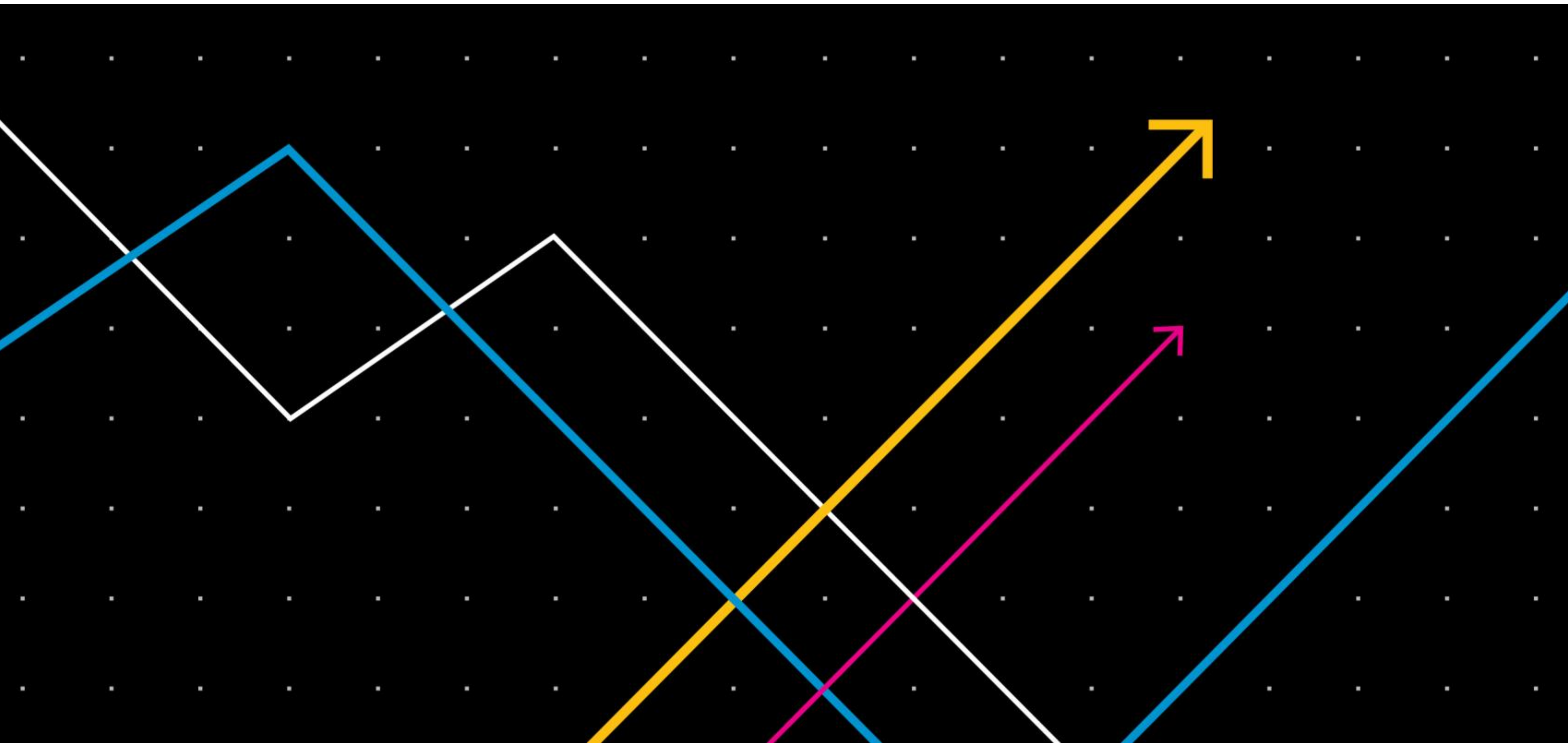

RESEARCH REPORT

How Do Workers Think about the Relationship between Their Job and Their Degree?

Evidence from the Science and Engineering Workforce

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Introduction

College graduates do not always use what they learn during school in their day-to-day work. In many cases, this disconnect between school and work is natural. Most jobs, even jobs closely related to a worker's field of study, include administrative and employer-specific tasks that are not taught in school. But sometimes workers do not use what they learn in school because they are employed far outside their field of study. Concerns about low levels of job relatedness have been particularly acute for science and engineering graduates. Research on job relatedness drives public debates about science and engineering worker shortages and occupational pathways. If science and engineering graduates are not using their education on the job, it could indicate a serious waste of human capital.

The most common data source for studying job relatedness is the National Science Foundation's National Survey of College Graduates (NSCG), which asks respondents about how their work on their "principal job" relates to their "highest degree." The NSCG is a representative survey of all college degree holders in the US, with particularly robust data collection on science and engineering graduates. In recent years, research on the relatedness of workers' jobs to their field of study has exploded. Much of this research focuses on the science and engineering workforce and has made use of the job relatedness data collected by the National Science Foundation. According to most studies, having a job unrelated to your field of study leads to job dissatisfaction and reduced earnings. Women in science and engineering are especially likely to exit jobs related to their field of study, though many disagree about what drives this.

Existing research on job relatedness has not investigated what respondents think of when they report their job relatedness on the NSCG. What does a "related job" really mean to respondents, and what are we measuring and analyzing when we use these data? Research takes self-reports of job relatedness as given without detailing precisely what the NSCG measures. No work has been done to understand why respondents answer the job relatedness question in the way that they do. This uncertainty around the National Center for Science Engineering Statistics (NCSES) job relatedness questions differs from other subjective questions in the NSCG, like about job satisfaction, which are well understood and validated. A better understanding of the job relatedness question will improve research on job relatedness and will be valuable for future revisions of the NSCG survey instrument.

To fill this knowledge gap, we analyze the NSCG to identify the individual and job characteristics that induce respondents to identify their job as related to their highest degree. Inferences about respondents' interpretation of job relatedness questions from existing NSCG data are necessarily indirect. We address this weakness in the analysis of the NSCG data by conducting semistructured interviews with college graduates to directly investigate their understanding and interpretation of job relatedness. Both the NSCG data analysis and the semistructured interviews provide insights into the use of and possible revisions to the NSCG's job relatedness variables.

This report focuses on the job relatedness question included in the NSCG, reproduced below in box 1. Respondents are asked about how their principal job relates to their highest degree, and they can answer that it is "closely related," "somewhat related," or "not related." The 2015 NSCG (the most recent survey wave) suggests that over 55 percent of employed college graduates report working in closely related jobs, 25 percent report working in somewhat related jobs, and 20 percent are in jobs that are not related. These results have been stable over time, based on the results of past waves of the NSCG. Public-use NSCG microdata is available for survey waves going back to 1993.

BOX 1

NSCG Job Relatedness Question

To what extent was your work on your principal job related to your highest degree? Was it:

[Mark one answer]

- Closely related
- Somewhat related
- Not related

Note: See the 2015 NSCG questionnaire at https://www.nsf.gov/statistics/srvygrads/surveys/srvygrads-newrespond2015.pdf.

The NSCG offers more reliable information on job relatedness than the available alternatives. Many surveys commonly used in social science research (e.g., the Census, the Current Population Survey, or the American Community Survey) include information on a respondent's educational background and labor market experiences but do not collect information on how a respondents' education connects to their work. Without an explicit question on job relatedness, such as the one asked in NSCG, this relationship can only be imperfectly inferred. Rothwell (2013), the Census Bureau,[1] Abel and Deitz (2015), Montt (2017), and Sellami et al. (2017) make independent, researcher-driven determinations about which occupations are related to a field of a study. By construction, these measures of job relatedness do not capture the diversity of job relatedness within an occupation-degree combination.

A related job could correspond directly with a field of study and a broad occupational category (e.g., an engineering major working as an engineer). Or, it could represent a worker's subjective assessment of more detailed tasks. A manager of a production line in a manufacturing plant with an engineering degree could use her knowledge of engineering frequently and report that she is employed in a related job. Alternatively, a worker that reports being an engineer rather than a manager, but whose day is consumed by sales tasks, meetings, or supervisory responsibilities may, in frustration, report their job as unrelated to their degree.

The analyses in this report distinguish between **factors that cause a graduate to work in an unrelated job**, such as family formation, lack of available related jobs, or weak job-finding networks, and **factors that induce a graduate to identify a job as unrelated**, such as job tasks or knowledge requirements. Though most existing literature discusses the former, this report reviews the latter. Several factors likely contribute to a survey respondent's subjective assessment of their job as related to their field of study. The most important determinant of job relatedness is the respondent's occupation, with some occupations hewing more closely to a field of study than other occupations. However, we hypothesize that occupations are complex constructs characterized by substantial within-occupation heterogeneity in workers' experiences. The details of a worker's tasks, supervisory responsibilities, and outputs— mediated by their career expectations—will determine their response to questions about how their job relates to their field of study. When a worker spends time in a job, their prior expectations about that job are either validated or invalidated, thus potentially changing how they think about their job. See Brunhaver and colleagues (2018) for a discussion of this process in engineering.

This report is the first focused attempt to understand how respondents think about the job relatedness question in the NSCG. It begins with a review of two important literatures: studies on the costs of low job relatedness for workers and studies that develop the "task approach" to labor markets, which provides a theoretical basis for our qualitative and quantitative data analyses. After the literature review, we explore whether differences in job relatedness are explained by differences in knowledge requirements on the job. Though knowledge requirements for a respondent's field of study are strongly associated with job relatedness, they do not explain all observed variation in job relatedness. We then analyze quantitative data from the NSCG and qualitative data collected during interviews to identify the factors contributing to workers' assessments of job relatedness. In addition to knowledge requirements, job tasks, federal support for research, and membership in professional associations are closely associated with job relatedness. Management tasks, which are typically contrasted with research and development responsibilities, were positively related to job relatedness in both the NSCG analysis and the interviews. This report concludes with a discussion of major themes and recommendations for future NSCG waves.

Literature Review

This section reviews two literatures relevant to this report: one on the consequences and causes of low job relatedness and another on the "task approach" to labor markets. The extant literature uses the NSCG job relatedness measure either as an independent variable determining wages (or some other outcome) or as a dependent variable determined by workers' decisions or external pressures. Both applications would benefit from a stronger understanding of the job relatedness variable. We also review the task approach to labor markets, because understanding jobs as equilibrium bundles informs our subsequent data analysis and interviews

The Causes and Effects of Low Job Relatedness

The literature estimating the change in earnings associated with working in an unrelated job is one of the most active areas of study using the NSCG's job relatedness measures. These studies traditionally find there is a large earnings decline associated with working in an unrelated job. Robst (2007a), one of the first papers in the literature, finds that working in an unrelated job comes with a 10 percent reduction in earnings for women and a 12 percent reduction for men, compared with workers in closely related jobs. These reductions are not constant across majors; liberal arts and humanities majors are more likely to work in related job, but the costs associated with low job relatedness for these graduates are not statistically different from zero. In contrast, natural science majors are more likely to work in jobs that are related to their field of study, but the cost of working in an unrelated job for natural science majors is greater. The social sciences present an intermediate case. These costs are also apparent when using a combined measure of overeducation (i.e., greater educational attainment than is required for the job) and mismatch (Robst 2008). Using subsequent years of National Center for Science Engineering Statistics data, Bender and Heywood (2009) both confirms Robst's (2008, 2007a) finding that low job relatedness is associated with reduced earnings and finds that it is also associated with reduced job satisfaction. Low job relatedness can also result in earlier retirement (Bender and Heywood 2017), and its costs are higher for lower-income people.[2]

Robst (2007b) further demonstrates that the costs of low job relatedness vary by reasons for mismatch: when workers are in unrelated jobs because of reduced demand, job amenities, or other constraints, they experience greater earnings reductions. Hunt (2016), another recent and widely cited analysis, uses the 2003 and 2010 NSCG to show that dissatisfaction with pay and promotion opportunities especially explain women's exits from science and engineering. This finding contrasts with prior research that finds family-related constraints as women's primary reasons for exiting jobs related to their science and engineering degrees (Preston 1994). Robst (2007b) emphasizes that reasons for working in an unrelated job are often endogenous to the wage itself, raising important concerns about attributing causality to these estimates.

Educational experiences of a major or degree are not homogenous: the same major can cover diverse coursework. Course variation within a major affects the costs of low job relatedness. Silos and Smith (2015) finds that switching occupations is associated with higher earnings for graduates who took diverse courses, presumably because broader educational portfolios allow workers to adapt to new occupational settings.

Working in an unrelated job is closely associated with entrepreneurial activity and self-employment (Bender and Roche 2013; Sell 2013; Stenard and Sauermann 2016). Self-employed workers are more likely to take on various management and sales responsibilities not directly related to their field of study. But in other cases, dissatisfaction with working in an unrelated job may push workers into self-employment. In Europe, workers who transition to self-employment increase their job relatedness, relative to the job they held before self-employment (Albiol Sanchez, Diaz-Serrano, and Teruel 2015). Among self-employed workers, those who continue in jobs unrelated to their degrees lose more earnings than workers who are not self-employed (Bender and Roche 2013).

Job relatedness measures have been used to understand the dynamics of narrower labor markets or fields of study, including psychology (Rajecki and Borden 2009); economics and business (Robst, VanGilder, and Steinke 2016); and engineering technology (Frase, Latanision, and Pearson 2017; Kuehn et al. 2015). These analyses show that the prevalence and impact of working in an unrelated job varies by field of study—highlighted previously by Robst (2007a). However, as in much of the literature on job relatedness, none of these analyses explore how respondents' understanding of what constitutes a "related job" varies by field. Respondents with differing backgrounds and experiences may understand the implications of the question differently.

Although much of the existing research treats working in an unrelated job as an unexpected, costly experience, some workers with good job prospects outside of their field of study choose to work in unrelated jobs willingly and rationally. Although workers with high job relatedness consistently earn more than those with low job relatedness, workers who self-select unrelated jobs may nevertheless earn more in their unrelated job options than they would have earned in an available related job. While unrelated jobs pay less on average, they may be a better deal for workers who self-select into them. An extreme and cliché example of this sort of self-selection would be a physics graduate working as a "quant" on Wall Street because it pays substantially more than working in a postdoctoral position or as a faculty member at a small liberal arts college. More typical cases might include science and engineering majors taking up unrelated management positions. Many researchers have recently explored self-selection into related and unrelated jobs (Gilmartin et al. 2018; Lee and Sabharwal 2016; Melguizo and Wolniak 2012; Zhu 2014).[3]

The National Center for Science Engineering Statistics largely focuses on the US, but job relatedness is a fertile area of research in other countries too. In addition to cross-country studies (Morgado and colleagues 2014; Verhaest, Sellami, and van der Velden 2017), researchers have studied job relatedness in Belgium (Sellami and colleagues 2017); Canada (Boudarbat and Chernoff 2012); France (Béduwé and Giret 2011); Germany (Ortiz and Kucel 2008); Ireland (Kelly, O'Connell, and Smyth 2010); Italy (Iammarino and Marinelli 2015); Korea (Kim and Park 2016); Pakistan (Farooq 2011); Spain (Oritz and Kucel 2008); and Switzerland (Pecoraro 2014). Findings are comparable to those in the literature on the US: low levels of job relatedness are associated with reduced earnings and job satisfaction. The lacuna in that literature is also comparable to that of the US: job relatedness measures with some prima facie plausibility are analyzed, but without in-depth exploration or validation.

The Task Approach to Labor Markets

Job relatedness measures vary across workers because occupations are more fluid and less homogenous than standard occupational classifications imply. Recently, labor economists have considered jobs as bundles of tasks that can be performed using various skills. Tasks are allocated through normal processes of comparative advantage and are influenced by technological progress. Autor and Handel (2013) argue that analyzing job tasks instead of education levels is integral to labor economics because tasks differ from education in two major respects. First, tasks are not durable investment goods like education: Workers and employers can modify task inputs as job requirements change. Assigning workers into tasks implies no one-to-one mapping between a worker's stock of human capital and the tasks performed. Second, tasks differ from traditional approaches to human capital because tasks are a high-dimensional bundle of activities; they must be performed jointly to produce output.

The task approach to understanding labor markets emerged from the inability of what Acemoglu and Autor (2011) call the “canonical model” to fully explain many labor market phenomena. The canonical model draws an equivalence between workers’ skills and their job tasks; technology is either a substitute for or a complement for labor, and this relationship is fixed. Technologies cannot replace particular tasks in the canonical model because the assignment of tasks to labor is static (Acemoglu and Autor 2011). However, a large body of research shows that capital can simultaneously substitute for and complement an occupation’s narrower tasks, suggesting that analyzing labor markets at a task level is useful (Autor 2013).

Autor, Levy, and Murnane (2003) provides an early empirical foundation for this approach. They test a “routinization hypothesis” whereby jobs with more routine task inputs are more likely to be automated (i.e., substituted for capital) than those with less routine tasks. The task approach to labor markets helps clarify which workers are vulnerable to trade flows (Antràs, Garicano, and Rossi-Hansberg 2006; Blinder 2009; Grossman and Rossi-Hansberg 2008; Jensen and Kletzer 2010) and technological change (Autor and Dorn 2013; Autor, Levy, and Murnane 2003; Goos and Manning 2007; McKinsey Global Institute 2017).

Empirically testing task models requires datasets that capture unique tasks performed on the job. The Occupational Information Network (O*NET), the most commonly used data on job tasks for the US, provides information on the knowledge, skills, and abilities required to work in many detailed occupations. We use the O*NET data in this report to supplement the NSCG. The major limitation of the O*NET data for job relatedness is that tasks are identified at the occupational level, not the worker level, preventing analysis of within-occupation heterogeneity. These data are also difficult to revise consistently and therefore only provide a static picture of job tasks and other characteristics.

Autor and Handel (2013) collects new data as a part of the Princeton Data Improvement Initiative survey on the job activities across various domains for a representative sample of US workers. Their analysis found that person-level measures of job tasks have predictive power for earnings.

A longitudinal dataset created by Stinebrickner, Stinebrickner, and Sullivan (2017), the Berea Panel Study, directly measures job tasks as reported by workers. Analysis of the Berea Panel Study identified a strong relationship between wages and job tasks, again validating the task model’s usefulness, even with data limitations. One study using German employment survey data found that changes in task composition of employment in between 1979 and 1999 are “primarily accounted for by changes in task inputs within detailed occupations rather than shifts in employment across occupational categories” (Autor 2013).[4]

Although the task approach tends not to focus on detailed occupations, some studies have analyzed the job tasks performed by science, technology, engineering, and mathematics (STEM) workers. Brunhaver and colleagues (2018) argues that STEM degree holders are especially prone to frustration with nontechnical professional skills and tasks on the job. STEM graduates perceive their degrees as highly technical and not requiring high-level professional skill, which influences their perception of their current job and can lead them to think less of these tasks when considering their job relatedness. Frase, Latanision, and Pearson (2017) surveyed employers of engineering technologists and engineering technicians to understand the task differences between those workers. The surveys suggested that technicians had more restricted task sets and were more likely to do maintenance and testing.

Use of Knowledge on the Job

The most obvious dimension along which workers may think about the relationship between their job and their degree is the level and type of knowledge used on the job. If knowledge requirements strongly align with a worker's field of study, their job should be closely related. This section explores the strength of the relationship between knowledge requirements and job relatedness.

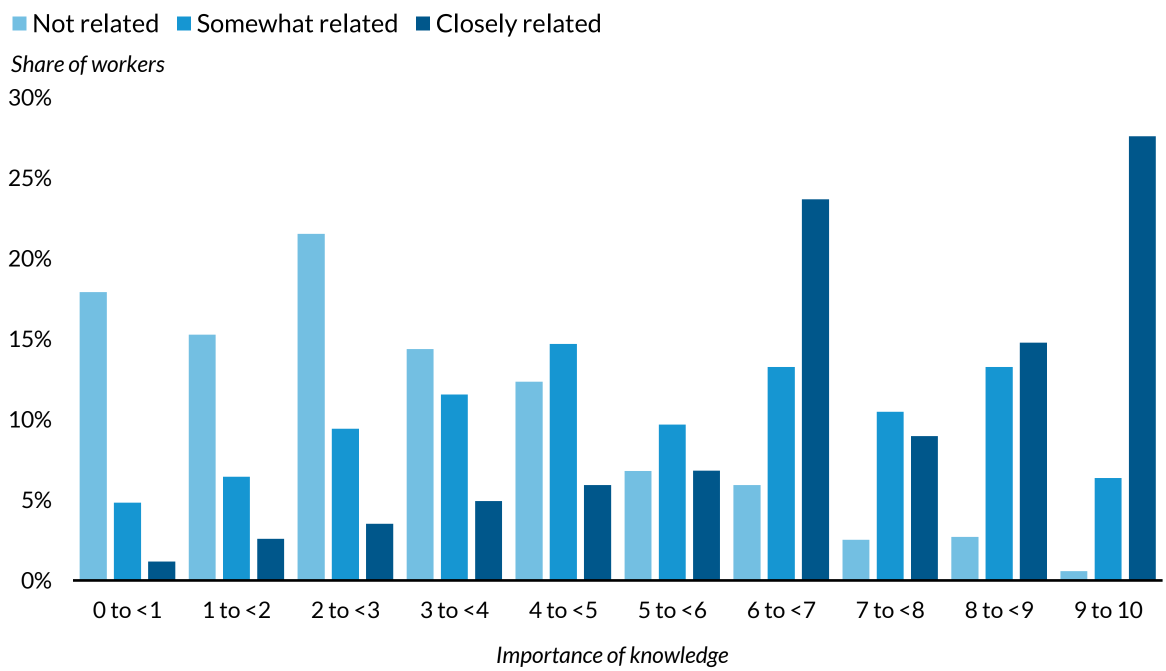
Unfortunately, the NSCG does not ask respondents about the knowledge requirements of their job. The most comprehensive data on occupational knowledge requirements are available in the US Department of Labor's O*NET database discussed previously. Knowledge requirements are recorded in O*NET by the importance of a domain of knowledge to a job and by the level of a domain of knowledge required for a job. Importance indicates how essential a knowledge or skill is, and level indicates the degree of mastery required. For example, engineering knowledge would be of high *importance* for both an engineer and an engineering technician, but the *level* of knowledge required is higher for an engineer. The O*NET database uses a one-to-five scale for importance measures and a zero-to-seven scale for level measures. For this report, we rescale both measures to a zero-to-ten scale.

We merge the O*NET data onto NSCG respondents' records using their occupational category to provide the best information on the *importance* and *level* of knowledge of their field of study required for their current job (figure 1). The distribution of knowledge importance and required knowledge levels for STEM majors in the NSCG for each job relatedness category is presented in figures 1 and 2, respectively. The importance and level of knowledge required for the job are represented on the horizontal axis using a scale from zero to ten (with zero indicating low knowledge requirements and ten indicating high knowledge requirements). Respondents who work in unrelated jobs have lower knowledge importance for their field of study than respondents in somewhat or closely related jobs. The average importance of a respondent's field of study is 3.3 for respondents in unrelated jobs, 5.7 for somewhat related jobs, and 7.8 for closely related jobs.

FIGURE 1

Importance of Knowledge of a STEM Major's Field of Study for Their Occupation

By job relatedness category



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Sources: 2013 and 2015 NSCG. Knowledge requirements are from the US Department of Labor's O*NET database.
Notes: Distributions are calculated for the analysis sample of STEM graduates in the 2013 and 2015 NSCG. Importance of knowledge of each respondent's field of study to their occupation from the O*NET database is rescaled to a zero-to-ten scale and plotted separately for each job relatedness category.

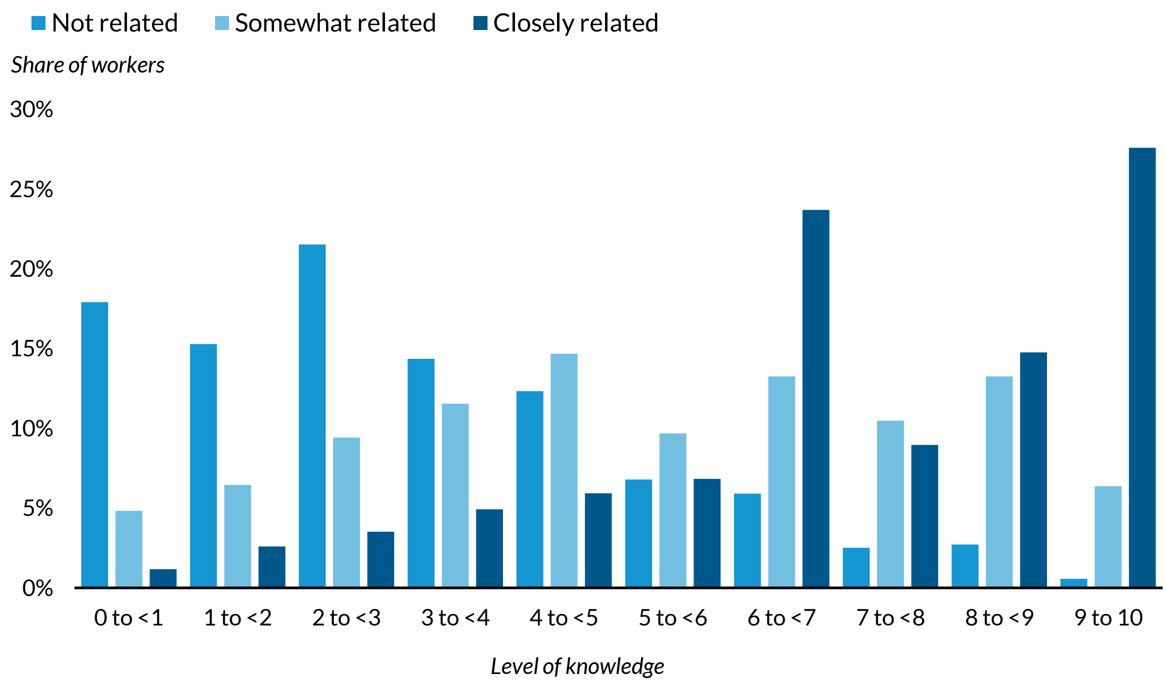
A similar pattern emerges for level requirements (figure 2). The average level of knowledge of a respondent's field of study required for their job is 3.1 for unrelated, 5.3 for somewhat related, and 7.0 for closely related jobs. The differences between these averages are all statistically significant. Despite these statistically significant differences in average knowledge requirements, all three job relatedness categories exhibit wide variability of knowledge requirements for their field of study *within the job relatedness category*. Approximately 18 percent of respondents in unrelated jobs still have higher knowledge importance and level scores in their field of study than the average for respondents in somewhat related jobs. This distribution suggests that knowledge requirements alone cannot definitively answer whether a job is related or not, and that within-occupation knowledge varies greatly.

More factors explain respondents' assessment of job relatedness than just the use of knowledge from their major field of study. Other job characteristics influence a respondent's interpretation of the NSCG question. We explore these other job characteristics using multivariate analysis of the NSCG data and interviews with employed college graduates.

FIGURE 2

Level of Knowledge of a STEM Major's Field of Study Required for Their Occupation

By job relatedness category



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Sources: 2013 and 2015 NSCG. Knowledge requirements are from the US Department of Labor's O*NET database.
Notes: Distributions are calculated for the analysis sample of STEM graduates in the 2013 and 2015 NSCG. Knowledge levels of each respondent's field of study required for their occupation from the O*NET database is rescaled to a zero to ten scale and plotted separately for each job relatedness category.

Multivariate Analysis

Job relatedness is typically used as an independent variable to predict pay differentials (Robst 2008, 2007a, 2007b) or job satisfaction (Bender and Heywood 2009). We use job relatedness as a dependent variable to understand the factors associated with identifying a job as related or unrelated. As noted above, the multivariate analyses distinguish between **factors that cause a graduate to work in an unrelated job**, such as family formation, lack of available work in a related job, or weak job-finding networks, and factors that induce a graduate to identify a job as unrelated, such as job tasks, knowledge requirements, job tenure, or supervisory responsibilities. We are only concerned with the latter to better understand how workers think about the relationship between their highest degree and their job.

Data

Data for the multivariate analysis comes from two sources: the NSCG and the knowledge, skill, and ability requirement fields of the O*NET data.[5] The NSCG is a nationally representative survey of college graduates fielded every two or three years by the National Science Foundation. Since 2010, the NSCG has used the American Community Survey as a sampling frame. The survey collects demographic, labor market, and educational data that are standard in federal surveys. It also collects information on issues important to the National Science Foundation, including information on research funding, job tasks, and participation in professional associations. This multivariate analysis will model NSCG respondents' job relatedness by various job characteristics using an ordered logit model.

The first independent variable is the number of years since the respondent earned their highest degree. A consistent finding in the literature is that job relatedness declines with age as workers disperse into other jobs and attain new skills (Bauer 2002; Bender and Heywood 2011; Biddle and Roberts 1994). A respondent's field of study (and therefore their job) may change dramatically over time, reducing how the job relates to the respondent's degree. Financial support for research is another important source of validation for STEM workers. Including research support variables in the models can determine whether workers who engage in federally funded research and development are more likely to report being in a related job than those who do not.

One of the most important factors determining a respondent's job relatedness is the tasks they perform on the job, which are called "work activities" in the NSCG. The survey provides information on the tasks that respondents engage in on the job and those that consume most of the respondent's time. To arbitrate between major and more incidental job tasks, the analysis includes dummy variables indicating whether a task is the respondent's primary or secondary task (tertiary and other tasks are not included). The models also include measures of knowledge and skill importance, discussed previously. The importance scales are highly correlated with the level scales for almost all fields, so the multivariate analysis uses only the importance scales. Finally, the models include dummy variables that indicate whether the respondent attends professional associations in their field of study.

The models do not control for respondents' occupations. Controlling for occupation would allow us to identify which occupations have higher or lower relatedness levels but would prohibit isolating which job characteristics are associated with low job relatedness.

Table 1 shows descriptive statistics on the analysis variables for the full sample of employed STEM graduates in the 2013 and 2015 NSCG waves and descriptive statistics on graduates' job relatedness responses. Many job characteristics and tasks, besides required knowledge of a respondent's field of study, are associated with the job relatedness.

TABLE 1

Descriptive Statistics for Full Sample by Job Relatedness Category

Variable	Full sample	Not related	Somewhat related	Closely related
Years since highest degree	17.1 (12.2)	19.2 (13.0)	18.4 (12.4)	16.3 (11.8)
Federal research and development support	15.7%	8.6%	13.7%	17.8%
Individuals directly supervised	2.9 (10.5)	2.6 (9.3)	3.0 (9.2)	3.0 (11.0)
Primary or secondary work activity is				
Accounting	9.3%	19.2%	14.1%	5.7%
Basic research	6.0%	3.8%	4.3%	7.0%
Applied research	11.6%	4.2%	9.8%	13.7%
Development	8.9%	3.9%	9.8%	9.6%
Design	9.2%	4.4%	9.8%	9.9%
Computer applications	13.8%	7.8%	15.2%	14.5%
Human resources	4.2%	6.5%	6.5%	3.0%
Management	33.5%	32.7%	40.5%	31.2%
Production, operations, maintenance	7.0%	9.6%	9.7%	5.5%
Professional services	34.6%	13.0%	17.1%	44.9%
Sales, purchasing, marketing	12.3%	35.5%	17.5%	5.6%
Quality or productivity management	8.0%	8.4%	11.3%	6.8%
Teaching	15.1%	7.3%	10.4%	18.2%
Knowledge and skill requirements for job				
Knowledge of own field of study	6.8 (3.0)	3.3 (2.4)	5.7 (2.8)	7.8 (2.4)
Administrative knowledge	5.4 (1.2)	5.6 (1.3)	5.6 (1.4)	5.3 (1.2)
Clerical skills	4.4 (1.2)	4.9 (1.6)	4.5 (1.3)	4.3 (1.1)
Customer relations skills	6.4 (1.5)	6.9 (1.2)	6.3 (1.4)	6.4 (1.5)
Sales knowledge	2.9 (1.6)	3.8 (2.1)	3.2 (1.9)	2.6 (1.3)
Attended professional meeting in past year	38.4%	20.9%	31.9%	44.2%
Member of professional society	48.4%	27.1%	39.3%	55.7%
Share of total (weighted)	**100.0%**	**9.0%**	**22.7%**	**68.0%**
Observations (unweighted)	**88,544**	**7,993**	**20,147**	**60,404**

Sources: 2013 and 2015 NSCG. Knowledge and skill requirements are from the US Department of Labor's O*NET database.
Notes: All statistics are reported in means. Standard deviations are in parentheses for continuous variables. All descriptive statistics are weighted to be representative of the national population of employed college graduates with their highest degree in a STEM field.

Research and development tasks, computer application tasks, and teaching have a clear positive correlation with job relatedness for STEM graduates. Professional service tasks are also strongly associated with job relatedness, reflecting the provision of many technical and scientific services through the professional services industry. NSCG respondents who report accounting, human resources, production, or sales as their primary or secondary work activity are less likely to report their jobs as closely related to their field of study. Management activities do not have a distinct positive or negative relationship with job relatedness. The number of people that a respondent directly supervises (a variable closely related to management tasks) also has no statistically significant descriptive association with job relatedness. Reflecting the results presented in figures 1 and 2, respondents who work in jobs where knowledge of their field of study is more important are more likely to consider their job closely related to their field of study.

Methods

We use an ordered probit model to estimate the relationship between job characteristics and job relatedness responses in the NSCG. The ordered probit accounts for the fact that the job relatedness variable is a discrete characterization of a continuous latent relatedness variable. Workers' views of their job relatedness exist on a spectrum, which they map on to the three available survey responses. The dependent variable in the ordered probit model is the NSG job relatedness variable.

The ordered probit model is motivated by assuming the existence of a latent variable:

$$y_i^* = \beta' X_i + \varepsilon_i$$

Where y_i^* is an (unobserved) latent degree of job relatedness underlying discrete responses to the job relatedness question. The latent variable is a function of the set of controls X_i, described in the data section. Observed levels of job relatedness are discrete and determined by the model as follows, assuming a normal distribution for the latent variable model:

$$y_i = \begin{cases} P(unrelated) = \varphi(-\beta' x_i) \\ P(somewhat\ related) = \varphi(\mu - \beta' x_i) - \varphi(-\beta' x_i) \\ P(closely\ related) = 1 - \varphi(\mu - \beta' x_i) \end{cases}$$

The parameters of the model are estimated using maximum likelihood including the cutoffs between the discrete job relatedness categories. Because many respondents appear in both the 2013 and 2015 NSCG waves, we also estimate a random effects ordered probit model.

Results

Table 2 presents marginal effects from the ordered probit models for all STEM graduates responding to the NSCG. The qualitative results are very similar between the models with and without random effects.

Job relatedness increases, though at a decreasing rate, as respondents get further away from their highest degree. This is inconsistent with expectations and the descriptive statistics reported in table 1 because of conditioning on other job characteristics in the models that vary with age, most notably task assignments.

Federal research and development support is a strong predictor of job relatedness. Again, the effect of federal research and development support is estimated conditional on job tasks (including research and development tasks), so the coefficient is not simply proxying for participation in research activities. It indicates that, even conditional on doing research, receiving federal support increases the likelihood that a respondent will identify their job as related to their highest degree.

The work activities with the strongest positive relationship with job relatedness are professional services and teaching. Typically, professionals and teachers are required, or at least expected, to work in their fields of study. Classic STEM work activities, including research and development, design, and computer applications, have a strong positive relationship with job relatedness. Some work activities indirectly related to STEM, such as management and production work, have a modest but positive relationship with job relatedness. Three task assignments—accounting, human resources, and sales tasks— were associated with a reduced likelihood that STEM graduates would identify their job as related to their highest degree.

Though many job tasks are associated with higher levels of job relatedness, most knowledge and skills were not particularly important. Among the knowledge and skill requirements, only knowledge of a respondent's own field of study clearly factored into assessments of job relatedness.

Attending professional meetings and membership in a professional society have a fairly strong association with high job relatedness. The combined effect of membership in a professional society and attending meetings is comparable with doing applied research as a primary or secondary work activity. Sales knowledge and clerical skills were two occupational knowledge requirements associated with reduced job relatedness. The results for job tasks also showed negative job relatedness for sales and administrative support tasks.

TABLE 2

Determinants of STEM Graduates' Job Relatedness Responses

Variable	Ordered probit	Random effects ordered probit
Years since highest degree	0.005***	0.010***
Years since highest degree, squared	-0.000***	-0.000***
Federal research and development support	0.184***	0.297***
Individuals directly supervised	0.003***	0.004***
Primary or secondary work activity is		
Accounting	-0.119***	-0.226***
Basic research	0.356***	0.697***
Applied research	0.422***	0.701***
Development	0.386***	0.496***
Design	0.299***	0.502***
Computer applications	0.400***	0.536***
Human resources	0.022	-0.067
Management	0.199***	0.247***
Production, operations, maintenance	0.105***	0.124***
Professional services	0.786***	0.963***
Sales, purchasing, marketing	-0.220***	-0.367***
Quality or productivity management	0.192***	0.138***
Teaching	0.561***	0.823***
Knowledge and skill requirements for job		
Knowledge of own field of study	0.189***	0.294***
Administrative knowledge	0.081***	0.117***
Clerical skills	-0.048***	-0.032***
Customer relations skills	0.010**	0.018**
Sales knowledge	-0.046***	-0.125***
Attended professional meeting in past year	0.217***	0.301***
Member of professional society	0.253***	0.412***
Observations	**88,544**	**88,544**
Cutoff between unrelated and somewhat related	0.749	0.571
Cutoff between somewhat and closely related	1.833	2.630
Rho	--	0.687
Pseudo R-squared	0.239	--

Sources: 2013 and 2015 NSCG. Knowledge and skill requirements are from the US Department of Labor's O*NET database.
Note: Year fixed effect not reported.

Perspectives from Employee Interviews

We contacted human resources and public relations departments at varying STEM employers to request referrals of employees that might be interested in participating in voluntary interviews. The employers contacted included National Laboratories, companies affiliated with national science and engineering associations, urban planning departments, health care systems, defense contractors, and technology and social media companies. Most employers were not willing or able to provide interviewees, but we interviewed fifteen college graduates employed in varying occupations.[6] Although the interviewees were not required to have STEM degrees, most had STEM backgrounds, both because of the types of employers we contacted and because our initial invitation to participate indicated that the research effort was funded by the National Science Foundation and focused on STEM graduates. The interviews were semistructured; though we used a standard interview protocol, many questions were open ended, resulting in varied content. The interview guide is provided in appendix A. The interviews began by replicating the NSCG survey question on job relatedness, allowing respondents to identify their jobs as closely, somewhat, or unrelated to their fields of study. We then asked interviewees what factors of their jobs and their education they considered when answering the job relatedness question.

Table 3 provides a summary of the fifteen interviewees. Many were senior managers, scientists, or engineers, with educational attainments ranging from bachelor's degrees to doctorates. Almost half of the interviewees had degrees in engineering; others held degrees in life and natural sciences. Because a STEM degree was not a requirement, four respondents had non-STEM degrees (two in urban planning, which included some engineering content). More of the interviewees held doctorates than the general public because of the strong representation of scientists and engineers. Interviewees were more likely to indicate their job was closely related to their highest degree than would be expected from the NSCG data. This could be attributable to self-selection; individuals that felt a strong connection between their jobs and highest degree might have been more interested in participating in an interview about job relatedness. Respondents may also have answered in a way that painted themselves in a positive light, fearing a negative response from the interviewer to a not related answer.

Several major themes emerged as respondents explained the reasoning behind their job relatedness answers. The two most important determinants of job relatedness were the respondents' *understanding of their degree content as narrow or broad* and their *most important job tasks*. Among job tasks, management responsibilities were discussed most consistently across all interviewees, although they disagreed on whether management responsibilities made their jobs less related to their field of study. Many interviewees discussed the importance of on-the-job learning for filling in the gaps between the knowledge taught in their degree programs and the knowledge required for their job. Finally, the interviews highlighted the role of professional associations, certifications, and expectations in assessing job relatedness. These factors were generally less important than job tasks and the breadth of the interviewees' degrees.

TABLE 3

Overview of Interviewees

Subject number	Highest degree	Current occupation	Job relatedness response
1	Biomedical engineering, PhD	Senior staff scientist, biosciences	Closely related
2	Chemistry, MS	Scientific associate	Not related
3	Nuclear engineering, PhD	Staff scientist, radiation protection	Closely related
4	Law and business, BA	Program manager, corporate social responsibility	Somewhat related
5	Urban planning, MA	City planner	Closely related
6	Computer science, BS	Software engineer	Closely related
7	Mechanical engineering, PhD	Senior manager in structural mechanics	Closely related
8	Aerospace engineering, MS	Senior manager	Closely related
9	History, BA	Senior program manager, corporate citizenship	Not related
10	Nuclear engineering, MS	Program manager in research and development	Closely related
11	Civil engineering, MS	Senior manager in planning department	Closely related
12	Urban and regional planning, MA	Wireless planner in planning department	Closely related
13	Metallurgical engineering, PhD	Senior fellow in metallurgy and engineering	Closely related
14	Geochemistry, PhD	Senior scientist, trace metal research	Closely related
15	Pharmacology and molecular sciences, PhD	Chief operating officer for bioenergy innovations and resource business development manager	Somewhat related

Source: Authors' interviews.

Narrow Versus Broad Conception of Degree

How broadly or narrowly a respondent construed their field of study shaped their sense of job relatedness. Some interviewees conceived their highest degree's content as being broader than just the specific research questions that they personally pursued. A senior staff scientist with a doctorate in biomedical engineering suggested that "topically, not a lot of [her] work now currently involves biomedical research *per se*," but "the process of science that [she] learned during [her] PhD prepared [her] for other research." A program manager with a background in computer programming and a bachelor's degree in law and business cited a unifying theme outside those fields, suggesting that "the one thing that underpins both [his] career choice and [his] choice of degree is that [his] favorite subject was math." He described the law as being structured and logical, like coding and math, and emphasized the similar problem solving in his education and job.

Sometimes the content of an interviewee's degree was broader than the degree title implied. A senior fellow with a doctorate in metallurgical engineering noted that his 1960s-era education would take a different name now. He described his degree as "not exclusive to metals because all materials are of interest, so a bit more general. All materials that have common characteristics and their use is something that, today, is more like material science." Often interviewees identified components of their degree that were outside of the field of study. One subject noted that the strong emphasis on formal presentation skills in his engineering program helped him tremendously on the job. A senior manager in a city planning agency with a master's degree in civil engineering described her degree as including broad skills like "drive, the desire to figure things out, and problem solving."

For a senior staff scientist with a doctorate in biomedical engineering, the broad, interdisciplinary nature of his field of study meant that he could work across different sciences. He noted, "I worked in a very interdisciplinary field. If I looked at the CV of myself and most of my colleagues, the degree names would be all over the place: mechanical engineering, chemical engineering, materials science, chemistry. Everyone's doing the same topics, and we speak slightly different languages." For him, "having an interdisciplinary degree helps [him] translate. So in that way, the degree provides the sort of Rosetta Stone that translates between the two disciplines." This respondent indicated his job is closely related to his degree, despite many other fields of study being part of his daily work.

These broad conceptualizations of a degree program's content were typically associated with high job relatedness. A city planner with a master's degree in urban planning highlighted the unknown elements of the job for which her degree's broad content prepared her, mentioning that "education gave [her] tools to address new problems, but not a sense of what those problems would be."

Having an interdisciplinary degree helps me translate. So in that way, the degree provides the sort of Rosetta Stone that translates between the two disciplines.
—Senior staff scientist with a doctorate in biomedical engineering

Other interviewees understood their highest degree as being much narrower. A scientific associate with a master's degree in chemistry considered her degree in terms of her own subfields, saying, "I studied inorganic chemistry when I was in graduate school, and I'm not doing that at all anymore… The industry for inorganic chemistry is more in paints and coating. The instruments that I work on, we look at polymers and biological systems. So, if I had studied polymer science or chemistry that would be close to what I'm doing." Not all respondents that described their degree narrowly said that their jobs were unrelated to their degree; some narrowly construed degrees were still related. A program manager at a National Laboratory with a master's degree in nuclear engineering described his studies as "radiochemistry and radiochemical processing" of a particular isotope. He felt that his work closely related to his degree because he used the processing techniques he learned in school, despite working with a different isotope. Much like the scientific associate who studied inorganic chemistry, he considered his field of study as more narrow. Unlike the staff associate, he still thought of his job as related.

Both broad and narrow understandings of the subject's highest degree are coherent and reasonable. Nevertheless, subjects' interpretation of the question and their degrees varies how the job relatedness question is answered. Interviewees with doctorates' conceptions of unrelated work may differ from those with other educational levels because of the highly specialized nature of their research.

Job Tasks

When first asked, interviewees tended to base their job relatedness assessment on titles rather than the content of their jobs. But when probed on particular tasks, respondents often described management and other nontechnical tasks as important in their day-to-day work. This response pattern corroborates the experience in interviews with engineering graduates conducted by Brunhaver and colleagues (2018), which found that respondents initially minimized the role nontechnical tasks played in their work until they were asked how their views of an engineering job changed over time. One interviewee, a wireless planner with a master's degree in urban and regional planning, answered quickly that her job is closely related to her degree. She described her technical job functions as reviewing and permitting installation for wireless telecommunications facilities. When probed on particular tasks, she emphasized communication as a crucial skill, despite her job's technical nature. This evolving response calls into question the NSCG survey question's ability to accurately capture the fluid nature in which workers perceive job relatedness.

Research and development was an important job task discussed by many interviewees. A chief operating officer with a doctorate in pharmacology and molecular sciences described his job as somewhat related to his degree partly because he had not conducted any bench science since earning his degree. His departure from research was planned: "I knew that I was not going to continue with bench research or follow a teaching pathway, so I guess I didn't have expectations, but I knew that what I wanted to do with my degree was get into roles where I could help PhDs to do research. The career path I've taken has allowed me to do that." This subject emphasized that his job was still somewhat related because he uses his doctorate "extensively" to complete job tasks, including proposals and business development. The doctorate helped him relate with researchers and "understand what it takes to get the research done, published, and get it funded."

Some tasks were perceived as conflicting with the ideals or objectivity of science. A staff scientist with a doctorate in nuclear engineering mentioned that his research is "intended to serve society," and that "many results are directly ingested by federal agencies to provide a foundation for regulations." He cautioned that "there's a line you have to draw as a scientist. If [he thinks] about cost implications, legal impacts, etc., then [he's] being unfaithful to the science side of things. There's some grey areas there, but, intentionally, a scientist is supposed to stay away from focusing on the broader picture."

Management

Management and supervisory tasks were important mediators of respondents' assessments of job relatedness, though their significance for job relatedness varied. Several respondents spent considerable time in management tasks. A program manager with a master's degree in nuclear engineering mentioned that the extent of her management activities surprised her. A senior manager at a planning department with a master's degree in civil engineering noted that each week she spends "at least 60% of [her] time in meetings that are not engineering related." Despite her substantial management responsibilities, the senior manager still identified her job as closely related to her highest degree. A senior fellow with a doctorate in metallurgical engineering corroborated the time-consuming nature of management: "Everything I do personally is involved with materials, but management functions simply added another dimension in terms of time commitments." A software engineer who reported his job as closely related to his computer science degree agreed that management tasks could be time consuming. But, the technical skills he learned in school were critical for management tasks.

A senior program manager with a bachelor's degree in history also agreed on the time-consuming nature of management. She had previously worked in a position with greater managerial commitments before moving to a new position with fewer commitments. Reflecting on the difference between the two jobs, she suggested that "the only real difference between when [she] had more management responsibilities and now is that [she] had less time [when she had more management responsibilities]." A senior scientist with a geochemistry doctorate reported that there were "always things in management that we have to respond to. In this day and age of emails, that eats up time." Not all subjects were tied up in management. A chief operating officer with a doctorate in pharmacology and molecular sciences described spending only about 5 percent of his time supervising three employees.

Many of the people that I manage hold degrees and have research backgrounds similar to my own. Managing them therefore requires knowledge of the same areas.
—A senior manager with a doctorate in structural mechanics

Many subjects recounted increased time spent on management tasks as they moved up the ranks in their company, though how this trend affected their job relatedness varied across respondents. A staff scientist with a doctorate in nuclear engineering described her nonresearch tasks as "just part of being a scientist" and not taking up much time. A senior manager with a doctorate in structural mechanics who described a similar trajectory of increased management activities explained, "Many of the people that I manage hold degrees and have research backgrounds similar to my own. Managing them therefore requires knowledge of the same areas. If you're asking whether I solve equations every day, I don't do that anymore, but I use what I know about mechanical engineering."

Others saw management differently. A senior staff scientist with a doctorate in biomedical engineering indicated that "[t]he job that [his] degree doesn't prepare for is managing people. You do more and more managing of people and less and less of the science itself." The senior fellow with a doctorate in metallurgical engineering agreed that management was not related, noting that, "short of the management work [he has] had, all the technical work [he has] done relates back to [his] training."

On-the-Job Learning

Several interviewees cited on-the-job learning as an important intermediator between their highest degree and their job. The interview guide did not include any questions about on-the-job learning, but interviewees independently raised the issue. Formal and informal learning on the job was typically characterized as a bridge between the knowledge attained in the classroom and the skills necessary for the job. A senior manager with a doctorate in mechanical engineering emphasized that "the main thing is that there is more to education than you learn in the books. On the job, you learn a lot of important things that help you apply your school work but that you'd never learn in school." A wireless planner with a master's in urban and regional planning described her transition from transportation to telecommunications planning as mediated by a job in consulting for a telecommunications company, which "gave [her] exposure to various agencies [in the area] and helped deepen [her] knowledge about planning in general." This on-the-job learning experience mediated her assessment of her job as closely related to her degree. A staff scientist with a doctorate in nuclear engineering noted, "I feel like I was trained as much as I could have been, but the field is so complicated that school doesn't prepare you. [You] have to learn as you go."

The formality of on-the-job learning varied across work environments. A program manager at a National Laboratory with a master's in nuclear engineering indicated that he picked up his cost estimation skills informally. He noted, "Cost estimating I did not learn from school, that just comes from balancing your checkbook and doing your tax returns." In contrast, a program manager for corporate responsibility with a substantial technology portfolio learned her technical skills in nondegree formal trainings and independent study. Others cited on-the-job learning as both formal and informal. A program manager with a bachelor's in law and business noted that a previous employer, a large management consultancy, "put us through a three-month intensive training course. Depending on the project, there was potentially more learning on the job." This interviewee reported that her company was intentionally recruiting program managers with nontechnical degrees who could be taught technical skills on the job to ensure a breadth of expertise.

On the job, you learn a lot of important things that help you apply your school work but that you'd never learn in school.
—A senior manager with a doctorate in mechanical engineering

Developments in the field and in technology and techniques sometimes led to on-the-job training. A senior scientist who thought of his job as closely related to his doctorate in geochemistry stated, "[I] had to learn new equipment. The basic equipment I still have in my lab, but I use it less because there's new techniques. In a job function, at the end of the day, the projects have to move, so I had to learn new techniques."

Professional Organizations and Credentials

Several interview respondents indicated either that they had some professional certification or license (e.g., a professional engineering [PE] license) or were a member of a professional organization. These certifications and memberships can validate or cultivate occupational identities that could inform job relatedness assessments. Most respondents with certifications, licenses, or association memberships agreed that those contributed to their occupational identity. A senior scientist with a doctorate in geochemistry said, "[Professional associations] play an intricate role; they guide new ideas, things I should be interested in. They help shape that because you're learning from other people, and they influence what you find interesting. [It can] drive what I want to do in the lab." Others were more skeptical; a staff scientist with a doctorate in nuclear engineering suggested that his professional association was "a bunch of PhDs running around patting themselves on the back."

A staff scientist with a doctorate in nuclear engineering noted the importance of social relationships outside professional associations, saying they are a factor in the assessment of one's job relatedness: "[The] social connections I made during graduate school are the foundation of [my] professional network right now. My mentor and his collaborators [from graduate school] are now my bosses."

For most engineers, a PE license was not considered particularly important, although some had one. This is because PE licenses are most common in civil engineering, and our interviews drew more heavily on a research and development workforce (table 3). A senior manager in a city planning agency with a master's degree in civil engineering stressed the importance of the PE for her job. Because she is the only employee in the agency with a PE license, she noted that other teams seek out her input or review on engineering related projects. The PE license clearly identifies her as an engineer and shapes her tasks. The same senior manager has a nondegree certificate in urban planning and noted its importance for her current job.

Expectations

Expectations anchor respondents' assessment of their job. Everyone has a vision for what life as a "real" scientist or engineer entails. Frequently, these expectations are not met as graduates confront management, accounting, and other administrative elements of their jobs. All interviewees were asked whether the reality of their jobs conformed or clashed with their job expectations as students, but for the most part, prior expectations did not factor heavily in their job relatedness response. Several interviewees indicated that their education was so long ago, they could not remember what their expectations were. Others said they were so focused on school that they didn't have any strong expectations about what their career paths would look like. A scientific associate with a master's degree in chemistry did affirmatively recall that she "expected at this point [she] would probably be in management."

Discussion and Recommendations

Several common themes emerged from the NSCG data analysis and the employee interviews: required knowledge of a worker's field of study mattered to a worker's assessment of job relatedness, in both the NSCG and the interviews. However, knowledge requirements were by no means the sole determinant of job relatedness. Federal support for research, the time since a worker earned his or her degree, and participation in professional societies were also significant factors. Perhaps the most important determinant of job relatedness, though, was a worker's job tasks. Classic STEM job tasks like research, development, and computer applications were of course positively associated with job relatedness. Management responsibilities were associated with higher reported job relatedness in the NSCG analysis than expected. The interviewees were more divided on whether management responsibilities positively contributed to job relatedness. Subjects whose management work required significant technical competence to be effective were more likely to report their job as closely related to their field of study. One-the-job training, which bridges the gap between formal education and work, emerged as a consistent and unexpected finding. On-the-job training in the knowledge and skills not provided in school helped keep the interviewees' degrees relevant.

The data analysis and interviews suggest several recommendations for future NSCG waves, including adjustment of question ordering, collection of more detailed task data, reinstatement of older job expectation questions, and enhancement of existing on-the-job training questions. Although careful planning and many competing priorities dictate the final content of the NSCG questionnaire, the National Center for Science Engineering Statistics should consider these possibilities for future waves of the survey:

- **Adjust job relatedness question ordering.** Question ordering is a significant factor in understanding the NSCG job relatedness responses. The NSCG job relatedness question is asked early in the survey's section on the respondent's principal job, before questions on job tasks, supervisory responsibilities, job satisfaction, federal funding, certifications, and other work-related experiences. The literature on survey design suggests that more specific and straightforward questions are best placed at the beginning of the survey, and more difficult, general, or intrusive questions should be asked later, cuing respondents that the more general questions should be considered separately from the specific questions (Newcomer and Triplett 2015). Earlier questions can also help define certain terms or concepts and provide context that respondents can draw upon in later questions (Groves 2004). An alternative ordering where job relatedness is asked at the end of the principal job section of the NSCG could help ensure responses better reflect respondents' job characteristics. The job relatedness question is more encompassing than every other question in the principal job section (except for the job satisfaction questions) and may therefore be more meaningful if asked at the end of the section.

- **Revive job expectations questions**. Interviews showed that respondents had varying expectations about their future careers when they earned their degree. Some fully anticipated their actual career trajectory, but others did not. The interviewees did not discuss their expectations as a reason for considering their job related to their degree, but it informed how they framed their job history. It may be helpful to bring back job expectations questions from older versions of the NSCG. Box 2 shows a question about graduates' expectations in the NSCG surveys conducted in and before 1999.
- **Collect more detailed task data**. Task variation within occupation presents another opportunity to better understand and improve the NSCG question. A large and growing body of research using the O*NET database exposes task variation within occupations, complicating how researchers can analyze the relation between degree and occupation. A ranked scale for the importance or presence of tasks in a given occupation may better capture true job relatedness.
- **Enhance existing on-the-job training questions**. Interviews proved that on-the-job training is an important bridge between school and work. Some training questions are already included in the NSCG, but these ask about intensity or duration of training, and subject matter of training would be useful. Accounting for informal educational experiences during formal schooling may further improve the accuracy of the NSCG question. Some interviewees noted the importance of informal educational pieces, like social networks, when assessing their job relatedness.

BOX 2

Graduates' Expectations Question in Older NSCG

Thinking back to when you completed your highest degree, would you say your work during a TYPICAL week on this principal job is:

[Mark one answer]

- Very similar to what you expected to be doing
- Somewhat similar to what you expected to be doing
- Not very similar to what you expected to be doing

Note: See the 1999 NSCG questionnaire at https://www.nsf.gov/statistics/srvygrads/surveys/srvygrads_1999.pdf

Appendix. Interview Guide

Introduction and Confidentiality Statement

Thank you so much for taking the time to speak with me today. My name is Daniel Kuehn, and I am a researcher at the Urban Institute, a nonprofit research organization based in Washington, DC. I am conducting a study, supported by the National Science Foundation, to understand how science and engineering graduates understand the relationship between their job and their field of study. The purpose of these interviews is to gain insights into how you think about the connection between your degree and your job.

The study also involves the analysis of a large survey previously conducted by the National Science Foundation. My interview with you today will provide important context for the analysis of the survey data. There are no right or wrong answers; I am only interested in your own reflections on your job and your education.

Before we get started with the questions, please be informed that your participation in this interview is strictly voluntary; you can choose not to answer any question, and you are free to leave the interview at any time. Although I will be taking notes during the interview, the information you provide will never be repeated with your name in any reports or in any discussions with anyone outside of Urban Institute, including your employer. The interview notes will be made available to other researchers, but no identifying or sensitive information will be released.

Additionally, it would be very helpful if I could record the conversation so I don't miss anything important in my notes. The recording will be deleted as soon as I have made a complete set of notes from the interview.

Do I have your permission to record? Do you have any questions before we begin?

Interview Questions

1. I'd like to begin with some basic background information on your education and your current job. What was the title of the principal job you held during the last week?
2. What was the level of your highest degree?:
    a. Bachelor's degree (e.g., BS, BA, AB)
    b. Master's degree (e.g., MS, MA, MBA)
    c. Doctorate (e.g., PhD, DSc, EdD)
    d. Other professional degree (e.g., JD, LLB, MD, DDS, DVM)
3. What was your field of study for that degree?
4. To what extent was your work on your principal job related to your highest degree? Was it...
    a. Closely related
    b. Somewhat related
    c. Not related
5. Can you tell us about how you think about your job's relatedness? What factors do you weigh in making that judgement?
    a. Was this an easy or a difficult determination to make?
6. What are your major job tasks? What role did these tasks play in determining the relation of your job to your field of study?
    a. [Probe: How does the interview subject interpret the relatedness of management, sales, or other tasks not obviously related to the academic content of the subject's degree?]
7. How did the reality of your job coincide or clash with your job expectations while you were earning your degree?
    a. [Probe: What job tasks surprised you? What tasks did you anticipate that did not end up being a part of your job?]
8. Has your sense of the relation of your job to your field of study changed over time? If so, how? Was this because your job tasks changed over time, or for some other reason?
9. Do you feel that everyone holding your job title is [closely related/somewhat related/not related] to your field of study?

Notes

[1] "Table 5. Employment in STEM Occupations by Field of Degree for the First Listed Bachelor's Degree: 2012," US Census Bureau Employment Statistics of College Graduates, accessed October 22, 2018, https://www.census.gov/data/tables/2012/demo/industry-occupation/college-graduates.html/.

[2] Keith A. Bender, and Kristin Roche, "Educational mismatch and the earnings distribution," *Southern Economic Journal* (forthcoming).

[3] Daniel Kuehn, "Three essays on connecting to work," (doctoral dissertation, American University, 2016).

[4] The data are from the Federal Institute for Vocational Education and Training (BIBB) and the Institute for Employment Research (IAB). IAB/BIBB employment data are widely used for studying the German economy and are particularly well suited to analyses of job tasks.

[5] We considered using other National Center for Science Engineering Statistics datasets, including the Survey of Doctoral Recipients and the National Survey of Recent College Graduates, but we ultimately rejected them because the NSCG allows for more detailed occupational codes and additional variables on job characteristics that the Survey of Doctoral Recipients and National Survey of Recent College Graduates do not include. Because the O*NET data is only available at the occupational level, we needed to use the most detailed occupations possible.

[6] The National Laboratories, urban planning departments, technology companies, and engineering services companies were the most responsive to our request for interviewees. We were unable to obtain interviewees from any defense contractors, health care systems, or social media companies.

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