

A Tribute to Robert J. Mislevy Part 1: Mapping the Skills of Tomorrow— Principled Assessment of Literacy and Numeracy Skills Embedded in U.S. Workplace Contexts

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Scopus Abstract

Changes in the U.S. workforce are reshaping the occupations projected to grow and the skills employees need to succeed. These changes underscore the need for training providers, adult educators, and assessment developers to better prepare learners and workers for evolving workplace demands. This exploratory study, situated within applied workforce development and assessment research, uses a data-driven mapping approach to identify the knowledge, skills, and abilities (KSAs) required in high-growth occupations, addressing a gap in empirically grounded analyses of how literacy and numeracy function in fast-growing occupations. In this study, we linked the U.S. Bureau of Labor Statistics (BLS), 2023) Employment Projections and Occupational Information Network (O*NET) databases to (1) identify fast-growing occupations in Job Zones 1–3 (those requiring little-to-moderate preparation), (2) specify literacy- and numeracy-related KSAs associated with these occupations, and (3) analyze the work contexts and task demands in which these KSAs are enacted. The analysis focuses on rapidly expanding roles in health care, advanced manufacturing, and logistics. Findings indicate that literacy and numeracy KSAs are embedded in routine workplace activities, including interpreting procedural documents, monitoring workflows, documenting production, and communicating with supervisors and coworkers. Study results provide actionable insights for designing instruction and assessment tasks that reflect job-relevant practices. By grounding workforce preparation in national labor data and occupational

analyses, this study illustrates an approach that aligns assessment with the literacy and numeracy demands of fast-growing occupations to assist instructional programs and assessment developers so that adult learners might develop the competencies needed to succeed in rapidly changing workplace contexts.

Structured Abstract

- **Background:** The U.S. workforce is undergoing rapid transformation due to technological change, automation, and shifting occupational structures, which in turn are reshaping the literacy and numeracy demands required for successful job performance (Autor et al., 2021; Glaser et al., 2001). While prior research has documented broad skill gaps, far less is known about how foundational literacy and numeracy skills are enacted within specific, fast-growing occupations, particularly the task contexts in which these skills are used and the levels of complexity at which they are applied. In the absence of such domain-specific evidence, workforce training programs and assessments risk relying on abstract, generic, or outdated representations of workplace skill use that weaken their instructional relevance and validity.
- **Literature Review:** Research on principled workplace assessment design emphasizes the alignment of the literacy and numeracy skills that are assessed, the tasks used to assess them, and the interpretive arguments that support score-based inferences. This alignment may be framed as a problem of domain representation: the degree to which assessments reflect the communicative, cognitive, and procedural practices of real work. Domain representation is critical in high-growth occupations, where literacy and numeracy are highly context-dependent and embedded within job-relevant activities rather than exercised as isolated skills. Despite this principle of skill contextualization, many large-scale and instructional assessments continue to rely on decontextualized item formats that underrepresent the multimodal, procedural, and time-constrained nature of workplace literacy and numeracy (Quellmalz et al., 2010). Studies of workplace practice show that workers routinely integrate information across multimodal sources—including technical manuals, digital dashboards, diagrams, charts, and workplace communication systems—leading to shifts in representational formats, registers, and tools (Oliveri et al., 2023; Suárez-Álvarez et al., 2022). These findings underscore the need for contextualized (e.g., scenario- and simulation-based) tasks that more accurately mirror workplace-relevant cognitive, situational, and representational demands (Cisco Systems, 2010; Quellmalz et al., 2010).
- **Research Questions:** This study examined the following three questions:

1. For Job Zones 1–3 (which require little to moderate training and preparation), which occupations and occupational groups are projected to be fast-growing according to U.S. Bureau of Labor Statistics (BLS) Employment Projections data?
 2. What literacy and numeracy knowledge, skills, and abilities (KSAs) are required for these in-demand occupations?
 3. In what work contexts are these KSAs most frequently applied and at what complexity levels?
- **Method:** This descriptive, exploratory study is situated within applied workforce and assessment research and uses a data-driven approach that included data from the U.S. BLS Employment Projections and O*NET databases. BLS data were used to identify fast-growing occupations in which adult learners are employed (i.e., Job Zones 1–3). O*NET data were used to map the literacy and numeracy KSAs associated with these occupations to Generalized Work Activities (GWAs) and their associated Detailed Work Activities (DWA), and to work contexts required for these occupations. DWAs provide more detailed or finer-grained task descriptions than GWAs. This data-driven approach enabled the analysis of how similar foundational skills manifest at different complexity levels across Job Zones. For example, reading in a Job Zone 1 occupation may involve interpreting a highway sign, whereas reading in a Job Zone 3 occupation may require interpreting technical documentation. While both tasks fall under the same GWA (reading), they differ substantially in cognitive demand, context, and consequence. Analyzing both GWAs and DWAs enabled us to identify the settings, purposes, and types of texts in which literacy and numeracy are enacted and to characterize variation in task complexity.
 - **Results:** Two main findings emerged. First, fast-growing occupations in Job Zones 1–3 cluster in health care, advanced manufacturing, and logistics; they require literacy and numeracy KSAs that are complex, contextualized, and tightly coupled with job-specific processes. These KSAs are embedded in activities such as interpreting technical manuals, recording and verifying production data, calibrating digital systems, and following safety and compliance protocols. Even labor-intensive roles require workers to integrate quantitative, procedural, and textual information, and to make rapid, high-stakes decisions. Second, O*NET complexity level indicators revealed systematic variation in complexity across Job Zones: Job Zones 1–2 involved the routine application of foundational skills within familiar contexts, whereas Job Zone 3 required interpretation, coordination, and problem-solving across multiple texts, tools, and situations.
 - **Discussion:** Our findings underscore that literacy and numeracy demands in fast-growing occupations are context-dependent, embedded in job-specific tasks, and enacted at levels of complexity that are often underestimated or misrepresented in entry-level roles. Reliance on grade-

level indicators or decontextualized skill measures obscures these demands and risks misrepresenting workers' capabilities. The results demonstrate the need for assessment designs that prioritize task relevance, contextual fidelity, and calibrated complexity across Job Zones, particularly in technology-mediated and time-constrained work environments. Contextualized, scenario-based assessment approaches are therefore critical for generating valid, instructionally useful evidence of workplace skill use.

- **Conclusion:** This study demonstrates how linking occupational growth projections with empirically derived descriptions of literacy and numeracy use can inform principled, workplace-aligned assessment design. By mapping KSAs to work activities and contexts in high-demand occupations, the study provides a foundation for identifying what skills matter, how they are enacted on the job, and at what levels of complexity. These insights support more accurate alignment among workforce instruction, assessment, and labor-market needs, particularly for adult learners in Job Zones 1–3 whose skills are often underrepresented by generic assessment frameworks.
- **Directions for Further Research:** Future research should extend this domain-mapping approach to additional occupations, Job Zones, and regional labor markets to examine the robustness of identified skill patterns over time and across contexts. Empirical validation studies, including workplace observations, stakeholder interviews, and pilot testing of scenario-based or simulation-based assessments are needed to evaluate whether proposed task designs elicit intended constructs and support fair, meaningful interpretations. Additional work should also explore how principled, contextualized assessment designs may anticipate evolving workplace demands to enhance workforce development preparation efforts.

*Keywords: adult education, employment projections, evidence-centered design, foundational skills, Job Zones, numeracy skills, Occupational Network (O*NET) database, principled assessment design, target language use domains, workforce development*

1.0 Background

Rapid advances in automation, artificial intelligence, and digital tools are reshaping the U.S. labor market, altering not only which occupations are expanding or contracting but also how literacy and numeracy are used in daily work (Autor et al., 2021). Across industries, workers increasingly engage with digital interfaces, data-rich environments, regulatory documentation, and multimodal communication embedded within complex workflows. These shifts heighten the stakes for adult education and workforce assessment systems: When assessments fail to reflect how skills are enacted on the job, they risk measuring generic abilities that do not translate into workplace readiness, advancement, or economic mobility.

Despite growing attention to workforce literacy and numeracy knowledge, skills, and abilities (KSAs), substantial gaps remain in how these skills are empirically characterized and assessed. Much of the existing literature relies on broad skill labels or grade-level proxies that obscure the contextual, procedural, and role-dependent nature of workplace performance. Such proxies implicitly assume that task difficulty is driven by textual features alone, rather than by consequences of error, decision-making responsibility, time pressure, or coordination with others. As a result, assessments may misrepresent workplace competence and offer limited instructional or developmental value, particularly for adult learners whose skills are acquired informally through work experience.

National labor-market projections and occupational databases provide valuable macro-level signals about employment trends and skill demand, yet they often lack the contextual specificity needed to inform principled assessment design. A central challenge, therefore, lies in translating labor-market and occupational data into assessment-relevant representations of literacy and numeracy; representations that capture how skills are used in actual work settings, under realistic constraints, and for real purposes. Addressing this challenge requires approaches that go beyond skill listing to articulate coherent construct models, specify task conditions, and support defensible evidentiary arguments linking observed performance to workplace competence.

In response to these challenges, this study advances a principled approach to workplace assessment design grounded in evidence-centered design (ECD), evidentiary reasoning, and construct modeling. Within this framework, construct models define which KSAs matter for competent performance and how they become observable through task features and performances; evidentiary arguments articulate why performance on particular tasks, under specified conditions, warrants inferences about real-world competence (Mislevy et al., 2003). Consistent with this perspective, literacy is conceptualized not as decontextualized reading or writing ability but as situated interaction with workplace texts, reading, interpreting, documenting, and coordinating action in service of work goals.

Although this article is designed to stand on its own, it is intentionally paired with a companion study. The two studies serve distinct but complementary purposes. The present study operates at a cross-industry (macro) level, demonstrating how national labor-market data and occupational standards can be translated into assessment-relevant representations of literacy and numeracy demands. The companion study, “Beyond the

Test—Designing Job-Aligned Assessments for Agricultural Workers,” provides an industry-specific instantiation, illustrating how these assessment design principles operate when grounded in field observations, worker interviews, and workplace texts. Together, the two articles advance a coherent, evidentiary approach to workplace assessment design, tracing a pathway from macro-level domain analysis to micro-level task design without duplicating analytic claims or empirical results.

This section outlines the challenges associated with the design of workplace assessments and provides four assessment design principles to address those challenges. These challenges include the complexities associated with identifying and representing workplace literacy and numeracy demands in ways that support evidentiary assessment arguments connected to labor-market analysis and instructional usefulness. The four design principles we elaborate include (a) misalignment between assessments and job demands (i.e., task selection), (b) insufficient attention to the conditions under which skills are used (i.e., contextual fidelity), (c) poorly calibrated task difficulty across roles and responsibilities (i.e., complexity calibration), and (d) limited consideration of how work and skill demands evolve over time (i.e., back-and-forward design). Table 1 summarizes these challenges and illustrates how each principle addresses a specific limitation of conventional assessment approaches.

Table 1

Recurring Challenges in Workforce Assessment Design and Corresponding Design Principles

Assessment Challenge	Description of the Challenge	Design Principle	How the Principle Addresses the Challenge
Misalignment between assessments and job demands	Assessments often prioritize generic reading or numeracy tasks that do not reflect the literacy practices workers use on the job, leading to construct underrepresentation and weak inferences about workplace competence.	Task selection	Prioritizes high-frequency, high-consequence, and economically meaningful tasks drawn from actual workplace practice, ensuring that assessment targets skills that matter for safety, productivity, and advancement.
Insufficient attention to conditions of skill use	Many assessments abstract skills from the physical, temporal, social, and technological conditions in which they are enacted, introducing construct-irrelevant variance and limiting instructional usefulness.	Contextual fidelity	Embeds tasks within realistic work scenarios that reflect real-world tools, texts, constraints, and collaborative practices, strengthening the link between observed performance and real-world competence.
Poorly calibrated task difficulty across roles	Task difficulty is frequently defined using grade-level or generic difficulty scales that do not align with role-specific responsibilities or decision-making demands in workplace settings.	Complexity calibration	Aligns task complexity with occupational roles and Job Zones, differentiating performance based on responsibility, judgment, and consequences of error rather than surface text features.
Limited attention to evolving skill demands	Assessments are often designed for current practices only, becoming outdated as technologies, regulations, and workflows change.	Back-and-forward design	Anchors assessments in current workplace practices while anticipating emerging demands, supporting adaptability and sustained relevance in dynamic labor markets.

Following Table 1, we describe the key challenges in workforce assessment design and introduce a set of assessment design principles that respond to these challenges, providing a conceptual bridge between domain analysis and the evidentiary reasoning needed to support principled assessment design.

1.1 Construct Models, Context, and Evidentiary Reasoning in Workplace Assessment

A central challenge in designing workplace-aligned assessments is the development of construct models that adequately represent how literacy and numeracy are enacted in real work settings (Corrigan & Slomp, 2021; Oliveri et al., 2020, 2021). Construct models specify the KSAs as assessment targets and make claims about, and how they are made observable through task features, performances, and evidence (Messick, 1995; Mislevy et al., 2003). As summarized in Table 1, this challenge manifests in recurrent misalignments between assessment tasks and job demands, insufficient attention to conditions of use, and difficulty calibrating task complexity across roles.

Within an ECD framework (elaborated further in the sections that follow), construct models play a foundational role in an evidentiary argument, linking observed performances to warranted inferences about competence in use-relevant contexts. An evidentiary argument answers the question: *Why should performance on these tasks, in these conditions, be taken as evidence of competence in the real world?*

When construct models are defined independently of workplace tools, representations, and workflows, they risk mischaracterizing how literacy and numeracy function in practice. Such decontextualized models may support narrow claims about accuracy or comprehension but provide weak evidentiary arguments for workplace performance (National Research Council, 2001). For example, a general reading construct may capture text comprehension in isolation while overlooking how reading supports procedural decision-making, safety compliance, coordination with others, or documentation under time pressure—activities central to performance in many of the occupations examined in this study.

From an evidentiary perspective, construct models must be grounded in domain analysis and embedded within principled design frameworks to support defensible inferences about real-world competence (Mislevy, 2018). Extending this position, Mislevy et al. (2025) argue for *socioculturally aware construct modeling*, in which reasoning and meaning making are treated as situated activities shaped by linguistic resources, cultural histories, workplace norms, and material conditions. In this view, assessment tasks are designed not to strip away context, but to reflect how workers interpret and act on texts and quantitative information within culturally and linguistically familiar systems of practice and skill use.

This sociocognitive perspective reframes assessment as the collection of evidence about how individuals engage with information in particular settings. Thus, performance is understood as an interaction between persons and contexts rather than as an isolated trait (Mislevy, 2018; Mislevy et al., 2025). In the present study, this perspective motivates construct models that foreground role-specific tasks, contextual constraints, and decision-making demands, providing the foundation for evidentiary arguments that

are instructionally meaningful, socioculturally responsive, and aligned with workplace realities.

1.2 Context, Transfer, and the Limits of Generic Assessments

A second challenge for workplace-aligned assessment design concerns transfer: the ability to apply skills learned in one context to new tasks, tools, or different situations (Barnett & Ceci, 2002; National Academies of Sciences, Engineering, & Medicine, 2012; Perkins & Solomon, 2012). Transfer is central to workforce readiness because workers must adapt literacy and numeracy practices across shifting conditions, technologies, and job demands rather than perform them in fixed or isolated formats.

From an evidentiary perspective, however, many existing assessments provide weak support for inferences about transfer. Generic reading passages or abstract problem sets often omit the procedural constraints, decision points, and social interactions that shape workplace activity (Quellmalz et al., 2010). As a result, such assessments offer limited evidence about how workers interpret safety protocols, perform calculations under time pressure, navigate digital interfaces, or document production data within real workflows (Suárez-Álvarez et al., 2022). The issue is not whether workers possess foundational skills, but whether assessment tasks elicit evidence of how those skills are coordinated and applied in use-relevant contexts.

The challenge of transfer can be illustrated using a sports analogy. Imagine two athletes. One has focused exclusively on basketball, practicing the same drills, under the same conditions, and mastering patterns specific to that sport. The other has engaged in cross-training, combining basketball with swimming, track, and martial arts. When both athletes try a new sport such as soccer or tennis, the cross-trained athlete may adapt more quickly. Their skills are supported by a wider range of physical patterns, balance strategies, and spatial reasoning. In contrast, the basketball-only athlete may excel in their original sport, but their finely honed abilities are tightly bound to its specific demands. This example illustrates the transfer problem: skills developed narrowly may appear strong within one context but may not generalize well to other situations. Cross training, by contrast, fosters flexibility, preparing the learner (or athlete) to carry competencies into new contexts more readily.

Several assessment programs demonstrate how principled, contextualized task designs can generate stronger evidence of transferable competence. For example, the computerized problem-solving component of the Programme for International Student Assessment (PISA) 2012 uses everyday scenarios that align task demands and scoring procedures with a clearly articulated construct model that differentiates cognitive processes such as information retrieval, model building, and monitoring, processes that are not tied to a single surface context but instead reflect broadly applicable cognitive skills (National Center for Education Statistics, 2022). Although surface contexts vary, the underlying processes remain stable, supporting evidentiary arguments about generalizable problem-solving capabilities.

Simulation-based environments provide a complementary approach. SimScientists (Quellmalz et al., 2010) demonstrates how paired contexts, dynamic visual representations, and diagnostic feedback elicit scientific reasoning across situations that differ in appearance but share common underlying structures. Such environments help

learners stretch their skills, applying them across shifting situations much like a cross-trained athlete navigating a new sport. Similarly, Cisco's Packet Tracer (Cisco Systems, 2010) embeds assessment within real-world troubleshooting activities, requiring learners to iteratively apply procedures as conditions change. In both cases, transfer is supported not by abstraction alone but by carefully designed variation that preserves construct relevance while shifting surface features of the assessment.

Together, these examples reinforce a central claim of this study: Transfer-relevant evidence emerges from principled assessment design, not from decontextualization. Assessments that intentionally select consequential tasks, embed them in realistic contexts, and calibrate complexity across conditions provide stronger evidentiary support for inferences about workplace competence than measures of purportedly "general" skill divorced from use. This insight motivates the design principles articulated in the sections that follow.

1.3. From Labor-Market Data to Principles for Workforce-Aligned Assessment Design

A third challenge for workplace-aligned assessment is understanding how literacy and numeracy KSAs become contextualized and support transfer across settings when both cognitive and work domains are hierarchically structured. Broad abilities such as reading comprehension or quantitative reasoning do not operate uniformly across contexts; instead, they take on increasingly specialized forms as they are enacted in workplace activities, tools, and decision-making responsibilities. For example, in work settings, reading may involve interpreting technical diagrams, cross-referencing procedural steps, integrating written instructions with physical action, or coordinating decisions under time pressure. Occupational classification systems such as the Occupational Information Network (O*NET) reflect this hierarchy by organizing skills and work activities from general descriptors to highly specific task statements.

When the level of generality represented in an assessment does not align with the level of specificity required by an occupation, the evidentiary basis for inferences about job performance is weakened. This misalignment does not diminish the value of general assessments for broad or diagnostic purposes; rather, it signals a limitation when assessments are used to support claims about workplace competence, readiness, or advancement. In such cases, the issue is not measurement precision alone, but whether the assessment elicits evidence relevant to the decisions it is intended to inform.

From an evidentiary-reasoning perspective, alignment between constructs, tasks, and workplace demands is therefore not optional. It requires explicit design principles that connect labor-market information, construct models, task features, and anticipated uses of assessment results into a coherent interpretive argument. In this study, we articulate four workplace-assessment design principles derived from national labor-market information, construct models, task features, and intended uses of scores in a coherent interpretive argument, one that justifies why performance on particular tasks, under particular conditions, constitutes credible evidence of competence in real work settings. Assessment design principles aid the translation of macro-level evidence about in-demand occupations into assessment designs that (a) represent the skills that matter in practice, (b) reflect the conditions under which those skills are enacted, (c) differentiate

performance meaningfully across roles, and (d) remain responsive to changing work demands.

1.4 Design Principles for Evidence-Based, Workplace-Aligned Assessment

To address the aforementioned challenges (see also Table 1), we introduce four assessment design principles that function as evidentiary anchors. Accordingly, they link labor-market information, construct models, task features, and intended uses of assessment results to articulate evidentiary arguments for designing workplace assessments. Rather than prescribing specific item formats or instruments, these principles articulate the conditions under which assessment tasks are more likely to generate evidence that is meaningful, use-relevant, and valid for workplace contexts. These principles support the construction of assessment arguments that are not only technically sound but also responsive to how literacy and numeracy function in actual work settings and to how assessment results are interpreted and used.

Principle 1 (Contextual fidelity) refers to embedding assessment tasks in realistic work scenarios that reflect the tools, workflows, communicative purposes, and constraints characteristic of high-growth occupations. Contextualization is foundational because workplace performance is not simply a matter of possessing skills but of using them effectively within specific material, social, and organizational conditions. Drawing on construct-representation arguments (Cronbach & Meehl, 1955) and Brunswik's (1956) sampling principles, contextual fidelity ensures the sampling of tasks from the environments in which performance occurs.

Mislevy (2018) demonstrates that decontextualized literacy and numeracy tasks often underestimate competence—particularly for multilingual, culturally diverse, and low-formal-education workers—because these sorts of tasks remove the contextual supports and activity structures that enable skilled performance (see also Mislevy et al., 2025). Accordingly, workplace-aligned assessment design requires systematic attention to work contexts. In this study, such information is drawn from O*NET work-activity and work-context variables (Oliveri & McCulla, 2019), supplemented by qualitative evidence in the companion study “Beyond the Test—Designing Job-Aligned Assessments for Agricultural Workers,” to interpret literacy and numeracy as embedded practices rather than abstract abilities. =

Principle 2 (Task selection grounded in job relevance) involves prioritizing KSAs that are consequential in fast-growing occupations to help ensure that assessments and the instructional systems connected to them support opportunities to learn the KSAs that matter most economically and professionally. From an ECD standpoint, omitting critical tasks leads to construct underrepresentation (i.e., a validity threat that may occur when an assessment fails to capture all the important aspects of KSAs that make up the intended construct), weakening the evidentiary argument by failing to sample important aspects of the intended domain.

Glaser et al. (2001) caution that many assessments measure what is convenient rather than what work actually requires. Literature on job analysis and vocational expertise highlights that consequential skills often reside in the “middle layer” of practice, tasks that integrate foundational literacy and numeracy with procedural knowledge, tool use, and decision making. By identifying fast-growing occupations (Research Question 1)

and mapping their literacy and numeracy KSAs (Research Question 2), this study operationalizes task selection as an evidentiary decision grounded in labor market demand rather than abstract skill taxonomies (Oliveri & Tannenbaum, 2019).

Principle 3 (Complexity calibration) refers to aligning task difficulty with the cognitive, procedural, and interpersonal demands of occupational roles across Job Zones, rather than defaulting to generic indicators such as grade level. Meaningful interpretation of assessment results requires an explicit theory of how performance varies as task demands increase (Mislevy et al., 2025). From an evidentiary perspective, poorly calibrated tasks either obscure meaningful differences in performance or introduce construct-irrelevant difficulty.

Research on skill hierarchies and cognitive complexity (Oliveri & McCulla, 2019; Webb, 1999) shows that both skills and occupations progress from routine applications to more integrative and adaptive forms of reasoning. When the generality of an assessment does not match the specificity of a job, evidence of transfer and workplace readiness becomes difficult to interpret. Research Question 3 addresses this principle by examining how literacy and numeracy are applied at varying complexity levels across Job Zones 1–3. Attention to complexity supports assessment designs that differentiate performance in ways that mirror real workplace progressions, from routine execution to coordination, troubleshooting, and decision making under uncertainty.

Principle 4 (Back-and-forward design linking current and emerging practices) anchors assessments in current workplace practices (back design) while anticipating emerging skills and conditions likely to shape future work demands (forward design). As automation, artificial intelligence, and digitalization reshape occupational tasks (Autor et al., 2021), foundational literacy and numeracy increasingly interact with digital interfaces, automated data, workflow systems, and compliance documentation. From an evidentiary standpoint, assessments that fail to anticipate these shifts risk producing evidence that is quickly outdated or misaligned with instructional goals for workplace-ready assessments.

Research on transferable skills (Haigler, 2021) suggests that assessments should capture not only what workers can do now, but also the adaptive reasoning they will need as work evolves. By analyzing O*NET work-context variables alongside employment projections, this study identifies early indicators of changing task structures, such as increased documentation or digital interaction, thereby grounding forward-looking assessment design in empirical labor-market evidence rather than speculation.

Consistent with these principles, this study conceptualizes literacy and numeracy not as isolated cognitive abilities but as work-embedded practices enacted through job-relevant activities. Within an ECD framework, principled assessment begins with domain analysis that clarifies which KSAs matter, the situations that elicit them, and the forms of evidence that support meaningful inferences about performance. Applying this logic to workforce development, we link national labor-market projections with O*NET occupational descriptors to demonstrate how these four principles can be operationalized for high-demand occupations in Job Zones 1–3. Because these sectors employ many adult learners with limited formal education or English proficiency, principled,

contextualized assessment design is essential for producing evidence that supports fairness, instructional relevance, and economic mobility.

The four principles outlined above provide the analytic and evidentiary foundation for the study's methodological approach. In the sections that follow, these principles guide how labor-market projections and occupational data are selected, organized, and interpreted. Specifically, they shape (a) the identification of high-growth occupations, (b) the mapping of literacy and numeracy KSAs to occupational activities, (c) the calibration of task complexity across Job Zones, and (d) the interpretation of findings in relation to current and emerging workplace demands. In this way, the methods are not simply descriptive but are explicitly aligned with an evidentiary argument about how workplace literacy and numeracy should be represented for the purposes of designing workplace-ready assessments.

This study is relevant to multiple audiences. Assessment developers can use the findings to design tasks that closely mirror the literacy and numeracy demands workers encounter on the job. For scholars and practitioners in measurement and adult education, the study demonstrates a method for translating occupational KSAs into assessments that are directly aligned with workplace practices. For readers of the *Journal of Writing Analytics*, the research contributes evidence on situated literacy and numeracy, illustrating how assessments may capture work-relevant activities and provide meaningful insight into performance in real-world contexts.

2.0 Literature Review

In this section, we turn to the empirical literature on workplace skill demands and adult learner experiences, drawing on evidence from large-scale surveys, national reporting systems, and workforce databases. These sources provide a population-level view of foundational literacy and numeracy skill demands, participation patterns, barriers to skill development, and equity considerations across industries and Job Zones 1-3. We also synthesize findings from work-focused research, including analyses of occupational databases (e.g., O*NET), employer surveys, and industry-based case studies. These sources clarify how literacy, numeracy, and problem-solving skills are embedded within specific occupations within Job Zones 1–3 and highlight variation in task complexity and occupational demands.

2.1 Findings from National Surveys and Reports on Skill Needs of Adult Learners

National data sources provide a quantitative and contextual foundation for understanding workers' literacy and numeracy needs, the diversity of their work roles, and the specific skills most relevant for workforce-aligned assessment design. They provide insight into the skill profiles of and challenges faced by adult learners:

- **National Reporting System (NRS) for Adult Education** – The NRS is the federally mandated data collection and reporting system for adult education programs in the United States. It tracks learner enrollment, educational gains, employment outcomes, and credential attainment. Because it uses standardized definitions across states, it produces comparable data for program planning and policy. In its 2023–2024 reporting year, the NRS documented that over 1.26 million adult learners faced

barriers such as low literacy, limited English proficiency, or cultural obstacles to employment, underscoring the importance of improving literacy skills to address work-related barriers (National Reporting System for Adult Education, n.d.).

- **National Center for Education Research (NCER)** – NCER is a subdivision of the Institute of Education Sciences (IES) within the U.S. Department of Education. It funds and disseminates rigorous research on pressing educational challenges, including adult education and workforce readiness (National Center for Education Statistics, 2022). Larson (2018) highlighted NCER-funded evidence showing that low literacy and numeracy remain significant challenges for workplace advancement, thereby underscoring the importance of evidence-based interventions.
- **National Association of State Directors of Adult Education (NASDAE)** – NASDAE is a membership organization of state-level adult education directors. It conducts an annual survey of state and local programs. In its 2021–2022 survey, NASDAE reported that 42% of adult learners were employed while pursuing career advancement through integrated education and training programs, highlighting that many adults are both workers and learners (National Association of State Directors of Adult Education, n.d.).

Adult education’s importance is further reinforced by the **Workforce Innovation and Opportunity Act** (WIOA, 2014), which requires states to align training and support services with employer needs. WIOA explicitly links literacy and skill development to economic advancement, improving coordination between workforce investment, education, and economic development systems.

Collectively, these sources show that adult education programs are central to the nation’s workforce strategy. They also underscore why studies like the present one are important (i.e., to pinpoint the specific skills required by industries where adult learners work or seek employment, and to inform the development of targeted training and assessments that support meaningful upskilling and reskilling).

2.2 Insights into Workforce Skills from Large-Scale Job Data

Findings from large-scale databases, complemented by case studies, provide a nuanced view of skill demands and their workplace context. Together, these analyses highlight which skills are most critical, how skill requirements vary across the three Job Zones, and how workforce data can guide the development of assessments that accurately reflect real-world tasks.

2.2.1 Workforce Case Studies

Rios et al. (2020) conducted a literature review of 21st-century workplace skills for the past 20 years and analyzed job advertisements from two major online websites, [Careerbuilder.com](https://www.careerbuilder.com) and [Collegerecruiter.com](https://www.collegerecruiter.com), between February 2017 and April 2017. The study analyzed the resulting large corpus of employer job postings to empirically identify which “21st-century skills” were most in demand. Using descriptive analyses of approximately 142,000 job advertisements (replicated on a second sample of 120,000 advertisements one year later), they produced one of the first lists of rank-ordered skills

demanded by employers. Oral and written communication emerged among the most frequently requested skills. They also showed that demand patterns varied by education level and degree-field requirements. These findings provide a data-driven foundation for skill identification and domain analysis activities, offering clearer guidance for developing educational standards and assessments that align with actual workplace demands rather than assumed priorities.

Sireci et al. (2024) leveraged the O*NET database, which contains detailed KSA ratings across over a thousand occupations, to explore the structure of cognitive and skill requirements relevant to contemporary workforce assessments. Using multidimensional scaling on the mean importance ratings of KSAs, the authors identified a two-dimensional solution that included Social Interaction/Reasoning and Verbal/Non-Verbal skills/abilities as the best representation of the data. These dimensions varied across Job Zones. That is, jobs requiring less education and training were sufficiently captured by the Social Interaction/Reasoning dimension, whereas jobs requiring more education and experience were better represented by the Verbal/Non-Verbal dimension. These findings highlight implications for designing assessments that better reflect the differentiated skill profiles of adult learners across occupational contexts.

Oliveri and McCulla (2019) also used the O*NET database to pinpoint which communication skills were most critical across Job Zones. They found oral comprehension essential in over 70% of jobs, while writing was more important in high-complexity occupations. By quantifying the frequency of face-to-face, telephone, and email communication activities, their analysis demonstrates how workforce data can inform targeted skill development.

These findings illustrate how national databases can inform not only workforce assessment planning but also the constructs embedded in assessments to help ensure they reflect the actual tasks and competencies demanded by employers. Building on national surveys and reports that highlight the importance of adult literacy and numeracy for employment and career advancement, it is also critical to understand how these skills are enacted in specific workplace contexts as informed by case studies.

2.3 Insights into Workforce Skills from Case Studies

Large-scale data show the barriers that low literacy and numeracy present, but case studies by Jonsson and Bläsjö (2020) and Visén (2021) provide detailed insights into the types of reading, writing, and communication tasks and numeracy tasks (Straesser, 2015) workers perform on the job. While large-scale studies reveal that literacy and numeracy requirements vary across occupations and tasks, from analyzing technical systems to following practical instructions and communicating effectively, case studies provide a finer-grained understanding of which literacy and numeracy aspects are relevant for different workplace contexts.

Visén's (2021) qualitative study examined vocational reading literacy practices in Swedish upper secondary school vocational education, focusing on how reading is integrated into teaching across childcare, technical, culinary, and industrial programs. Drawing on New Literacy Studies (Barton, 2007), the researchers combined interviews from nine vocational teachers and classroom observations of four student groups in three schools. Analyses of text categories, genres, reading events, and reading types revealed

that students engaged with a broad range of texts (from general to highly specialized) and that reading practices varied by vocational context to address distinct purposes for varied audiences (see also Oliveri et al., 2023, for an application to writing analytics in cross-disciplinary studies). Study findings underscore the complexity of disciplinary reading practices in vocational education and suggest that understanding these practices is critical for supporting students in developing the critical and context-sensitive reading literacy necessary for success in their fields.

Jonsson and Bläsjö (2020) examined professional writing in multilingual business contexts in Sweden, where employees were expected to work in both Swedish and English. Using linguistic ethnography, the study analyzed how professionals navigated between translanguaging and monolingual modes of communication in their daily work. The researchers found that when monolingual texts were produced, the surrounding literacy practices remained multilingual, and employees often anticipated a future or secondary audience choosing English for broader reach or Swedish to keep matters local. They also observed the continued use of multimodal approaches, from digital tools to pen-and-paper, and the blending of academic, business, and personal discourse. These results deepen the understanding of workplace literacy by showing that knowing when and how to shift between language modes, genres, and modalities is a critical skill in multilingual professional settings.

In numeracy, Straesser (2015) took a broad view of “work” (including unpaid labor) to explore the relationship between numeracy and work, focusing on how workplace-related mathematics were shaped by specific forms and constraints. The author synthesized the literature on workplace mathematics and vocational numeracy and analyzed three case studies alongside the Programme for the International Assessment of Adult Competencies (PIAAC) survey data. They paid particular attention to mathematical knowledge, dispositions toward mathematics, and the role of tools in industrial contexts. The findings show that workplace mathematics often integrates mathematical knowledge into a single test, which in turn, points to several key takeaways, including reflections on the term *numeracy* and on the importance of a *critical orientation* to numeracy from a workplace perspective, underscoring the need to rethink how numeracy is conceptualized and assessed in vocational and adult learning contexts.

Building on the insights from Jonsson and Bläsjö (2020), Straesser (2015), and Visén (2021), our research extends this focus to other workplace contexts. For example, Oliveri et al. (2021) examined workplace English communication to inform the development of scenario-based tasks that aligned with workplace settings such as interpreting design specifications, reading technical instructions, and coordinating with team members. The tasks illustrated various aspects of workplace literacy such as analytical, practical, and communicative literacy practices.

Our companion study, “Beyond the Test—Designing Job-Aligned Assessments for Agricultural Workers” (Oliveri et al., 2026), illustrates other examples of contextualized scenario-based tasks applied to agricultural contexts (and strawberry harvesting, more specifically) to show how adult learners and employees engage in various aspects of literacy and numeracy tasks, such as reading and interpreting safety protocols and

production records. The tasks combine technical vocabulary, procedural comprehension, and quantitative reasoning.

Thus, case-based studies reveal how literacy and numeracy are enacted in daily tasks, while large-scale databases, such as O*NET, provide an opportunity for within and across industry generalization. Yet few studies have systematically combined these approaches to inform assessment design for adult learners. That is, while prior studies identify skill importance at the occupational level, they rarely specify the task contexts, complexity gradients, and evidentiary implications needed for principled assessment design.

The present study addresses these gaps by using O*NET data to map literacy and numeracy KSAs to in-demand occupations and then linking these findings to actual workplace practices documented in prior case studies. This approach directly supports the development of assessments that capture constructs in better alignment with workplace needs. This research contributes a model for integrating national workforce data with situated literacy practices to build contextualized, scenario-based assessments that more accurately reflect literacy and numeracy demands in workplace settings.

Research on adult education and workforce preparation underscores the need to align instruction with the actual cognitive, literacy, and numeracy demands of contemporary workplaces (Suárez-Álvarez et al., 2022, 2024). Existing workforce assessments often rely on grade-level indicators, generic literacy scales, or isolated skill proxies. These approaches obscure how literacy and numeracy are enacted across occupations and Job Zones, leading to misalignment between assessment results, training decisions, and real workplace demands. Yet, as the literature indicates, we know too little about how these skills are enacted across specific occupational contexts, especially in Job Zones 1–3, which include many entry-level roles accessible to adults with limited formal education or English proficiency. These occupations often serve as critical access points into the labor market, offering opportunities for on-the-job learning and pathways for advancement. Without a fine-grained description of how literacy and numeracy practices are embedded in these workplaces, training programs and assessments risk relying on abstract or outdated skill models, limiting learners' ability to secure, retain, or advance in employment (Kirsch et al., 2021; Oliveri & Tannenbaum, 2017).

3.0 Research Questions

This study investigated three research questions; each aligned with a core assessment design principle:

1. *For Job Zones 1–3, which occupations and occupational groups are projected to be fast-growing according to U.S. BLS Employment Projections data for 2022–2032? Addressing task selection, this question identifies expanding occupations to ground construct models in labor-market realities. Locating where workforce demand is projected to concentrate helps ensure that assessments target KSAs with clear economic relevance and guides adult education programs toward high-value career pathways.*
2. *What literacy and numeracy KSAs are required for these in-demand occupations? Using O*NET data, this question addresses back / forward design by identifying*

workplace-aligned KSAs essential for current performance while also supporting future skill development as job demands evolve.

3. *In what work contexts and at what complexity levels are these KSAs most frequently applied?* Drawing on O*NET work activities and Job-Zone classifications, this question addresses *contextualization* and *complexity calibration*. It clarifies the tasks, settings, and decision-making demands that shape real-world literacy and numeracy use, informing the design of assessment scenarios that are realistic, appropriately challenging, and aligned with potential employer expectations.

Answers to these questions and their associated assessment design principles provide a foundation for developing literacy and numeracy workforce-preparation assessments that are empirically grounded in current and future-looking skill demands and directly connected to actual workplace requirements (see also Oliveri & McCulla, 2019; Texas Workforce Commission, 2019).

4.0 Methods

This descriptive, exploratory study employed a data-driven mapping approach situated within literacy, numeracy, and workforce research. Its purpose is not to validate an assessment instrument or to estimate relationships between skills and worker outcomes. Instead, guided by the ECD framework, the study demonstrates how national labor market data and occupational information can be translated into assessment-relevant representations of literacy and numeracy demands. The contribution lies in clarifying the Target Language Use (TLU) domain, articulating task-relevant conditions, and specifying what would constitute credible evidence of competence in workplace contexts prior to task development and validation.

This study was guided by two (ECD and TLU) assessment design frameworks and by the four assessment design principles introduced in Section 1.3. Together, ECD and TLU provide a structured approach for linking observed workplace practices to construct, evidence, and task models (Mislevy et al., 2003). These frameworks support systematic identification of literacy and numeracy practices that matter in workplace settings, the conditions under which they are enacted, and the types of evidence needed to support defensible inferences about performance.

Aligned with these frameworks, the analysis illustrates how the four design principles may be operationalized through the translation of labor-market and occupational data into assessment-relevant representations of literacy and numeracy demands. Specifically, the mapping links domain characteristics, task contexts, and role-based complexity levels to potential assessment targets, demonstrating how ECD and TLU can be used jointly to support coherent construct definition and task design. The goal is not to predict individual performance or validate assessment scores, but to support domain analysis and evidence modeling as precursors to principled assessment development.

The study draws on two publicly available data sources: employment projections from the U.S. Bureau of Labor Statistics (BLS, 2023) and the Occupational Information Network (O*NET). Together, these sources are synthesized to inform downstream

decisions in workplace-aligned assessment design by providing empirically grounded representations of literacy and numeracy practices as they are enacted in work contexts.

4.1 Assessment Design Frameworks

Two complementary assessment design frameworks informed this study: Evidence-Centered Design (ECD) and Target Language Use (TLU). ECD provides a principled structure for specifying constructs, identifying what counts as evidence, and designing tasks that support defensible inferences about performance. TLU focuses on the real-world literacy and numeracy demands of work, identifying the tasks, texts, interactions, and decision-making processes through which skills are enacted in occupational contexts. Used together, these frameworks support assessment and instructional designs that are both contextually grounded and evidentially coherent. See “Beyond the Test—Designing Job-Aligned Assessments for Agricultural Workers” (Oliveri et al., 2026).

4.1.1 The Evidence-Centered Design Framework

In this study, ECD served as the analytic backbone for domain analysis. Developed by Mislevy et al. (2003), ECD provides a systematic, evidence-based approach to assessment design, from identifying relevant KSAs to designing tasks that elicit evidence of those KSAs. In this way, ECD ensures scoring rubrics capture the relevant features of the constructs to be assessed and assessments are instructionally useful (Oliveri et al., 2021). Rather than treating assessment as test construction alone, ECD emphasizes evidentiary reasoning: specifying which aspects of performance matter, under what conditions they should be observed, and how those observations support interpretation and use. ECD consists of five interconnected processes (Mislevy & Oliveri, 2019):

- domain analysis – identifies the KSAs that are most valued in a given context
- domain modeling – maps the relationships among those KSAs
- conceptual assessment framework (CAF) – specifies how the constructs will be measured, the task features that will be used, and the evidence to be collected
- assessment implementation – develops tasks, scoring procedures, and delivery mechanisms
- assessment delivery – administers and manages the operational aspects of the assessment.

The current study focuses on the first process, domain analysis, to identify the literacy and numeracy skills most relevant to adult learners in Job Zones 1–3. Domain analysis involves gathering substantive evidence about a domain of interest to determine which KSAs are most critical (Mislevy et al., 2003; Schmidgall et al., 2019). This evidence can come from occupational databases such as O*NET, literature reviews, expert interviews, and the direct observation of work practices.

In our analysis, we draw specifically on O*NET data to examine workplace literacy and numeracy demands across occupations in Job Zones 1–3. Identifying these KSAs in the domain analysis stage lays the foundation for the subsequent ECD layers and provides a stronger basis for designing valid, workplace-aligned assessments that reflect the real demands of jobs and support adult learners’ skill development. Although this

study does not extend into domain modeling or CAF, our findings can inform future efforts that do, including the development of contextualized, scenario-based assessments and curricula. see “Beyond the Test—Designing Job-Aligned Assessments for Agricultural Workers” (Oliveri et al., 2026) for an illustration of how these ECD layers can be applied to the agriculture sector.

We use ECD not only as a framework for aligning constructs, tasks, and evidence but also as an anticipatory design framework. Anticipatory design frameworks are forward-looking approaches that integrate current evidence with projections of future trends to inform the design of assessments, curricula, or training materials. Rather than reacting to changes after they occur, these approaches emphasize proactively identifying emerging workforce demands and building adaptability into educational and workforce systems (Oliveri et al., 2021). In fast-evolving labor markets driven by automation and demographic shifts, this orientation is essential for ensuring that assessments remain relevant and actionable over time (Mislevy et al., 2025).

Using ECD as an anticipatory framework allows us to go beyond cataloging existing literacy and numeracy demands by considering future skills that workers may need. For example, in our domain analysis, we not only examined current O*NET data but also reviewed industry reports, labor-market projections, and technological trend analyses to anticipate new task types and performance expectations. This forward-looking evidence informs the KSAs we highlighted and positions subsequent assessment and curriculum development to prepare learners for both present and emerging workplace contexts. An anticipatory application of ECD also enhances the adaptability and resilience of assessment systems themselves. By embedding flexibility in the domain analysis stage, assessment designers can more easily update task specifications, scoring rubrics, or task-delivery modes as job demands evolve. This approach supports iterative improvement rather than one-time development, ensuring that workplace-aligned assessments remain valid, fair, and instructionally useful as industries and occupations change. In doing so, ECD serves not only as a technical framework for assessment design but as a strategic tool for aligning workforce education with the dynamic realities of employment.

4.1.2 Target Language Use Assessment Framework

We also draw on the TLU domain framework (Bachman & Palmer, 1996, 2010), which complements ECD by guiding the identification of the specific language and literacy skills required by real-world occupational contexts. While ECD focuses on the underlying constructs and evidence needed for assessment, TLU identifies the language requirements that workers are expected to perform. Rather than relying on abstract definitions of “reading,” “writing,” or “math,” TLU asks: *What do workers actually read, write, calculate, or communicate? How quickly must they process and act on information? What decisions depend on these literacy and numeracy tasks?* These questions are relevant across industries. For example, agricultural workers may need to interpret pesticide labels, follow sanitation protocols, or record production data (Oliveri et al., 2026); healthcare workers read patient charts or document clinical notes (Ohlin et al., 2024); and manufacturing employees follow complex standard operating procedures (Devos, 2023).

Using TLU in tandem with ECD allows test developers to *embed* assessments in specific contexts while still maintaining a rigorous evidence-based structure. This integrated approach not only increases validity but also supports multiple ways for workers to demonstrate competence, producing results that are more directly actionable for workplace training, safety monitoring, and performance evaluation, enhancing both the fairness and the utility of assessments.

4.2 Data from the Bureau of Labor Statistics

Employment Projections data from the BLS database (2022–2032) (BLS, 2023) provided employment growth projections for 832 occupation titles. The file included:

- employment numbers in 2022 and 2032
- number of occupational openings (i.e., the projected number of openings or positions for workers entering the occupation, defined as the sum of net occupational employment change and occupational separations, not including workers changing jobs within an occupation as they do not generate openings and there is no net change in openings from this movement)
- median annual wage
- typical entry-level education (e.g., some high school, lower than bachelor's degree)
- related work experience (e.g., none, less than 5 years, 5 years or more)
- typical on-the-job training (e.g., none, short-, or long-term on-the-job-training)

4.3 Data from the Occupational Network Database

We also analyzed data from O*NET (v.28.2): the KSAs, work context, and work activities questionnaires to identify literacy- and numeracy-related KSAs, work context, and work activities. The questionnaires from the worker- and job-oriented characteristics were selected from the O*NET content model. O*NET classifies occupations into five Job Zones:

- Job Zone 1: May require a high school diploma or GED
- Job Zone 2: Requires a high school diploma and possibly vocational training
- Job Zone 3: Typically requires an associate degree or equivalent vocational training
- Job Zone 4: Requires a bachelor's degree
- Job Zone 5: Requires a graduate or professional degree (e.g., master's, doctorate)

Data from Job Zones 1–3 were analyzed to investigate the jobs adult learners in Job Zones 1–3 do. We also used data from the worker-related and work-related characteristics clusters from the O*NET content model, the work context questionnaire, and the work activities.

The worker-related characteristics refer to characteristics necessary for the KSAs to demonstrate effective work performance. The work-oriented characteristics are variables describing the occupational characteristics that influence occupational requirements in an occupational (or work) context. The work context describes an organization's social and/or physical characteristics that influence how people do their work; for instance, it provides details regarding the social interactions (e.g., face-to-face communications,

emailing) relevant to how workers communicate at work. Data from three questionnaires from the worker-related characteristics cluster were analyzed—knowledge, skills, and abilities—and one questionnaire— work context—from the job-oriented cluster.

As this study relied entirely on publicly available datasets and did not involve the collection of personally identifiable information from human participants, no formal Institutional Review Board (IRB) review or approval was required. All analyses were conducted in accordance with ethical research practices, ensuring that occupational data were used responsibly and in aggregate form to protect privacy and confidentiality.

4.3.1 KSAs from O*NET

Each of the three KSA questionnaires have 66, 70, and 104 variables, respectively. Table 2 lists the literacy- and numeracy-related variables that were selected from the knowledge, skills, and abilities questionnaires and defines each variable as specified by O*NET. For literacy, the following variables were selected: (a) reading, including reading comprehension and written comprehension; (b) writing and written expression; (c) listening, including active listening, auditory attention, speech recognition, and oral comprehension; and (d) speaking, including oral expression and speech clarity. For numeracy, the following variables were selected: (a) operations and algebraic thinking, including mathematical reasoning and number facility, and (b) geometry, including visualization. For each literacy- and numeracy-related KSA, O*NET provides importance ratings (1 = not important, 3 = important, 5 = extremely important;) and level ratings (1 = low expertise, 4 = moderate, 7 = high). The ratings were gathered from occupational analysts with relevant work experience, graduate education, and experience in job analysis.

Table 2

*Literacy and Numeracy Variables from O*NET Knowledge, Skills, and Abilities Questionnaires*

Variable	Definition
<i>Knowledge</i>	
English language	Knowledge of the structure and content of the English language, including the meaning and spelling of words, rules of composition, and grammar.
Mathematics	Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
<i>Skills</i>	
Active listening	Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
Mathematics	Using mathematics to solve problems.
Reading comprehension	Understanding written sentences and paragraphs in work-related documents.
Speaking	Talking to others to convey information effectively.

Variable	Definition
Writing	Communicating effectively in writing as appropriate for the needs of the audience.
<i>Abilities</i>	
Auditory attention	The ability to focus on a single source of sound in the presence of other distracting sounds.
Mathematical reasoning	The ability to choose the right mathematical methods or formulas to solve a problem.
Number facility	The ability to add, subtract, multiply, or divide quickly and correctly.
Oral comprehension	The ability to listen and understand information and ideas presented through spoken words and sentences.
Oral expression	The ability to communicate information and ideas in speaking so others will understand.
Speech clarity	The ability to speak clearly so others can understand.
Speech recognition	The ability to identify and understand the speech of another person.
Visualization	The ability to imagine how something will look after it is moved around or when its parts are moved or rearranged.
Written comprehension	The ability to read and understand information and ideas presented in writing.
Written expression	The ability to communicate information and ideas in writing so others will understand.

Table 3 summarizes the complexity levels associated with each of the literacy- and numeracy-related variables.

Table 3

*Complexity-Level Descriptors for Literacy and Numeracy Variables from O*NET Knowledge, Skills, and Abilities Questionnaires*

Variable	Complexity Descriptor
<i>Knowledge</i>	
English language	1: Write a thank-you note. 4: Edit an article for a news website. 7: Teach a college English class.
Mathematics	1: Add two numbers. 4: Analyze data to determine areas with the highest sales. 7: Derive a complex mathematical equation.

Skills

Variable	Complexity Descriptor
Active listening	1: Take a customer's order. 4: Answer inquiries regarding credit references. 7: Serve as a judge in a complex legal disagreement.
Mathematics	1: Count the amount of change to be given to a customer. 4: Calculate the square footage of a new home under construction. 7: Develop a mathematical model to simulate and resolve an engineering problem.
Reading comprehension	1: Read step-by-step instructions for completing a form. 4: Understand an email from management describing new personnel policies. 7: Read a scientific journal article describing surgical procedures.
Speaking	1: Greet tourists and explain tourist attractions. 4: Interview applicants to obtain personal and work history. 7: Argue a legal case before the Supreme Court.
Writing	1: Write down a guest's order at a restaurant. 4: Write an email to staff outlining new directives. 7: Write a novel for publication.
<i>Abilities</i>	
Auditory attention	1: Listen to a lecture while people nearby are talking. 4: Listen for your flight announcement at a busy airport. 7: Listen to instructions from a coworker in a noisy sawmill.
Mathematical reasoning	1: Add two numbers. 4: Analyze data to determine areas with the highest sales. 7: Derive a complex mathematical equation.
Number facility	1: Add 2 and 7. 4: Calculate a discounted price. 7: Compute the interest payment that should be generated from an investment.
Oral comprehension	1: Understand a television commercial 4: Understand a coach's oral instructions for a sport. 7: Understand a lecture on advanced physics.
Oral expression	1: Place an order at a restaurant drive thru. 4: Give instructions to a lost motorist. 7: Explain advanced principles of genetics to college freshmen.
Speech clarity	1: Call numbers in a bingo game. 4: Make a stadium-wide announcement during a sporting event. 7: Give a lecture to a large audience.
Speech recognition	1: Recognize the voice of a co-worker. 4: Identify a former customer's voice over the phone. 7: Understand a speech presented by someone with an unfamiliar accent.

Variable	Complexity Descriptor
Visualization	1: Imagine how to place paper in a printer so the letterhead comes out on top. 4: Follow a diagram to assemble a metal storage cabinet. 7: Anticipate future moves in a chess game.
Written comprehension	1: Understand signs on the highway. 4: Understand an apartment lease. 7: Understand an instruction book on repairing Artificial Intelligence systems.
Written expression	1: Write a note to remind someone to take food out of the freezer. 4: Write a job recommendation for a subordinate. 7: Write an advanced economics textbook.

Note: The numbers indicate the level of complexity associated with the variable; 1 = low, 4 = moderate, 7 = high expertise required to carry out the knowledge, skill, or ability.

The complexity level ratings were provided by occupational analysts (Tsacoumis & Willison, 2010). As shown, each literacy- and numeracy-related KSA has a different complexity level, with lower levels for each variable indicating lower complexity levels and higher numbers indicating higher complexity levels. As an example, Level 1 in written expression requires examinees to write a note to remind someone to take food out of the freezer, and Level 7 requires writing an advanced economics textbook, indicating higher levels of complexity with higher rating levels. These ratings were used to calculate the mean complexity level ratings of the KSAs for each Job Zone. Higher mean level ratings indicate a greater level of expertise required to perform the job.

4.3.2 Work Context Data from O*NET

The work context questionnaire has frequency and importance ratings for the 57 work contexts that occur in daily job activities. For face-to-face discussions, public speaking, telephone conversations, electronic mail, and written letters and memos, the O*NET rating captures how often each context occurs on the job (1 = never, 2 = once a year or more but not every month, 3 = once a month or more but not every week, 4 = once a week or more but not every day, and 5 = every day). A slightly different scale is used for “contact with others” (1 = no contact with others, 2 = occasional contact with others, 3 = contact with others about half the time, 4 = contact with others most of the time, 5 = constant contact with others). For variables such as coordinating or leading others, dealing with external customers, working with a group or team, and the importance of being exact or accurate, the scale reflects perceived importance (1 = not important at all, 2 = fairly important, 3 = important, 4 = very important, 5 = extremely important). In all cases, higher ratings indicate a higher frequency or importance rating. Ten literacy- and numeracy-related variables from the work context questionnaire were selected. The first nine variables were literacy-related, and the last one was numeracy-related. Table 4 lists the selected work context variables and the corresponding questionnaire items.

Table 4
*Literacy and Numeracy Variables from O*NET Work Context Questionnaire*

Variable	Question
Literacy-related work context	
Contact with others	How much contact with others (by telephone, face-to-face, or otherwise) is required to perform the current job?
Coordinate or lead others	In your current job, how important are interactions that require you to coordinate or lead others in accomplishing work activities (not as a supervisor or team leader)?
Deal with external customers	In your current job, how important are the interactions that require you to deal with external customers (as in retail sales) or the public in general (as in police work)?
Electronic mail	How frequently does your current job require telephone conversations?
Face-to-face discussion	How often does your current job require face-to-face discussions with individuals and within teams?
Letters and memos	How frequently does your current job require written letters and memos?
Public speaking	How frequently does your current job require public speaking (one speaker with an audience)?
Telephone	How frequently does your current job require telephone conversations?
Work with a group or team	How important are interactions that require you to work with or contribute to a work group or team to perform your current job?
Numeracy-related work context	
Importance of being exact or accurate	How important is being very exact and highly accurate?

Data from the work activities questionnaire was used, which links job task statements to categories arranged hierarchically in terms of detail and specificity, from general work activities (GWA) at the broadest level to detailed work activities (DWA) at a more fine-grained level of abstraction. Thus, GWAs represent the broadest category of work activities and refer to aggregations of similar job tasks or behaviors that support the accomplishment of broad work functions.

Each job task statement, which may include job descriptions, postings, training guides, curricula, and technology used in specific occupations, was tagged with one or more GWA categories (Dierdorff & Norton, 2011). The DWA clusters tasks within a GWA for the same job family and captures simple work activities that have some degree of occupational context. The DWA is useful for identifying the transferable skills across occupations within a job family (i.e., a group of related occupations that share similar functions, skills, knowledge, and work and work activities, even if the specific job titles, levels of responsibility, or industries differ; jobs within a family are linked by common core competencies and task types, and they often follow comparable career pathways or

progression structures; Hansen et al., 2014). The intermediate work activities (IWAs) provide a more general activity statement that links multiple job families and highlights skills transferable across broader occupational groups (Hansen et al., 2014). For this study, we selected the IWAs to examine transferable work activities across the identified in-demand occupational groups.

4.4 Data Analysis Procedures

To address Research Question 1, we linked the O*NET KSA and GWA data with the U.S. BLS 2022–2032 Employment Projections data using the Standard Occupational Classification (SOC) coding system. The SOC system, developed by the Office of Management and Budget (Gregory et al., 2019), provides a common occupational taxonomy that supports alignment across federal workforce datasets by organizing occupations hierarchically and associating them with standardized occupation titles, job task statements, required KSAs, and work activity categories.

The initial BLS employment projections for 2022–2032 included 832 occupations (BLS, n.d.), while the O*NET All Occupations data file included 1,016 occupations. O*NET extends the SOC structure by appending two additional digits to each SOC code, enabling finer grained distinctions among detailed occupation titles. By merging these datasets through their shared SOC codes, we expanded the number of occupational titles represented in the employment projections and incorporated additional occupational attributes not available in the BLS data alone, including Job Zone classifications and detailed KSA and work activity descriptors.

This integration leveraged the hierarchical nature of the SOC system, which ranges from broad major groups to increasingly specific detailed occupations. For example, SOC Major Group 17-0000 represents Architecture and Engineering Occupations, which includes SOC Minor Group 17-2000 (Engineers). Within this group, SOC 17-2110 identifies Industrial Engineers, and O*NET further disaggregates this category into detailed occupations such as 17-2112.01 Human Factors Engineers and Ergonomists and 17-2112.02 Validation Engineers. Using this structure allowed us to connect projected employment growth to occupation-specific information at multiple levels of specificity, supporting more precise identification of job-relevant knowledge, skills, and work contexts for principled assessment design.

After merging the initial data sources, occupations that were relevant to the study were selected based on the following inclusion criteria: 1) classified in Job Zones 1–3, given the focus on entry-level occupations for adult learners rather than professionals; 2) required a high-school diploma or associate degree; 3) contained complete information; and 4) had a matching O*NET SOC code. Occupations without KSA information were excluded. For an overview of prior research spanning all five Job Zones, see Oliveri and McCulla (2019).

The results of the merging process found that 467 occupations in the U.S. BLS Employment Projections data matched the study's inclusion criteria. Occupation titles were grouped into 21 occupational groups. The median percentage change for each occupational group was calculated. The results were rank-ordered to identify the fastest-growing occupations. The merging process was then expanded to additional O*NET data sources, including O*NET Knowledge, Skills, Work Context, and Work Activities,

using the O*NET SOC code to link them for the projected in-demand occupational groups, as described later.

To investigate Research Question 2, the mean importance rating of each of the 14 literacy and numeracy KSAs was calculated for each occupational group on a scale of 1–5 (1 = not important, 2 = somewhat important, 3 = important, 4 = very important, and 5 = extremely important). Next, the mean importance ratings were dummy coded using the criteria that if the datapoint was ≥ 3.0 , it was recoded as a 1 and if the datapoint was < 3.0 , it was coded as a 0. A threshold of 3.0 was chosen because it was the midpoint of the scale at which the importance of KSAs could be divided. Finally, the percentage of literacy and numeracy KSAs rated as important were calculated for each occupational group.

To analyze Research Question 3, the mean importance rating for each of the 10 literacy- and numeracy-related variables from the work context questionnaire was calculated to assess the relative importance of these work contexts and better understand where and how literacy and numeracy are used at work. Next, the analyses using job task statements and work activities data were expanded by selecting the work activities for all occupations that reflected literacy and numeracy skills and abilities based on the following criteria: 1) the GWA corresponded to literacy- or numeracy-related variables in this study and/or 2) the literacy- or numeracy-related variables were rated as important (≥ 3.0). This combined approach (linking frequency/ importance ratings with actual work activities) clarifies which tasks are valued more and under what conditions workers perform them.

5.0 Results

Results of Research Question 1—*For Job Zones 1–3, which occupations and occupational groups are projected to be fast-growing according to the U.S. BLS Employment Projections data for 2022–2032?*—revealed that 467 occupation titles met the study’s inclusion criteria. Among the 21 occupational groups, the median employment percentage change ranged from -6.40 to 6.00, where positive values indicated projected employment growth and negative values indicated decline. Eighteen occupational groups showed positive median values, while three showed negative values.

Table 5 summarizes the occupations, employment, and wages for 2022–2032 for jobs requiring less than a bachelor’s degree, rank-ordered by median change. Four occupational groups were projected to be in demand with values at or above 5.00, followed by other occupational groups with much lower values, 3.25 or below. Thus, the following four groups were selected as the focus of our study and guided our analysis of workplace literacy and numeracy skills: Personal Care and Service (median = 6.00 among 27 occupations), Healthcare Technical and Practitioners (median = 5.55 among 22 occupations), Healthcare Support (median = 5.40 among 15 occupations), and Computer and Mathematical Industry (median = 5.00 among 1 occupation).

Table 5
Occupations, Employment, and Wages (2022–2032) for Jobs Requiring Less than a Bachelor’s Degree

Major Groups/Job Families	Number of Occupations	Employment 2022 (Hundreds)	Projected Employment 2032 (Hundreds)	Employment Rate	Employment Percent	Median Annual Wage	
	(%)	Median	Median	Range	Median	Range (\$)	Median (\$)
*Personal Care & Service	27 (5.80)	54.1	62.8	(-9.6)–16.0	6	27650–96370	34990
*Healthcare Practitioners & Technical	22 (4.70)	91.05	99.7	0.4–20.5	5.55	33960–89530	56625
*Healthcare Support	15 (3.20)	66.7	70.3	(-3.8)–26.1	5.4	31410–64250	37160
*Computer & Mathematical	1 (0.20)	736.2	772.9	NC	5.0	NC	57890
Educational Instruction & Library	4 (0.90)	289.2	298.6	(-6.1)–3.4	3.25	35330–44110	37140
Life, Physical, & Social Science	7 (1.50)	21.2	22.3	(-1.3)–10.1	3.2	41520–100420	50840
Transportation & Material Moving	43 (9.20)	30.7	32.4	(-2.2)–20.6	3.2	30380–132250	47490
Protective Service	21 (4.50)	62.2	59.8	(-0.75)–14.8	3.1	27270–96290	49100
Legal	2 (0.40)	208.25	216.2	1.7–4.2	2.95	50490–59200	54845
Arts, Design, Entertainment, Sports, & Media	11 (2.40)	21.3	22.4	(-18.0)–9.7	2.8	33160–94270	50660
Building & Grounds Cleaning & Maintenance	8 (1.70)	242.9	249.8	0.1–3.5	2.55	29960–50810	39875
Installation, Maintenance, & Repair	49 (10.50)	36.6	35.1	(-29.8)–44.9	2.5	34240–93720	50130
Business & Financial Operations	3 (0.60)	13.6	13.3	(-2.6)–7.4	1.5	48250–69380	49330
Food Preparation & Serving Related	15 (3.20)	459.2	478.4	(-13.7)–20.4	1.5	27640–56520	29790
Construction & Extraction	56 (12.00)	29.85	33.6	(-28.5)–22.3	1.45	36080–99000	49300
Management	4 (0.90)	24.7	24.65	(-6.7)–2.6	1.35	61310–82760	76410
Architecture & Engineering	11 (2.40)	49.6	46	(-7.2)–8.3	0.9	47180–74410	61310

Major Groups/Job Families	Number of Occupations	Employment 2022 (Hundreds)	Projected Employment 2032 (Hundreds)	Employment Percent Rate	Median Annual Wage		
	(%)	Median	Median	Range	Median	Range (\$)	Median (\$)
Sales & Related	13 (2.80)	266.1	268.7	(-20.6)–4.1	0.5	28240–62400	35800
Farming, Fishing, & Forestry	10 (2.10)	32.7	31.25	(-9.4)–8.6	-3.0	32270–54490	40075
Production	97 (20.80)	28.5	27.7	(-28.2)–16.0	-5.0	29060–115870	41940
Office & Administrative Support	48 (10.30)	159.45	125.4	(-38.6)–9.7	-6.4	28910–65980	41905

*Note: n = 467; * = In-demand occupation group; NC = Not computed due to lack of variance. This table summarizes employment trends, projected growth, and median wages for U.S. occupations that require less than a bachelor's degree. Employment 2022 (hundreds) = The total number of jobs in an occupation or industry in 2022, reported in hundreds. For example, the value of 500 represents 50,000 workers. Projected Employment 2032 (hundreds) = The expected total number of jobs in the same occupation or industry in 2032, also reported in hundreds. This projection is based on BLS employment forecasts. Employment Percent Rate (%) = The projected percentage change in employment between 2022 and 2032. It is calculated as follows: projected employment 2032 – employment 2022 divided by employment 2022 multiplied by 100. This indicates the relative growth or decline of each occupation or industry over the 10-year period. These columns together provide a snapshot of current workforce size, anticipated growth, and relative expansion or contraction of occupations to guide workforce planning and assessment design. Median Annual Wage (\$) = The middle point of annual wages reported in U.S. dollars for full-time workers in the occupation or industry, where half earn more and half earn less. Median Annual Wage Range (\$) = For occupations with varying roles or levels, this shows the span of median wages across the sub-roles or percentiles reported in U.S. dollars.*

These four occupational groups resulted in a total of 65 occupations: 27 in personal care and service, 22 in healthcare practitioner roles, 15 in healthcare support, and 1 in the computer and mathematical group. This distribution underscores that while all four groups were projected to grow, the prevalence of occupations meeting the higher-context criteria was much greater in the health and personal-care sectors than in computer/mathematical roles.

The results of Research Question 2—*What literacy and numeracy KSAs are required for these in-demand occupations?*—are shown in Table 6. Table 6 summarizes the percentage of importance ratings for all literacy- and numeracy-related KSAs within each fast-growing industry. The results are sequenced by the number of jobs within an occupation, and variables are grouped by their relevance to the literacy or numeracy constructs.

Table 6

Percentage of Occupations Within Each Industry Rating Each Literacy and Numeracy KSA as Important or Higher

	Personal Care & Service	Healthcare Practitioner & Technical	Healthcare Support	Computer & Mathematical
Number of occupations	26	21	17	1
Literacy-related KSA				
English language	88	95	94	100
Reading comprehension	54	100	94	100
Written comprehension	62	100	94	100
Active listening	100	100	100	100
Oral comprehension	96	100	100	100
Auditory attention	0	14	12	100
Speech recognition	96	100	100	100
Writing	27	95	76	100
Written expression	46	100	94	100
Speaking	96	100	100	100
Oral expression	100	100	100	100
Speech clarity	96	100	100	100

Numeracy-related KSA

	Personal Care & Service	Healthcare Practitioner & Technical	Healthcare Support	Computer & Mathematical
Mathematics knowledge	12	52	0	0
Mathematics skills	4	10	0	0
Mathematical reasoning	4	5	0	0
Number facility	4	14	0	0
Visualization	15	24	12	0

Note: This table shows the percentage of occupations within each industry that rated each literacy and numeracy variable as important (rating of 3) or higher. Percentages were rounded to the nearest unit.

The results indicate that English language knowledge is widely regarded as important across occupations, with 88–100% of occupations rating it higher than 3.0. Speaking and listening skills, including active listening, oral comprehension, speech recognition, oral expression, and speech clarity, were also highly valued, with over 90% of occupations across all groups identifying these skills as important.

Reading-related skills (reading and written comprehension) were considered important by more than 90% of healthcare and computer/mathematical occupations, but only 54–62% of occupations in the personal care and service group rated them as important. A similar pattern was observed for writing skills (writing and written expression), valued by over 90% of healthcare and computer/mathematical occupations, but only 27–46% of personal care and service occupations.

Numeracy-related skills, such as mathematics knowledge, mathematics skills, mathematical reasoning, and number facility, were rated as important by 4–52% of occupations, primarily in personal care/service and healthcare practitioner/technical groups. Visualization skills were considered important by all groups except computer/mathematical occupations; however, this finding for the computer/mathematical group should be interpreted with caution, as it is based on a single occupation and is not necessarily representative of the entire group—many computer and mathematical occupations, particularly those in higher Job Zones, are, in fact, expected to demand advanced numeracy skills, such as visualization, as a key growth-related competency.

Briefly said, the results shown in Table 6 indicate that literacy skills—especially English language, speaking, and listening—are highly important across all occupational groups, while reading and writing skills show greater importance in healthcare and computer/mathematical occupations than in personal care/service. Numeracy and

visualization skills are generally less widely rated as important, though they remain relevant in specific groups such as healthcare and personal care/service.

The results for Research Question 3—*In what work contexts are these KSAs most frequently applied and what levels of complexity?*—are shown in Table 7. Table 7 presents the mean importance ratings for literacy- and numeracy-related work contexts across the four in-demand occupational groups. The results reveal that activities such as telephone conversations, face-to-face discussions, contact with others, work with a group or team, deal with external customers, and coordinate or lead others were found to be important and frequently occurring and were rated above 3.0. A rating of 3 indicated the activity occurred once a month or more often but not weekly. Public speaking had a lower mean importance across all groups. Reading- and writing-related work contexts were also considered important. Reading and writing electronic mail were rated higher than 3.0 across all groups, while reading and writing letters and memos was more important in healthcare groups (mean ratings ranged from 3.05–3.08) and less important for personal care/service and computer/mathematical groups (mean ratings ranged from 2.70–2.79). For numeracy-related contexts, being exact and accurate was rated as important across all groups.

Table 7

Literacy- and Numeracy-Related Work Contexts Mean Importance Ratings Across the Four In-Demand Occupation Groups

	Personal Care & Service	Healthcare Practitioner & Technical	Healthcare Support	Computer & Mathematical
Number of occupations	26	21	17	1
Literacy-related work context				
Contact with others	4.61	4.80	4.77	4.38
Coordinate or lead others	3.43	3.71	3.70	4.25
Deal with external customers	3.88	4.07	3.71	2.01
Electronic mail	3.04	4.14	3.67	5.00
Face-to-face discussion	4.55	4.66	4.59	4.83

	Personal Care & Service	Healthcare Practitioner & Technical	Healthcare Support	Computer & Mathematical
Letters & memos	2.70	3.08	3.05	2.79
Public speaking	2.29	1.80	2.02	2.03
Telephone	3.83	4.52	4.15	4.61
Work with a group or team	4.14	4.46	4.40	4.07
Numeracy-related work context				
Importance of being exact or accurate	3.90	4.59	4.22	4.04

Table 8 illustrates the types of workplace interactions in which literacy and numeracy skills are applied, providing a foundation for the next step: examining IWAs linked to literacy and numeracy skills. As mentioned in the previous section, this step required linking the GWA database to literacy- and numeracy-related IWAs; these analyses provided us with insights into how literacy and numeracy KSAs are contextualized in workplace tasks.

Table 8

Intermediate Work Activities from the Four In-Demand Industries by Literacy and Numeracy Activity

Intermediate Work Activity	Literacy				Numeracy	
	R	W	S	L	O	G
Administer basic health care or medical treatments.			√	√	√	√
Administer emergency medical treatment.			√	√		√
Administer therapeutic treatments.			√	√		√
Advise others on the design or use of technologies.	√	√	√	√		
Advise others on educational or vocational matters.	√	√	√	√		
Advise others on products or services.	√	√	√	√		
Advise patients or clients on medical issues.	√	√	√	√		√
Analyze business or financial data.	√					

Intermediate Work Activity	Literacy				Numeracy	
	R	W	S	L	O	G
Analyze health or medical data.	√					
Assign work to others.		√	√	√		
Assist healthcare practitioners during medical procedures.			√	√	√	√
Assist individuals with special needs.			√	√		√
Assist others to access additional services or resources.			√	√		
Care for plants or animals.			√	√		
Collect information about patients or clients.	√			√		
Communicate with others about operational plans or activities.		√	√	√		
Communicate with others about specifications or project details.		√	√	√		√
Conduct amusement or gaming activities.			√	√	√	
Confer with clients to determine needs or order specifications.		√	√	√		
Confer with healthcare or other professionals about patient care.		√	√	√		√
Coordinate artistic or entertainment activities.			√	√		
Coordinate group, community, or public activities.		√	√	√		
Coordinate with others to resolve problems.		√	√	√		
Counsel others about personal matters.	√	√	√	√		
Determine operational methods or procedures.	√				√	
Diagnose health conditions or disorders.	√					
Direct organizational operations, activities, or procedures.		√	√	√		√
Evaluate patient or client condition or treatment options.	√					
Evaluate personnel capabilities or performance.	√					
Evaluate the characteristics, usefulness, or performance of products or technologies.	√					
Evaluate the quality or accuracy of data.	√					
Execute financial transactions.	√	√				
Explain medical information to patients or family members.	√	√	√	√	√	√
Explain regulations, policies, or procedures.	√	√	√	√		
Fit assistive devices to patients or clients.			√	√		√

Intermediate Work Activity	Literacy				Numeracy	
	R	W	S	L	O	G
Follow standard healthcare safety procedures to protect patients and staff members.	√					
Gather information from physical or electronic sources.	√			√		
Interview people to obtain information.	√			√		
Investigate organizational or operational problems.	√			√		
Maintain current knowledge in the area of expertise.	√					√
Maintain health or medical records.		√				
Maintain operational records.		√				
Maintain sales or financial records.		√				
Manage budgets or finances.		√	√	√		√
Manage control systems or activities.		√	√	√		
Mediate disputes.			√	√	√	
Monitor equipment operation.	√					√
Monitor health conditions of humans and animals.	√					√
Monitor individual behavior or performance.	√					
Monitor the operation of a computer or information technologies.	√					
Monitor operations to ensure adequate performance.	√					
Monitor operations to ensure compliance with regulations or standards.	√				√	√
Monitor safety or security of work areas, facilities, or properties.	√					
Perform administrative or clerical activities.	√	√				
Perform human resources activities.			√	√		√
Prepare health or medical documents.		√				
Prepare informational or instructional materials.		√				
Prepare reports on operational or procedural activities.		√				
Present information in legal proceedings.		√	√	√		√
Present research or technical information.		√				
Process digital or online data.	√					
Promote products, services, or programs.			√	√		√

Intermediate Work Activity	Literacy			Numeracy		
	R	W	S	L	O	G
Provide general assistance to others, such as customers, patrons, or motorists.			√	√		
Provide information or assistance to the public.		√	√	√		
Provide information to guests, clients, or customers.		√	√	√		
Provide support or encouragement to others.			√	√		√
Read documents or materials to inform work processes.	√			√		
Research healthcare issues.	√			√		
Research technology designs or applications.	√			√		
Resolve computer problems.	√					
Respond to customer problems or inquiries.			√	√	√	
Sell products or services.			√	√	√	√
Set up computer systems, networks, or other information systems.	√					
Study details of artistic productions.	√			√		√
Supervise personnel activities.		√	√	√	√	√
Teach life skills.	√	√	√	√		√
Train others on health or medical topics.	√	√	√	√	√	√
Train others on operational or work procedures.	√	√	√	√		√
Train others to use equipment or products.	√	√	√	√		√
Treat injuries, illnesses, or diseases.			√	√		√
Verify personal information.	√					

Note: R = Reading; W = Writing; S = Speaking; L = Listening; O = Operations and Algebraic Thinking; G = Geometry

Table 8 summarizes literacy and numeracy IWAs among the four in-demand industries. The results shown in Table 8 reveal that 81 IWAs were linked to literacy and/or numeracy skills. Across the 80+ work activities analyzed, literacy-related KSAs occurred more often than numeracy activities, particularly in the form of speaking, listening, reading, and writing skills. Activities such as administering medical treatments, advising patients, communicating operational plans, conferring with other professionals, gathering information, maintaining records, preparing documents and reports, training others, presenting information, and providing assistance or information to the public all rely heavily on speaking (oral expression, speech clarity) and listening (active listening, oral comprehension). Reading comprehension is central to tasks like reading documents, researching healthcare issues, following safety procedures, and maintaining medical or operational records. Writing skills support activities such as

preparing health documents, instructional materials, operational reports, or legal/technical presentations.

By contrast, numeracy-related KSAs appear less often than literacy activities. Tasks such as analyzing business, financial, or medical data; evaluating the quality or accuracy of data; executing financial transactions; managing budgets; monitoring performance metrics; diagnosing conditions; or training others on procedures requiring measurement or calculation demand mathematical reasoning, number facility, and operations/algebraic thinking. Some tasks, such as visualizing equipment set-ups, fitting assistive devices, or studying production details, draw on geometry/visualization skills.

Numeracy-related KSAs follow a similar upward pattern, but at lower overall percentages: 0% in Job Zone 1, 4.55–13.64% in Job Zone 2, and 2.38–26.19% in Job Zone 3, with complexity spanning tasks from counting change to calculating square footage. In contrast, speaking- and listening-related KSAs maintain high importance across all Job Zones (95.45–100%), though complexity increases with Job Zone. For instance, speaking complexity spans greeting tourists and interviewing applicants, while listening complexity includes taking customer orders and responding to credit inquiries. Table 9 summarizes the importance and complexity ratings of literacy and numeracy KSAs across Job Zones 1–3.

Table 9
Literacy- and Numeracy-KSA Ratings Across the Four In-Demand Occupational Groups

	Job Zone					
	1	2	3	1	2	3
Number of jobs per Job Zone	1	22	42	1	22	42
	% of Occupations with KSA Rated as Important or Higher			Mean Complexity Ratings		
Literacy-related KSAs						
English language	100	86	95	3.39	3.10	3.65
Reading comprehension	0	55	95	2.00	2.87	3.61
Written comprehension	0	64	95	2.75	2.95	3.13
Active listening	100	100	100	2.50	3.01	3.73

	Job Zone					
	1	2	3	1	2	3
Number of jobs per Job Zone	1	22	42	1	22	42
	% of Occupations with KSA Rated as Important or Higher			Mean Complexity Ratings		
Oral comprehension	100	95	100	3.00	3.54	3.98
Auditory attention	0	5	10	1.88	2.04	2.17
Speech recognition	100	95	100	3.00	3.02	3.42
Writing	0	32	81	2.00	2.58	3.13
Written expression	0	50	93	2.00	2.57	3.29
Speaking	100	100	100	2.75	2.86	3.57
Oral expression	100	100	100	3.62	3.41	3.94
Speech clarity	100	91	100	3.00	2.94	3.23
Numeracy-related KSAs						
Mathematics knowledge	0	14	26	2.19	2.35	2.61
Mathematics skills	0	5	5	1.75	1.63	2.18
Mathematical reasoning	0	5	2	1.38	1.46	2.16
Number facility	0	5	7	1.50	1.73	2.25
Visualization	0	5	24	2.00	2.20	2.63

Overall, the data in Table 9 highlight that even lower-skill occupations in Job Zones 1–3 require minimum complexity levels of literacy, numeracy, and communication skills, with speaking and listening consistently important across all Job Zones and reading, writing, and numeracy increasing in importance and complexity at higher Job Zones. These findings indicate that assessments targeting workplace skills cannot assume minimal skill requirements for entry- and middle-skill occupations. Rather, they must reflect the range of baseline competencies and the increasing complexity of tasks as job responsibilities rise. Even occupations in the lowest Job Zones (1–3) (i.e., those requiring limited formal preparation) often require moderate to high proficiency in speaking and listening, and at least basic proficiency in reading, writing, and numeracy. This finding challenges the assumption that lower Job Zone occupations have minimal skill demands, suggesting that baseline proficiency requirements are rising across many sectors and that workers may need support to meet these demands.

Table 10 summarizes the relevant findings for each research question, describes how they illuminate the workplace-aligned assessment principles, and articulates the implications for assessment design.

Table 10
Research Questions, Findings, and Implications

Research Question	Summary of Findings	Principle(s) Supported, Rationale	Assessment Design Implications
RQ1. For Job Zones 1–3, which occupations and occupational groups are projected to be fast-growing?	Identified 467 qualifying occupations; four occupational groups met the $\geq 5\%$ median growth criterion (Personal Care & Service; Healthcare Practitioners/ Technical; Healthcare Support; Computer & Mathematical). Growth was strongest in health and personal-care occupations.	<u>Task selection</u> : Identifying fast-growing occupations helps prioritize which KSAs to target so assessments focus on skills that matter contextualized in real-world workplaces.	Prioritizes which occupational contexts to target in assessment development. Helps ensure that assessments reflect industries where literacy and numeracy demands are rising.
RQ2. What literacy and numeracy KSAs are required for these in-demand occupations?	Speaking and listening skills were consistently rated highly (90–100%) across all groups. Reading, writing, and numeracy showed industry variability: strong in healthcare and computer/mathematical occupations, lower in personal care/service. Numeracy is more selective but essential where used.	<u>Task selection and back-and-forward design</u> : Mapping KSAs to projected high-growth occupations helps ensure assessments measure critical skills and allows integration of emerging competencies (e.g., digital data entry, automated data interpretation).	Confirms literacy and numeracy as domain-specific, not generic. Helps determine which KSAs should be prioritized in task design for high-growth occupations.
RQ3. In what work contexts and at what complexity levels are these KSAs applied?	Work activities show high importance for communication and teamwork; reading/writing emails is common across groups; numeracy is applied in accuracy-dependent contexts. IWAs highlight that literacy dominates across tasks while numeracy appears selectively but is critical when used. Complexity increases predictably by Job Zone.	<u>Contextualization and complexity calibration</u> : Leveraging O*NET and BLS data helps ensure assessments mirror actual work activities and complexity levels in alignment with workplace needs.	Provides guidance on task contextualization by connecting KSAs to concrete tasks and contexts. Supports the development of assessments that resemble actual workplace constraints, such as technology-mediated communication.

6.0 Discussion

Findings from this data-driven KSA analysis indicate that projected workforce growth in Job Zones 1–3 is concentrated in personal care, health support, and health practitioner roles, alongside growth in selected technology-supported service and logistics occupations. These patterns suggest that future labor-market expansion may be driven not only by advanced technical roles but also by occupations that integrate caregiving, coordination, and technology-mediated service work. Across these roles, literacy and numeracy emerge as foundational enabling skills that operate alongside interpersonal and intrapersonal competencies rather than as standalone KSAs.

Across occupational groups, speaking, listening, reading, writing, and numeracy were consistently rated as important, including in jobs often characterized as entry-level. Speaking and listening were salient across all sectors, reflecting the communicative and collaborative nature of current work demands (Oliveri et al., 2019). Reading, writing, and numeracy demands varied by occupational domain: healthcare roles emphasized procedural reading, documentation, and compliance-related writing, whereas computer- and mathematically oriented roles emphasized quantitative reasoning, data interpretation, and verification. These patterns reinforce the concept that literacy and numeracy are not generic skills, but domain-specific practices shaped by task goals, tools, and consequences.

The analysis also showed that foundational skills are frequently enacted in time-sensitive, technology-mediated contexts. Workers in healthcare are expected to read safety protocols, interpret dosage tables, and document patient care, while computer/mathematical workers are expected to analyze data and verify calculations. These results suggest that contextualized task design is essential; assessments that abstract skills from their use contexts risk underrepresenting the cognitive and situational demands of real work. Assessments should simulate real-world workplace conditions, such as reading digital reports, interpreting instructions, or performing calculations under realistic constraints to elicit evidence of workplace-ready literacy and numeracy skills.

Regarding Job Zones, we found that even lower-level jobs require moderate to high proficiency in foundational skills, challenging assumptions that basic literacy and numeracy are sufficient in entry-level roles. Higher Job Zones demand greater complexity in reading, writing, and quantitative reasoning, whereas speaking and listening skills remain consistently important across Job Zones. These analyses revealed that even roles classified at lower Job Zones frequently require moderate to high levels of reading and quantitative reasoning. Such findings indicate a rising floor of essential skills across the labor market, one that may outpace the preparation of many adult learners unless assessments and training more accurately reflect these realities.

A central implication of these findings is the inadequacy of grade-level indicators and other coarse skill metrics for representing workplace literacy and numeracy demands. Grade-level indicators are poorly suited for workplace assessment not because they lack technical rigor but because they encode assumptions about learning progression misaligned with how literacy and numeracy function at work. In occupational contexts, task difficulty is driven less by textual length or syntactic complexity than by consequences of error, decision-making responsibility, time pressure, and coordination with others. Findings from this study show that literacy and

numeracy demands vary systematically by occupational role and Job Zone, not in linear grade-level terms but through expanded responsibility for interpreting information, making judgments, and acting under constraint. Replacing grade-level proxies with role-calibrated task complexity (i.e., the alignment of assessment task demands with occupational responsibilities, decision-making authority, and consequences of error) advances assessment practice by aligning evidentiary claims with how competence is enacted and evaluated in real workplace settings. This shift from grade-level indicators to role-calibrated task complexity represents a step forward for assessment, enabling more defensible claims about how literacy functions in real work contexts.

6.1 Limitations

Although this study identifies the literacy and numeracy KSAs embedded in high-growth occupations, the study is subject to a few limitations that should be considered when interpreting the findings. First, the analysis used a single snapshot of BLS employment projections and O*NET skill ratings to identify “skills of tomorrow.” This span makes it possible to compare many occupations at once but limits sensitivity to regional labor-market variation, rapidly evolving technologies, and emerging occupational roles that may not be fully represented in national datasets. Future studies should adopt longitudinal designs and incorporate state- or region-specific data to better capture evolving literacy and numeracy skills over time and across geographic contexts. Such approaches would strengthen anticipatory design and support the updating of task models; see, for example, the companion article *Beyond the test—Designing job-aligned assessments for agricultural workers* (Oliveri et al., 2026) for a California-focused case study.

Second, BLS and O*NET databases provide valuable information on skills, but their indicators of skill importance and work context are based on surveys and expert ratings that may lag actual practice and underrepresent informal, adaptive, or tacit dimensions of skill enactment. Future studies should combine these data sources with direct observations and measures of how workers use literacy and numeracy on the job, including stakeholder interviews, digital trace data from training systems, or small-scale performance studies. Moreover, co-designing studies with employers and workers is essential. Workers hold critical, situated knowledge about job requirements that may not be visible to external researchers (Eraut, 2000; Lave & Wenger, 1991).

Additionally, because this study focused on mapping rather than validating, we cannot confirm that the identified skills predict job performance or training success. Pilot studies with adult learners using performance-based scenarios or formative assessments, combined with stakeholder input, can validate that assessments capture the skills that truly matter, enhancing contextualization and practical utility.

7.0 Conclusion

This study contributes a principled, design-oriented approach for translating labor-market data into assessment-relevant representations of workplace literacy and numeracy demands. By integrating BLS employment projections with O*NET KSAs, work activities, and work context descriptors, the study demonstrates how domain analysis can

inform decisions about what to assess, how to represent complexity, and how to align assessment design with real-world occupational demands.

Rather than treating literacy and numeracy as decontextualized skills, the findings emphasize their enactment within specific work processes, technologies, and decision-making environments. The study operationalizes four assessment design principles (task selection, contextualization, complexity calibration, and forward-looking design) that together provide a roadmap for developing workplace-aligned assessments that are fair, instructionally useful, and responsive to economic change. These principles align with ECD by strengthening construct representation and clarifying the evidentiary basis for score interpretation.

Importantly, the study is positioned as a precursor to assessment development rather than as an evaluation of learner outcomes or psychometric performance. Its primary contribution lies in offering a systematic method for identifying priority occupations, surfacing job-relevant skill demands, and translating those demands into design-relevant insights. In doing so, the study supports adult education and workforce systems seeking to align instruction and assessment with the realities of in-demand industries, particularly for learners in Job Zones 1–3.

8.0 Directions for Further Research

Future research should extend the approach illustrated in this study in at least three directions to strengthen its empirical grounding and practical impact. First, longitudinal and regionally disaggregated analyses are needed to capture how literacy and numeracy demands evolve over time and across local labor markets. Such work would enhance forward-looking assessment design by identifying emerging task demands not yet fully reflected in national databases.

Second, large-scale occupational data should be triangulated with direct evidence of workplace practice. Observations, interviews, participatory co-design sessions, and performance-based studies with workers can help validate and refine construct interpretations derived from BLS and O*NET data. Incorporating worker and employer perspectives is especially important for identifying informal practices, adaptive decision making, and communication demands that may be underrepresented in standardized occupational descriptions.

Third, future studies should transition from mapping to task development and validation. Designing and piloting scenario-based assessments grounded in the identified KSAs and work contexts would allow researchers to examine reliability, fairness, and interpretive validity, as well as relationships between assessment performance and training or employment outcomes. Validation efforts should be aligned with intended uses, recognizing differences between formative, instructional, and credentialing applications.

Finally, this line of research should expand to additional Job Zones and occupational sectors, including emerging roles shaped by automation and digital transformation. A sustained program of research that integrates domain analysis, participatory design, task modeling, and validation can support the development of a new generation of workplace assessment—tools that not only measure skill but also support learning, mobility, and equity for adult learners in in-demand industries.

This study and its companion study “Beyond the Test—Designing Job-Aligned Assessments for Agricultural Workers” (Oliveri et al., 2026) are intentionally designed as a coordinated pair that operate at different levels of analysis while advancing a shared principled assessment design agenda. The present study provides a macro-level, cross-industry domain analysis that uses national labor-market and occupational data to identify how literacy and numeracy demands are embedded in fast-growing occupations, how these demands vary by Job Zone, and how task complexity can be calibrated for assessment design. The companion study extends this work through a micro-level, industry-specific analysis of agricultural labor, demonstrating how these same principles can be operationalized through TLU analysis, participatory domain refinement, and scenario-based task design. Together, the two articles illustrate a coherent design logic: broad labor-market evidence establishes where and why assessment priorities should be set, while deep contextual analysis shows how those priorities can be translated into job-relevant, equitable, and instructionally useful assessment tasks. This layered approach clarifies how principled assessment design can remain both scalable across industries and responsive to the lived realities of specific workplaces.

Author Note

This research extends the pioneering contributions to assessment theory of Dr. Robert J. Mislevy, particularly his research on principled assessment design. It illustrates how principles of task selection, contextualization, complexity calibration, and forward-looking design may guide workforce-aligned assessment design, including task development and scoring approaches.

The research reported here was partially supported by the Institute of Education Sciences (IES), U.S. Department of Education (grant number R305N210031). The opinions expressed are those of the authors and do not represent the views of IES or the U.S. Department of Education.

Acknowledgment

We sincerely thank Karl Haigler, Rae Nelson, Anson Green, and Frank Mercer, and the Adult Skills Assessment Program Advisory Board for their invaluable insights and thoughtful conversations that informed the development of this article. We are also grateful to René Lawless for reading earlier drafts and offering insightful feedback that strengthened the manuscript. Their expertise and guidance were essential in shaping our approach to understanding and assessing workplace-relevant skills.

Author Biographies

Dr. Maria Elena Oliveri is a Research Associate Professor in the College of Engineering at Purdue University specializing in performance-based assessment in educational and workplace contexts. Her work focuses on fairness, equity, and sociocultural validity, advancing culturally and linguistically responsive approaches to assessment design and interpretation. Grounded in sociocognitive and evidence-centered design (ECD) frameworks, her research investigates principled claims about knowledge,

skills, and practices as they are enacted in real-world tasks. At Purdue, Dr. Oliveri's work includes leading and collaborating on assessment research related to workforce readiness in semiconductors and cutting-edge technologies, where she designs job-aligned semiconductors and advanced manufacturing skill pathways and associated assessments. Dr. Oliveri's scholarship integrates psychometrics, sociocultural theory, and learning analytics to design assessment systems that treat skills as situated action—embedded in disciplinary, professional, and workplace activity. Recent work examines the use of stealth performance assessment, combining task design, generative artificial intelligence and analytics to support assessment for learning, feedback literacy, and equitable decision-making across engineering, advanced manufacturing, agriculture, and adult workforce education. Across these efforts, Dr. Oliveri emphasizes minimizing construct-irrelevant variance, enhancing fairness, and consequences of testing, and maximizing construct coverage through task-centered assessment systems aligned to actual workplace demands.

Aria Immanuel is a graduate student at the University of Massachusetts Amherst in the department of Educational Policy, Research, and Administration (EPRA). His work focuses on psychometrics, assessment design, workforce-relevant skills, and equity-centered approaches to education and training. His research examines how literacy, numeracy, and problem-solving skills are embedded in real-world occupational contexts, with particular attention to in-demand industries and the agricultural sector. Aria is a co-author of peer-reviewed articles in the *Journal of Workplace Assessment* that explore innovative methods for identifying and assessing job-aligned skills, including studies on in-demand occupations and agricultural work contexts. Through this work, he contributes to advancing assessment practices that are grounded in authentic workplace tasks and responsive to the needs of diverse learners and workers. At UMass Amherst, Aria engages in interdisciplinary research that bridges education, workforce development, and applied measurement. He is especially interested in translating research findings into practical tools and frameworks that support employers, educators, and policymakers in designing fair, valid, and meaningful assessments. Aria's scholarship reflects a commitment to improving pathways into and through work by ensuring that assessments recognize the full range of skills individuals bring to complex, evolving labor markets.

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