T3 INNOVATION NETWORK

# Work Group 3 Report

Developing and Analyzing Competencies

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**U.S. CHAMBER OF COMMERCE FOUNDATION**
Center for Education and Workforce

# INTRODUCTION

The T3 Innovation Network organized Work Group 3 to explore the most important stakeholder use cases relevant to developing and analyzing competencies consistent with the T3 Network guiding principles.

The work group was asked to:
- Identify stakeholder use cases that require improvements in how competencies are developed and analyzed.
- Develop plans and propose pilot projects for how semantic web and artificial intelligence (AI) technologies can be used to improve the development and analysis of competency data.
- Identify potential solutions and pilot project opportunities to address these critical use cases (all work groups were given this task).
- Identify implications for a long-term vision of a shared public-private data infrastructure.

Work Group 3 was informed by an expert meeting held in conjunction with the PESC annual meeting. Meeting attendees consisted of competency experts, artificial intelligence and machine learning experts, and members of communities of practice that benefit from improved competency information. This meeting focused on identifying the biggest challenges to scalable competency translation and articulating how the AI community and competency framework community can better work together to solve these challenges.

Based on this expert meeting, the work group held two webinars. The first webinar focused on reviewing the relevant stakeholder use cases from Work Group 1 and the technical challenges and issues identified in the expert meeting. It also identified additional use cases, challenges and potential solutions. The second webinar focused on potential solutions, pilot project ideas, and implications for a public-private data infrastructure.

This work group report first summarizes use cases that were reviewed by the work group and technological challenges that cross-cut these use cases. Next, the report summarizes pilot project ideas that have emerged through the group's discussion.

# STAKEHOLDER USE CASES

The expert group and Work Group 3 reviewed employer, learner (student/worker), and education and training provider use cases from Work Group 1 as well as technical challenges and issues for each major use case category.

## Improving Search & Discovery

- **Open Linked Data**. Stakeholder competency data is not always published on the open web in ways that can be accessed, analyzed, and linked to other data to improve the search and discovery process in the talent marketplace.
- **Competency Development and Translation.** Stakeholders cannot develop, translate, compare, and analyze competencies to improve search and discovery of the best opportunities in the talent marketplace.

# Improving Application Processing & Verification

- **Competency Development and Translation.** Stakeholders cannot translate, compare, and analyze competencies to improve screening and selection. This challenge occurs, in part, because of how stakeholders develop and communicate their competency requirements.

# Improving Performance Analytics

- **Access to Large-scale Competency Data and Analytic Tools**. Stakeholders do not have equal access to large-scale competency data and tools needed to make better decisions.

The expert meeting and first meeting of Work Group 3 reviewed the major challenge of assessing fit of competencies within and between employers, education and training providers, and learners.
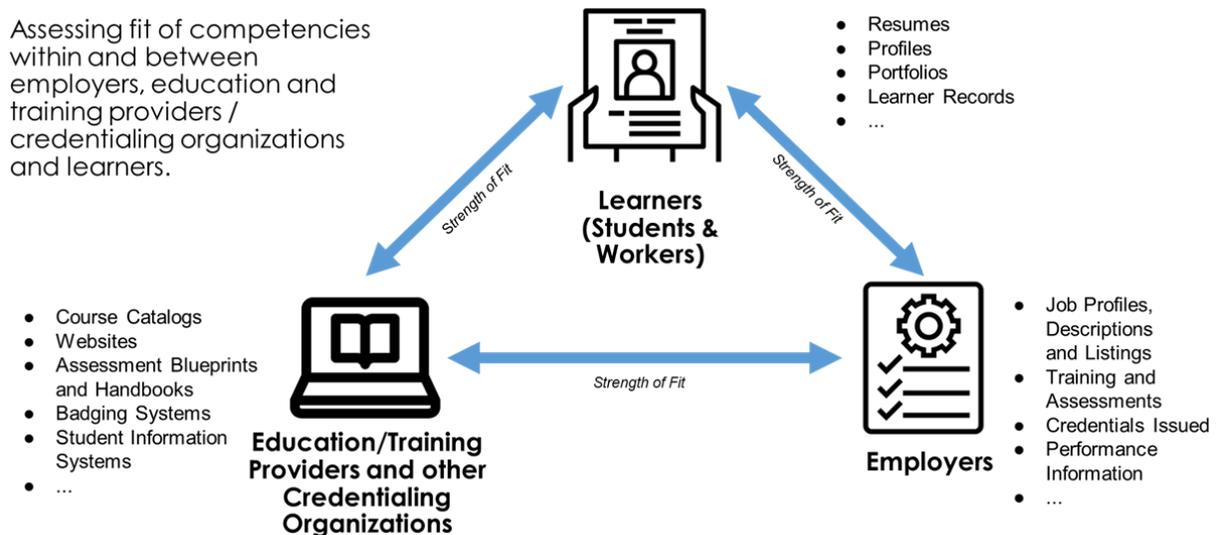


# Expert Meeting Findings

**Competency Data**

- People interpret the term "competencies" differently and they embody a broad range of perspectives (academic, work, learner/worker), jargon, and intentions that require having context information attached.
- Large quantities of competency information are not available in machine actionable formats with clear licenses.

- Different data standards for competencies are used across the employer, learner, and education and training provider domains. It is possible to describe competency-to-competency and other alignments and equivalence.
- Competency outcome information is needed to differentiate what was expected and what performance actually looks like.

**Artificial Intelligence (AI)**

- AI algorithms exist that will be conducive to analyzing intended meaning and generating competency equivalents and statements. However, AI is not magical; it is mathematical and takes knowledge of data and tweaking of the algorithms to get accurate and meaningful results.
- A robust community and shared AI libraries would accelerate progress.
- It will be essential to consider bias in training data (e.g., resumes only show successes).
- Companies and researchers are using AI for workforce development solutions that utilize some of the data related to competencies.
- Clear objective functions, access to data that provides competencies and context, and outcome information (positive and negative) are all needed to develop useful AI algorithms.

# Work Group 3 Findings

**Competency Data**

- Need for raw competency information/data, ideally with open licenses.
- Need for AI community to recognize the broad landscape of taxonomies, grammar, intent, and context without intentions to impose additional requirements.
- Need to convert large quantities of competency information to structured, machine actionable data with clear licenses.
- Identify open education and employment outcomes data with clear licenses.
- Determine additional data standards updates/requirements needed to enable linked open data.

**Artificial Intelligence (AI)**

- Determine AI algorithms best suited for interpreting, aligning, and generating competencies and defining necessary metrics for training given defined tasks and use cases.
- Recruit domain/subject experts and AI experts to participate in pilot projects that are familiar with workforce development data.
- Identify and access open, machine actionable data sources that have quantities and varieties of data needed across domains (employers, learners/workers, and education and training providers).
- Ensure access to and ability to distribute training data.
- Enable access to, and build a community around, open source AI libraries for applied research and experimentation with competencies.

# CHALLENGES & PILOT PROJECTS

Work Group 3 explored the major challenges and related potential pilot projects listed below.

## Context Engineering

Characteristics of the competency framework environment complicate the task of creating, interpreting, translating, comparing, and inter-framework mapping of competencies by both humans and machines. Below are the challenges and potential pilot projects for Context Engineering.

**Challenges:**
- **Lack of machine-actionable data.** There is a need for a vast majority of competency frameworks, related concept schemes, topical lists, and other resources to be expressed in machine-actionable form with clear licenses.
- **Tweet-sized, acontextual statements.** Competencies, as fundamental semantic units, are tweet-sized and acontextual statements of knowledge, skill, or ability. The tweet-sized brevity and frequent incomplete phrasing make it difficult for machines to elicit meaning without contextualizing resources such as assignments, verbose syllabi, assessment rubrics, handbooks/primers, textbooks, example exams, learner-produced artifacts, domain ontologies, and outcomes information (positive and negative). In any given case, such contextualizing resources may or may not be available to AI algorithms.
- **Unsettled domain vocabularies.** There is a lack of settled competency domain vocabularies which has caused confusion and a misunderstanding outside siloed communities of practice complicating cross-framework comparisons and mappings in the absence of clarifying domain resources.
- **Inconsistent granularity.** Framework granularity and structure range from the frequent flat list enumerating relatively general competency statements to deeply structured (ontology-like) hierarchies resulting in widely divergent levels of context and specificity. These variances in granularity/specificity and semantic richness make cross-framework competency comparisons difficult.
- **Supply-and demand-side disconnects.** Designers, builders, implementers, and users on the supply-and demand-sides of the talent pipeline don't all share the same semantic context and purpose for interacting with competency frameworks. This results in challenging disconnects that must be bridged for effective translations, comparisons, and mapping.
- **Probabilistic mapping.** Cross-framework mappings are probabilistic with exact mappings seldom achieved except in well-established, highly collaborative domains of practice. Thus, given many of the challenge variables and issues enumerated here, reliable measurement of a useful "strength of fit" in cross-framework competency translations and comparisons is difficult for both humans and machines.

**Related Pilot Projects:**
1. Develop systematic approaches to dynamic competency framework creation with updates and maintenance that leverage existing data standards and sources, as well as emerging data flows from both the demand-side (employer) and the supply-side (education and training).
2. Explore translation of structured product operation and maintenance information into competencies in support of product lifecycle management and the generation of training and certification resources.
3. Explore how to develop applications and open-source tools to assist program, course, and lesson plan developers in creating open, machine-actionable learning outcomes that can be connected to other competencies and open learning resources.
4. Develop applications leveraging AI to enhance the "meaning" of competencies through analysis of context embodied in associated resources (e.g., ontologies, conditions, performance levels, assessments, evidence) and the subsequent augmentation of the description metadata of the competencies.
5. Explore the creation of living job profiles that connect employers together to build shared competency models using a shared description language for use in linking profiles directly to curriculum and training offerings to dynamically close emergent gaps as employer needs evolve.
6. Explore how to use open competency data to inform the updating of government occupational data systems.

# Socialization & Incentivization

A number of challenges are rooted in social circumstances in both public and private sectors that under-incentivize demand and supply side stakeholders in collaborative development of the necessary expertise, methodologies, and commitment to develop a more cohesive, richly contextualized, and linked competency framework ecosystem. Below are the challenges and potential pilot projects for Socialization & Incentivization.

**Challenges:**
- **Proprietary resources & lack of transparency.** Proprietary AI algorithms and competency frameworks significantly reduce the shared levels of data and expertise necessary to develop applications for employers, learners, and education and training providers.
- **Lack of training and expertise.** Levels of expertise in creating useful competency frameworks vary considerably on both supply-and demand-sides of the talent pipeline.
- **Lack of a perceived value proposition.** Many education and training programs do not see sufficient incentives to invest in development and maintenance of clearly articulated competencies for their credentials, learning opportunities, or assessments. Nor do education and training programs incentivize a consistent rendering of competencies in structured, machine-actionable forms necessary to allow for effective cross-framework translations, comparisons and mapping.

**Related Pilot Projects:**
1. Explore new business models that provide better revenue opportunities for organizations to enhance wrap around services that:
   a. make competencies and related resources openly available; and
   b. make AI algorithms available as either open or 'black box' resources.
2. Develop open, available training and software that simplifies the creation, curation, and publication of well-defined competencies and their frameworks on both the supply-and demand-side of the talent pipeline.
3. Funders commit to incorporating open license and machine readable requirements when funding the development of new or existing competency frameworks and models.

# Training Data & AI Algorithms

Given the potential magnitude of a globally linked ecosystem of competency frameworks in which competencies can be created, interpreted, translated, compared, and cross-mapped at web scale, tractable solutions will require significant machine deployment of AI in its various forms. Below are the challenges and potential pilot projects for Training Data for AI Algorithms. The challenges under this section are deeply rooted in the previous two potential pilot projects.

**Challenges:**
- **Proprietary applications and AI Algorithms.** Proprietary applications and AI algorithms make it difficult to make needed connections between competencies and improve the use of competency data in developing applications for employers, learners, and education and training providers.
- **AI domain community.** Lack of a robust AI domain community and shared libraries hinder progress.

**Related Pilot Projects:**
1. Determine AI algorithms best suited for interpreting, aligning, and generating competencies and defining necessary metrics for training given defined tasks and use cases.
2. Develop clear objective functions and access to data that provides competencies and context including both positive and negative outcomes information for use with AI algorithms.
3. Investigate implicit and explicit bias in the development and use of algorithms for competency translation.

# IMPLICATIONS FOR A PUBLIC-PRIVATE DATA INFRASTRUCTURE

Given the use cases and challenges discussed above, the work group reviewed a set of implications for the long-term development of an open and distributed data and technology infrastructure for the talent marketplace.

The work group reviewed the following:
- Promote the development of an open and distributed competency data and technology infrastructure that can support an open applications marketplace for employers, learners, and education and training providers consisting of:
    o Structured and unstructured competency data embedded in job descriptions, learner records, and education and training programs and credentials.
    o Competency frameworks, taxonomies, and ontologies used to benchmark, compare, and translate competencies from employers, learners, and education and training providers.
    o Competency metadata that captures assertions about the connections and relationships between competencies as well as connections between frameworks, taxonomies, and ontologies.
    o Translation services that support the integration and use of competency data based in different schema, standards, and formats.
    o Open applications and AI algorithms that make connections between competencies and improve the use of competency data in developing applications for employers, learners, and education and training providers.