

CaSS AUTHORING TOOLS

Final Report (February 2021)



Prepared by
The ADL Initiative

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Table of Contents

1. Introduction	1
2. CAT Functionality	1
3. Challenges and Solutions	2
3.1. Vocabulary is Critical	2
3.2. Configurations	2
3.3. Frameworks Structure and Relations	2
3.4. Visual Display and User Interface (UI)	3
3.5. The CAT UI Solution	3
3.6. Crosswalks	3
3.7. The CAT Crosswalking UI	3
3.8. Collaboration and Review is Important	3
3.9. Import/Export	4
3.10. Ties to xAPI and Assertions - Alignment	4
3.11. Administrator Tool	4
4. Recommendations	4
4.1. Additional Rules	4
4.2. Rollup Rules	5
4.3. Rubrics	5
4.4. Conditions	5
4.5. Improvements to Version Control	5
4.6. Importing and Aligning Standard Credentials	5
4.7. Automation	5
4.8. Process Support	6
4.9. Integration	6
4.10. Copying Versus Linking	6
4.11. xAPI Alignment	6
4.12. Public Views of Frameworks	6
4.13. Usability Enhancements	6
4.14 CAT Configuration	7
4.15 CaSS Applications and CaSS Library	7

1. INTRODUCTION

This document serves as the final report for the Competency and Skills System (CaSS) Authoring Tools (CAT) project, contract 47QFLA19C0008. CaSS is intended to support all forms of competency- and skills-based education, training and talent management. CaSS has three major components. The first enables organizations to define, manage, and share “competencies” in human readable and machine actionable forms, where “competencies” is a generic term that encompasses knowledge, skills, abilities, attitudes, traits, educational curriculum standards, learning objectives, and many other such objects that define what a person or group of people know and can do. *This first part is the focus of the CAT project.* The other two components that collect performance data and estimate competencies that people or teams possess are not covered in this report.

This report outlines the functionality that CAT supports, the challenges faced in developing CAT, and recommendations for future work. It includes large portions of the CAT User Guide as an appendix to provide insight into how CAT works. More details can be found in the complete CaSS Authoring Tools User Guide¹, the CaSS Authoring Tools Administrator Guide², and in comments in the code, available on GitHub³.

2. CAT FUNCTIONALITY

In CaSS, competencies are organized into *frameworks* that represent structured collections of related competencies. Frameworks are also called *competency models* in existing practice, see for example the US Department of Labor Competency Model Clearinghouse.⁴ Frameworks usually include a set of competencies required by a job or task, conferred by a credential, associated with (an academic) subject, or that define a set of desired knowledge and behaviors (as in 21st century skills), but there is no restriction on what a framework can represent.

In CaSS, competencies can have many properties, informed by practice and by several standards that are used to represent competencies and frameworks, including the Achievement Standards Network, the Credential Transparency Description Language, the Institute of Electrical and Electronics Engineers (IEEE) 1484.20.1 (Reusable Competency Definitions), the Common Educational Data Standards (CEDS), the Postsecondary Education Standards Council (PESC), MedBiquitous, InLoc, HR Open and others. These properties include (among others):

- Name and Description.
- Identifiers that are defined by users or generated by the system⁵.
- Type, which labels the “competency” as a competency, skill, knowledge, etc. in accordance with the vocabulary and definitions used by an organization.
- Relations between competencies (e.g., “A requires B” or “A is the same as B” or “A enables B”) and between a document, learning opportunity, assessment or other resource and a competency (e.g., the resource *teaches*, *assesses*, or *defines* the competency).

¹ <https://adlnet.gov/assets/uploads/CaSS%20Authoring%20Tools%20User%20Guide.pdf>

² <https://adlnet.gov/assets/uploads/CaSS%20Authoring%20Tools%20Administrator%20Guide.pdf>

³ <https://github.com/cassproject/CASS>

⁴ <https://www.careeronestop.org/competencymodel/home.aspx>

⁵ All objects in CaSS can be accessed via unique URLs

- Taxonomies, which are used to label competencies with properties that help define their context or intended use. Taxonomies can be used to scope a competency to a profession, department, or educational level, to identify level of difficulty, and more.

With this as background, CAT enables users to:

- Import and export frameworks from existing sources.
- Edit existing and author new frameworks.
- Collaborate on the development and authoring of frameworks (using comments).
- Crosswalk frameworks, where “crosswalking” is the process of mapping competencies in one framework to those in another. A crosswalk can express which competencies in two frameworks are the same or similar and which in one framework are sub-competencies of those in another.

In addition, CAT has administrative tools that allow organizations to configure CaSS for their own use and to meet their own needs. Configuration tools allow administrators to define the types, relations, taxonomies, and other properties that will be available to users in their organizations. CAT also includes user management that enables administrators to set up organizations, groups, and teams and assign permissions on this basis.

3. CHALLENGES AND SOLUTIONS

Prior to developing CAT, the CaSS project had over four years of experience using earlier versions of CaSS to create competency frameworks and integrating CaSS into other systems (e.g., Credential Engine, Navy ARTT). The following critical factors and challenges were identified based on this experience.

3.1. Vocabulary is Critical

Each organization has its own terminology and definitions. The term “competency,” for example, is defined differently by different organizations. Some organizations talk about KSAs, but “A” might stand for “Attitude” or “Ability” or in some cases, both. In K-12 the term is referred to as a “standard.” And so on. It is vital that the objects and properties of objects in CaSS be displayed to end users in the terminology they understand, so it was a requirement for CAT to do the same.

3.2. Configurations

The vocabulary issue is handled in CAT by *configurations*. Configurations are used by CaSS administrators to define types, taxonomies, allowable relations, and the potential value of other properties. A configuration can apply to a given organization or instance of CaSS. It is possible to define multiple configurations and let users choose among them (with a default). However, the purpose of configurations is to hide the unneeded complexity and flexibility of CaSS from users while allowing them to interact with CaSS in the way they expect.

3.3. Frameworks Structure and Relations

Many real-world competency frameworks and competency models are hierarchical. Unfortunately, the meaning of the hierarchical relation is often not made explicit. The authors of a framework assume that if B is a “sub-competency” of A in the hierarchy it implies some relation to A, but are not clear as to whether it means that B is required by A, contained in A, enables A, or something else. This is not a problem for displaying or editing the framework, but it is a problem when calculating proficiency levels inside the framework.

Moreover, it is wrong to assume that all relationships are hierarchical or that a framework can only have one relation. Many tools do this, and assume that frameworks are trees, which is not always the case. It was a requirement that CAT be able to handle multiple relationships and not include unwarranted assumptions about the structure of competency frameworks and models. CaSS has these capabilities, but a method was needed to enable users to view and edit frameworks with this degree of complexity.

3.4. Visual Display and User Interface (UI)

The above discussion points out just one of the challenges faced when visually displaying frameworks. Requirements for the UI included the ability to:

- Display, navigate, and edit frameworks with hundreds or thousands of competencies.
- Display, navigate, and edit frameworks with multiple relationships and with multiple hierarchical levels (three to seven levels are quite common in real-world frameworks).
- Display and edit multiple properties for each competency.
- Do all the above in the limited real estate of a computer monitor.

Existing tools often do this by making over-simplifications, such as assuming that frameworks are simple, hierarchical trees, but this would not suffice for CAT.

3.5. The CAT UI Solution

CAT UI issue is solved through filters that allow users to hide IDs, labels, and other properties to reduce the information on the screen and enable collapsing of hierarchical frameworks. CAT also supports native browser search tools to facilitate navigation and keyboard shortcuts for common actions.

3.6. Crosswalks

Crosswalks identify relations between competencies in two different frameworks. For example, a crosswalk might help educators and policy makers understand how third grade science standards in Texas relate to those in California. Another example is the process of taking a competency framework built around a Military Occupational Specialty and using that to see its relevance to the skills required for civilian jobs when transitioning from the military to civilian life. For CAT, crosswalking posed a significant UI challenge. Given that it is difficult to display a *single* framework, it is even more challenging to display *two* frameworks while enabling the editing of relations between the competencies.

3.7. The CAT Crosswalking UI

The CAT crosswalk tool displays two versions of the framework, shows existing relationships via icons and colors, and enables new ones to be added through an intuitive workflow. Users can also filter the views of each framework to see which items have been crosswalked and, which have not.

3.8. Collaboration and Review is Important

Authoring competency frameworks is not a solitary exercise. Organizations need a review process and often use multiple Subject Matter Experts (SMEs), Instructional System Designers (ISDs), and facilitators when authoring competencies and arranging them into competency frameworks. Supporting distributed, collaborative workflows was a challenge for CAT. After considering options, the CAT design team settled on enabling a commenting, and a system that works as an analog to collaborative editing of word processing applications. This is not a full workflow management system but rather a simple and familiar way to facilitate collaboration that includes the separate edit/comment permissions.

3.9. Import/Export

CAT supports importing frameworks expressed in ASN, CTDL-ASN, CASE, spreadsheet, or text formats. The spreadsheet importer requires the identification of which properties are in which columns. The text importer uses carriage returns and spacing to separate competencies and define their hierarchical relations. The tool includes the ability to import competencies by cutting and pasting text into a text box, which has proven to be a very popular and time-saving method. CAT can export frameworks in the preceding formats and several others. This is critical for enabling the exchange of competency frameworks.

3.10. Ties to xAPI and Assertions - Alignment

As briefly mentioned, CaSS has capabilities beyond managing competencies and frameworks. These include the ability to collect xAPI statements from a Learning Record Store (LRS) and convert them into what CaSS calls *assertions* about the competencies possessed by an individual or group. Since xAPI statements report on *activities* and *outcomes of the activities*, and *not on competencies*, CaSS must be told how to relate an activity or outcome to a competency. This approach also aligns with the ADL Initiative's Total Learning Architecture (TLA) Master Object Model (MOM), an xAPI profile that normalizes the xAPI statements coming out of a learning activity.

A simpler form of this is identifying which “resources” (e.g., training exercises, courses, documents, credentials etc.) teach or assess (or define) a competency. The process of identifying relations between activities, resources, and competencies is called *alignment*. CAT supports resource alignment but does not currently have a tool for defining how to interpret xAPI statements.

3.11. Administrator Tool

Finally, there is a UI in the CAT Administrator Tool where configurations are defined. Just as is the case for end-user authoring, usability is a challenge. The CAT Administrator Tool starts off with a base set of configuration parameters. Administrators can then add custom properties. To enhance usability, different sets of parameters are set in a logical order via a set of navigable blocks. The blocks include general details, framework properties, competency properties, competency relationships, and resource alignment options.

4. RECOMMENDATIONS

Having developed and delivered “version 1” of CAT, the Eduworks team has identified several places where improvements can be made. These are reported here.

4.1. Additional Rules

Organizations may want to implement additional rules. For example, an organization may require that every framework be hierarchical, or that every framework has a top node with type “competency.” Another example might be that top nodes contain only competencies of type “skill” or “ability,” and that a competency of type “ability” never has any lower-level competencies. Some organization may require that every competency have an associated assessment or rubric, or that every competency be linked to a document that defines it. CAT has no way to write or enforce rules of this type. We recommend that the next iteration of CAT have these capabilities.

4.2. Rollup Rules

A key concept in competency modeling is that of a “*rollup rule*.” Rollup rules define how multiple competencies relate to a given competency *C*, specifically for the purpose of determining whether a person or group of people possess *C*. One might question whether rollup rules are part of a framework or are logic that belongs to an application that uses the framework, but in existing standards and in the literature about competencies the former view is taken.

4.3. Rubrics

Many competency standards and applications support *rubrics* that inform how to determine whether a person or group possesses a competency and the level at which it is possessed. Rubrics may also be interpreted as defining competency levels. Although CaSS has a mechanism for supporting rubrics, CAT does not currently support rubrics. However, future versions should. In doing so, a distinction must be made between human-readable rubrics expressed as tables and machine-actionable rubrics in which explicit measurable criteria are given for assessing competency levels.

4.4. Conditions

In the ISD literature, competencies include *conditions*. For example, the ability to sink a free throw may vary depending on whether it is attempted during gym practice, in the middle of a game, or in a pressure situation. Conditions can be expressed as taxonomies in CAT, but that does not allow different assessments or relations to be associated with different conditions. This should be addressed in a future iteration.

4.5. Improvements to Version Control

CAT currently supports version control with the ability to undo recent changes. Improvements to version control should include the ability to select and revert to earlier versions and indicate who made which changes.

4.6. Importing and Aligning Standard Credentials

CAT currently supports framework import. For convenience, future versions should include the ability to import credentials in standardized formats (e.g., CTDL) and store associated competency frameworks as well as automatically align them with existing frameworks. This capability would be useful for career planning and staffing applications.

4.7. Automation

There are opportunities for automation and auto-completion or auto-suggestion in CAT. Automated crosswalking is one that is anticipated in the current CAT UI. Automated resource alignment and suggesting tags from a taxonomy are others. Including automation may increase scalability and usability.

4.8. Process Support

Although CAT has commenting and suggesting features that support multi-party workflows, it does not have any modules that support specific competency framework development processes. The process reported in Competency Framework Development Process Report⁶ is one such process that CAT could support with a UI and with additional collaboration and document management tools. This is a consideration for future versions of CAT.

4.9. Integration

As developed and deployed, CAT is a standalone tool used to create frameworks that can be referenced via URLs as “linked data” and consumed by other applications. It would be much more convenient and would vastly lower the barrier to implementing competency-based training and talent management, if CAT were integrated directly into common content authoring tools, learning experience platforms, and human capital management platforms. We recommend a study to determine the feasibility, practicality, and cost of creating such integrations.

4.10. Copying Versus Linking

An important feature of CaSS is the ability to add competencies from one framework to another. There are two ways to do this. One option creates a *copy* of a competency that can then be edited with no restrictions, although CaSS records its original source for future reference. Changes to the original do not affect the copy and are not reported to users. Another option creates a *link* to an existing competency. Although some properties may be added - e.g., a relation can be added or a tag from a taxonomy can be added - changes in properties such as the name or description of the original competency will automatically be reflected in the “copy.” The CAT UI does not currently make clear which is happening. Future UIs should distinguish between copying and linking in a way that is meaningful to users.

4.11. xAPI Alignment

Future versions of CAT should include tools for aligning scores and outcomes generated by resource with assertions about specific competencies. Internally, these tools would tell CaSS how to convert xAPI statements into assertions.

4.12. Public Views of Frameworks

Currently, frameworks can be accessed via URLs. The URLs return JSON representations. Users have requested links that display the framework in an editor view that is human readable. This is an important feature for future versions of CAT.

4.13. Usability Enhancements

Users have provided feedback concerning usability. Identified enhancements include moving frequently used tools to a separate area where they can be persistently accessed; adding more keyboard shortcuts; providing more visual clues that indicate actions have taken place; and enabling the import tool to be available on more screens so that users can import frameworks and competencies while engaged in other actions.

⁶ <https://adlnet.gov/resources/publications/2020/03/Competency-Framework-Development-Process-Report/>

4.14 CAT Configuration

CAT can be configured with user management, competency and framework configuration data, key management, publishing capabilities, and branding. The requirements and configuration options for CAT can be found in the `cass-editor` README⁷ on GitHub.

4.15 CaSS Applications and CaSS Library

CAT works with the CaSS application. The CaSS application can be deployed in two ways, as a set of docker containers or as a stand-alone application that can be accessed through APIs. The CaSS software library has been published to NPM⁸ and Maven Central⁹. New applications can be written to work with CaSS using the CaSS software library. More information about the CaSS library and connecting new applications with CaSS is available in the CaSS Developer Guide¹⁰.

⁷ <https://github.com/cassproject/cass-editor/blob/master/README.md>

⁸ <https://www.npmjs.com/package/cassproject>

⁹ <https://mvnrepository.com/artifact/com.eduworks>

¹⁰ <http://devs.cassproject.org/index.html>