receives most of the attention and resources, workplace learning scholars now realize informal and incidental learning are the actual processes by which most employees learn what they need to know to do their work (Kwakman, 2003; Marsick & Watkins, 2018). This insight has led researchers to attend to the environmental conditions and job characteristics supporting a high degree of learning among the workforce (Eraut, 2011; Marsick & Watkins, 2015; Skule, 2014). Research on environmental conditions explores the structural affordances and constraints to informal learning at work and provides contextual information to understand how learning is motivated and supported. In contrast, job characteristics research is a close examination of what people do, the challenges they encounter, the knowledge and learning resources they contribute and access, the actors they interact with, and other contributing factors for what and how deeply people can learn at work.

Our review examines this literature for increased understanding of the structural workplace factors that foster learning and maintenance of relevant work-related technical, cognitive, and so-called noncognitive, social skills (Organisation for Economic Co-operation and Development [OECD], 2009). Most related research assumes a correlation among cooperation/collaboration, information sharing, and workplace learning (Kilgo, Sheets, & Pascarella, 2015; Ku, Tseng, & Akarasriworn, 2013; Latham, Julien, Gross, & Witte, 2016; Steensma, 1996). Therefore, this review also includes a closer examination of factors related to cooperation/collaboration and information sharing and their implications for learning at work. The review concludes with two research-based propositions motivating this study's research questions.

Environmental Conditions and Learning

Contemporary workplace learning research examines how employers can encourage learning and development of certain workplace skills (Olsen & Tikkanen, 2018). Consequently, it is concerned with understanding the structural and environmental conditions within the employers' control that foster learning at work. In turn, studies emphasize social and practice-based learning theories (Olsen & Tikkanen, 2018) that characterize learning as both self-directed and occurring in dialogue and in collaboration with others (Tikkanen, 2002). Therefore, context and how it affords or constrains learning at work is a central focus of contemporary workplace learning research (Billett, 2004; Schwartz, 2019).

Several studies illuminate the environmental factors that support learning in organizations. For example, Russ-Eft (2002) identified five factors that aid learning and knowledge transfer at work: supervisor support, supervisor sanctions, workload, opportunity to use information, and peer support. These five factors indicate employees are

more likely to learn if they feel supported, understand their job, and maintain access to appropriate organizational resources. Likewise, Ellinger's (2005) research surfaced the importance of positive organizational factors such as "learning-committed leadership and management," "an internal culture committed to learning," "work tools and resources," and "people who form webs of relationships for learning" (p. 401). If the workplace lacks these factors or if there are structural barriers such as time and fast-paced change, workplace learning is diminished (Ellinger, 2005), with implications for performance improvement (Klein & Moore, 2016).

Social Characteristics of Jobs and Learning

The workplace learning research emphasizes organizational context's impact on learning, but it does not isolate or examine the specific job characteristics that enable a high degree of learning. Research on the characteristics of learning intensive jobs (Skule, 2014) seeks to fill this gap.

Støren, Lundetræ, and Børing (2018) found empirical evidence of job features that seem critical for learning: supportive conditions, feedback, mentally challenging tasks, coordination and collaboration with colleagues, and routines promoting continued use of cognitive skills. Similarly, Lee, Cable, Gino, and Staats (2004) found other job characteristics that promote learning include participation in multiple work-related social entities (in and outside of work), planned time off and time for reflection, organization recognition and support for learning, teamwork, management support, and bottom-up approaches to innovation. Skule (2014) identified the characteristics of learning intensive jobs: a high degree of exposure to demands from customers, management, colleagues, and owners; a high degree of exposure to changes in technology, organization, and work methods; managerial responsibility; extensive external professional contact; good opportunity for feedback from work; support and encouragement for learning from management; and a high probability skills will be rewarded through interesting tasks, better career possibilities, or better pay.

While this research suggests job characteristics matter for whether one learns at work, other studies have found the more skills are used, the more likely they are to be maintained. Indeed, the PIAAC assessment of U.S. workers revealed regular use of cognitive skills offset the natural skill decline related to maturation (OECD, 2013). Workers who reported they were overeducated for their current position scored lower on the PIAAC skills when compared with workers in their age and educational cohorts who reported they engaged in work tasks on par with or exceeding their current level of education or degree (OECD, 2013). Taken together, these findings suggest certain job characteristics not only help workers develop cognitive skills as measured by PIAAC, they may also ensure for their ongoing maintenance.

Factors Related to Cooperation/Collaboration and Information Sharing

Though workplace learning research has established a relationship between the social characteristics of jobs and the learning and maintenance of skills, including cognitive,

technical, and social, there is limited research that explains specifically how social interactions, and specifically cooperation/collaboration and the sharing of information on the job leads to the development and maintenance of these skills. Nevertheless, there is some research that informs this study's design.

At the interpersonal level, Yang and Maxwell (2011) reported concerns about power and potential use of information urges some skepticism of sharing with others (Constant, Kiesler, & Sproull, 1994). Yang and Maxwell (2011) speculated:

> In such cases, information can be viewed as a form of property, which when surrendered, exposes the individual to threats of loss of status within the organizational setting. In both positive and negative cases, individual predilections regarding information sharing may also interact with various organizational factors—such as competition and collaboration—that either hinder or foster information-sharing behavior. (p. 165)

Even in environments purported to be collaborative or cooperative rather than competitive, instances such as these show there are motivations for individuals to resist sharing information, which could lead to lack of learning or development at the individual level.

Regarding cooperation/collaboration as an organizational factor affecting the likelihood of good information-sharing practices, Kim and Lee (2006) argued the centralization of information within an organizational environment is likely to diminish individual desires and capacities to share what they know. In short, people may be more likely to share information with others at work when they feel they have the autonomy to choose when and how to share.

These findings are consistent with additional research exploring cooperation/collaboration in work environments. Sonnenwald (1995) and Sonnenwald and Pierce (2000) explored the concept of "contested collaboration," in which they argued individuals often only engage in cooperative behaviors to the extent that they are also able to advance their own interests and knowledge. Thomson and Perry (2006) explained, "Although information sharing is necessary for collaboration, it is not sufficient for it to thrive. Without mutual benefits, information sharing will not lead to collaboration" (p. 27). Therefore, the ways in which employees interpret the mutual benefits of information sharing within their work environment are extremely important to understanding collaborative behaviors.

Based on this literature review, the present study is focused on examining two underlying propositions. First, a high degree of cooperation/collaboration and information sharing at work is related to higher levels of adult competencies, as measured by PIAAC. Second, the use of PIAAC skills at work relates to the improvement and maintenance of those same skills. The first proposition corresponds to Research Question 1 and second proposition corresponds to Research Question 2, both articulated below.

Method

Led by the OECD (2016), PIAAC is an international survey and data set of adult skills. The PIAAC survey's primary focus, and the central value of the data set, is a skills-based

assessment of participants' literacy, numeracy, and problem solving in technology-rich environments (PS-TRE) proficiencies. The data set also contains extensive background data, including but not limited to educational and work history, family background, civic engagement, health information, and social characteristics of jobs.

To address the previously stated purpose, *to investigate the extent to which cooperation/collaboration at work and sharing work-related information are associated with cognitive skills, as measured by the PIAAC*, we pose the following two research questions:

Research Question 1: What is the relationship between *cooperation/collaboration* and *information sharing* and *literacy, numeracy, and PS-TRE skills* across industry sectors, controlling for gender and education?
Research Question 2: How does the relationship between *cooperation/collaboration* and *information sharing* and *adults' use of specified skills* differ by industry, controlling for gender and education?

Instrument

Given the focus on U.S. industries, the choice of which is detailed below, this study examined data from the U.S. PIAAC Household Survey, specifically the 2012/2014 U.S. National Public Data Files, derived from the PIAAC first cycle, rounds one and two (OECD, 2019). IBM's SPSS was used in conjunction with the International Data Base Analyzer to account for the plausible values (imputed proficiency scores) of literacy, numeracy, and PS-TRE and the sampling and replicate weights for accurate and unbiased parameter and standard error estimation. Each person who took an assessment received 10 plausible values as a reflection of their skill. These values account for the uncertainty inherent with measures of such skills in these types of surveys (OECD, 2016). It also results in more accurate estimates of group proficiency (OECD, 2016).

There were three cognitive skills defined and measured by PIAAC (OECD, 2012). *Literacy* was defined as "understanding, evaluating, using and engaging with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential" (OECD, 2012, p. 20). *Numeracy* was defined as "the ability to access, use, interpret, and communicate mathematical information and ideas, in order to engage in and manage the mathematical demands of a range of situations in adult life" (OECD, 2012, p. 34). Last, *PS-TRE* was defined as "using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks" (OECD, 2012, p. 47). PIAAC focused on problem solving for personal, work, and civic purposes in a technology-rich environment. This definition is very specific to a technology-rich environment as compared with more general problem-solving skills. As a result, it is important to keep this in mind while reviewing the results, implications, and limitations of this study.

Each of the measures have levels associated with cognitive abilities and skills (OECD, 2016). Table 1 shows the levels for literacy (LIT), numeracy (NUM), and the levels for PS-TRE.

Table 1. Plausible Value Score Ranges by Level and Skill.

Skill	Below Level 1	Level 1	Level 2	Level 3	Level 4	Level 5
Literacy	<176	176-225	226-275	276-325	326-375	375+
Numeracy	<176	176-225	226-275	276-325	326-375	375+
PS-TRE	<241	241-290	291-340	341+	—	—

Note. PS-TRE = problem solving in technology-rich environments.

Analysis

The first step was to run a model to examine the relationships in general. Modelling in this way allows for detailed analysis of the relationships between the variables in the model. To narrow this study, not all industry sectors were included.

Industry sectors. The study was limited to industry sectors that are predicted by the U.S. Department of Labor's Bureau of Labor Statistics (BLS, 2015) to have the largest projected employment growth between 2014 and 2024, thereby adding the greatest number of new jobs to the U.S. economy. Those sectors were then cross-referenced with the sectors identified in the PIAAC survey (OECD, 2012). There were eight sectors which appeared on both the BLS list and the survey. They were as follows: (a) Accommodation and food service (AFS), (b) Administrative and support service (AdSupp), (c) Construction, (d) Education, (e) Financial and insurance (FI), (f) Human health and social work (HHS), (g) Public administration and defense (PubAdmin), and (h) Wholesale and retail trade including repair of motor vehicles and motorcycles (WRT). These industries are projected to represent 60% of the workforce in 2024 (BLS, 2015). This framework allowed us to access the PIAAC data for those industries that will employ a significant portion of the U.S. population in the coming decade. We then ran models for each of these eight industries and analyzed the results.

For each of the models only complete response cases were used. Some variables were recoded to create models which met reporting standards (an acceptable number of cases) and had statistical power. The details for the analysis procedures for each research question are described in the following sections.

Research Question 1. A linear regression model was run for each of the eight industries. Each model included cooperation/collaboration and information sharing. These two variables had five values along a frequency scale. To meet OECD's reporting standards (AIR PIAAC Team, 2019) and aide in the interpretation of results, the five responses were recoded in slightly different ways. The cooperation/collaboration responses were collapsed to three values: "Up to ½ time" (the reference value, combining "None of the time," "Up to ¼ time," and "Up to ½ time"), "More than ½ time" (unchanged) and "All the time" (unchanged). The information-sharing responses were

collapsed to two values: "Less than once a week" (the reference value, combining "Never," "Less than once a month," and "Less than once a week/at least once a month") and "Once a week or more" (combining "At least once a week" and "Every day"). This recoding was done in order to increase the *n* for each cell as well as practical comprehension of the results—for example, there is very little difference between "Never" and "Less than once a month" or cooperating/collaborating "Up to ¼ time" and "Up to ½ time."

Each model also included the demographic control variables, Education level and Gender with Male as the reference value. The derived Education variable had six values aligned with U.S. education levels. However, because of the variance in respondents' education levels between industries the education level variable was additionally recoded in three different ways to maintain comprehension as well as increase the power of the results (AIR PIAAC Team, 2019). Because of this, the recoded variable is a reflection of the distribution of the education level of each industry. For instance, to increase the number of cases in the higher education levels in the Construction industry the highest recoded category included Associates Degree, Bachelor's Degree, and Graduate Degree.

For four industries (Education, FI, HHS, and PubAdmin), education level was recoded into two levels and this group was categorized as *More College Degrees*. For three industries (AFS, AdSupp, Construction), education level was recoded into four levels and categorized as *Some College Degrees*. Last, WRT was recoded into three levels and categorized as *Fewer College Degrees*. Table 2 details the recoding of the education variable for these three categories.

An alpha level of .05 determined significance for each variable's relationship to the PIAAC competencies. Research Question 1 was addressed using the following base model:

$$PIAAC\ Skills = \beta_0 + \beta_1 COLL + \beta_2 INFO + \beta_3 EDUC + \beta_4 GENDER + Residual$$

In this model, PIAAC skills denoted the predicted average values for the three PIAAC cognitive assessment scores: LIT, NUM, and PS-TRE. β_0 designated the intercept value, while COLL reflected cooperation/collaboration and INFO reflected sharing work-related information. EDUC reflected education level derived and coded as described above. Last, GENDER was included in the model as a binary response choice on the PIAAC survey. Residual is the error term in the model.

Research Question 2. We examined cooperation/collaboration and information sharing and their relationships to various work activities for each of the eight industries. For each skill use at work measure, linear regression was run for COLL, INFO, EDUC, and Gender in a full model for each industry. The variables were coded as they were for Research Question 1.

For Research Question 2, the four specified skills are reflected by four PIAAC-derived variables. All these are indexed variables were derived from a series of self-report questions which form a section of PIAAC survey known as the Job Requirements

Table 2. Education Variable Coding by Industry.

Industry	Acronym used	Education level: Less than high school	HS/HS equivalent	Post-HS certificate or similar	Associate degree	Bachelor degree	Graduate degree
Fewer college degrees							
Wholesale and retail trade; repair of motor vehicles and motorcycles	WRT	Same (reference)	Same	Post-High school education			
Some college degrees							
Accommodation and food service	AFS	Same (reference)	Same	Same	College degree		
Administrative and support service	AdSupp						
Construction	Construction						
More college degrees							
Education	Education	No college degree (reference)			College degree		
Financial and insurance	FI						
Human health and social work	HHS						
Public administration and defense; compulsory social security	PubAdmin						

Note. Shaded areas show the recoded variables. HS = high school.

Approach module (OECD, 2016). Each one is a measurement of the extent to which a person reports using a particular skill at work. They are READWORK: to what extent one uses reading skills (e.g., reading directions, memos, or forms); WRITWORK: to what extent one uses writing skills (e.g., writing letters, memos, or articles); NUMWORK: to what extent one uses numeracy skills (e.g., make or use calculations and prepare charts); and ICTWORK: to what extent one uses information and communication technology skills (e.g., use word processing, spread sheet programs, or an Internet browser). For all four skills, the higher the indexed score the more frequently one uses the skill. The base model was represented with this linear regression model:

$$SKILLUSE = \beta_0 + \beta_1 COLL + \beta_2 INFO + \beta_3 EDUC + \beta_4 GENDER + Residual$$

The alpha level of .05 determined significance for each variable's relationship to cooperation/collaboration and information sharing. In this model, SKILLUSE denoted the four skills-use-at-work variables, β_0 designated the intercept value, with the other variables being the same as in the model for Research Question 1.

Participants

The complete U.S. PIAAC data set included 8,670 respondents (National Center for Education Sciences, 2016), 3,243 of whom work in the eight selected industries and

Table 3. Gender by Industry for the Complete Respondent Population for the Selected Industries (Percentages in Parentheses).

Industry	Male	Female	Total
Accommodation and food service	131 (4.7)	204 (7.2)	335 (11.9)
Administrative and support service	121 (4.3)	101 (3.6)	222 (7.9)
Construction	210 (7.5)	26 (1.0)	236 (8.4)
Education	133 (4.7)	298 (11.0)	431 (15.4)
Financial and insurance	84 (3.0)	112 (4.0)	196 (7.0)
Human health and social work	116 (4.1)	472 (16.8)	588 (21.0)
Public administration and defense; compulsory social security	160 (5.7)	114 (4.0)	274 (10.0)
Wholesale and retail trade; repair of motor vehicles and motorcycles	252 (9.0)	272 (10.0)	524 (18.7)
Total	1,207 (43.0)	1,599 (57.0)	2,806

were considered for the present study. All respondents were between the ages of 16 and 74 years. Tables 3 and 4 present the number of participants in each industry by gender and education level. For this study, only those who identified into one of the eight industries and answered the questions on cooperation/collaboration and information sharing, as well as gender and education level were included. Last, due to the requirement that survey respondents needed to take the PS-TRE assessment on a computer there were a total of 2,806 complete respondent sets used for this study. Of those, approximately 57% of respondents were women and the most common level of educational attainment was a high school diploma or equivalent, at about 40%.

Results

The purpose of the study was to examine relationships between cognitive skills, as measured by the PIAAC survey, and the frequency that people engage in cooperation/collaboration at work as well as the extent to which they share work-related information from industry to industry. Some overarching results regarding cooperation/collaboration and information sharing by industry are included in Table 5 using the original five value Likert-type scale coding. The industry with highest mean for cooperation/collaboration was AFS, while the lowest mean was in Education. With respect to sharing work-related information the highest mean score was in PubAdmin with the lowest in AdSupp. Results for the full models include the intercept (base score) in each skill for each industry and the extent to which the skill is affected by education level, gender, and the behaviors of collaborating at work and sharing work-related information.

Research Question 1

The first research question: What is the relationship between *cooperation/collaboration* and *information sharing* and *literacy, numeracy, and PS-TRE skills* across

Table 4. Education Level by Industry for the Complete Respondent Population for the Selected Industries.

Industry	Less than high school	HS/HS equivalent	Post-HS certificate or similar	Associate degree	Bachelor degree	Graduate degree	Total
Accommodation and food service	65	193	20	25	26	6	335
Administrative and support service	36	105	21	23	32	5	222
Construction	32	130	28	17	23	6	236
Education	9	72	12	24	131	183	431
Financial and insurance	3	58	15	24	71	25	196
Human health and social work	11	185	77	102	122	91	588
Public administration and defense; compulsory social security	0	83	26	28	83	54	274
Wholesale and retail trade; repair of motor vehicles and motorcycles	57	297	38	40	74	18	524
Total	213	1,123	237	283	562	388	2,806

Note. Shaded areas show the variables in their recoded categories. HS = high school.

industry sectors, controlling for gender and education? The detailed results for each model are presented in the appendix as Tables R1.1, R1.2, and R1.3. Table 6 shows the significant results for this question. Analysis revealed a negative correlation to all three PIAAC measures of competencies for those who cooperate all the time as compared with those who cooperate up to ½ time. There were no significant relationships between the PIAAC competencies and those who cooperated/collaborated (between more than half of the time but not all the time), except for those in AFS in literacy and PS-TRE. Meanwhile, those that shared information once a week or more had a positive association with PIAAC competencies with varying degrees across industries and particular competencies.

Research Question 2

The second research question: How does the relationship between *cooperation/collaboration* and *information sharing* and *adults' use of specified skills* differ by industry controlling for gender and education? The four specific skills were reading, writing, numeracy, and information and communication technology (ICT); results varied across industries and types of skill use. As with Research Question 1, the models are presented alongside the appropriate model for all eight industries in Tables R2.1, R2.2, and R2.3 in the appendix. A summary of the significant findings pertaining to this research question is presented in Table 7. The results from the

Table 5. Means and Standard Deviations for Time Cooperating/Collaborating and Sharing of Work-Related Information by Industry.

	Time cooperating/ collaborating			Sharing work-related information		
Industry	*N*	*M*	*SD*	*N*	*M*	*SD*
All eight industries	2,989	3.81	1.36	3,242	4.18	1.31
Accommodation and food service	406	4.31	1.12	412	4.32	1.20
Administrative and support service	213	3.63	1.44	280	3.50	1.69
Construction	247	4.03	1.32	305	4.14	1.38
Education	441	3.27	1.36	459	4.07	1.21
Financial and insurance	195	3.35	1.29	208	4.37	1.05
Human health and social work	618	3.83	1.41	666	4.22	1.31
Public administration and defense; compulsory social security	290	3.84	1.24	293	4.59	0.88
Wholesale and retail trade; repair of motor vehicles and motorcycles	579	3.97	1.31	619	4.19	1.33

second research question, which focused on how often people use various skills, showed cooperation/collaboration at work and sharing work-related information were largely positively related to skills use, although the extent of the relationship varied by industry. Sharing work-related information was positively related to the use of specified skills across industries, while collaborating at work was only related to skills use in four industries—Construction, Education, HHS, and WRT. As with the PIAAC competencies, education level was positively correlated to many of the measures of skills use.

Discussion

Among the eight industries that were the focus of this study, PIAAC competencies were related to cooperation/collaboration at work and sharing of information in some of the eight industries. Skills use at work was related to cooperation/collaboration and information sharing in a small number of industries and in varying ways. The following sections present a detailed discussion of the two research questions, organized by three industry education profiles in this study which are detailed below: More College Degrees, Some College Degrees, and Fewer College Degrees.

PIAAC Competencies: Research Question 1

Research Question 1 asked: What is the relationship between *cooperation/collaboration* and *information sharing* and *literacy, numeracy, and PS-TRE skills* across industry sectors, controlling for gender and education? The following three sections present a discussion of the findings by industry education profiles as detailed in Table 6.

Table 6. Summary of Significant Linear Regression Coefficients Between PIAAC Skills and Cooperation/Collaboration and Information Sharing.

		Literacy			Numeracy		PS-TRE		
		Time cooperating/ collaborating		Sharing work-related information	Time cooperating/ collaborating[a]	Sharing work-related information	Time cooperating/ collaborating		Sharing work-related information
Industry	Acronym used	More than 1/2 the time	All the time	Once a week or more	All the time	Once a week or more	More than 1/2 the time	All the time	Once a week or more
Accommodation and food service	AFS	23.42*					23.68*		
Administrative and support service	AdSupp		−25.91*		−28.05*				
Construction	Construction			22.41*		20.73*			
Education	Education		−15.10*		−18.21*			−16.50*	
Financial and insurance	FI								
Human health and social work	HHS		−13.44*	27.20*	−16.90*	26.38*			
Public administration and defense; compulsory social security	PubAdmin				−17.44*			−14.57*	10.19*
Wholesale and retail trade; repair of motor vehicles and motorcycles	WRT		−22.84*	23.34*	−27.22*	21.33*		−22.68*	16.47*

Note. PIAAC = Program for the International Assessment of Adult Competencies; PS-TRE = problem solving in technologically rich environments.
[a]Estimates not shown were found not to be statistically significant.
*$p < .05$.

Table 7. Summary of Significant Linear Regression Coefficients Between Skills Use at Work and Cooperation/Collaboration and Information Sharing.

		Reading skill use		Writing skill use	Numeracy skill use			Information and communication technology skill use		
		Time cooperating/ collaborating[a]	Sharing work-related information	Sharing work-related information	Time cooperating/ collaborating		Sharing work-related information	Time cooperating/ collaborating		Sharing work-related information
Industry	Acronym used	All the time	Once a week or more	Once a week or more	More than 1/2 of the time	All the time	Once a week or more	More than 1/2 of the time	All the time	Once a week or more
Accommodation and food service	AFS		0.37*							
Administrative and support service	AdSupp		0.38*							
Construction	Construction							0.81*	0.57*	
Education	Education					−0.10*				
Financial and insurance	FI									
Human health and social work	HHS	0.26*	0.50*	0.64*		0.52*				
Public administration and defense; compulsory social security	PubAdmin		0.39*							
Wholesale and retail trade; repair of motor vehicles and motorcycles	WRT	0.26*	0.35*	0.31*	0.29*		0.39*			

[a]Estimates not shown were found not to be statistically significant.
*$p < .05$.

More college degrees. The industries in this profile include Education, FI, HHS, and PubAdmin. Time cooperating/collaborating is negatively related to numeracy in each industry with people in Education, HHS, and PubAdmin who cooperate/collaborate all the time to have lower scores in numeracy (by 18 points, 17 points, and 17 points, respectively) than those people who cooperate/collaborate up to ½ the time. Those who cooperate/collaborate all the time also had lower literacy scores in Education (15 points lower) and HHS (13 points lower), and as well as lower PS-TRE scores in Education (16 points lower) and PubAdmin (14 points lower). In addition, the sharing work-related information more than half the time compared with less is positively associated with both literacy and numeracy in HHS where those who share information once a week or more can expect a numeracy score 27 points higher than those who do not. Given that each level of the PIAAC skills represents a 50-point difference in score many of these differences seem meaningful.

Some college degrees. The industries in this profile include AFS, AdSupp, and Construction. Those in Construction who share work-related information once a week or more could expect scores 22 points and 21 points higher, in literacy and numeracy, respectively, when compared with people who do not. Those in AFS can expect to see a higher literacy score (23 points) and higher PS-TRE scores (24 points) when cooperating more than half the time. Those in AdSupp have lower literacy and numeracy scores when they cooperate all the time.

Fewer college degrees. The one industry in this profile is WRT. Those in this industry reported cooperating/collaborating all the time had lower scores in all three competencies, 23 points lower for literacy, 27 points lower for numeracy, and 23 points lower PS-TRE compared with those who cooperate up to ½ time. The results also suggest that those who share work-related information once a week or more can expect higher scores in all three competencies (23 points higher in literacy, 21 points higher in numeracy, and 16 points higher in PS-TRE. These two results also demonstrate that cooperation/collaboration are not only distinct activities but are different enough to have countering relationships to cognitive skills.

Summary for Research Question 1. The idea that one's literacy, numeracy, and PS-TRE skills are negatively related to frequent cooperation/collaboration differs from research that shows they are positively related (Kilgo et al., 2015; Ku et al., 2013; Steensma, 1996; Støren et al., 2018). One reason for this may be that the more people work in cooperative teams, the more they specialize in their particular skill set within the team. They take on the tasks they enjoy and do most effectively, thus avoid utilizing those skills in which they are weaker. Over a sufficient amount of time, one would expect their ability to use those weaker skills would deteriorate. Another reason may be the reverse—that those people with lower PIAAC skills are more likely to cooperate/collaborate in their work than those with higher skills. In either case, these results provide a contrast to previous research.

Across all eight industries (for all educational profiles), those who share work-related information once a week or more can expect to have higher literacy, numeracy, and PS-TRE scores and vice versa. One possible explanation for this finding may be that jobs in which the jobholder is required to share information also require literacy, numeracy, and PS-TRE competencies, resulting in higher scores for those people. Alternatively, it may be that if a jobholder is frequently interacting with and sharing information, or information is a central commodity of the job, then the jobholder is continuously using, and therefore maintaining or updating, PIAAC-related competencies.

Yet unknown is the direction of the relationship between PIAAC competencies and cooperation/collaboration and information sharing, leaving the following open questions: Do high levels of cooperation/collaboration and information sharing lead to a changed level in PIAAC competencies? Or, do jobholders' levels of PIAAC competency lead them to jobs that require correspondingly more or less cooperation/collaboration and information sharing? What is the relationship between cooperation/collaboration and information sharing? In either case, the findings do not strongly support our first proposition, which was that a high degree of cooperation/collaboration and information sharing is related to higher levels of adult competencies, as measured by PIAAC.

Skills Use at Work: Research Question 2

Research Question 2 asked: How does the relationship between cooperation/collaboration and information sharing and *adults' use of specified skills* differ by industry, controlling for gender and education? The following three sections present a discussion of the findings by industry education profiles as detailed in Table 7.

More college degrees. From the four industries corresponding to this educational profile, HHS showed a positive relationship between reading, writing, and numeracy and sharing work-related information; and a positive relationship between reading and levels of cooperation/collaboration. In PubAdmin, reading use increased with sharing work-related information once a week or more. In Education, there was a negative relationship between numeracy skill use and cooperating all the time.

Some college degrees. In this industry educational profile, there are four significant relationships. Reading skill was positively related to sharing work information once a week or more in AFS and AdSupp. Construction saw a positive correlation in ICT skill use for those who collaborated more than half the time and all the time.

Fewer college degrees. This profile includes only the WRT industry. Sharing work-related information once a week or more was positively correlated to reading, writing, and numeracy skill use on the job. Cooperating all the time was also correlated with

reading skill use, while cooperating more than half the time was positively correlated with numeracy skill use.

Summary for Research Question 2. For the four skills analyzed, reading skill use is positively correlated with the sharing of work-related information in five of eight industries. Writing skill use was strongly correlated with sharing work-related information once a week or more in HHS and WRT. Numeracy skill use was negatively related to cooperation/collaboration in Education and positively related to collaboration in HHS and WRT. Finally, ICT was positively correlated with collaboration time in Construction only. One explanation for this finding is that coordination of the work of many trades across shifts and projects sites and the use of complex project management systems leads the industry toward a heavy reliance on ICT systems to manage their communications.

For Research Question 2, the results regarding sharing work-related information seem to align with the findings from the first question because they are both positively related to literacy. Findings support our Proposition 2: The use the skills related to the PIAAC competencies reinforces their improvement and maintenance.

Study Limitations

Limitations of the study include the possibility that by limiting our analysis to the complete cases for each of our models, the results may not be as generalizable. Furthermore, coefficient estimates may be biased if the incomplete cases were not missing completely at random. A limitation specific to the PS-TRE model for Research Question 1 is that the population was different than those for LIT and NUM. This was due to the PS-TRE responses that were only those from people who were able to complete the assessment on a computer—those who took a paper assessment for PS-TRE did not get a score. Additionally, regarding participant employment, the industry sectors and job types are classified according to broad, internationally relevant categories, creating limitations for interpreting the data and results by sector. Last, the R^2 values for some of the models further limiting the generalizability of the results.

A further limitation of the analysis is the vagaries of language coupled with inability to draw casual direction. For example, the results do not indicate whether people with high skills simply cooperate/collaborate less or people who cooperate/collaborate more do so because they have low skills. There is also the limitation that the collaboration/cooperation and information-sharing measures are confounded with other variables not accounted for in the model. Last, regardless of the specificity with which cooperation, collaboration, and information sharing and other such terms are defined, their definitions vary from person to person thus introducing a source of variance that cannot be eliminated from surveys such as the PIAAC Background Questionnaire.

Significance of the Study

Previous studies have shown that much of the skills and knowledge needed for work is learned informally on the job (Manuti, Pastore, Scardigno, Giancaspro, & Morciano, 2015). Consequently, contemporary workplace learning research examines the environmental conditions and job characteristics that foster a high measure of learning in the workplace. In addition, workplace learning researchers have become increasingly interested in the social characteristics of jobs and how these and other structural features of the workplace foster or thwart individual learning at work. The present study contributes to these ongoing conversations in a variety of ways. First, this study utilized a large, national data set to forge a small sample size of self-reported learning potential of jobs. Second, this study demonstrates how collaboration and teamwork may not, in all cases, lead to increased performance. A high measure of information sharing and collaboration may also detract from learning and skill formation. Finally, the findings of this study, which contract much of the existing literature, suggest the importance of other contextual features of work, in addition to social characteristics.

Implications for Practice and Future Research

Emphasis, or perhaps overemphasis, on cooperation/collaboration as opposed to a more transactional approach of sharing work-related information has some potential to diminish individual performance on PIAAC cognitive competencies. The literature on the effects of job characteristics on workplace learning identifies a number of features that support learning in the workplace; many beyond the social characteristics explored in this study. Other features, such as the task, knowledge, and contextual features also contribute and may interact in ways that matters for the creation of a dynamic learning culture. What this data may show is that in some industries and workplaces there is an overemphasis on the social characteristics in job design, leaving little support and time for the other activities known to support workplace learning, like management support and time for reflection. These results have implications for workplace learning. For example, employers might experiment with a more balanced approach to job design by considering the many features that contribute to a learning culture. Also, employers may wish to consider opportunities to encourage sharing work-related information to balance expectations of cooperation/collaboration. Such encouragement may mean giving jobholders information and having them perform job tasks alone rather than creating highly cooperative environments in which jobholders rely on one another.

Future investigations of the PIAAC data should emphasize learning at work. Building from the present research question, other qualities of participants' work context that

may influence their learning and subsequent performance on the three PIAAC variables of literacy, numeracy, and PS-TRE merit exploration and align with others' calls for future research (Olsen & Tikkanen, 2018). For example, relevant variables and work qualities include autonomy in work tasks, variety of work tasks, task significance, job complexity, jobs with a high degree of learning, frequency and type of skills use at work, and feedback on work performance. Additional research should further explore the influence of demographics characteristics, such as gender (Massing & Gauly, 2017), on workplace learning.

Conclusions

This study is a key starting point to analyze additional future connections between work and job functions and activities, learning at work, and cognitive skills. The positive relationship between information sharing and PIAAC competencies (Research Question 1), information sharing and reading skills at work (Research Question 2), but the inconclusive relationship between cooperation/collaboration suggest that there are inherently different learning requirements and opportunities in information sharing versus cooperation/collaboration. For example, cooperation/collaboration may encourage a divide and conquer approach that allows individuals to stay within an existing specialization rather than learn, creating depth of skill but not breadth. Additionally, the communication burden in information sharing versus cooperation/collaboration may require different utilization of PIAAC competencies and related skills at work. Last, it is possible that these two measures are capturing or masking a source of variation associated with skills and skills use. Certainly, these results leave many questions and potential avenues for future research which may be of interest to adult education and learning scholars and practitioners who operate in a variety of professional contexts. When it comes to collaboration/cooperation at work, we wonder: do we really know what we think we know, and if not, why not? We believe this is an important line of investigation for researchers in the field.

Appendix

Table R1.1. Linear Regression Coefficients of PIAAC Measures by Industry With More College Degrees.

	LIT			NUM			PS-TRE		
Industry sector	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*
Education									
Constant	276.92*	7.37	37.55	268.28*	7.85	34.18	277.26*	9.94	27.88
Time cooperating/collaborating									
More than 1/2 time	−6.49	7.37	−0.88	−3.13	7.64	−0.41	−4.37	8.41	−0.52
All of the time	−15.10*	4.88	−3.10	−18.21*	6.31	−2.89	−16.50*	5.15	−3.20
Sharing work-related information									
Once a week or more	3.98	4.70	0.85	4.91	5.44	0.90	3.21	5.08	0.63
Education level									
College degree	28.40*	7.17	3.96	30.90*	7.37	4.19	15.95	8.58	1.86
Gender									
Female	0.34	5.58	0.06	−12.17*	5.80	−2.10	−0.46	5.14	−0.09
R^2	.15			.16			.07		
Financial and insurance activities									
Constant	272.56*	14.91	18.29	249.08*	16.41	15.18	272.60*	13.33	20.46
Time cooperating/collaborating									
More than 1/2 time	−9.26	9.66	−0.96	−1.52	10.78	−0.14	1.70	8.00	0.21
All of the time	−19.65	10.40	−1.89	−13.78	11.21	−1.23	−6.52	9.38	−0.70
Sharing work-related information									
Once a week or more	9.63	10.93	0.88	16.66	11.28	1.48	5.43	9.72	0.56
Education level									
College degree	28.74*	9.03	3.18	43.70*	9.88	4.42	22.58*	9.04	2.50
Gender									
Female	4.94	7.46	0.66	−11.14	7.59	−1.47	−6.63	6.83	−1.00
R^2	.16			.28			.11		

(continued)

Table R1.1. (continued)

Industry sector	LIT			NUM			PS-TRE		
	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*
Human health and social work activities									
Constant	247.39*	8.89	27.82	236.08*	8.26	28.57	256.22	9.53	26.90
Time cooperating/collaborating									
More than 1/2 time	−3.21	5.73	−0.56	−5.41	5.91	−0.91	2.98	6.92	0.43
All of the time	−13.44*	5.04	−2.67	−16.90*	5.44	−3.11	−8.59	4.72	−1.82
Sharing work-related information									
Once a week or more	27.20*	7.91	3.44	26.38*	7.99	3.30	16.41	8.91	1.84
Education level									
College degree	36.50*	4.08	8.95	40.79*	5.13	7.95	24.37*	4.26	5.73
Gender									
Female	2.48	1.40	1.77	−20.10*	6.54	−3.07	−12.86*	6.25	−2.06
R^2	.23			.25			.14		
Public administration and defense; compulsory social security									
Constant	264.15	12.83	20.58	262.60	13.04	20.14	263.43	3.17	83.19
Time cooperating/collaborating									
More than 1/2 time	−0.84	6.90	−0.12	2.37	9.21	0.26	0.45	3.00	0.15
All of the time	−12.23	6.90	−1.77	−17.44*	7.95	−2.19	−14.57*	2.48	−5.87
Sharing work-related information									
Once a week or more	19.98	11.79	1.69	13.05	12.17	1.07	10.19*	2.57	3.96
Education level									
College degree	28.71*	6.75	4.25	32.63	7.51	4.34	23.64*	2.05	11.54
Gender									
Female	−4.19	5.49	−0.76	−20.45*	6.42	−3.19	−11.86	7.75	−1.53
R^2	.17			.22			.11		

Note. PIAAC = Program for the International Assessment of Adult Competencies; LIT = literacy; NUM = numeracy; PS-TRE = problem solving in technologically rich environments; *SE* = standard error.
*$p < .05$.

Table R1.2. Linear Regression Coefficients of PIAAC Measures by Industry With Some College Degrees.

	LIT			NUM			PS-TRE		
Industry sector	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*
Accommodation and food service activities									
Constant	207.75*	12.15	17.10	197.43*	12.07	16.36	242.88*	12.93	18.78
Time cooperating/collaborating									
More than 1/2 time	23.42*	10.97	2.13	23.80	12.47	1.91	23.68*	10.82	2.19
All of the time	11.29	9.53	1.18	9.57	9.85	0.97	13.11	10.70	1.22
Sharing work-related information									
Once a week or more	−0.51	7.11	−0.07	0.71	7.12	0.10	−6.07	9.12	−0.67
Education level									
HS or equivalent	39.90*	7.40	5.39	38.76*	7.93	4.88	19.03*	7.81	2.44
Post-HS cert or similar	45.24[a]	12.13	3.73	47.31[a]	12.15	3.89	21.12	12.54	1.68
College degree	65.15*	9.91	6.58	67.58*	10.56	6.40	31.81[b]	10.83	2.94
Gender									
Female	4.48	5.94	0.75	−4.90	6.10	−0.80	1.45	5.80	0.25
R^2	.17			.17			.07		
Administrative and support service activities									
Constant	222.53*	14.54	15.30	217.19*	15.03	14.45	264.94*	14.82	17.87
Time cooperating/collaborating									
More than 1/2 time	−7.30	9.79	−0.75	−9.95	11.15	−0.89	−7.57	10.74	−0.70
All of the time	−25.91*	9.20	−2.82	−28.05*	9.87	−2.84	−18.66	9.36	−1.99
Sharing work-related information									
Once a week or more	13.45	10.89	1.23	8.20	11.37	0.72	6.19	11.45	0.54
Education level									
HS or equivalent	31.95*	11.75	2.72	28.93*	12.32	2.35	−7.40	13.24	−0.56
Post-HS cert or similar	25.72	15.79	1.63	28.29	16.75	1.69	−25.37	17.88	−1.42
College degree	61.21*	13.31	4.60	70.10*	14.85	4.72	10.56	15.07	0.70

(continued)

Table R1.2. (continued)

Industry sector	LIT				NUM				PS-TRE			
		b_i	*SE*	*t*		b_i	*SE*	*t*		b_i	*SE*	*t*
Gender												
Female		11.28	7.52	1.50		0.34	8.52	0.04		14.99	8.81	1.70
R^2	.29				.31				.18			
Construction												
Constant		215.92*	15.43	13.99		210.00*	13.92	15.08		235.12*	15.23	15.44
Time cooperating/collaborating												
More than 1/2 time		−0.86	12.05	−0.07		7.97	11.25	0.71		4.53	13.79	0.33
All of the time		−16.60	12.43	−1.34		−19.17	11.01	−1.74		−18.65	10.62	−1.76
Sharing work-related information												
Once a week or more		22.41*	10.19	2.20		20.73*	9.83	2.11		25.88	14.79	1.75
Education level												
HS or equivalent		31.67*	9.96	3.18		32.36*	10.32	3.14		1.19	8.39	0.14
Post-HS cert or similar		44.14[b]	14.83	2.98		62.51[b]	17.31	3.61		21.93[a]	10.83	2.03
College degree		48.50[b]	13.49	3.59		57.54[b]	13.07	4.40		16.30	12.30	1.33
Gender												
Female		9.27	8.29	1.12		−11.00	9.51	−1.16		10.02	12.05	0.83
R^2	.18				.23				.13			

Note. HS = high school; PIAAC = Program for the International Assessment of Adult Competencies; LIT = literacy; NUM = numeracy; PS-TRE = problem solving in technologically rich environments; *SE* = standard error.

[a]Reporting standards not met (less than 30 cases).

[b]Results should be interpreted with caution due to small sample size (between 30 and 61 cases).

*$p < .05$.

Table R1.3. Linear Regression Coefficients of PIAAC Measures With Fewer College Degrees.

	LIT			NUM			PS-TRE		
Industry sector	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*
Wholesale and retail trade; repair of motor vehicles and motorcycles									
Constant	217.74*	8.61	25.29	217.19*	8.82	24.63	252.70*	8.91	28.35
Time cooperating/collaborating									
More than 1/2 time	−3.56	6.19	−0.58	−1.96	6.51	−0.30	−2.26	7.04	−0.32
All of the time	−22.84*	5.26	−4.34	−27.22*	5.37	−5.07	−22.68*	5.51	−4.11
Sharing work-related information									
Once a week or more	23.34*	5.77	4.05	21.33*	6.67	3.20	16.47*	7.20	2.29
Education level									
HS or equivalent	40.62*	8.02	5.07	35.88*	7.18	5.00	7.59	7.13	1.06
Post-HS cert or higher	56.88*	8.11	6.97	54.84*	8.15	6.73	23.11*	8.66	2.67
Gender									
Female	3.63	4.47	0.81	−9.27	4.72	−1.96	1.37	4.61	0.30
R^2	.27			.26			.13		

Note. HS = high school; PIAAC = Program for the International Assessment of Adult Competencies; LIT = literacy; NUM = numeracy; PS-TRE = problem solving in technologically rich environments; *SE* = standard error.
*$p < .05$.

Table R2.1. Means and Regression Coefficients of Indexed Skill Use at Work by Industry With More College Degrees.

	Reading skills			Writing skills			Numeracy skills			Information and communication technology skills		
Industry sector	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*
All industries												
Constant	1.60*	0.05	31.63	1.63*	0.06	29.57	1.98*	0.06	34.49	1.61*	0.07	23.21
Time cooperating/collaborating												
More than 1/2 time	0.02	0.05	0.34	0.00	0.05	0.02	0.05	0.04	1.22	0.06	0.05	1.20
All of the time	−0.04	0.04	−1.20	−0.01	0.04	−0.27	−0.02	0.04	−0.43	−0.21*	0.05	−4.18
Sharing work-related information												
Once a week or more	0.45*	0.05	9.86	0.46*	0.05	10.05	0.26*	0.05	4.86	0.39*	0.05	7.42
Education level												
College degree	0.65*	0.03	23.58	0.49*	0.03	16.10	0.33*	0.04	8.75	0.57*	0.04	13.28
Gender												
Female	−0.10*	0.03	−3.82	−0.05	0.03	−1.60	−0.24*	0.04	−6.23	−0.12*	0.04	−2.92
R^2	.14			.08			.05			.10		
Education												
Constant	1.88*	0.17	10.81	1.76*	0.18	9.89	1.80*	0.23	7.71	1.60*	0.24	6.62
Time cooperating/collaborating												
More than 1/2 time	0.07	0.20	0.35	0.18	0.12	1.51	−0.04	0.14	−0.66	0.16	0.13	1.21
All of the time	0.04	0.11	0.32	0.20	0.14	1.42	−0.10*	0.15	2.01	−0.08	0.13	−0.64
Sharing work-related information												
Once a week or more	0.25	0.11	2.33	0.22	0.12	1.84	0.34	0.17	2.01	0.23	0.14	1.64
Education level												
College degree	0.88*	0.15	5.97	0.62*	0.14	4.32	0.26	0.17	1.51	0.57*	0.15	3.78

(continued)

Table R2.1. (continued)

Industry sector	Reading skills				Writing skills				Numeracy skills				Information and communication technology skills			
		b_i	*SE*	*t*		b_i	*SE*	*t*		b_i	*SE*	*t*		b_i	*SE*	*t*
Gender																
Female		−0.15	0.11	−1.37		−0.04	0.10	−0.35		−0.12	0.10	−1.17		−0.15	0.11	−1.33
R^2	.18				.08				.04				.10			
Financial and insurance activities																
Constant		2.56*	0.21	12.30		2.37*	0.18	12.97		2.62*	0.23	11.48		2.48*	0.26	9.42
Time cooperating/collaborating																
More than 1/2 time		0.12	0.21	0.58		0.03	0.17	0.18		0.11	0.12	0.88		0.08	0.20	0.37
All of the time		−0.04	0.16	−0.24		0.11	0.16	0.68		0.16	0.16	1.02		−0.21	0.25	−0.83
Sharing work-related information																
Once a week or more		0.18	0.14	1.30		0.07	0.16	0.41		−0.02	0.24	−0.09		0.36	0.22	1.62
Education level																
College degree		−0.12	0.15	−0.80		0.01	0.12	0.11		0.18	0.14	1.31		0.15	0.19	0.78
Gender																
Female		−0.21	0.13	−1.63		0.05	0.11	0.44		−0.28*	0.12	−2.41		0.00	0.15	0.00
R^2	.03				.01				.04				.03			
Human health and social work activities																
Constant		1.47*	0.12	12.15		1.96*	0.14	13.94		1.39*	0.16	8.52		1.59*	0.16	9.85
Time cooperating/collaborating																
More than 1/2 time		0.13	0.10	1.21		−0.22	0.13	−1.72		0.06	0.17	0.38		0.02	0.15	0.15
All of the time		0.26*	0.07	3.56		0.08	0.09	0.85		0.02	0.12	0.15		−0.03	0.10	−0.26
Sharing work-related information																
Once a week or more		0.50*	0.09	5.78		0.64*	0.13	4.73		0.52*	0.12	4.41		0.22	0.14	1.55

(continued)

Table R2.1. (continued)

Industry sector	Reading skills			Writing skills			Numeracy skills			Information and communication technology skills		
	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*
Education level												
College degree	0.47*	0.06	8.30	0.30*	0.09	3.46	0.28*	0.08	3.50	0.24*	0.09	2.62
Gender												
Female	−0.01	0.09	−0.06	−0.33*	0.12	−2.81	−0.10	0.11	−0.87	−0.21	0.11	−1.91
R^2	.18			.11			.07			.04		
Public administration and defense; compulsory social security												
Constant	2.16*	0.17	13.00	2.49	0.27	9.09	2.29*	0.36	6.45	1.96*	0.28	6.90
Time cooperating/collaborating												
More than 1/2 time	0.04	0.13	0.33	0.23	0.15	1.55	0.15	0.25	0.59	0.20	0.16	1.23
All of the time	−0.05	0.13	−0.36	0.10	0.18	0.56	−0.18	0.24	−0.75	−0.11	0.15	−0.71
Sharing work-related information												
Once a week or more	0.39*	0.18	2.21	0.07	0.28	0.24	−0.40	0.33	−1.21	0.10	0.28	0.37
Education level												
College degree	0.34*	0.11	3.02	0.16	0.14	1.08	0.41*	0.17	2.41	0.34*	0.16	2.15
Gender												
Female	−0.34*	11.00	−3.20	−0.17	0.12	−1.50	−0.09	0.14	−0.64	0.03	0.14	0.21
R^2	.14			.08			.06			.10		

Note. *SE* = standard error.
*$p < .05$.

Table R2.2. Means and Regression Coefficients of Indexed Skill Use at Work by Industry With Some College Degrees.

	Reading skills			Writing skills			Numeracy skills			Information and communication technology skills		
Industry sector	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*
All industries												
Constant	1.06*	0.06	18.47	1.19*	0.10	12.42	1.84*	0.07	26.46	1.20*	0.11	10.55
Time cooperating/collaborating												
More than 1/2 time	0.02	0.05	0.52	0.01	0.05	0.15	0.05	0.04	1.29	0.06	0.05	1.25
All of the time	0.00	0.03	−0.05	0.01	0.04	0.19	−0.01	0.04	−0.25	−0.21*	0.05	−3.99
Sharing work-related information												
Once a week or more	0.39*	0.05	8.55	0.44*	0.05	9.70	0.25*	0.05	4.70	0.38*	0.05	7.05
Education level												
HS or equivalent	0.64*		11.98	0.48*	0.08	5.63	0.15*	0.06	2.68	0.42*	0.09	4.45
Post-HS cert or similar	0.90*		9.79	0.65*	0.10	6.26	0.24*	0.07	3.50	0.53*	0.14	3.93
College degree	1.24*		26.41	0.95*	0.09	10.82	0.48*	0.06	8.24	0.98*	0.11	9.14
Gender												
Female	−0.12*		−4.83	−0.06	0.03	−1.78	−0.25*	0.04	−6.27	−0.13*	0.04	−3.04
R^2	.18			.09			.05			.11		
Accommodation and food service activities												
Constant	0.64*	0.19	3.28	1.32*	0.34	3.82	2.04*	0.27	7.47	1.32*	0.64	2.07
Time cooperating/collaborating												
More than 1/2 time	0.03	0.18	0.17	−0.52	0.29	−1.75	0.14	0.21	0.67	0.29	0.31	0.94
All of the time	0.27	0.17	1.57	−0.17	0.23	−0.75	0.32	0.16	1.94	0.38	0.25	1.53
Sharing work-related information												
Once a week or more	0.37*	0.16	2.36	0.58	0.31	1.85	−0.05	0.24	−0.22	−0.24	0.68	−0.36

(continued)

Table R2.2. (continued)

Industry sector	Reading skills b_i	Reading skills *SE*	Reading skills *t*	Writing skills b_i	Writing skills *SE*	Writing skills *t*	Numeracy skills b_i	Numeracy skills *SE*	Numeracy skills *t*	Information and communication technology skills b_i	Information and communication technology skills *SE*	Information and communication technology skills *t*
Education level												
HS or equivalent	0.42*	0.09	4.46	0.06	0.20	0.28	−0.06	0.14	−0.45	0.14	0.26	0.52
Post-HS cert or similar	0.39	0.32	1.25	0.26	0.62	0.41	0.17	0.24	0.72	0.04	0.36	0.11
College degree	1.06*	0.24	4.34	0.83*	0.24	3.43	0.39	0.24	1.66	0.80*	0.30	2.63
Gender												
Female	−0.16	0.12	−1.30	−0.29	0.21	−1.36	−0.24	0.15	−1.56	−0.41	0.22	−1.84
R^2	.17			.16			.06			.16		
Administrative and support service activities												
Constant	0.58*	0.21	2.85	1.12*	0.36	3.09	1.57*	0.23	6.69	0.85*	0.31	2.73
Time cooperating/collaborating												
More than 1/2 time	−0.41	0.25	−1.66	−0.46	0.28	−1.62	−0.12	0.22	−0.54	0.51	0.36	1.41
All of the time	0.00	0.17	−0.01	0.26	0.22	1.21	−0.04	0.20	−0.21	0.50	0.28	1.80
Sharing work-related information												
Once a week or more	0.38*	0.16	2.34	0.24	0.20	1.22	0.27	0.21	1.27	0.17	0.33	0.51
Education level												
HS or equivalent	1.00*	0.28	3.61	0.93*	0.39	2.37	0.34	0.22	1.54	0.64	0.35	1.85
Post-HS cert or similar	1.52[a]	0.71	2.15	0.50	0.48	1.04	0.98	0.51	1.90	0.95	0.59	1.62
College degree	1.32*	0.32	4.19	1.27*	0.39	3.27	0.93*	0.26	3.59	1.31*	0.35	3.73
Gender												
Female	−0.05	0.17	−0.31	−0.05	0.03	−1.46	−0.32	0.18	−1.75	−0.09	0.32	−0.28
R^2	.20			.16			.11			.10		

(continued)

Table R2.2. (continued)

Industry sector	Reading skills			Writing skills			Numeracy skills			Information and communication technology skills		
	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*
Construction												
Constant	1.04*	0.30	3.48	1.36*	0.37	3.66	1.75*	0.20	8.75	0.61	0.56	1.08
Time cooperating/collaborating												
More than 1/2 time	0.09	0.22	0.41	0.45	0.26	1.73	0.29	0.19	1.53	0.81*	0.36	2.24
All of the time	0.03	0.18	0.17	0.03	0.19	0.13	0.23	0.19	1.25	0.57*	0.27	2.16
Sharing work-related information												
Once a week or more	0.19	0.20	0.96	0.35	0.29	1.21	0.27	0.19	1.42	0.10	0.38	0.26
Education level												
HS or equivalent	0.84*	0.28	3.06	0.22	0.30	0.76	0.16	0.17	0.95	0.76	0.42	1.79
Post-HS cert or similar	0.94[b]	0.26	3.61	0.04	0.39	0.11	0.38	0.22	1.42	0.37	0.46	0.81
College degree	1.25[b]	0.32	3.61	0.79*	0.36	2.22	0.90*	0.22	4.04	1.34*	0.47	2.87
Gender												
Female	−0.31	0.25	−1.20	−0.40	0.28	−1.39	−0.03	0.04	−0.70	−0.22*	0.05	−4.23
R^2	.12			.12			.13			.18		

Note. HS = high school; *SE* = standard error.
[a]Indicates reporting standards not met (less than 30 cases).
[b]Indicates the results should be interpreted with caution due to small sample size (between 30 and 61 cases).
*$p < .05$.

Table R2.3. Means and Regression Coefficients of Indexed Skill Use at Work With Fewer College Degrees.

Industry sector	Reading skills			Writing skills			Numeracy skills			Information and communication technology skills		
	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*	b_i	*SE*	*t*
All industries												
Constant	1.07*	0.06	18.17	1.19*	0.10	12.51	1.84*	0.07	26.66	1.21*	0.12	10.54
Time cooperating/collaborating												
More than 1/2 time	0.02	0.05	0.42	0.01	0.05	0.14	0.05	0.04	1.23	0.06	0.05	1.17
All of the time	−0.03	0.04	−0.69	−0.01	0.04	−0.27	−0.03	0.04	−0.69	−0.24*	0.05	−4.75
Sharing work-related information												
Once a week or more	0.40*	0.05	8.60	0.45*	0.05	9.91	0.26*	0.05	4.86	0.40*	0.06	6.93
Education level												
HS or equivalent	0.64*	0.05	11.94	0.47*	0.08	5.60	0.15*	0.06	2.64	0.41*	0.09	4.37
Post-HS cert or higher	1.17*	0.05	23.15	0.89*	0.09	10.30	0.43*	0.05	7.90	0.91*	0.11	8.41
Gender												
Female	−0.12*	0.03	−4.64	−0.06	0.03	−1.76	−0.25*	0.04	−6.17	−0.12*	0.04	−3.00
R^2	.17			.09			.05			.09		
Wholesale and retail trade; repair of motor vehicles and motorcycles												
Constant	1.16*	0.14	8.13	0.95*	0.23	4.07	1.56*	0.18	8.52	1.17*	0.28	4.13
Time cooperating/collaborating												
More than 1/2 time	0.02	0.18	0.13	0.27	0.17	1.55	0.29*	0.13	2.24	−0.03	0.17	−0.16
All of the time	0.26*	0.11	2.28	0.17	0.14	1.19	0.16	0.11	1.45	−0.20	0.13	−1.54
Sharing work-related information												
Once a week or more	0.35*	0.10	3.64	0.31*	0.13	2.31	0.39*	0.11	3.60	0.27	0.19	1.43
Education level												
HS or equivalent	0.52*	0.13	3.94	0.50*	0.21	2.37	0.23	0.13	1.82	0.24	0.22	1.11
Post-HS cert or higher	0.94*	0.12	7.89	0.79*	0.24	3.33	0.64*	0.14	4.45	0.82*	0.24	3.40
Gender												
Female	−0.25*	0.09	−2.89	0.00	0.11	0.02	−0.07	0.11	−0.64	0.02	0.12	0.19
R^2	.11			.05			.08			.09		

Note. HS = high school; *SE* = standard error.
*$p < .05$.

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