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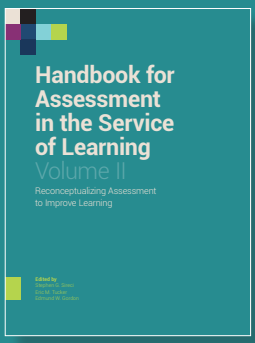

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Abstract

This chapter explores how a Culturally and Linguistically Responsive (CLR) approach can enhance Workplace Assessment for Learning (WAfL) in engineering education. WAfL emphasizes formative, authentic assessment embedded in real-world tasks to support both technical and conceptual learning. We argue that integrating CLR assessment principles—particularly co-design and task contextualization—strengthens WAfL by recognizing learners' diverse ways of knowing, cultural experiences, and problem-solving approaches. Through examples such as interpreting well systems and modeling water treatment facilities, we show how contextualized tasks can reveal important cultural and experiential differences that affect how students engage with engineering problems. Rather than penalizing students for unfamiliar reasoning pathways, CLR-informed WAfL encourages instructors to understand the roots of students' thinking and use it as a springboard for learning. We highlight how formative, evidence-centered design enables students to build metacognitive skills and reflect on their own learning processes. The chapter concludes with an application of these ideas in the context of semiconductor engineering, drawing on a case study for illustrative purposes. This example demonstrates how WAfL and CLR assessment can converge to create equitable learning experiences that prepare students for complex, international engineering work environments.

Principles Addressed:

Principle 1: Assessment **transparency** provides clear information about assessment content and use to assist learners, teachers, administrators, and parents.

Principle 6: Assessment **equity** requires fairness in design of tasks and their adaptation to permit their use with respondents of different backgrounds, knowledge, and experiences.

Introduction[1]

In today's rapidly evolving, globalized workplace, it is essential that workers not only have theoretical knowledge and technical skills, but also have crucial professional competencies such as teamwork, professional communication, negotiation, problem-solving, and decision-making skills. These skills are necessary for success in contemporary, multicultural workplaces (National Academy of Engineering, 2004). Within this context, skill development requires employees to be able to understand how co-workers' cultural, linguistic, and educational backgrounds shape their perspectives on and approaches to demonstrating their skills (Jesiak, Zhu, Woo, Thompson, & Mazzurco, 2014; Lohmann, Rollins, & Joseph Hoey, 2006). While training and instruction can help employees acquire these skills, often assessment of these skills is limited. As a result, workplace assessments are needed that not only gauge technical abilities, but also evaluate professional skills that are aligned with culturally and linguistically diverse workplaces (Geisinger, 2016; Oliveri, Mislevy, & Elliot, 2020; Oliveri & Wendler, 2020).

1 Acknowledgments: We wish to acknowledge and thank Drs. Tamara Moore and Eric Johnson for authoring the engineering task included in this chapter. Their expertise in curriculum development and engineering task design has significantly shaped the development of our associated assessments. This contribution highlights the value of collaborative task co-design between curriculum and assessment developers to advance learning and create assessments that support diverse educational settings.

In this chapter, we focus on research on Culturally and Linguistically Responsive (CLR) assessments to prepare learners for the challenges of a diverse, complex modern workplace (Oliveri, 2020; Oliveri, Lawless, & Mislevy, 2019; Oliveri & Wendler, 2020). We focus our chapter in the field of Engineering, which requires workers with technical proficiency, robust professional skills, and a global mentality to thrive in a diverse workplace (Fajaryati, Budiyono, & Wiranto, 2020; Oliveri & Markle, 2017; Paretti & McNair, 2008). Thus, our chapter draws on our prior research on assessing engineering competencies with culturally and linguistically diverse (CLD) populations using a sociocognitive perspective (Douglas, Neumann, & Oliveri, 2023; Oliveri et al., 2019).

Building on our prior work, we identify two significant challenges in engineering education assessment: (a) empowering multiple groups of learners to demonstrate their knowledge and skills in varied ways, and (b) addressing the global demand for engineers with advanced understanding capable of collaborating with globally distributed teams. To address these challenges, we identify two specific frameworks designed to assist in the development of assessments of engineering competencies for CLD populations.

The first framework uses a co-design participatory research approach (Roschelle & Penuel, 2006). A co-design approach guides the assessment development process by involving multidisciplinary subject-matter experts such as industry professionals, educators, and students, to collaboratively develop assessments that consider stakeholders' diverse needs and perspectives to enhance the relevance and inclusivity of the assessments. The second framework is the sociocognitive evidence-centered design (SC-ECD) approach (Oliveri et al., 2019). The SC-ECD approach facilitates evidence-based argumentation, considering the social context of assessment, aligning assessments with educational objectives, and guiding decisions on what to measure and how. To illustrate these frameworks, we use a case study focused on semiconductors and engineering education with the intent to inform workplace readiness and take a holistic approach to assessing both professional and technical skills. By demonstrating the inclusion of a co-design framework and the SC-ECD approach, we show how assessment transparency and assessment equity can be achieved in workplace assessments for learning in engineering education.

Literature Review

Engineering Education in a Globalized Workplace

In a globalized workforce, engineers must be able to apply their technological and scientific knowledge in engineering practices, which involve professional skills such as collaborating with distributed, multicultural teams, problem-solving, and design decision-making (Ball et al., 2012; Fajaryati et al., 2020; Jesiak et al., 2014; Lohmann et al., 2006). Globally, engineering educators strive to equip engineering students with the skills to integrate diverse perspectives from various stakeholders and successfully execute projects in multicultural contexts (Kim & Care, 2020; National Research Council, 2012; UNESCO, 2016). For example, Auer and Rüütmann (2021) emphasized the need for engineers to address complex, ill-defined problems, collaborate effectively in multinational teams, and stay ahead of technological advancements. As a result, merely having broad knowledge is insufficient. Engineers must have a deep understanding of their discipline, professional skills, and ability to work with CLD populations as well as the ability to work with unfamiliar contexts beyond textbook problems (ABET Criterion 3 Outcomes 1–7; Jorion et al., 2015). In response to such changes, educational practices have shifted from expecting rote memorization and basic skill application to encouraging students to use their knowledge alongside professional skills to complete complex tasks in the global engineering workplace (Kim & Care, 2020; Pellegrino, 2012).

To achieve these educational shifts, assessment approaches must align with the competencies educators aim to impart and recognize the diverse ways students can demonstrate their abilities in the complex modern engineering workplaces. Our work is meant to augment the research on assessment in engineering education that has been informed by ABET accreditation standards in the U.S. (Olds, Moskal, & Miller, 2005) as well as a variety of approaches that include problem-based learning and authentic learning (Merzdorf et al., 2023; Paretti, 2006) as well as reflection (Cajander, Daniels, McDermott, & von Konsky, 2011). This focus is crucial not only to meet the needs of educators, psychometricians, and professionals committed to fostering inclusive, equitable assessments for CLD populations but to also proactively confront potential biases ingrained in curriculum and assessment development, which might disadvantage marginalized learners and contribute to societal disparities (Lyons, Oliveri, & Poe, 2025).

Culturally and Linguistically Responsive Teaching and Assessment

In recognition that many traditional approaches to teaching did not serve historically minoritized students, CLR research and teaching practices and its variants (e.g., culturally responsive teaching, culturally sustaining pedagogy, and culturally relevant pedagogy) emerged in the 1990s (Gay, 2002, 2013; Ladson-Billings, 1995a, 1995b; Lee, 1998; Qualls, 1998). CLR approaches seek to include students' rich cultural and linguistic backgrounds such that those backgrounds are validated in school contexts. For instance, Ladson-Billings (1995a, 1995b) advanced that CLR assessments connect learning to students' home and community cultures and situate content within meaningful contexts, leveraging students' funds of knowledge. To make assessments more relevant and meaningful, Moll, Amanti, Neff, and Gonzalez (1992) further highlighted the importance of drawing on the concept of "funds of knowledge" to enable students to use their accumulated cultural and linguistic experiences to navigate their social worlds and to develop and use materials that connect with students' home and community experiences.

CLR-informed approaches to teaching include a range of practices, including allowing students to draw on their own background experiences and knowledge in classroom contexts, acknowledging and valuing the range of linguistic practices students bring to school systems, and developing students' critical consciousness to solve real-world problems, especially those related to social inequities. In this way, cultural and linguistic variation were central to educational practice and recognized that students could draw on that variation in developing and critiquing knowledge within the context of high-achieving classroom learning.

For our purposes, we see promise in two hallmarks of CLR-informed assessment. First, CLR assessments do not merely seek to represent learners' identities in test items, but rather include co-design in assessment development. In co-design, members from different cultural groups are included in the assessment-design team. This step requires being mindful of power dynamics across team members to evenly represent different cultural groups. Hood (1998) also suggested diversifying expert groups to co-define assessment constructs, minimize rater bias, and pilot tasks to evaluate their psychometric properties. Qualls (1998) underscored the crucial role of co-design and collaboration across all assessment development stages within evenly distributed cultural groups in an assessment design team. More recently, Randall (2021) emphasized the need for an anti-racist assessment approach to deliberately include Black, Indigenous, and People of

Color's sociocultural identities throughout the assessment process, from the planning to the development phases.

Second, CLR assessment values task contextualization that integrates learners' ways of knowing and learning (Solano-Flores & Nelson-Barber, 2001). As noted by the National Academies of Sciences, Engineering, and Medicine (2018), student learning is deeply influenced by social and cultural contexts. These factors need to be considered in assessment design and score interpretation, rather than reflecting only the values of test designers (Nasir & Hand, 2006). As a result, Hood (1998) suggested considering students' linguistic and cultural backgrounds for assessment validity, advocating for the creation of culturally specific tasks grounded in content validity.

Bennett (2023) and Randall et al. (2022) suggested that contextualizing academic knowledge and skills within students' lived experiences and frames of reference enhances personal relevance, increases engagement, and better measures what students know and can do. Without considering linguistic diversity, assessment passages and questions can become a source of construct-irrelevant variance, becoming less accessible, leading to score misinterpretation, disconnection, and increased cognitive load for CLD learners (O'Dwyer, Sparks, & Nabors Oláh, 2023; Oliveri, 2019; Oliveri et al., 2019). A CLR assessment approach aims to recognize and incorporate test takers' diverse cultural backgrounds and linguistic patterns when responding to test items or constructed-responses, rather than treating them as errors (Mislevy, Oliveri, Slomp, Wolf, & Elliot, 2025).

The implications of CLR assessment extend beyond test design to include score interpretation. Evans (2021) and Solano-Flores and Nelson-Barber (2001) argued that CLR assessment practices should inform how scores are interpreted and used. For example, most methods used to analyze differential item functioning (DIF) often assume cultural neutrality. These methods identify items that perform differently across groups, but do not address the cultural assumptions embedded in the items themselves. When cultural assumptions are identified within test items, such as an assumption that test takers are familiar with municipal water supplies, we can begin to conduct more nuanced analyses of differences in test scores.

For instance, to continue our description of the water example: Consider a test item that describes the processing of municipal water supplies. For rural students accustomed to well-water systems, this context may require additional cognitive effort to imagine how municipal water is stored and treated. The complexity increases if the item asks a policy-related question about EPA standards for contaminants. In many rural areas, well water is not subject to the same regulatory requirements, the cost of testing and treating well water typically falls on the well owner. In contrast, municipal water supplies are regularly tested and the cost of water treatment is often part of the local tax burden. What, then, can we infer about the framing of a test item on water treatment using a municipal water context? Such framing may inadvertently introduce construct-irrelevant variance for certain test-taker groups during test design—for example, should we delay water testing because we cannot afford to treat the water if there are contaminants? Score differences arising from these embedded cultural assumptions could go unnoticed in traditional analyses that focus on disaggregation by gender, race, ethnicity, or other commonly used demographic characteristics. CLR assessment practices encourage deeper exploration of such cultural contexts to enhance fair and valid score-based inferences. By explicitly considering such differences, developers can create varied tasks that cater to the specific needs of CLD populations and develop more nuanced ways of analyzing test scores.

CLR Assessment Frameworks for Workplace Assessments for Learning

In the context of the workplace, workplace assessments for learning (WAfL) can be designed to support learning of complex constructs like teamwork, communication, metacognition, problem-solving, and decision-making (See Wiliam, 2011, for a discussion of AfL). Prior research on WAfLs highlight their importance across occupations, particularly in science, technology, engineering, and math (STEM; Douglas et al., 2023; Oliveri et al., 2021). These assessments rely on next-generation item types such as simulations, scenario-based assessments (SBAs), and situational judgment tests (SJTs) to provide authentic learning experiences immersed in realistic workplace settings (Merzdorf et al., 2023). WAfLs are designed to allow test takers to collaborate, innovate, and apply their knowledge to solve real-world problems, preparing them for advanced technical workplaces (Douglas et al., 2023).

The hallmark of WAfL, like other forms of AfL, is that they are designed to support learning, that is, they "provide information about what kinds of instructional activities are likely to result in improving performance" and "the learner engages in actions to improve learning; this may be undertaking the remedial activities provided by the teacher, asking a peer for specific help, or reflecting on different ways to move her own learning forward—after all, the best designed feedback is useless if it is not acted upon" (Wiliam, 2011, p. 12). In engineering contexts,

> *assessment feedback guides engineering students to monitor and regulate their learning. Lizzio and Wilson (2008) state that the implication of feedback on students' learning is in the identification of their strengths and weaknesses in their performance. Assessment feedback in this sense can develop a kind of self-regulation among students for the improvement of their learning (Nicol, 2009).* (Subheesh & Sethy, 2020, p. 12)

If we return to the water treatment example, we can see the potential of a WAfL approach. Rather than waiting for summative test results to identify conceptual issues, an engineering professor might use a workplace simulation to assess computational accuracy and conceptual understanding. For example, in a water treatment facility simulation, students could be asked to calculate flow measurements and demonstrate their conceptual understanding of how water treatment facilities function, including the role of external government agencies in standard-setting. The simulation becomes an even more powerful illustration of WAfL if students assess their own learning beforehand, developing metacognitive abilities to distinguish between computational errors versus conceptual misunderstandings.

From a CLR perspective, students' background experiences with wells may shape their thinking in different ways—some may focus on depth, material composition, or flow rate, based on local use or community knowledge, rather than thinking about wells in terms of regional water supply systems or contaminants that must be monitored. These variations highlight how learners' prior knowledge and cultural context influence the framing of technical problems. When embedded in WAfL tasks, such examples allow instructors to surface and address these differences productively, supporting equity in assessment and instruction.

A WAfL approach ensures that the task is not only technically rigorous, but also relevant to real-world scenarios engineers may face—particularly in complex, international, and interdisciplinary settings. In addition to thoughtful task design, WAfL requires the generation of scores through authentic, open-ended tasks. These tasks reflect real-world problems that lack clear-cut answers and can be approached from multiple directions. Gutiérrez Ortiz, Fitzpatrick, and Byrne (2021) note that such tasks often present either insufficient information—prompting students to determine what is needed and how to obtain it—or too much information—requiring students to sift through data and identify what is relevant. These conditions support construct representation and encourage diverse problem-solving strategies. To further illuminate student thinking, instructors may prompt learners to describe their initial steps in problem solving. Kalyuga and Sweller (2004) found that novices tend to rely on trial-and-error or rigid procedures, while experts employ more strategic, high-level approaches. These think-aloud methods can reliably differentiate between varying levels of competence and provide instructors with formative insights into student understanding—one of the key goals of WAfL. As we illustrate later, these considerations are important to acknowledge from a CLR perspective to ensure that students' diverse ways of thinking and problem-solving are appropriately recognized and not misinterpreted as errors.

In sum, we see much potential in applying a CLR assessment approach to WAfL by advancing two hallmarks of CLR assessment: co-design and task contextualization. These principles support the integration of learners' varied ways of knowing and learning within an evidence-centered framework. In the next section, we illustrate the application of the ideas within the context of a semiconductor engineering program.

Case Study: An Application of the CLR Assessment Frameworks to Semiconductor Engineering

To address the growing challenges of rebuilding a secure domestic microelectronics industry, the U.S. and its allies require a skilled workforce with advanced multi-dimensional skills. Essential to this endeavor is the development of instructional materials and assessments that bridge the gap between workplace and academic cultures, to promote workforce development initiatives, prepare recent graduates for work, and stimulate interest in industrial careers. Addressing this goal necessitates a strategic CLR WAfL assessment development approach that includes understanding the unique barriers underrepresented students face and designing assessments that minimize cultural and linguistic validity issues.

Framework 1: A Co-Design Approach

Roschelle and Penuel (2006) described co-design as a collaborative process involving stakeholders such as teachers, employers, researchers, and developers working together in defined roles to create educational innovations, prototypes, and assessments tailored to specific workplace or academic needs. Unlike traditional top-down approaches typically used in large-scale assessment design where the psychometrician designs tests, the co-design process actively engages stakeholders, empowering them with ownership and agency over resulting products.

A co-design approach can help create more culturally responsive and equitable assessments. By involving members of a population who are often marginalized, a co-design framework can better address the power dynamics and biases inherent in traditional assessment practices. It allows for the development of assessments that recognize and value the diverse cultural and social contexts in which learning occurs, leading to fairer and more accurate measurement of knowledge and skills. Suárez-Álvarez, Oliveri, Zenisky, and Sireci (2024) demonstrated how co-design can facilitate early identification of potential pitfalls and biases in assessment design. By involving industry specialists, academic institutions, and adult learners, they identified assessment needs within the Adult Skills Assessment Program through focus groups and literature reviews. This process helps determine assessment priorities, contextualize tasks within real-world scenarios, and develop materials that reflect diverse learners' lived experiences.

Table 1 outlines the key stakeholders suggested for co-designing assessments in engineering education programs focused on semiconductors. The table identifies each stakeholder, describes their role in the assessment-design process, and highlights their importance in ensuring that assessments are CLR and inclusive.

Table 1.
Co-Design Stakeholders and CLR Assessment Considerations

Stakeholder	Stakeholder Roles and Relevant CLR Considerations
Academic Institutions, Faculty	Design curriculum & learning objectives with industry, educators, community representatives, and learners; align educational content with industry needs. Include diverse faculty members for inclusivity and curricular relevance to industry.
Federal Employers, Industry Partners, & Workforce Development	Shape assessments to reflect public sector needs with companies ranging in size and culture; reflect needed KSAs and inform real-world scenario development. Include individuals from underrepresented groups. Ensure career resources are inclusive and address diverse career pathways.
Current and Prospective Students	Offer feedback on learning experiences, participate in piloting assessments. Collaborate with peers and instructors, incorporate examples and scenarios from various cultures; advocate for multiple assessment formats (e.g., oral presentations, practical projects and accommodate different learning styles).
EdTech Companies/ Technologists	Develop technology-based tasks and tools for assessments. Use analytics and reporting tools to track the performance of different groups and provide support as / where needed. Develop assessments that use diverse cultural references and are more relatable. Create a more personalized assessment experience. Develop prompts that account for a range of cultural norms and values including analyzing responses for potential cultural biases and adjusting scoring algorithms accordingly.
Cultural and Linguistic Consultants	Advise on strategies to integrate CLR principles into assessment design and implementation, help eliminate biases and ensure equitable assessment practices.

Co-design starts with the goal of creating tangible innovations and includes documenting the classroom context through instructor engagement and accommodating flexibility based on teacher input. Effective collaboration is ensured through strong facilitation and well-defined roles, while central accountability for quality assurance is maintained by the principal investigator or researcher. This collaboration fosters the creation of innovative forms of assessment, such as simulations, SBAs, problem-based learning, and SJTs. These methods evaluate the multi-dimensional skills required in the microelectronics field, providing authentic learning experiences that mirror workplace realities. Faculty from various backgrounds, students with different learning needs, and industry professionals from diverse sectors all contribute to a more comprehensive and inclusive curricular and assessment design process. This diversity enriches the development process and ensures that the resulting assessments are equitable and effective.

Creating partnerships between academia and industry further strengthens the alignment of educational outcomes with workforce requirements. Co-designing assessments with industry partners helps educators understand the skills valued in the workplace and incorporate these into assessment tasks. By integrating these considerations, a semiconductor engineering program can more effectively prepare a diverse and highly skilled workforce and diversify the student population to include more CLD learners.

In such programs, a strategic and CLR co-design approach brings together stakeholders from industry, educators, and students to design assessments for learning to help ensure the training and assessment program meets the demands of the microelectronics industry. Co-designing assessments that are CLR not only enhances the learning experience but also strengthens the program's overall impact because it addresses employers' concerns about the potential of employees to work in global, complex workplaces. In other words, it helps to close the gap between academia and the workplace. However, co-design alone is not sufficient to address all test design considerations. Thus, in the next section, we illustrate our second framework, the CLR expanded ECD (e-ECD) Assessment for Learning approach, which we refer to as the expanded sociocognitive ECD (SC-ECD) approach. It builds on the assessment for learning approach proposed by Arieli-Attali et al. (2019) and includes CLR considerations for constructing assessments that accurately measure the intended skills and knowledge while being sensitive to cultural and linguistic differences. The SC-ECD assessment for learning approach

combines co-design and CLR e-ECD approaches to help ensure the assessments for microelectronics engineering are both inclusive and methodologically rigorous, integrating cultural and linguistic responsiveness with technical rigor.

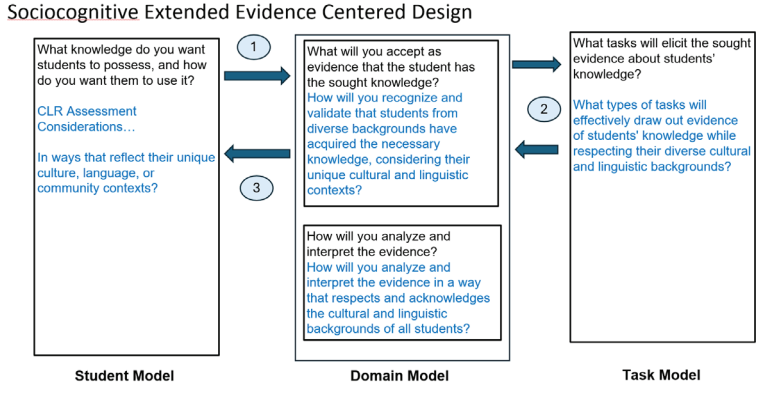
Framework 2: The Expanded Sociocognitive Evidence-Centered Design Framework (SC-ECD)

The e-ECD approach (Arieli-Attali et al., 2019) complements a co-design framework. The e-ECD approach builds on the original Evidence-Centered Design (ECD) framework conceived by Mislevy, Almond, and Lukas (2003). ECD has been applied to various contexts, including engineering assessments and knowledge-in-use tasks that incorporated disciplinary ideas, cross-cutting concepts, and science practice (Harris et al., 2019; Pellegrino et al., 2014). Arieli-Attali et al.'s e-ECD framework extends traditional ECD by integrating learning aspects with assessment elements and considering both cross-sectional and longitudinal perspectives on learning. In the framework referred to as SC-ECD, Oliveri et al. (2019) expanded ECD in alignment with CLR assessment design and development principles.

SC-ECD builds on e-ECD to guide assessment design by addressing evidentiary aspects relevant to the construct and various assessment facets including considerations for learning and assessment, digital instructional content, and measurement models for learning. (Figure 1 shows components of the e-ECD approach; the relevant CLR assessment considerations are shown in blue text).

Figure 1.

ECD Model Adapted for CLR Assessments



Source: Adapted from Pellegrino et al., 2014

Table 2 offers example answers to the questions listed in Figure 1 for each of the components of the e-ECD model along with CLR assessment considerations. In alignment with our goals to design WAfLs for CLD learners, the focal tasks include innovative, workplace-relevant constructs including teamwork, communication, and problem-solving. In the task, we also suggest creating opportunities to engage with fictitious clients in diverse company settings. We elaborate on task design decisions when we illustrate the application of our frameworks to engineering education and semiconductors.

Table 2.

Components and Examples of the CLR Assessment e-ECD Model

Key Component	Design Principle	Elaboration	Cultural/ Linguistic Considerations
Learning and assessment	Assess integrated technical and professional skills to provide learners opportunities to practice skills bridging the academic and workplace contexts	Contextualize tasks in realistic, authentic scenarios that are relevant to modern workplace settings	Engage in varied cultural contexts with peers from different cultural and linguistic backgrounds
Digital instructional content	Create authentic learning scenarios and provide opportunities for hands-on, project-based learning	Include varied forms of communication, negotiation, problem-solving, and teamwork	Include scenarios across different contexts including rural or urban contexts
Measurement models for learning	Cognitive diagnostic models, open-ended responses, engineering projects, or rubrics to provide feedback to learners	Use analysis methods that enable diverse responses that acknowledge varied ways of item responding	Allow for diverse linguistic, cognitive, and substantive patterns to be used in responding to tasks

An Example of CLR Assessment Task Design and Scoring in Engineering Education and the Semiconductor Industry

Table 3 shows a task related to developing a stroke recovery system and designing an Application Specific Integrated Circuit (ASIC) at a Semiconductor Company. To deepen students' understanding, this task prompts students to tackle technical challenges in ASIC design for medical devices, explore stroke rehabilitation principles, navigate regulatory requirements, and engage in industry collaboration. The task is contextualized to enhance engagement by grounding it in real-world applications like improving stroke patient recovery. This practical focus makes engineering concepts tangible and relevant, likely boosting student interest. Students learn skills such as ASIC design, low-power optimization, manufacturing processes, quality control, and meeting regulatory standards—also key for semiconductor careers. It also emphasizes collaboration, project management, and communication, crucial in any workplace. The task assesses technical proficiency, problem-solving, regulatory compliance, and innovation. Students analyze neurostimulation technology in stroke rehabilitation, address technical challenges, and propose solutions by demonstrating creativity and interdisciplinary collaboration. However, the task lacks CLR assessment elements and opportunities for students to engage in CLR learning. Including diverse cultural and linguistic perspectives would enhance its relevance and inclusivity, ensuring all students can relate to and benefit from the learning experience.

Table 3.

Example Assessment for Learning Task for the Semiconductor Industry

Chicago Neuroscience Selects Semiconductor Company to Develop ASIC for New Stroke Therapy Neurostimulation Device; Technology Intended to Improve Patient Recovery

FRANCIS, Indiana—Semiconductor Company, a leading designer and manufacturer of state-of-the-art integrated mixed-signal and structured digital products for the automotive, medical, and industrial markets. Today Chicago Neuroscience, Inc. (CNI), a medical device company, selected Semiconductor Company to design and manufacture the Application Specific Integrated Circuit (ASIC) for the CNI Stroke Recovery System. Hayden Levy, MD, a neurosurgeon who is CNI's Medical Director, commented on CNI's investigational therapy: "After a stroke, the brain attempts to compensate for the damaged area by reorganizing through a process known as neuroplasticity. However, many survivors of stroke remain impaired for the rest of their lives. We have spent years developing a device system which is intended to help improve function in stroke survivors months or even years after their strokes." The American Stroke Association estimates that about 700,000 people in the U.S. experience a stroke every year. The estimated direct and indirect healthcare costs related to stroke was over $56 billion in 2005. Initial research has demonstrated that cortical stimulation of healthy brain tissue near the area damaged by the stroke, in combination with rehabilitation, may facilitate neuroplasticity and improve function. CNI's stroke therapy device involves the precise delivery of low levels of electricity to the surface of the brain (the cortex) via an implanted stimulator system. Results from two feasibility studies presented at medical congresses this year assessed the safety of cortical stimulation in the rehabilitation of chronic stroke patients and suggest a greater improvement in recovery of hand/arm function compared to controls. The company is currently enrolling patients in a larger pivotal clinical study to confirm these results. The ultra-low-power consumption ASIC for the CNI system is being designed and produced by Semiconductor Company at the company's Fort Wayne, Indiana design center and Dallas, Texas manufacturing facility. "After an intense evaluation of a number of potential partners serving this market, it became clear that Semiconductor Company offers outstanding capabilities, custom production processes, and experience as a manufacturer of ASICs for implantable medical devices," said Justine Wyler, Ph.D., president and CEO of Chicago Neuroscience, Inc. "Numerous medical device companies have come to rely on Semiconductor Company to meet the critical technical requirements of implantable devices," said Hayden Barnes, vice president of the medical and wireless product line at Semiconductor Company. "We are very excited to partner with CNI to bring their potentially life-changing product to patients. We have worked diligently to develop a successful track record in delivering critical integrated circuits on time and above the required quality levels. We look forward to continuing that success with CNI."

AfL task-relevant questions include asking students: 1. Write an explanation for why Chicago Neuroscience, Inc. (CNI) selected Semiconductor Company as a partner? 2. Thinking about how engineers design digital circuits and try to optimize the circuit designs: What features of the circuit are you trying to optimize? Why do you try to optimize those features? 3. For each feature optimized, explain why you think this is an important feature to be optimized? 4. When designing a circuit, it is crucial to ensure that your code functions properly. Therefore, compile a list of strategies to debug circuit code when it malfunctions.

Table 4 shows the ways that the task could be extended to include CLR assessment considerations. That is, while keeping in line with the task shown, this activity could be extended to encourage students to think about whether cultural or linguistic differences would emerge if two or more different cultural groups were to engage with this task. The CLR assessment considerations should be developed through the co-design process in which students and industry stakeholders participate in the task design process.

Table 4.

Revised Task with Cultural and Linguistic Diversity Considerations

Skills/Learning Objectives	Items Relevant to the Skill	Task Design Considerations	CLR Assessment Considerations
Understanding Cultural Perspectives	U.S. Perspective: Focus on the high prevalence of stroke and significant healthcare costs. CLR assessment Perspective: Discuss cultural attitudes toward technology and medicine.	Emphasize innovative medical devices to improve long-term recovery and reduce healthcare costs.	Highlight diverse cultures' advanced healthcare system with a focus on preventative care and rehabilitation. Discuss the acceptance and integration of new medical devices.
Technical Design and Development	U.S.-based Engineers: Design ASIC to meet stringent U.S. regulatory standards and ensure compatibility with existing infrastructure. CLR assessment/ CLD Engineers: Adapt ASIC design to be compatible with other cultures' healthcare practices.	Focus on energy efficiency and integration with other medical technologies used in American hospitals.	Consider local regulatory requirements and preferences for medical device design. Possibly integrate traditional medicine approaches.

Table 4. (continued)

Skills/Learning Objectives	Items Relevant to the Skill	Task Design Considerations	CLR Assessment Considerations
Collaboration and Communication	Intercultural Collaboration: Form interdisciplinary teams with members from both the U.S. and other cultures. Meetings and Documentation: Conduct meetings that respect different communication styles.	Share best practices and innovative ideas. Provide clear agendas and summaries in both English and other languages.	Use multilingual support tools to facilitate communication and ensure all team members can contribute effectively. Ensure technical documentation is available in different languages, using culturally relevant examples and terminologies.
Patient-Centric Design	American Patients: Consider expectations and needs of stroke patients, including a preference for advanced technology. CLD Patients: Adapt designs to fit local practices.	Focus on comprehensive aftercare.	Consider the holistic approach preferred by patients from different cultures, which might include complementary therapies alongside high-tech solutions.

Table 4. (continued)

Skills/Learning Objectives	Items Relevant to the Skill	Task Design Considerations	CLR Assessment Considerations
Example Questions:	Technical Challenge: How would you design the ASIC to comply with FDA regulations and integrate with U.S. healthcare technologies?	Focus on meeting FDA's medical device regulations.	Adapt ASIC design to meet other culture's healthcare regulations and consider local medical practices, including the potential integration of traditional medicine.
	Cultural Considerations: Discuss challenges and benefits of introducing advanced neurostimulation devices to American stroke patients.	Address potential challenges in technology adoption.	How might different cultural attitudes towards rehabilitation and technology influence the design and acceptance of the neurostimulation device?
	Collaboration and Communication: Describe strategies for effective communication and collaboration between U.S. and CLD teams.	Ensure cultural and linguistic differences are respected and leveraged.	Enhance the project by leveraging cultural and linguistic differences.

Note. In this scenario, Chicago Neuroscience, Inc. (CNI) has selected Semiconductor Company to design and manufacture the Application Specific Integrated Circuit (ASIC) for their new stroke recovery system, intended to improve patient recovery through neurostimulation. The project involves interdisciplinary collaboration and understanding diverse cultural perspectives on medical practices.

By incorporating CLR considerations into the task design, students can better articulate, understand, and critique the global context of engineering projects and develop skills that are crucial for working in diverse, interdisciplinary teams. They can also learn to develop scoring and evaluation methods of such skills through the rubric-design process.

CLR Scoring Processes

Evaluating responses to open-ended problems presents a challenge from a CLR assessment perspective. A central issue is designing formative learning rubrics that can capture the range of possible responses to the CLR-informed task (Wylie & Lyon, 2016). One effective strategy is to score the complexity of students' solutions relative to all possible solutions. For instance, Fortus et al. (2019) utilized a rubric to evaluate students' three-dimensional learning about energy, focusing on the integration of core notions, scientific and engineering practices, and cross-cutting concepts. Descriptive self-assessments, where students explain and critique their problem-solving process, can also provide insight into their understanding and differentiate between novice and expert strategies. The point here is that a CLR assessment perspective to scoring values process as well as product. It is often more useful in classroom contexts to understand how students came to a solution rather than merely scoring the solution itself. From a CLR assessment perspective, scoring process and product provides greater transparency in assessing student learning and builds equity in the classroom assessment context because students are not merely rewarded for getting a single right answer.

Using a flexible performance-based rubric, instructors, students, and stakeholders can work together to develop rubrics that specifically foreground the issues they identified as CLR values in the task design. Co-design is critical here for three reasons. First, co-design of the rubric in relation to co-designing the task ensures a closer alignment of the scoring to the initial prompt. In the case of the revised task with cultural and linguistic diversity considerations (Table 4), the rubric would likely include facets related to understanding cultural perspectives as well as technical design and development, collaboration and communication, and patient-centric design (Table 5).

Second, because rubrics often use vague terms like "clarity," a column may be added to the rubric in which scorers work together to define, in their own words, the trait that they are scoring. In this way, definitional variations in concepts such as "technical accuracy" come to light. Broad concepts such as "communication" would be defined in linguistically correct ways through the use of terms such as cohesion (connection of sentences to each other), stylistic variation (variation in structure and length of sentences), lexicon (use of technical language), surface error (typographical, capitalization, and punctuation errors) (Gopen & Swan, 1990: Irish, 2015; see also Steiss et al., 2024, for an example related to writing in history). This approach would ensure stereotypes related to language use would be minimized in the design of the rubric. Such stereotypes are most likely to affect multilingual writers when scorers are unable or untrained to distinguish different types of linguistic features in texts. By comparing definitions and working together to develop a shared understanding of a specific trait, students, teachers, and other stakeholders come to better understand that there is often not a shared assumption that informs scoring. Instead, consensus must be built by recognizing different viewpoints.

Third, in a CLR assessment approach, teachers (or graduate assistants) are not the sole arbitrators in the assessment process. Instead, assessment is a team effort where students assess each other through peer review and students self-assess their own work. Teachers and/or industry stakeholders also participate in the process. Invariably, there will be disagreement. Rather than seeing that disagreement as evidence of construct-irrelevant variance or lack of reliability, such disagreement becomes a source of awareness about different viewpoints and how to negotiate those different viewpoints in a complex workplace. This approach allows students to demonstrate their knowledge and skills in various ways, ensuring a fair and comprehensive evaluation. The collection of evidence related to the varied viewpoints of scores becomes, also, a powerful source of evidence related to the assessment process and can help inform future task designs as well as be used in crafting validity arguments related to response processes.

Table 5.

4-Point Rubric for Workplace Communication in a Microelectronics Problem

Criteria	Level 1 (Basic)	Level 2 (Developing)	Level 3 (Proficient)	Level 4 (Advanced)
Technical Design and Development: Circuit optimization and features	identifies features of the design but cannot frame those choices from an engineering perspective	identifies features of the design solely from an engineering perspective	identifies features of the design from an engineering perspective with an awareness of their effects on patients	identifies features of the design from an engineering perspective with an awareness of their effects on patients and considers possible solutions to negative effects on patients
Technical Design and Development: Code debugging	identifies features of the debugging process but cannot frame those choices from an engineering perspective	identifies features of the debugging process from an engineering perspective	identifies features of the debugging process from an engineering perspective with an awareness of their effects on patients	identifies features of the debugging process from an engineering perspective with an awareness of their effects on patients as well as considers possible solutions to negative effects on patients
Technical Accuracy: Lexicon	Uses basic technical terms inaccurately	Uses technical terms correctly most of the time	Uses technical terms accurately and appropriately	Uses technical terms accurately, appropriately, and with confidence

Table 5. (continued)

Criteria	Level 1 (Basic)	Level 2 (Developing)	Level 3 (Proficient)	Level 4 (Advanced)
Organization	information is presented in a way that does not resemble a workplace email, including addressee, subject line, and purpose statement	information is presented in a way that resembles a workplace email, including addressee, subject line, and purpose statement but may be too long or not sufficiently detailed	information is presented in a way that resembles a workplace email, including addressee, subject line, and purpose statement and that provides detailed yet scannable response to the task	information is presented in a way that resembles a workplace email, including addressee, subject line, and purpose statement and that provides detailed yet scannable response to the task. E-mail may include a request for next steps or reply from management
Understanding Cultural Perspectives	Shows little awareness of cultural and linguistic differences	Shows some awareness of cultural and linguistic differences, such as awareness that not all readers may be from a single context	Demonstrates awareness and sensitivity to cultural and linguistic differences, such as awareness that not all readers may be from a single context and strives to use a consistent lexicon and sentence structure to aid readability	Demonstrates a deep understanding and sensitivity to cultural and linguistic differences, effectively incorporating them into communication. For example, the author shows awareness that not all readers may be from a single context and strives to use a consistent lexicon and sentence structure to aid readability. The author suggest ways that the team can accomplish design goals across time zones and other challenges brought on by the demands of the global workplace

Conclusion

In this chapter, we sought to bridge assessment design between the academic and workplace contexts, by offering an exploration of their application to the engineering context. By addressing the limitations inherent in traditional curricula and assessment models, we advocate for innovative WAfL approaches grounded in CLR assessment principles. CLR assessment principles are not merely about acknowledging differences in a global workplace, rather embedding that awareness within the ways that assessment practice is undertaken. Specifically, we argue that co-design and sociocognitive evidence-based models that are informed by CLR assessment principles provide the expanded ways of thinking that are needed to address assessment of learning in contemporary engineering practice and help students bridge academic and workplace contexts. Such practices result in assessment that is not just more equitable for diverse learners but also more transparent as it brings more stakeholders to the table.

In the end, the engineering education context is a robust site for the development of CLR WAfL. Engineering curricular development has long been attuned to workplace realities, which has resulted in the ready adoption of teaching approaches such as project-based learning. Yet, the assessment of learning in engineering education has often lagged behind pedagogical innovation. Moreover, the inclusion of CLR principles in engineering education has been limited, in part, because of the separation of technical skills training and "soft skills" training (e.g., teamwork, communication, metacognition, problem-solving, and decision-making). Using co-design and evidence-based measures, CLR WAfL brings together these two elements for the improvement of learning and assessment design.

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