

Common Education Data Standards (CEDS) Version 7.1 Data Model Guide Addendum

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INTRODUCTION

CEDS includes a broad scope of elements spanning much of the P-20W spectrum (pre-kindergarten through workforce education) and provides a context for understanding the standards' interrelationships and practical utility. CEDS focuses on data elements and modeling across the Early Learning, K12, Postsecondary, Career and Technical Education (CTE), Adult Education, and Workforce sectors, and it has data domains for Assessments, Competency Frameworks (Learning Standards), Credentials, Learning Resources, and Authentication and Authorization. CEDS includes domains, entities, elements, option sets, and related uses.

The version 7.1 minor release of CEDS added a domain to support facilities data entity and element definitions. The latest version of the standards and related resources can always be found at the CEDS website at <https://ceds.ed.gov>.

The CEDS standards are composed of several pieces of information that provide context for, and describe the data items within, CEDS. These are as follows:

- Domain
- Entity
- Element
- Option Set
- Related Uses (these are defined as Connections in the online CEDS Connect tool)
- Alternative names and other notes

The CEDS website offers four ways to view and interact with CEDS:

1. By Element—Via the [CEDS elements page](#) users can access a searchable catalog of the CEDS vocabulary.
2. By Relationship—Through the [CEDS Data Models](#) users can explore the relationships that exist among entities and elements.
3. By Comparison—The [CEDS Align Tool](#) allows users to load their organization's data dictionary and compare it, in detail, to CEDS and the data dictionaries of other users.
4. By Use – The [CEDS Connect Tool](#) allows users to define a use of education data derived from CEDS elements. It can define a policy or research question, report, or metric that might be calculated using the elements defined in the CEDS standards.

ABOUT THIS DOCUMENT

This document is an addendum to the “Common Education Data Standards (CEDS) Version 7 Data Model Guide” describing the additions to the Domain Entity Schema (DES) and Normalized Data Schema (NDS) in the version 7.1 minor release. Together the two documents describe how to use the CEDS Data Model Version 7.1, as published on the CEDS website.

The Domain Entity Schema (DES)

The Domain Entity Schema (DES) provides a user-friendly structure to help people easily identify elements organized by domain and entity. The **domains** for CEDS Version 7.1 include the following:

- Early Learning (abbreviated as EL)
- K12 (Elementary and Secondary Education)
- Postsecondary Education (abbreviated as PS)
- Career and Technical Education (abbreviated as CTE)
- Adult Education (abbreviated as AE)
- Workforce (abbreviated as WF)
- Assessments
- Credential
- Competencies
- Learning Resources
- **Facilities (NEW)**
- Implementation Variables
- Authentication and Authorization

Entities are commonly thought of as persons, places, events, objects, or concepts about which data can be collected. An entity provides the context for a data element. Some examples of entities include Early Learning Child, K12 Student, K12 Staff, Postsecondary Student, and Postsecondary Institution. There are more than 100 entities in the DES.

The CEDS website presents the DES structure as a hierarchy of folders. This makes it easy to browse to an entity and expand it to show its elements.

The Normalized Data Schema (NDS)

CEDS supports the standardization of educational organizations and their relationships with other organizations, with people, and with time. The Normalized Data Schema (NDS) is a reference model for operational implementations aligned to the CEDS standards. The P-20W focus of CEDS means that it supports a transition from siloed, domain-specific, or location-specific datasets, to data that are compatible across domains and geographic boundaries. In addition to supporting the existing federal and state reporting requirements, as well as supporting the analysis and comparison of aggregate

statistics, the standards also support moving data along with a learner from an early learning program, to K12, to postsecondary, and to workforce learning programs.

The NDS supports the multiple roles and relationships in learning processes: the inputs, process steps (work), and outputs of learning.

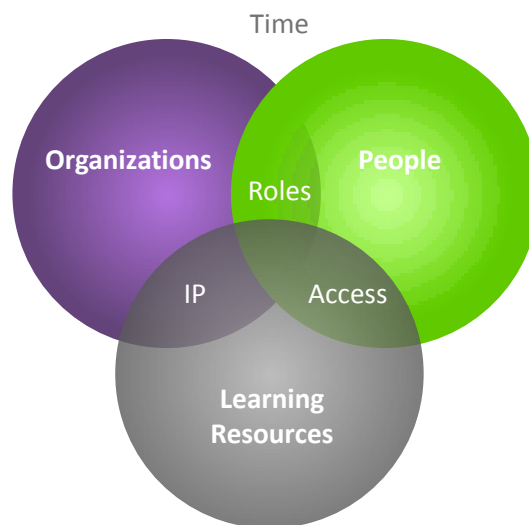
The NDS is a Third Normal Form¹ structure organized around the key concepts of organization, person, role, and learning resources (see the diagram). The NDS was developed with the goal of supporting physical implementations that could function as an “operational data store” for integrated P-20W data, providing the most current available view of each organization, person, and role.

The NDS starts with a flexible directory of organizations that may have multiple parent-child relationships with one another. People exist independently, and roles exist within the context of their relationship to a specific organization, for a specific date range.

Each person shares common attributes, or data points, that allow the model to represent a person at all levels of education. Each person has one or more “roles.” Roles are a time-aware association between a person and an “organization.”

At the intersection of organizations, persons, and learning resources are key learning processes. CEDS includes definitions of process data elements, such as assignments, activity, and achievements. Also defined in CEDS are the data elements and relationships covering formative, summative, and benchmark assessment processes. The NDS model also supports key relationships, such as the relationships between competencies (and/or learner goals) and learning resources, assignments, and assessment items.

CEDS NDS Conceptual Model



Naming Conventions and Key Terms

The CEDS initiative has adopted a set of naming conventions for data entities and elements for the purpose of consistency. Terms and concepts found in element definitions, categories, and options—or referred to in CEDS communications—that may need further explanation are available in the glossary section of the CEDS website. See <https://ceds.ed.gov/Glossary.aspx> for the key terms related to CEDS.

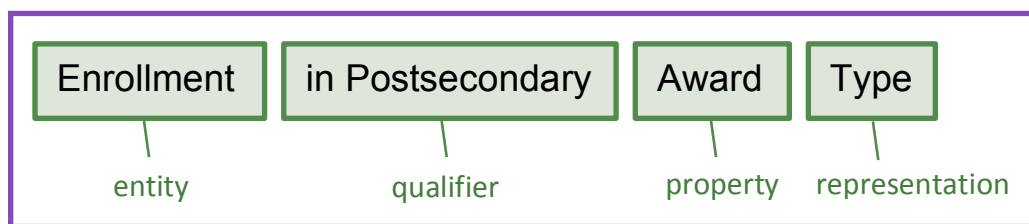
The standard name of a data element in CEDS is defined for human readability and understandability, and to avoid possible confusion when using an element in a different context or across domains.

¹See http://en.wikipedia.org/wiki/Third_normal_form.

CEDS elements include a “Technical Name” in a more machine-readable format, which may support alignment with external technical standards. CEDS also supports an “Alternate Name,” which is used for discoverability when searching. Unless otherwise set based on an external standard, CEDS technical names are the full CEDS element name with spaces and special characters removed and with initial caps on each word (Pascal case). For example, the CEDS element “Country Code” has the technical name “CountryCode.” Additional technical conventions used in the NDS are documented elsewhere in this guide.

Based on the [ISO 11-179 guidelines](#) element names have **name parts** that consist of discrete terms.

The name parts may be entity terms, property terms, representation terms (optional), or qualifier terms (optional). Consider the following illustration.



Entity Terms

Entity terms provide the context for an element. For example, in the following data element names, the terms *Person*, *Accountability Report*, *Dental Insurance Coverage*, and *Advance Placement* are entity terms.

- Person Middle Name
- Accountability Report Title
- Dental Insurance Coverage Type
- Advance Placement Credits Awarded

Property Terms

A property is an attribute common to all members of an entity. For example, all persons have a date of birth. In the following data element names, the terms *Name*, *Title*, and *Credits Awarded* are property terms.

- Person Middle Name
- Accountability Report Title
- Dental Insurance Coverage Type
- Advance Placement Credits Awarded

Note that in this list, three of the element names have an Entity-Property structure. One of the element names (“Dental Insurance Coverage Type”) has an Entity-Representation structure.

Representation Terms (Optional)

Representation terms describe the form of representation, or the kind of information for which the data element is defined. For example, this document defines the following representation terms and their uses: “Indicator,” “Status,” “Identifier,” “Descriptor,” “Description,” and “Type.”

In “Dental Insurance Coverage Type,” *Type* is a representation term. Element names use the “Type” suffix when the element has an option set, a controlled vocabulary of values used to classify or categorize the entity.

Qualifier Terms (Optional)

Entity terms define a context for an element. If the context is applicable to only one domain, the entity terms may include a qualifier to make it clear that the element is for a specific domain. For example, in the element name “Postsecondary Enrollment Type,” it is clear that this enrollment type element is defined for use in the postsecondary domain only—i.e., its option set may not be compatible with K12 uses.

Qualifier terms may appear before or after an entity term, as appropriate to convey meaning.

Element Identifiers

Each CEDS element has a **Global ID** (see the image below). On the website, this is labeled as the “CEDS Element ID.” The Global ID persists across different versions of CEDS. In other words, the Global ID will always remain the same, even if other attributes of the element (Name, Definition, Format, Option Set, etc.) change.

Each element also has a **Version-specific URL** (see the image). For example, the element “Assessment Result Score Value” was updated in CEDS Version 5. The updated element kept the same Global ID (000245) as in the previous version, but it was issued a unique URL.

Users can reference the version-specific definition of an element by using the element’s URL. They can find previous and future versions of an element by searching for its other version(s) using the element’s global **CEDS Element ID** (aka the Global ID).

The screenshot shows the 'Element Details' window for the element 'AbilityGroupingStatus'. It includes a list of related entities, the CEDS Element ID (000328), the element's technical name, and its XML schema definition. A callout box highlights the 'Global ID' as common to all versions, and another callout points to the 'Version specific URL'.

Element Details (press "ESC" key to close)

Related Entities and Categories

- K12 -> Course Section
- K12 -> K12 Course
- K12 -> K12 School -> Institution Characteristics

CEDS Element ID
000328

Global ID common to all versions of this element

Element Technical Name
AbilityGroupingStatus

XML

```
<xs:simpleType name="AbilityGroupingStatus">
  <xs:annotation>
    <xs:documentation>Usage: Ability Grouping Status</xs:documentation>
  </xs:annotation>
  <xs:restriction base="xs:token">
    <xs:enumeration value="Yes"></xs:enumeration>
    <xs:enumeration value="No"></xs:enumeration>
  </xs:restriction>
</xs:simpleType>
```

Version specific URL

URL
<https://ceds.ed.gov/CEDSElementDetails.aspx?TermId=7000> (Email this link)

Close

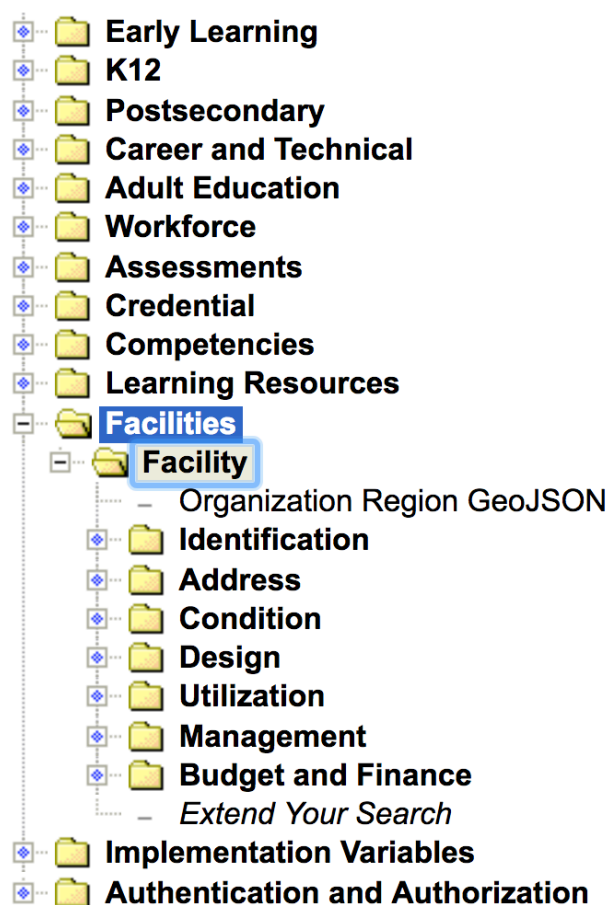
CEDS DOMAIN ENTITY SCHEMA

Domain Entity Schema (DES) Structure

The Domain Entity Schema (DES), as illustrated to the right, provides a user-friendly structure that allows stakeholders from each domain to easily identify elements they are interested in, sorted by entity and attribute category.

Some facts about the DES are as follows:

- The DES is a hierarchy of domains, entities, attribute categories, and attributes.
- It is used primarily as an index to search, map, and organize elements.
- CEDS elements may exist in more than one place in the DES.
- It contains strong constraints specific to the sub-type.
- The DES contains mostly unit-level elements with only a few derived/aggregated attributes. (CEDS [Connect](#) is available for defining derived/aggregated metrics based on unit-level elements.)
- The DES provides a framework for a more “flat” and “de-normalized” view of data element definitions, in the context of an organization, process, or person-role (e.g., a K12 Student).



The Domain Entity Schema changes with each version of CEDS. Nodes are added and removed based on input from the development community and to accommodate expanded uses for new and existing elements. The DES context(s) for each element are specific to the version and are included on the “Element Details” page.

In the DES on the CEDS site, user can enter the “Element Details” page for a particular element and see a unique URL. This unique URL identifies the data element at a specific DES location, for the specific version of CEDS. For example, in the Element Details page indicated by the URL

<https://ceds.ed.gov/CEDSElementDetails.aspx?TermxTopicId=19808>, the number after “TermxTopicId=” uniquely identifies the element at this specific location within the DES.

Note that the “TermTopicId=” used in this URL is different from the “TermId=” used in the URL on the Element Details page accessed from the elements page. The TermTopicId is for a specific location in the DES. The TermId references the version-specific element definition apart from DES context.

Also note that, in the downloadable template for the Align tool, the column “CEDS Element Data Model ID” on the “CEDS_Element_Listing” tab corresponds to the number after “TermxTopicId=” within the context-specific URL.

Domain and Entity Changes in Version 7.1

Domains provide a common perspective for stakeholders with differing backgrounds and interests to approach the CEDS model. Domains describe the various entities and their attributes, roles, and relationships, plus the constraints that govern the integrity of the model elements comprising a particular problem domain.

In version 7.1 the **Facilities** domain was added. The following table displays the CEDS domains after the version 7.1 update.

Domain		Definition
Early Learning	EL	The stage in human development from birth through the early school years (often defined as birth to age 8) during which significant social, emotional, cognitive, language, psychological, and physical development occurs.
Elementary and Secondary	K12	The formal instructional program whose curriculum is designed primarily for students who have entered kindergarten through those who have exited high school.
Postsecondary	PS	The formal instructional program whose curriculum is designed primarily for students who are beyond the compulsory age for high school. This domain includes programs whose purpose is academic, vocational, and continuing professional education, and excludes avocational and adult basic education programs. (See also the Integrated Postsecondary Education Data System [IPEDS]).
Career and Technical Education	CTE	Career and technical education programs, as defined by Perkins IV, and information about the students served by these programs.
Adult Education	AE	Programs that help adults get the basic skills they need to be productive workers, family members, and citizens. This domain includes information about the adults served by these programs.
Workforce	WF	Workforce and employment development programs, including people’s participation in them, as well as the employment and earnings data that are matched between education and workforce data sources.
Assessments		Entities and elements that support the design, administration, and scoring or evaluating the results of assessments used to measure one or more persons’ mastery of one or more learning objectives.
Credential		A qualification, achievement, personal or organizational quality, or aspect of an identity typically used to indicate suitability.

Competencies	Learner competencies established in learning standards documents or competency frameworks that may be adopted as expectations by education agencies, and that may exist within the structure of a taxonomy or competency-based pathways.
Learning Resources	Materials that support teaching and learning.
Facilities	The CEDS domain that includes entities and elements related to a building or buildings located on a single site.
Implementation Variables	Elements used to implement data systems and processes, such as variables to track the date that a report was produced.
Authentication and Authorization	Data used to authenticate the identity of a person, and to restrict or grant access to online systems, services, or information.

Entities

Entities are persons, places, events, objects, or concepts about which data can be collected. An entity provides the context for a data element. In version 7.1 the following entity definitions were added within the new Facilities domain:

Campus	The building or buildings located on a site that are under the control of a single entity.
Facility	The building or buildings located on a single site.

See the Version 7 Data Model Guide for definitions of the remaining entities other than those in the Facilities domain.

CEDS NORMALIZED DATA SCHEMA (NDS) ADDENDUM

The CEDS Normalized Data Schema (NDS) offers Entity Relationship Diagrams (ERD) providing visual representations of how the tables, or entities, within a data model pertain to each other. The NDS is available in PDF format and as SQL scripts for import into data modeling tools. Scripts are included to populate reference tables with applicable controlled vocabulary (CEDS option sets) and tables with metadata mapping CEDS element definitions to columns defined in the NDS. Also, a spreadsheet file is included along with this document. The file “Table and Column Listing” is available on the NDS page (<https://ceds.ed.gov/dataModelNDS.aspx>) and by direct link here: https://ceds.ed.gov/data/xls/NDS-Reference-v7_1.xlsx.

The nomenclature used to describe the NDS includes terms often used for a physical model. This facilitates the comprehension of the contents, since more people are familiar with physical terms (such as a *table* having *fields* or *columns* as opposed to the terms *entity* and *element* used for CEDS definitions. Additionally, since the terms *entity* and *element* are used within the DES, using the physical terms when discussing the NDS differentiates the context.

NDS Core Structure Logic

The NDS Logical Model provides a logical database model, normalized to Third Normal Form, such as might be used for the integration of P-20W data systems through a well-normalized “operational data store.”

The NDS is not designed to address the needs of all possible physical implementations. For example, a database supporting data from only one domain (Early Learning, K12, or Postsecondary) could use a less normalized model.

Because CEDS elements are defined at the unit level, the NDS also addresses unit-level data. Aggregate metrics that might be derived from CEDS elements generally are not included in the NDS. Instead, these metrics can be defined using CEDS Connect and modeled in a reporting data store. Some examples of reporting data store structures are included in the *Version 7 Data Model Guide*.

This CEDS logical model includes longitudinal aspects, such as for tracking enrollment status over time. However, it does not directly address the production aspects of log and change management. In a physical implementation, a sub-model supporting the audit of edits to all attributes may be used.

Comparability of education data has some exciting possibilities for educators, administrators, and vendors. The NDS is designed for Data at Rest. It serves to provide a level of interoperability such that

- standardized terminology succeeds in promoting more effective communication and in streamlining knowledge transfer;
- mapping takes less effort;

- the development of reports, imports, exports, dashboards, and/or modules can be more easily shared across organizations;
- there is centralized or baselined design documentation; and
- resources can be shared.

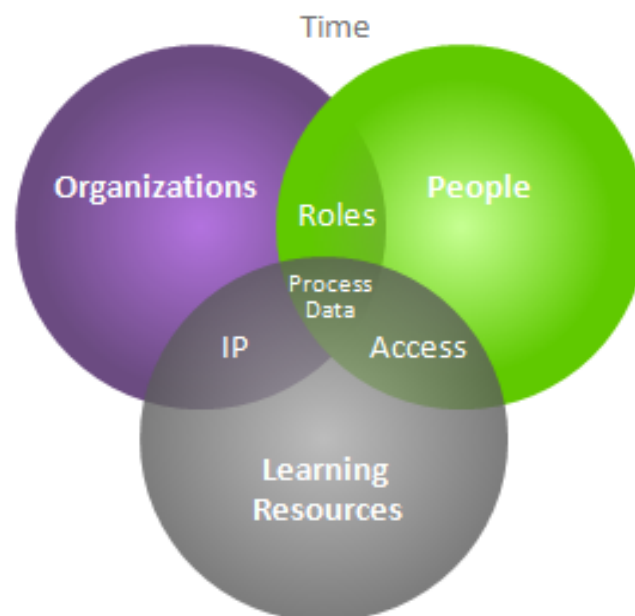
Traceability largely addresses the internal aspects of a P-20W system. It ensures that the data surrounding a person's education can be persistently stored and accurately retrieved.

To provide a data model that promotes comparability and traceability across P-20W boundaries, the data abstraction process must reconcile myriad sources, interpretations, and definitions for each data structure. The NDS's highly normalized data model promotes these requirements.

The resulting model is flexible, and it supports diversified needs across P-20W education agencies while providing a consistent approach that supports comparability. Consequently, a layer of abstraction exists based on several key concepts:

- Time—A duration which constrains the relevance of data
- Person—An individual
- Organization—Any organizing entity that is not a Person (e.g., a school, district, program, institution, course section, or jurisdiction)
- Role—A date-sensitive affiliation between a Person and an Organization
- Learning Processes—The inputs, process steps, and outputs related to the work of People and education Organizations

The relationship between these concepts is illustrated in the following diagram.

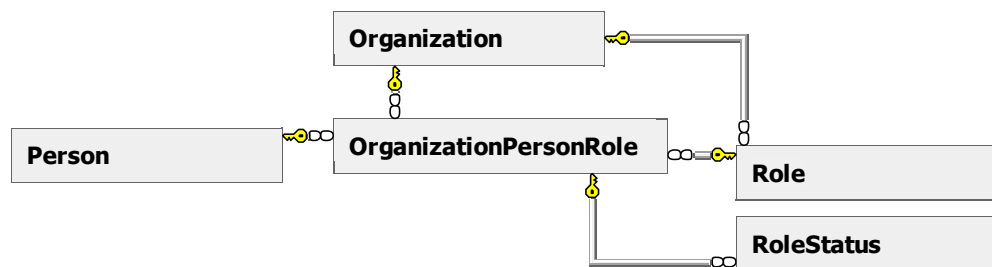


Note that people in the NDS only have roles in relationship to a specific organization and a designated date range. Persistent information about a person is modeled separate to the person's role and relationship to an organization.

NDS Entity Relationship Model

A High-Level Logical Model

Here is an example of a high-level logical model in the NDS:



Normalization and the NDS Model

Normalization is a data-structuring process that results in the following:

- The elimination of redundancies— Normalization prevents update anomalies and reduces the amount of stored data.
- An ensured accuracy of data— Normalization prevents insert anomalies and guarantees the quality of the data.
- The understanding of data—Discrete objects clearly identify a purpose.
- Scalability— Normalization better accommodates growth.
- Extensibility— Normalization facilitates the modification of the model.

A system is considered to be well normalized if it meets the Third Normal Form. C.J. Date said that database design is common sense formalized. Applying normalization is similar to factoring algebraic equations: simply reduce factors to like terms. Identifying whether or not an attribute exists always or sometimes determines its “optionality” or “nullability.” Determining what type of relationship the attribute has (for example, a person has only one birthplace, whereas a person may speak one or more languages) determines the “cardinality.”

As a result of normalization, some CEDS elements are not represented as distinct fields in the NDS. However, every CEDS element is supported. For example, the CEDS elements Organization Name (000204), Name of Institution (000191), Program Name (000626), and Responsible Organization Name (000631) all normalize to Organization: Name in the NDS.

Normal Forms

Each form must comply with lower-level forms. The main premises of the first three normal forms are as follows:

- First Normal Form (1NF)—Records are uniquely identifiable and contain no repeating fields.
- Second Normal Form (2NF)—All attributes are directly dependent on the primary key.
- Third Normal Form (3NF)—Non-key fields do not have dependencies on other non-key fields.

Reference Data

When a known set of values (**controlled vocabulary**) exists, as defined in the **option set** of a CEDS element, the model uses a reference table. In the data model, reference tables have the prefix “Ref.”

CEDS provides scripts to populate reference tables with option sets from the CEDS element definitions. CEDS Option Sets and NDS reference tables include the following:

- Code—A machine-readable value that uniquely identifies the option. Codes contain a numeric or alphanumeric string with no spaces. In some cases, “spacer” characters are used, including the hyphen (-), slash (/), period (.), and underscore (_). All options contain at least one code value.
- Description—A human-readable label or short description of the option up to 100 characters with spaces.
- Definition—A longer human-readable text defining the option.

Surrogate Keys

Surrogate keys are used instead of natural keys to simplify joins. Joins are simplified in that there is always one field to join to one table. Composite keys, which require one or more fields and data knowledge to join tables, were not used for this data model. Additionally, surrogate keys allow the logical primary key to be changed without implementing logic to handle the change. This was considered necessary to support the wide range of datasets, since some potential uses of this model allow for primary keys to change over time.

While surrogate keys typically are not represented in a logical model, the prevalence of super-type/sub-type data, combined with education data being so closely tied to organization identifiers and person identifiers, resulted in the decision that they be included.

The Use of Super-types/Sub-types

To provide a database flexible enough to fit multiple business models, configurable hierarchies and reference data are critical. To promote the association of these concepts, the NDS uses a super-type/sub-type construct. Super-types/sub-types may be used when an idea has common and different elements. For example, a parent and an Early Learning child can both be categorized as people and can share certain people elements, such as the birth date and home address. However, only the parent will have a job, and only the child will have a lunch program.

NDS utilizes three super-types:

- Person—Data about people
- Organization—Anything that is not a person, such as a district, school, or course
- Role—A person’s data that relate to an organization, such as a student’s attendance


Common Model

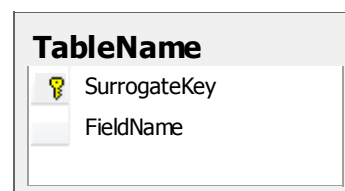
Each of the three super-types (Person, Organization, and Role) contains information that applies to all types. For example, each person, regardless of role, has demographic information, and all types of organizations may have calendar information.

Understanding the NDS Entity Relationship Diagrams

NDS Table and Field Syntax

Tables

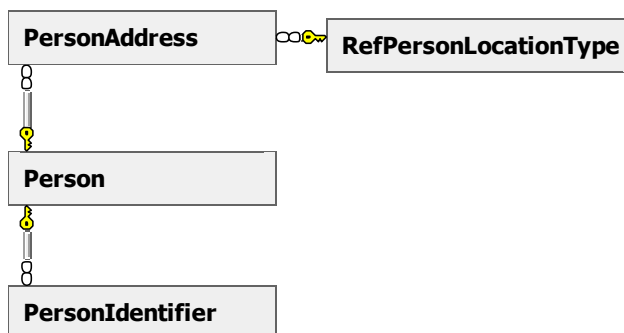
Tables are represented as a rectangle. The surrogate key is indicated by a key  symbol. This is shown in the image to the right.




The function of the surrogate key is to uniquely identify one record from all other records within the same table. The CEDS model uses a design standard of “surrogate keys.” Surrogate keys do not replace primary keys; however, they simplify using them.

Relationships



The heart of the Entity Relationship Diagram (ERD) is an illustration of how data relates to itself. By effectively using lines and boxes, we can gather understanding from a simple diagram:



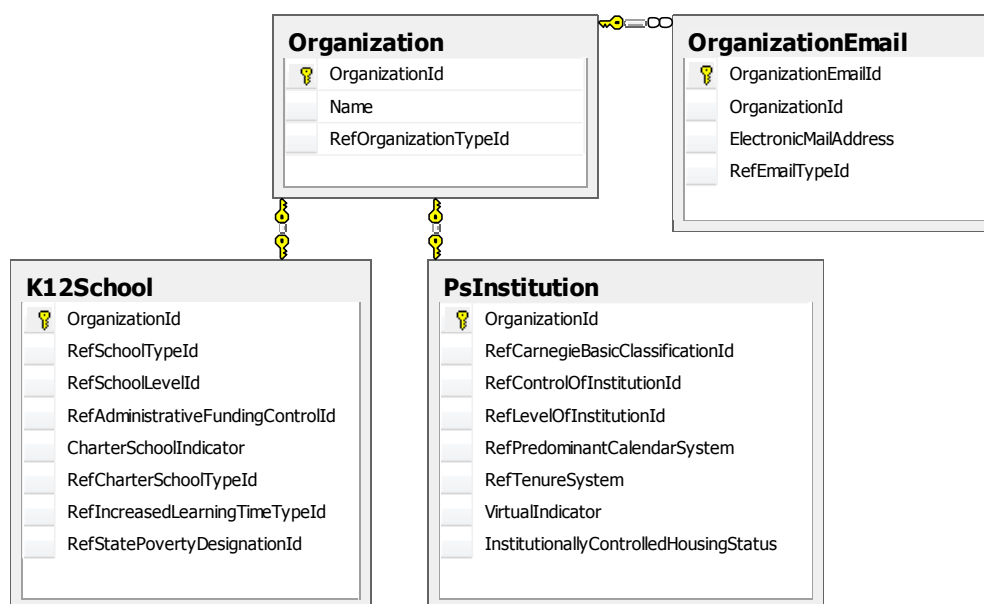
This diagram tells us that a Person may have an Address and an Identifier. The infinity  symbol tells us that there may be more than one Address and Identifier for a Person. We also know by the “Ref” table that the PersonLocationType field in the PersonAddress table uses a CEDS-controlled vocabulary. “Ref” tables represent the option set defined for CEDS elements.

The NDS model leaves it up to the implementation to define additional business rules. For example, a system may apply a business rule to limit the number of PersonIdentifiers that may be associated with a Person, or to ensure that a PersonIdentifier for a given Person Identification System must be unique. A best practice for multitier applications is to enforce such rules at all tiers of the application.

Since the CEDS Data Model uses surrogate keys, the presence of identifying relationships is reduced to super-type/sub-type relationships.

The symbols on the ends of the lines indicate the cardinality of the relationship. The key-to-infinity  symbol represents a one-to-many relationship, and the key-to-key  symbol represents a one-to-one relationship, such as a sub-type relationship. For example, K12 School is a sub-type of Organization, and their relationship in a diagram has a key on both ends.

Super-type/sub-type relationships indicate that a record of a super-type may have a corresponding sub-type record, but a sub-type record cannot exist without the parent super-type. The power of the super-type/sub-type construct is that it allows one object to have different sets of properties. By extension, this mechanism allows multiple tables to be referenced by one common object. For example, a K12 school and a postsecondary institution are two kinds of organizations. Common attributes include a name and zero or more email addresses, but they each have some domain-specific attributes as well. Notice in the diagram below that both K12School and PsInstitution use the surrogate key (OrganizationId) of the parent table (Organization).



Finding CEDS Elements in the NDS Model

All CEDS elements are supported in the NDS model except elements in the “Implementation Variables” domain, which would be used in a reporting data store. Sometimes there is a one-to-one correspondence between the CEDS element and a table column in the NDS model. For example, the CEDS element Financial Account Name corresponds to the Name column in the NDS table “Financial Account.”

In other cases, as a result of normalization, CEDS elements may not represent distinct fields in the NDS. Consider the following element.

Child Developmental Screening Status

Definition

The result of a brief standardized screening tool aiding in the identification of children at risk of a developmental delay/disorder.

Option Set

Further evaluation needed	FurtherEvaluationNeeded
No further evaluation needed	NoFurtherEvaluationNeeded
No Screening Performed	NoScreeningPerformed
Appropriate Assessment Tool Unavailable	AssessmentToolUnavailable
Personnel Unavailable	PersonnelUnavailable

The element represents a specific kind of Assessment Result. The NDS already has a well-developed model supporting assessment results that may be used, as shown in the diagram below. Each of the values in the option set may be stored as “Assessment Performance Level” using an “Assessment Performance Level Identifier” and “Assessment Performance Level Label.” Then, the result of an early learning screening, “Early Learning Child Developmental Screening Status,” may be recorded as an Assessment Result and linked to the appropriate Assessment Performance Level.

See the *Version 7 Data Model Guide* for additional data model and usage examples.

APPENDIX A: NDS ENTITY RELATIONSHIP DIAGRAMS ADDENDUM

The following entity relationships diagram (ERD) provides visual representations of the CEDS Normalized Data Schema (NDS) for the new facilities domain.

Also see

- the **Version 7 Data Model Guide** (https://ceds.ed.gov/pdf/CEDS-7-0-Data-Model-Guide_for_508.pdf) for diagrams representing the full scope of data elements in CEDS;
- the accompanying **Table and Column Listing** (https://ceds.ed.gov/data/xls/NDS-Reference-v7_1.xlsx), which includes a complete table and column listing updated for version 7.1; and
- the **Database Model Downloads** section of the Normalized Data Schema page (<https://ceds.ed.gov/dataModelNDS.aspx>) on the CEDS site for SQL scripts to create, update, and populate option sets and metadata for version 7.1.

Facilities

The following shows the NDS tables added in version 7.1 to support facilities-related data elements.

