

Common Education Data Standards (CEDS) Version 7 Data Model Guide

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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 latest version of the standards and related resources can be found at the CEDS website at <http://ceds.ed.gov>.

The CEDS standards are composed of several pieces of information that provide a 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.

WHAT'S NEW IN VERSION 7

In version 7 there are 106 new data element definitions and 97 updated elements. In all, the standards contain 1,567 unique data element definitions. In addition, more than 50 elements have been added to new contexts within the CEDS Domain Entity Schema (DES) to reflect additional uses.

Version 7 spans P-20W (early learning through workforce), with significant improvements related to data vocabulary for

- credentials definition and assertions;
- competency frameworks;
- K12 special education data used locally for Individualized Education Programs (IEPs) and compliance;
- IPEDS postsecondary finance;
- reporting variables; and
- School Courses for the Exchange of Data (SCED) updates.

The latest release also includes various updates and clarifications in response to feedback from the CEDS community after the version 6 release.

Data Model Changes

Both the Domain Entity Schema (DES) and Normalized Data Schema (NDS) have been modified to reflect new elements and the application of existing elements to new use cases.

DES Changes

Significant changes to the **Domain Entity Schema** include the following:

- The Achievement category under the Assessments domain is now its own domain called “Credential.” The top level defines the credential itself, such as might be offered or awarded by an organization. The domain has a separate category for “Credential Award” with information about a credential conferred to or earned by a person. This change reflects the significant expansion of the standards for credentials and coordination with other standards organizations including the Credential Transparency Initiative, Open Badges, PESC, and IMS Global.
- The “Learning Standards” domain has been renamed “Competencies” with the categories “Competency Framework,” “Competency Framework Item,” and “Competency Framework Item Association” replacing “Learning Standard Document,” “Learning Standard Item,” and “Learning Standard Item Association.” This change reflects the expanded use of CEDS standards, the emergence of “competencies” as the preferred term across P-20W sectors (“learning standards” is a K12-centric term), and coordination with other emerging standards.
- An “Implementation Variables” domain has been added. This domain contains elements related to implementation, such as “Report Date,” that are neither the unit-level data elements defined

elsewhere in CEDS nor CEDS Connections that define aggregate metrics based on unit-level elements.

- Changes and additions to categories under K12 Student → Individualized Program were made as CEDS expanded for comprehensive coverages of special education data used locally for IEPs and compliance.

NDS Changes

The **Normalized Data Schema** also reflects significant changes in line with the changes to the DES and in response to maintenance requests from the field by organizations implementing physical models.

The NDS changes include

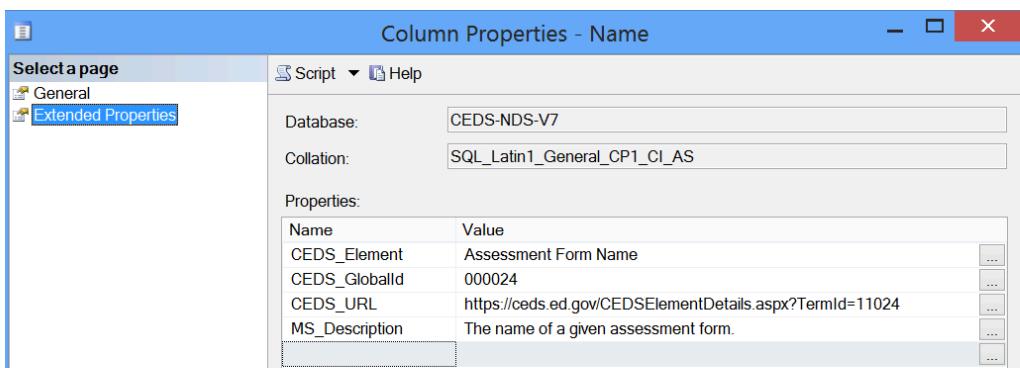
- changes that reflect all the updates to the standards and DES element contexts;
- renaming some tables based on name changes in the standards, such as LearningStandardItem to CompetencyFrameworkItem; and
- additional metadata properties.

New Metadata Properties

The NDS now includes additional metadata properties making it easier for technical users to understand the alignment between columns in the normalized model and elements in the standards.

Tables and columns generated from the MS-SQL scripts include these extended properties:

- CEDS Element – The name of the CEDS element that the column represents
- CEDS GlobalId – The CEDS element identifier
- CEDS_URL – URL to the version-specific page defining the element



NDS Potentially Breaking Changes

For those with existing physical database implementations based on the NDS, the version 7 update includes some potentially “breaking changes.” If your current implementation uses any of the tables

below, then scripts and code using these tables will need to be updated accordingly. Most of the impacted tables are to replace “LearningStandard” and “Achievement” tables and column names with new tables/columns for “Competency” and “Credential.”

The breaking changes are limited to the following tables:

- AchievementEvidence
- Achievement
- AssessmentParticipantSession_Accommodation (two columns affected:
RefAssessmentAccommodationCategoryId and RefAssessmentAccommodationTypeId have been moved to AssessmentAccommodation RefAssessmentAccommodationCategoryId and RefAccommodationTypeId)
- AssessmentRegistration_Accommodation (three columns affected:
RefAssessmentAccommodationCategoryId, RefAssessmentAccommodationTypeId, and OtherDescription have been moved to AssessmentAccommodation
RefAssessmentAccommodationCategoryId, RefAccommodationTypeId, and OtherDescription)
- AssessmentSubtest_LearningStandardItem
- CourseSection (one column affected: RelatedLearningStandards has been replaced by RelatedCompetencyFrameworkItems)
- CompetencyItem_CompetencySet (one column affected: LearningStandardItemId has been replaced by CompetencyFrameworkItemId)
- ELChildService (one column affected: ReasonForDeclinedServices has been moved to ServicePlan)
- LearningGoal
- LearningStandardItemAssociation
- LearningStandardItemEducationLevel
- LearningStandardItem
- LearningStandardItemDocument
- RefAssessmentAccommodationType
- RefLearningStandardDocumentPublicationStatus
- RefLearningStandardItemAssociationType
- RefLearningStandardItemNodeAccessibilityProfile
- RefLearningStandardItemTestabilityType
- ServicesReceived (one column affected: RefServicesId has been moved to ServiceProvided)

Additional details are included in the NDS scripts provided with the version 7 release.

To preserve existing data in these tables, you will need to

1. comment out the portion at the end of the update script that contains **alter** and **drop** statements;
2. create the new tables with the modified version 7 update script;

3. populate the new tables from data in the existing tables and update any customized scripting that utilizes these tables and columns; and then
4. execute the **alter** and **drop** scripts that were previously commented out.

Detailed comments in the update scripts provided with the release support this process.

Look for the following text in the update script:

WARNING!!!!

Potentially breaking changes start here.

All data in these tables and columns should be moved to the new database locations before running any of the alter and drop statements below.

WARNING!!!!

ABOUT THIS DOCUMENT

This document describes how to use the CEDS Data Model Version 7, as published on the CEDS website. The CEDS Data Model includes a hierarchical schema of domains and entities—as a nontechnical reference showing CEDS elements in context—and a fully normalized logical model. In addition to the normalized reference model, this document includes examples showing CEDS elements in the context of other types of data models, such as the star schema typically used in dimensional data warehouse design.

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 include the following:

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

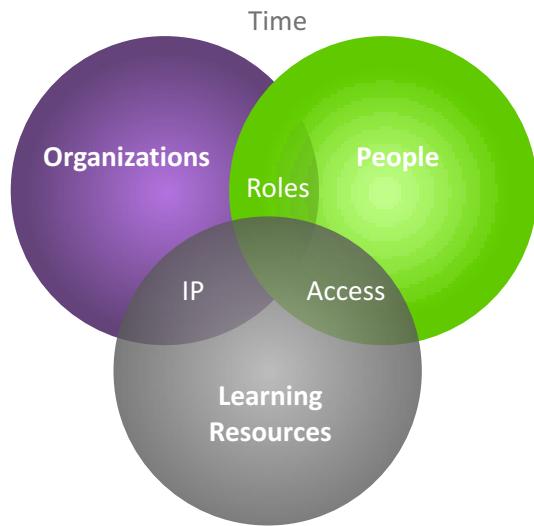
The NDS is a Third Normal Form* structure organized around the key concepts of organization, person, role, and learning resources (see the diagram). The NDS was developed with the goal of supporting physical implementations that could function as an “operational data store” for integrated P-20W data,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

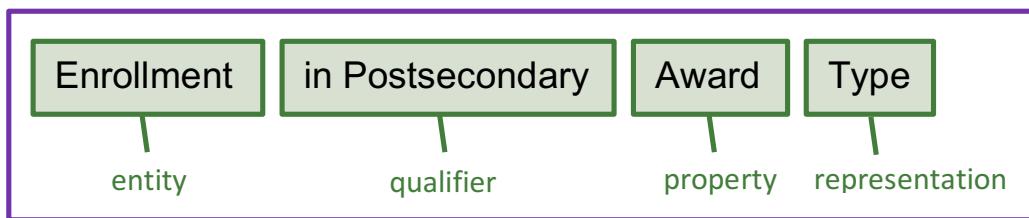
*See http://en.wikipedia.org/wiki/Third_normal_form

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.

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.

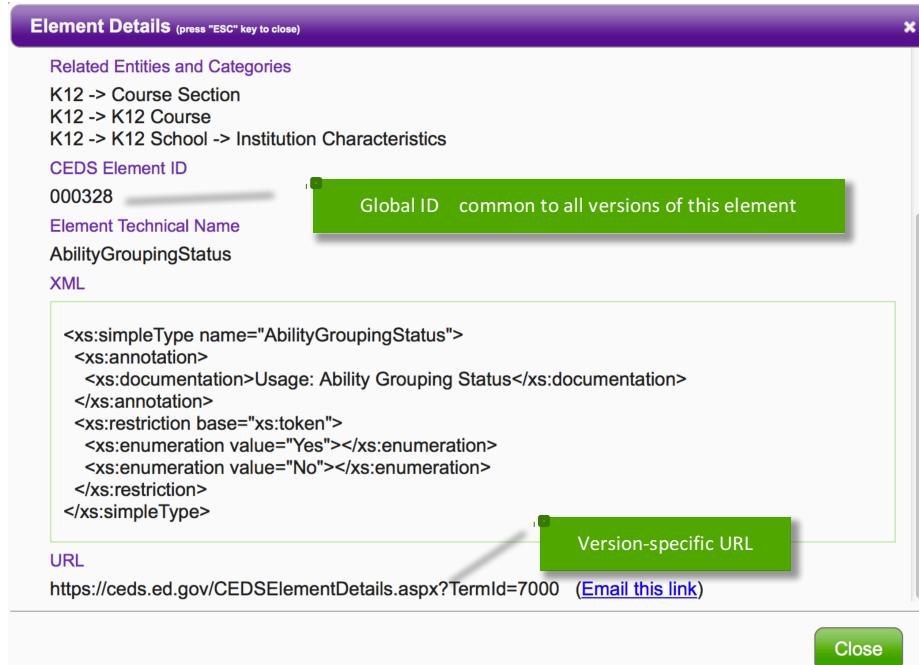
Qualifier terms may appear before or after an entity term, as appropriate to convey meaning.

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).



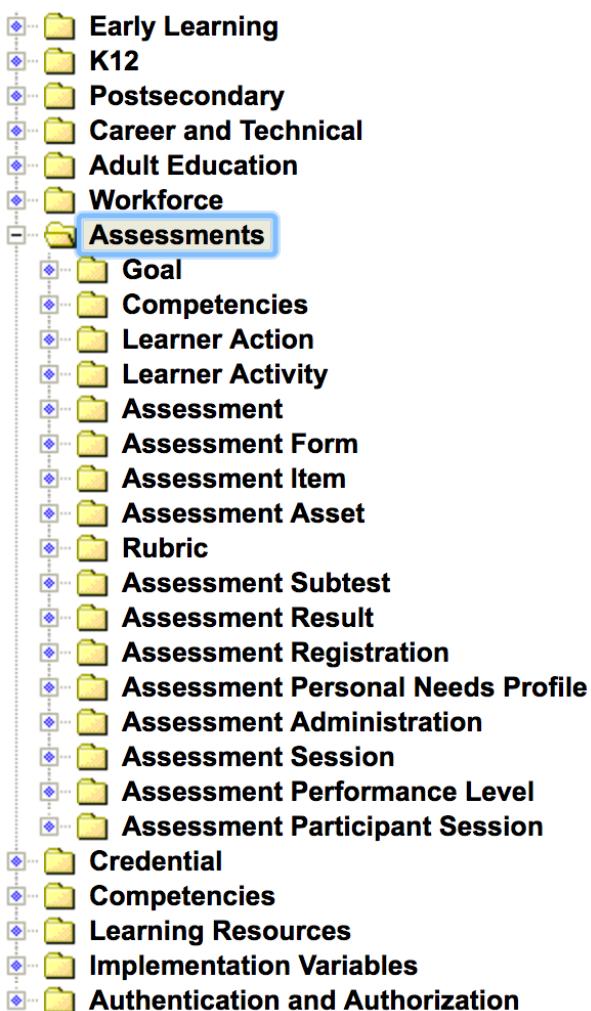
CEDS DOMAIN ENTITY SCHEMA

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. This is illustrated in the image on the next page.

In the DES on the CEDS site, a 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.

The screenshot shows the 'Element Details' page for the 'Telephone Number' element. The left sidebar has 'Home' and 'Domains' selected. The main content area has a title 'Telephone Number'. Under 'Definition', it says 'The telephone number including the area code, and extension, if applicable.' Under 'Format', it says 'Alphanumeric - 24 characters maximum'. Under 'Option Set', it says 'None'. A section titled 'Related Domains, Entities and Categories' lists various contexts where 'Telephone Number' is used, such as 'Adult Education -> AE Staff -> Contact -> Telephone' and 'K12 -> K12 School -> Telephone'. A green 'New' button is visible next to some entries. A purple bracket on the right side groups the 'Related Domains, Entities and Categories' section and is labeled 'DES contexts for the element "Telephone Number"'.

Element Details (press "ESC" key to close)

Telephone Number

Definition
The telephone number including the area code, and extension, if applicable.

Format
Alphanumeric - 24 characters maximum

Option Set
None

Related Domains, Entities and Categories

- Adult Education -> AE Staff -> Contact -> Telephone
- Adult Education -> AE Student -> Contact -> Telephone
- Career and Technical -> CTE Staff -> Contact -> Telephone
- Career and Technical -> CTE Student -> Contact -> Telephone
- Early Learning -> EL Child -> Contact -> Telephone
- Early Learning -> EL Organization -> Contact -> Telephone
- Early Learning -> EL Staff -> Contact -> Telephone
- Early Learning -> EL Staff -> Professional Development -> Instructor
- Early Learning -> EL Staff -> Professional Development Activity -> Session - Location
- Early Learning -> Parent/Guardian -> Contact -> Telephone
- K12 -> K12 School -> Telephone
- K12 -> K12 Staff -> Contact -> Telephone
- K12 -> K12 Staff -> Professional Development Activity -> Session - Location
- K12 -> K12 Student -> Contact -> Telephone
- K12 -> LEA -> Telephone
- K12 -> Organization -> Contact -> Telephone **New**
- K12 -> Parent/Guardian -> Contact -> Telephone
- K12 -> SEA -> Contact -> Telephone
- Postsecondary -> Parent/Guardian -> Contact -> Telephone
- Postsecondary -> PS Student -> Contact -> Telephone
- Workforce -> Workforce Program Participant -> Contact -> Telephone **New**

DES contexts for the element "Telephone Number"

Domains

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. The following table displays the CEDS domains.

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.
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. The tables on the following pages display CEDS entities at the top level of each domain in the DES.

Early Learning (EL)

Early Learning (EL) is the CEDS domain on 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.

Entity	Description
EL Organization	An institution that provides early learning services. This can be a grantee with delegates at various locations, possibly in one or more buildings; it has an assigned administrator(s).
EL Child	A person for whom instruction, services, and/or care are provided in an early childhood program under the jurisdiction of a school, education agency, or other institution or program.
Parent/Guardian	A person having parental or legal guardianship responsibility for a learner.
EL Family	All persons (i) living in the same household who are (a) supported by the income of the parent(s) or guardian(s) of the child enrolling or participating in the program, or (b) related to the child by blood, marriage, or adoption; or (ii) related to the child enrolling or participating in the program as parents or siblings by blood, marriage, or adoption.
EL Staff	A person who performs specified activities for a public or private education institution, agency, or household that provides instructional and/or support services to students or staff at the early childhood level.
EL Class/Group	A cohort of children receiving services together, or in some cases individually, usually for a predetermined amount of time, with at least one assigned primary teacher.
Early Learning Program	An entity with information about a system of services, opportunities, or projects, designed to meet academic or non-academic needs. (A Program entity may be related to an organization as the service provider and to people as program staff, participants, and recipients of program services. CEDS broadly defines Program for information about program types such as work-study programs or athletic programs that are not specifically defined. CEDS also has more specific program entities such as PS Institution Program and CTE Program.)

Elementary and Secondary (K12)

Elementary and Secondary (K12) is the CEDS domain on the formal instructional program whose curriculum is designed primarily for students who have entered kindergarten through those who have exited high school.

Entity	Description
K12 School	An institution that provides educational services, has one or more grade groups (PreK through 12), has one or more teachers, is located in one or more buildings, and has an assigned administrator(s).
Local Education Agency (LEA)	Local educational agency, or LEA, means a public board of education or other public authority legally constituted within a state for either administrative control or direction of, or to perform a service function for, public elementary schools or secondary schools in a city, county, township, school district, or other political subdivision of a state, or for a combination of school districts or counties as are recognized in a state as an administrative agency for its public elementary schools or secondary schools.
State Education Agency (SEA)	The SEA is the state-level entity primarily responsible for the supervision of the state's public elementary and secondary schools.
K12 Student	A person for whom instruction, services, and/or care are provided in an elementary or secondary educational program under the jurisdiction of a school, education agency, or other institution or program.
Parent/Guardian	A person having parental or legal guardianship responsibility for a learner.
K12 Staff	An individual who performs specified activities for any public or private education institution, agency, or household that provides instructional and/or support services to students or staff at the early childhood level through high school completion.

K12 Course	The organization of subject matter and related learning experiences provided for the instruction of students on a regular or systematic basis, usually for a predetermined period of time (e.g., a semester or a two-week workshop) to an individual or group of students (e.g., a class).
Course Section	A setting in which organized instruction of course content is provided to one or more students for a given period of time. (A K12 Course may be offered to more than one Course Section. Instruction may be delivered in person by one or more instructors or via a different medium. Sections that share space should be considered as separate Course Sections if they function as separate units for more than 50 percent of the time.)
Organization	An organization, institution, agency, or business referenced to by schools, social services, or other education agencies.
Program	A system of services, opportunities, or projects designed to meet academic or non-academic needs. (A Program entity may be related to an organization as the service provider, and to people as program staff, participants, or recipients of program services. CEDS broadly defines Program for information about program types, such as work-study programs or athletic programs, that are not specifically defined. CEDS also has more specific program entities, including PS Institution Program and CTE Program.)
Incident	An infraction ranging from a minor problem behavior that disrupts the orderly functioning of a school or classroom (such as tardiness) to a criminal act that results in the involvement of a law enforcement official (such as robbery). A single event (e.g., a fight) is one incident regardless of how many perpetrators or victims are involved.
Calendar	A set of dates associated with an organization.
Facility	An installation in which school administration at the district or system level is housed. It includes all buildings, structures, and other stationary items that are located on a single site or on contiguous or adjacent sites and that are used for district or system administrative purposes.

Postsecondary (PS)

Postsecondary (PS) is the CEDS domain on the formal instructional program whose curriculum is designed primarily for students who are beyond the compulsory age for high school. This 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]).

Entity	Description
PS Institution	An organization that provides educational programs for individuals who have completed or otherwise left educational programs in secondary school(s).
PS Student	An individual who is a prospect, applicant, admitted student, enrolled student, or alum of a postsecondary institution.
PS Section	A postsecondary instructional course in a particular field of study that typically involves a prescribed number of instruction periods or meetings for enrolled students.
PS Staff	A person who performs specified activities for any public or private education institution, agency, or household that provides instructional and/or support services to students or staff at the postsecondary level.
PS Applicant	An individual who is an applicant of a postsecondary institution.
Parent/Guardian	A person having parental or legal guardianship responsibility for a learner.
Learning Resource	The CEDS entity that includes information about materials that support teaching and learning.
Organization	An organization, institution, agency or business referenced to by schools, social services, or other education agencies.

Career and Technical Education (CTE)

Career and Technical Education (CTE) is the CEDS domain on career and technical education programs, as defined by Perkins IV, and information about the students served by these programs.

Entity	Description
CTE Student	A person for whom instruction, services, and/or care are provided in a Career and Technical Education program and who has met the state-defined threshold of Career and Technical Education participation, as defined in the state's approved Perkins IV State Plan.
CTE Staff	An individual who performs specified activities for any public or private education institution, agency, or household that provides instructional and/or support services to students or staff in a Career and Technical Education program.
Program	A system of services, opportunities, or projects designed to meet academic or non-academic needs. (A Program entity may be related to an organization as the service provider and to people as program staff, participants, and recipients of program services. CEDS broadly defines Program for information about program types, such as work-study programs and athletic programs, that are not specifically defined. CEDS also has more specific program entities such as the CTE Program.)
Course	The organization of subject matter and related learning experiences provided for the instruction of students on a regular or systematic basis, usually for a predetermined period of time (e.g., a semester or a two-week workshop) to an individual or group of students (e.g., a class).
Course Section	A setting in which organized instruction of the course content is provided to one or more students for a given period of time. (A Course may be offered to more than one Course Section. Instruction may be delivered in person by one or more instructors or via a different medium. Sections that share space should be considered as separate Course Sections if they function as separate units for more than 50 percent of the time.)

Adult Education (AE)

Adult Education (AE) is the CEDS domain on programs that help adults get the basic skills they need to be productive workers, family members, and citizens. It includes information about the adults served by these programs.

Entity	Description
AE Student	A person for whom instruction and/or services are provided in an Adult Education program.
AE Staff	A person who is employed by an Adult Education program.
AE Provider	A program that helps adults get the basic skills they need to be productive workers, family members, and citizens.
Program	A system of services, opportunities, or projects, designed to meet academic or non-academic needs. (A Program entity may be related to an organization as the service provider and to people as program staff, participants, or recipients of program services. CEDS broadly defines Program for information about program types, such as work-study programs and athletic programs, that are not specifically defined. CEDS also has more specific program entities such as the CTE Program.)
Course Section	A setting in which the organized instruction of course content is provided to one or more students for a given period of time. (A Course may be offered to more than one Course Section. Instruction may be delivered in person by one or more instructors or via a different medium. Sections that share space should be considered as separate Course Sections if they function as separate units for more than 50 percent of the time.)

Workforce (WF)

Workforce (WF) is the CEDS domain on people's participation in workforce and employment development programs, as well as on employment and earnings data that are matched between education and workforce data sources.

Entity	Description
Workforce Program Participant	A person for whom instruction and/or services are provided in a workforce and/or an employment development program.
Quarterly Employment Record	Person-level employment and earnings information from quarterly employment and earnings-related data from sources such as State UI Wage Records, the Wage Record Interchange System, or the Federal Employment Data Exchange System (FEDES).

Assessments

Assessments is the CEDS domain that includes entities and elements to 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.

Entity	Description
Assessment	An instrument used to evaluate a person with at least one form, section, and Assessment Item. (A summative assessment typically addresses a particular level, subject, and date range. A person's individual responses during the summative assessment administration are evaluated, and then the results are scored using one or more Assessment Subtest Scoring Rules.)
Assessment Form	An instance of an assessment that can equate scores with another instance of that same assessment.
Assessment Session	An entity with information related to an instance of delivering an assessment during a specific period of time.
Assessment Item	A specific prompt that defines a question or protocol for a measurable activity that triggers a response from a person used to determine whether the person has mastered a learning objective.
Assessment Asset	An entity that represents content used to compose an Assessment Item, is referenced by an item but not part of the item content itself, or is content that is included as part of a section within an assessment form. Assets can be static content such as artwork or dynamic assets such as calculators or other tools.
Assessment Subtest	An entity that defines information for scoring an Assessment Form based on a set of Assessment Item responses with explicit rules to produce an Assessment Subtest Result, which may be for the entire Assessment Form or one aspect of evaluation based on a subset of Assessment Items.
Assessment Result	An entity that includes information about a person's results from an assessment, which may be for the entire assessment or one aspect of evaluation. The entity includes the score value and information about the score, such as a diagnostic statement. Note that information for interpreting an assessment result is available in the related Assessment Subtest information. This includes the minimum, maximum, and optimal values for the measurement. The Subtest may in turn be associated with one or more content standards using the Learning Standard Item Association entity.
Assessment Registration	An entity with information related to a specific person registered for an Assessment Administration, assigned a specific Assessment Form for participation in one or more Assessment Sessions.

Assessment Administration	Information related to an assessment event or administration period. It includes information related to the time period of administration and the place(s) of administration.
Assessment Personal Needs Profile	An entity that includes information about the personal needs and preferences for assessment participants, based on the IMS Global (R) Accessible Portable Item Protocol.
Assessment Participant Session	An entity that includes information about a specific person's participation in an Assessment Session.
Goal	An entity that includes information about a goal set for a person or organization.
Competency Framework Item	Content that describes either a specific competency (learning objective) or a grouping of competencies within the taxonomy of a Competency Framework.
Assessment Performance Level	<p>An entity that includes information about the performance levels that may be assigned to an Assessment Result and specifications for selecting the performance level based on a score. Four styles are supported:</p> <ol style="list-style-type: none"> 1. Specification of performance level by lower and upper cut score 2. Specification of performance level by lower cut score only 3. Specification of performance level without any mapping to scores 4. Specification of performance level by mapping to other scores <p>Performance levels are repeatable. A list of all the possible performance levels for an Assessment Result are derived from the relationship between Assessment Subtest and Assessment Performance Level. The performance levels that have been met for a specific Assessment Result are derived from the relationship between Assessment Result and Assessment Performance Level.</p>

Competencies (Learning Standards)

Competencies is the CEDS domain that includes entities and elements that define learner competencies established in learning standards documents or competency frameworks that may exist within the structure of a taxonomy or competency-based pathways.

Entity	Description
Competency Framework	A collection of items, typically arranged in a hierarchical structure or classification scheme, reflecting expectations of learner competencies within a single subject area covering one or more levels. Examples include the Head Start Child Outcomes Framework, the Common Core State Standards for Mathematics, the Degree Qualification Profile, and the Accountability Criteria for National Health Care Cluster Foundation Standards.
Competency Framework Item	<p>Content that describes either a specific competency (a learning objective) or a grouping of competencies within the taxonomy of a Competency Framework.</p> <p>Note: Use the Competency Framework Item Type element to indicate the level of grouping in a hierarchy (e.g., "Subject," "Strand," or "Competency"). A competency may have child items of type "Indicator" used to describe how that competency may be assessed. Items may be associated with other entities, such as Assessment Items or Rubrics, using "Competency Framework Item Association."</p>
Competency Framework Item Association	The relation of competency framework items to other competency framework items to support competency maps or to relate competency framework items to other objects such as learning resources.

Competency Set	An entity that supports the definition of a set of competencies that represent completion or partial completion of a unit, course, program, degree, certification, or other achievement/award, including information that specifies whether completion requires achievement of all items in the set or some number of items.
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Implementation Variables

Information used for implementing data systems and processes, such as variables to track the date that a report was produced.

Entity	Description
Report	An entity with information about a report, such as the date the report was generated or the date the report was submitted to an authority.

Learning Resources

Information about materials that support teaching and learning.

Entity	Description
Learning Resource	The content, materials, or informational resources that support learning.
Peer Rating	A person's rating of a Learning Resource.
Peer Rating System	A system by which a person can rate a Learning Resource.

Authentication and Authorization

Information used by an application or service that authenticates the identity of a person or authorizes a person's access to information or services.

Entity	Description
Authentication	An application or service that can authenticate the identity of a person. The CEDS entity that includes information about an authentication provider, the login identifier used to authenticate a person's identity, and other information related to authentication of a person's identity.
Authorization	Information about a data system or application that an authenticated person may access.

CEDS NORMALIZED DATA SCHEMA (NDS)

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.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 later in this 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.

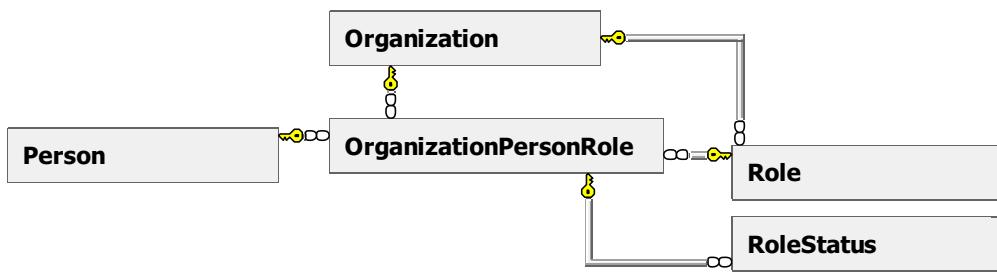
Traceability largely addresses the internal aspects of a P-20W system. It ensures that the data surrounding a person’s education can be persistently stored and accurately retrieved.

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.

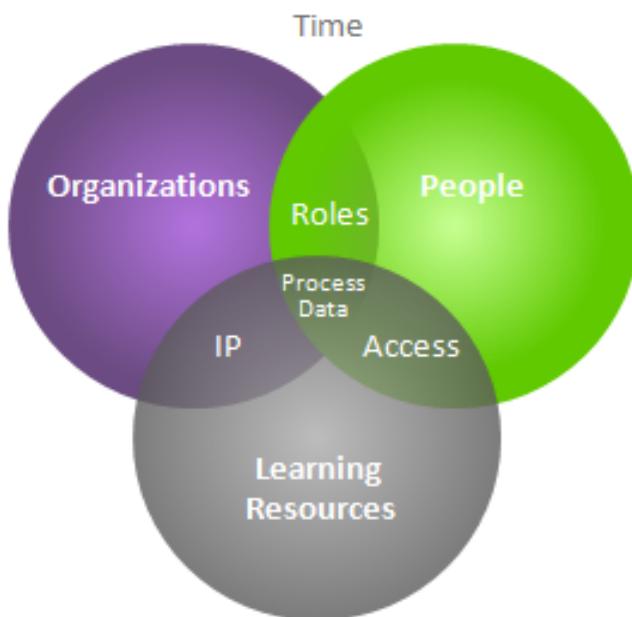


Note that people in the NDS only have roles in relationship to a specific organization and a designated date range. Persistent information about a person is modeled separate to the person's role and relationship to an organization.

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.

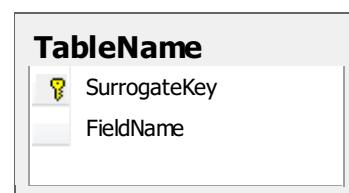
Understanding the NDS Entity Relationship Diagrams

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.

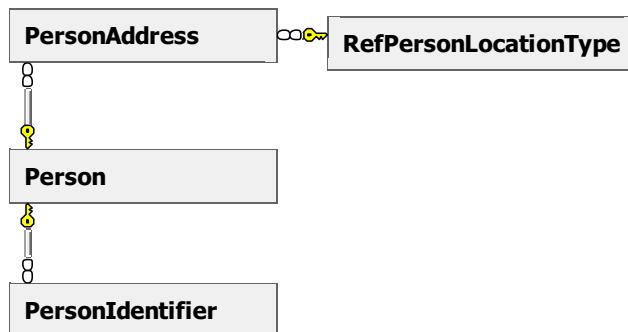
The function of the surrogate key is to uniquely identify one record from



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:



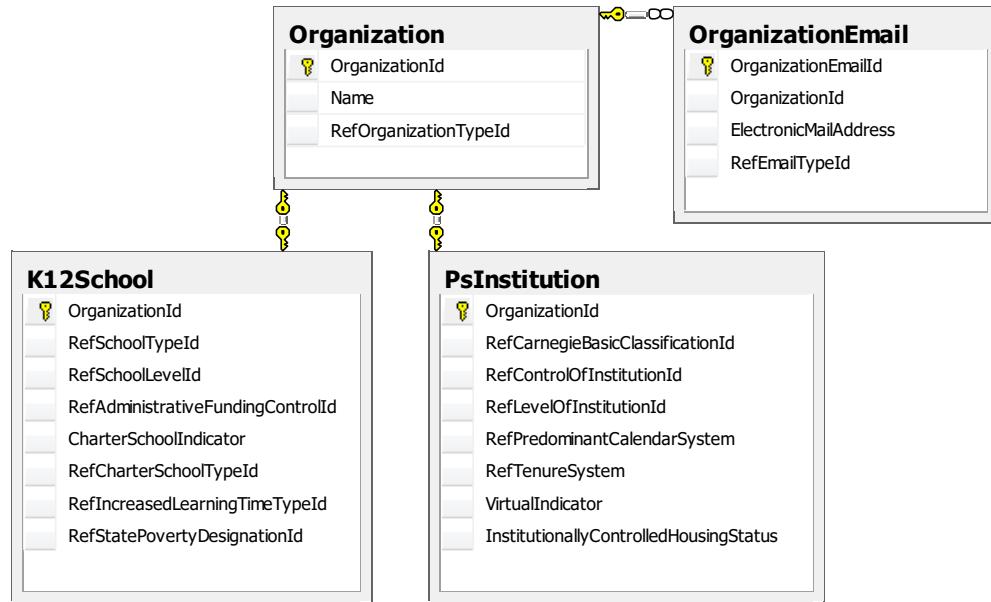
This diagram tells us that a Person may have an Address and an Identifier. The infinity symbol tells us that there may be more than one Address and Identifier for a Person. We also know by the “Ref” table that the PersonLocationType field in the PersonAddress table uses a CEDS-controlled vocabulary.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

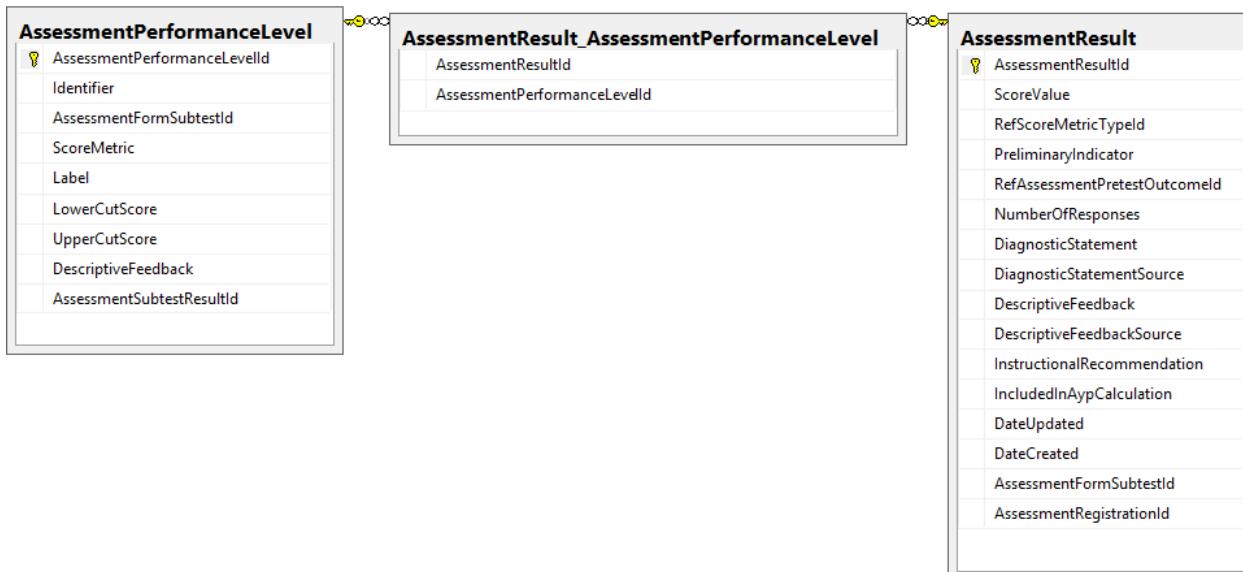
Definition

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.



Normalization of CEDS PersonStatus Elements

Person Status elements from the CEDS data dictionary have been “normalized out” of the NDS model. These are attributes of a person with a value of “Yes” or “No” that may change over time. For example, CEDS defines elements for a student’s homelessness, migrant, and limited English proficiency status. Instead of separate fields, the NDS model handles PersonStatus as a row in the table “PersonStatus.” The related table RefPersonStatusType contains the possible types of status (e.g., homeless, migrant, limited English proficient) that correspond to the individual elements in the CEDS data dictionary.

PersonStatus	
PersonStatusId	
PersonId	
RefPersonStatusTypeid	
StatusValue	
StatusStartDate	
StatusEndDate	

CEDS Use within P-20W Enterprise and Web-Scaled Architectures

A typical architecture that crosses P-20W education boundaries is made up of any number of source systems, an operational data store, and a data warehouse for analytics and reporting. Data that move from an authoritative source transactional system to other integrated systems and operational data store(s) most often must be transformed for compatibility with the receiving system. The CEDS NDS reference model is normalized to represent an example structure for a P-20W operational data store.

This section provides examples of CEDS data elements as they may exist in a de-normalized P-20W state longitudinal database.

CEDS standardizes data element definitions and option sets to make the data more compatible and to serve as a common vocabulary. CEDS does not define standards for the movement of data, but organizations that do set standards for data movement have embraced CEDS as a common vocabulary.

Despite the existence of the CEDS common vocabulary, it is recognized that different data models are used to support different uses. It has been beyond the scope of CEDS to develop a data warehouse model. However, the following example data warehouse star schemas demonstrate the application of the CEDS standards into a data warehouse domain of the P-20W enterprise architecture.

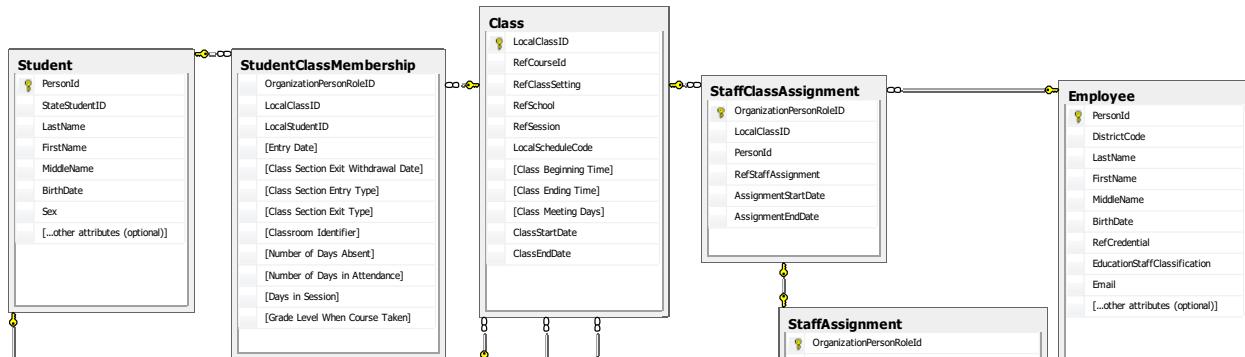
Case Study #1: The Teacher-Student Data Link—Data to Analyze Student Growth and Teacher Preparation

For this example, we look at data that link students to teachers and data that link teachers to their educator preparation programs. A number of factors make this example a good fit. It reaches across domains (K12, PS, and Assessments) and involves data from multiple source systems. It also involves some interesting transformations of data between the schemas of source systems—i.e., the CEDS NDS as a reference P-20W *normalized* operational data model, and an example *de-normalized* star schema. Further, it involves the high-profile data domains of enrollment and assessment results.

This example uses student growth rather than achievement, recognizing that there are multiple methods for measuring student growth. In this example, we recognize that there is a step of calculating growth from assessment data, but we will not get into the details of any specific method. The target data model is designed to receive those metrics using one or more methods.

It is also worth noting that student growth based on assessment data is just one of multiple measures when using the teacher-student data link to answer questions about the effectiveness of educator preparation programs. Other measures of teacher effectiveness—such as classroom observations and student surveys—and other measures of program effectiveness are needed.

We start with an example source system that links teachers to students as course-section enrollment records. The following illustration shows how the teachers and students might be linked through a Course Section in a student information system. Note that this is a fictitious view of data as they might be structured in a student information system; it is not part of the CEDS DES or NDS models.



A “Student Class Membership” record captures a student’s enrollment in a class (Course Section) with details such as Start Date and End Date. Similarly, a “Staff Class Assignment” record captures a teacher’s

association with the class, including Start and End dates, the teacher's Role, and a Teacher of Record Indicator.

Note that this example does not cover all the issues that need to be addressed when implementing the use of teacher-student data links. Key success factors—such as teacher-of-record policies, data governance policies, source system readiness, roster verification, and scheduling processes—must be considered.

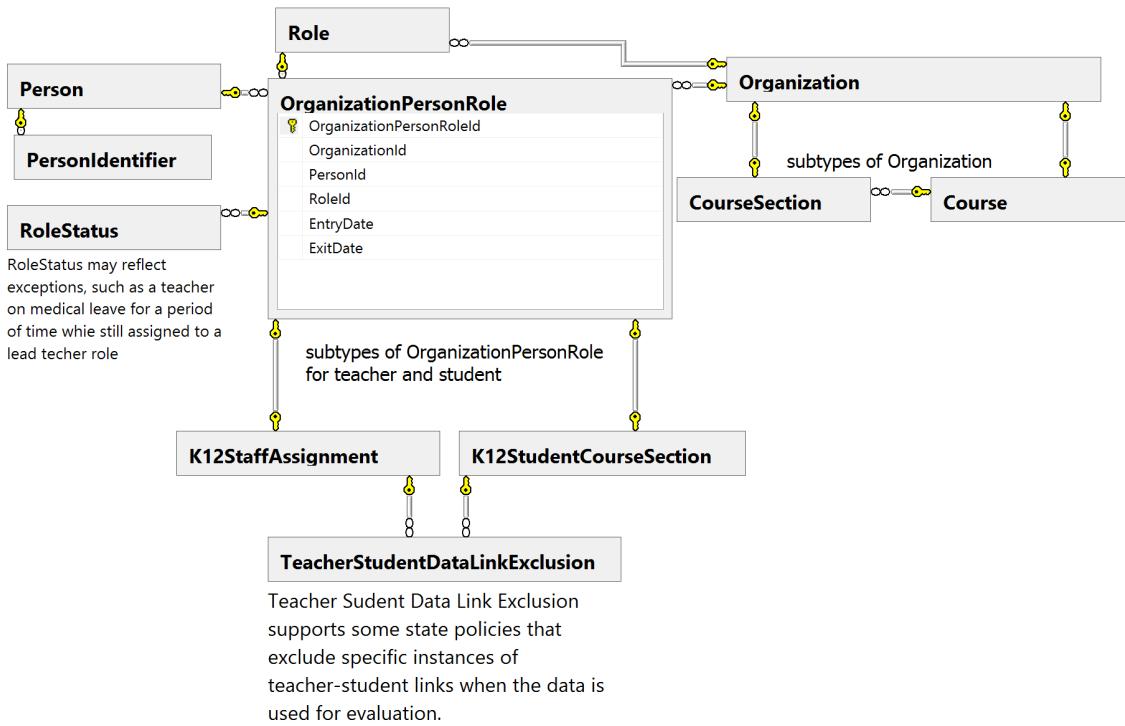
For more information, refer to the National Forum for Education Statistics' *Forum Guide to the Teacher-Student Data Link: A Technical Implementation Resource*, available at http://nces.ed.gov/forum/pub_2013802.asp. For information about teacher-student data link implementation, see the Teacher-Student Data Link (TSDL) Project website at www.tsdl.org.

From Source System to Operational Data Store

A P-20W implementation must transform the data from the source system into a data schema such as the CEDS NDS. Both systems may use elements defined by the CEDS standards, but the structure of the data is different.

A key difference is that the source system defines “student” and “employee” as separate entities, whereas the NDS model takes a P-20W approach so that a “person” may have the role of a PS Student while enrolled in a teacher preparation or professional development program. The same “person” takes on the role of a teacher when assigned to a K12 Course Section. The NDS model also normalizes K12CourseSection as a subclass of Organization.

The following illustration shows how the CEDS NDS is organized by person-organization-role. It shows the section of the data model pertaining to the teacher-student data link.



In this model, each person associated with the course section is represented as a record in OrganizationPersonRole. If the person is a teacher, teacher's aide, or paraprofessional, the model uses K12StaffAssignment to capture the information required for that type of association. If the person is a student, the model uses K12StudentCourseSection to capture the information required for the student's association with the course section.

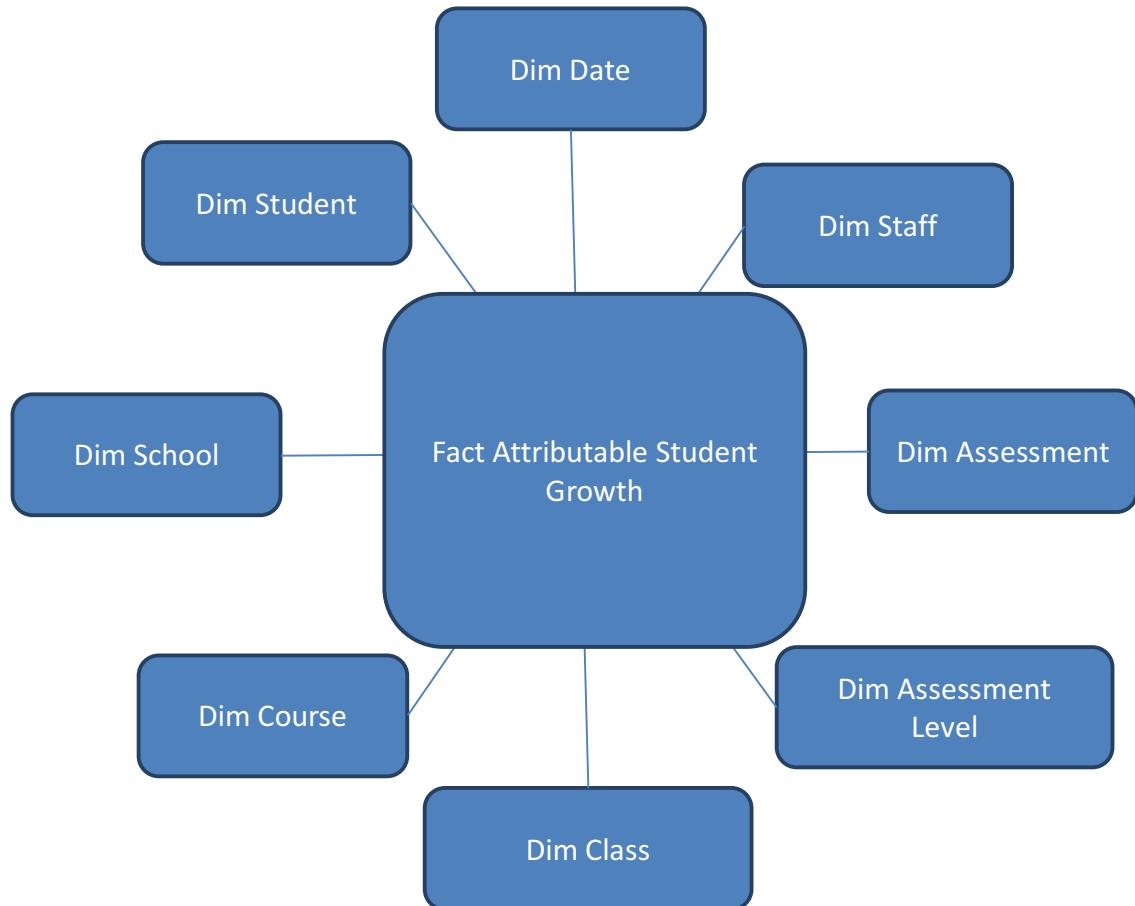
The OrganizationPersonRole table includes the ExitDate and EntryDate fields that apply to the student enrollment or staff assignment to the course section. This allows for the capture of the specific "dosage" information often required for teacher-student data link analysis. For example, a teacher who goes on medical leave, is replaced temporarily, and then returns later in the year, may have two records in OrganizationPersonRole for the course section, one with EntryDate=2013-09-01 and ExitDate=2013-10-15, and another with EntryDate=2014-02-03 and ExitDate=2014-06-17. (RoleStatus may also be used to capture changes in the person's association with the course section over time. This might be factored into TSDL metrics.)

To transform the data from the K12 source system to the P-20W operational data schema, these actions must be taken:

1. Personal information about the student and staff (teacher) needs to be transformed into the Person tables of the NDS.
2. Information about the course section and corresponding course needs to be transformed into Organization, CourseSection, and Course.
3. Information about course section enrollment for the student and teacher's assignments needs to be transformed into the model that uses the common OrganizationPersonRole.

Moving to the Data Warehouse

A best practice for the reporting structure is a “star schema” data structure, with Fact tables representing numeric measures (e.g., student growth) and with conformed Dimension tables containing attributes by which the fact data are filtered, sorted, and labeled (e.g., school name, teacher identifier, and course-section identifier). The following diagram shows an example of a “star schema” data model that might be used in a dimensional data warehouse.



Like the transformation from the K12 student information system to the P-20W operational data store, a transformation from the normalized data store to the de-normalized star schema in the data warehouse is needed due to the differences in structure. Moreover, like the previous transformation, both schemas may use CEDS standard element definitions.

This example star schema, like the source system, is organized by a person’s role (student, staff) in the context of a course section—i.e., the student enrolled in a course and the staff member assigned to a course. (The figure assumes that one growth or value-add methodology is used, but adding a “Dim Growth Model” table could allow for growth to be calculated in multiple ways and compared, as long as the system is configured and/or users are trained to avoid invalid comparisons.)

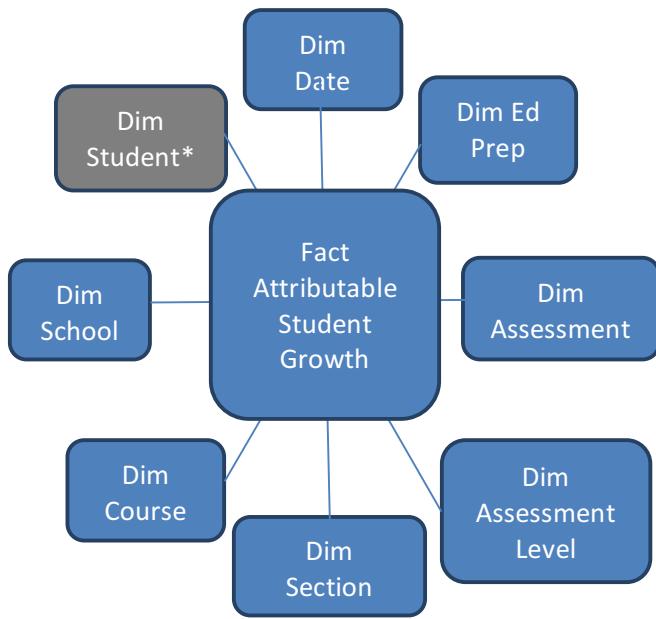
Note that the star schema is an effective model for analytics within a relational database management system due to its usability, scalability, and performance. The performance is gained due to the reduced number of join operations that the relational database management systems must execute, and

because the Dimension tables are kept “shallow” but “wide,” while the Fact tables are “deep” but “narrow.” Fact tables may contain millions or billions of rows (deep), but they contain only numeric measures and keys (narrow). Dimension tables contain fewer rows (shallow), but they have a rich set of descriptive labels (wide). Non-relational database technologies accomplish performance gains for analytics using other methods.

In the above example, we can attribute student growth to a teacher, to a course section taught by one or more teachers, to a course, or to a school.

What if, instead, we want to look for trends in student growth based on the educator preparation program from which a teacher received training? The primary teacher prep program could be an attribute of the Staff dimension, but another approach is the use of postsecondary data. This is possible because CEDS crosses P-20W data domains.

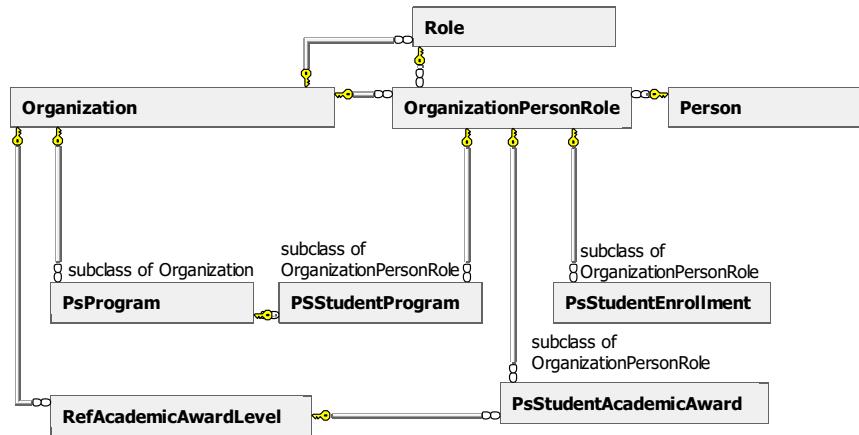
Since a teacher may have multiple degrees from multiple institutions, all being a part of his or her teacher preparation experience, we could redesign the star schema with a Dim Educator Prep Program.



* A best practice for data warehouse design is to use the most atomic level of data available. In this case, the grain is a record in the Fact table for every student growth metric that can be associated with a course section. The end user of the system may not have the option of seeing student-level results, but the student-level detail needs to be in the Fact table to support the flexibility of rolling up the data along the other dimensions.

Note that this would get more complicated if we wanted to optimize the analysis of questions that involve the timing or level of participation, versus the completion of the program, for each educator at each prep program. For this example, however, we will limit the design to merely the educator prep program(s) *completed* by the teachers assigned to a particular course section.

To finish the example, we will show how CEDS elements that relate to postsecondary teacher preparation programs might be transformed from the CEDS NDS to the Dim Ed Prep Program table. The following illustration shows the CEDS NDS tables that might be needed to populate the Dim Ed Prep Program table.



The table below shows some of the information that might be needed to populate Dim Ed Prep Program and the source elements, as defined in the CEDS NDS.

Source Table	Source Column	Destination Column
Organization (PsInstitution)	Name	Institution Name
OrganizationIdentifier (PsInstitution)	Identifier (selected by RefOrganizationIdentificationSystemId)	IPEDS Identifier
Organization (PsProgram)	Name	Program Name
PsProgram	RefCIPCodeId (using Ref table to look up the code)	CIP Code
PsStudentAcademicAward	RefAcademicAwardLevelId	Academic Award Level
Source Table	Source Column	Destination Column
Organization (PsInstitution)	Name	InstitutionName
OrganizationIdentifier (PsInstitution)	Identifier (selected by RefOrganizationIdentificationSystemId)	IPEDSIdentifier
Organization (PsProgram)	Name	ProgramName
PsProgram	RefCIPCodeId (using Ref table to lookup the code)	CIPCode
PsStudentAcademicAward	RefAcademicAwardLevelId	AcademicAwardLevel

For this transformation, we first need the data that link the Person assigned as Teacher of Record for a Course Section to his or her educator prep program, and then we can get the data we need about the organizational attributes of the program and institution. The transformation rules may include filters

such as only populating the table when the Postsecondary Program is for specific CIPCodes (Classification of Instructional Program Code).

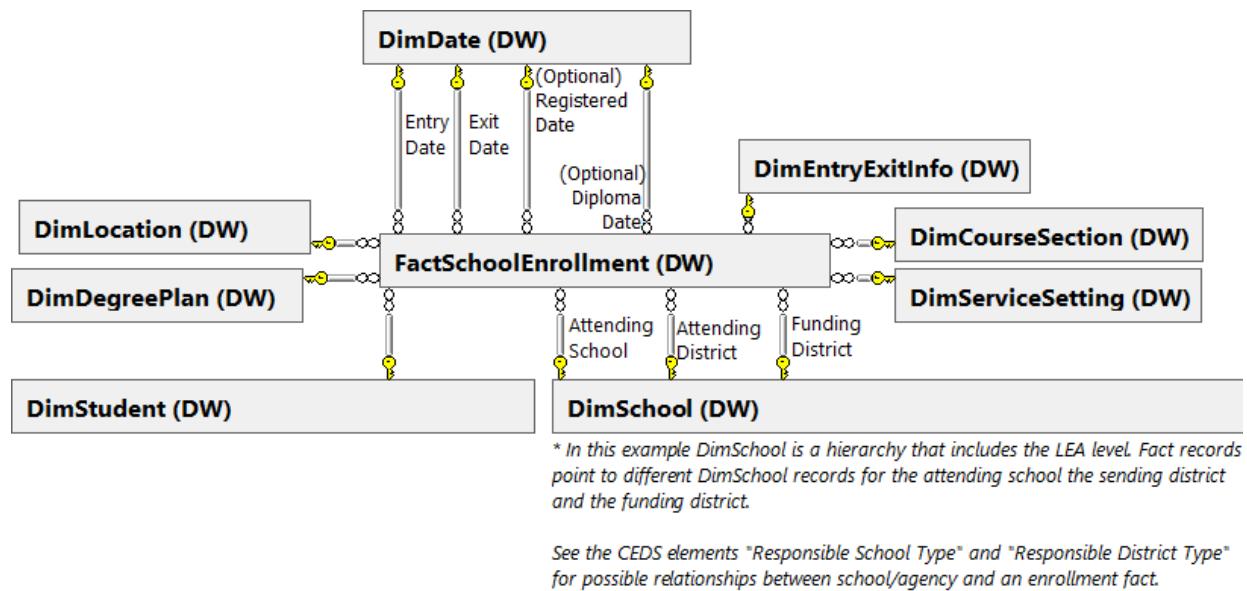
Case Study #2: Data Warehouse Star Schema for Student Enrollment

In this example, we look at a star schema for ad hoc queries about student enrollments in a school or school district. The goals of the design are the flexibility and usability of the data for ad hoc queries, as well as optimized performance. Optimized performance refers to the database engine's ability to return results quickly, even if there are millions of enrollment facts.

The star schema accomplishes performance in part by simplifying the structure, requiring fewer table joins for each query, and making the Fact tables "narrow." Fact records are "narrow" in that they are limited to non-string measurement values (e.g., numeric values that can be summed for aggregation of counts), and surrogate keys to the Dimension tables. The Dimension tables are "wide," containing the string values from which the user can choose for filtering and sorting.

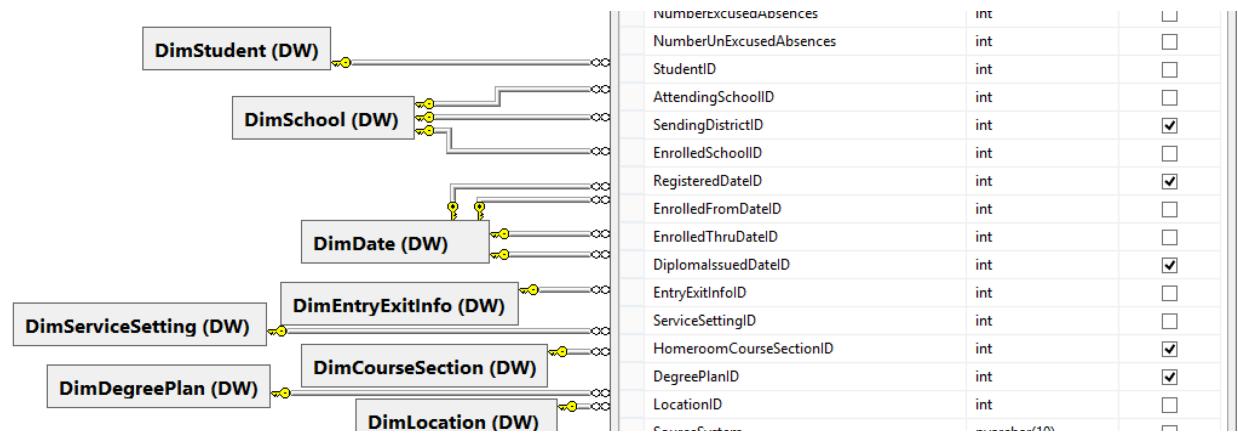
By designing the Fact table to store data at a granular level, the model maximizes flexibility for ad hoc queries; that is, the model is not designed for a limited number of predefined queries, but can sort and select aggregations of the granular measurements based on the selection of any number of attributes from the related Dimension tables.

In the model shown below, the FactSchoolEnrollment table may contain a row for each student enrollment record in a state. This could be down to the Course Section enrollment level or to the School/Program level. Result sets perform aggregation operations on the facts, such as to count the number of students enrolled at any point in time within a school with certain characteristics.



DimSchool represents a hierarchy of local education agencies and schools and/or the coordinating or governing board and institutions of higher education. The model allows for the selection of any organizational characteristic within DimSchool to be used to filter or sort a result set.

Here is another view of the Dimension tables (on the left), and an expanded view of the Fact table surrogate key columns (on the right).



This Fact table is “narrow,” containing columns of integer values as metrics (e.g., “Number of . . .” or “Percentage of . . .”) or as surrogate keys to a row in a Dimension table. The metrics in the Fact table may correspond to CEDS Connections, whereas the attributes within the Dimension tables may be defined based on CEDS element definitions. For example, the table DimCourseSection may contain columns aligned to the following CEDS Course Section elements for K12:

- Course Section Identifier
- Classroom Identifier
- Session Begin Date
- Session End Date
- Session Designator
- Session Type
- Class Beginning Time
- Class Ending Time
- Class Meeting Days
- Class Period
- Timetable Day Identifier
- Course Section Time Required For Completion
- Instruction Language
- Course Section Single Sex Class Status
- Receiving Location of Instruction
- Course Section Instructional Delivery Mode
- Virtual Indicator
- Course Aligned with Standards
- Additional Credit Type
- Advanced Placement Course Code
- Blended Learning Model Type
- Career Cluster
- Course Applicable Education Level
- Course Certification Description
- Course Description
- Course Funding Program
- Course Identifier
- Course Interaction Mode
- Family and Consumer Sciences Course Indicator
- National Collegiate Athletic Association Eligibility
- Tuition Funded

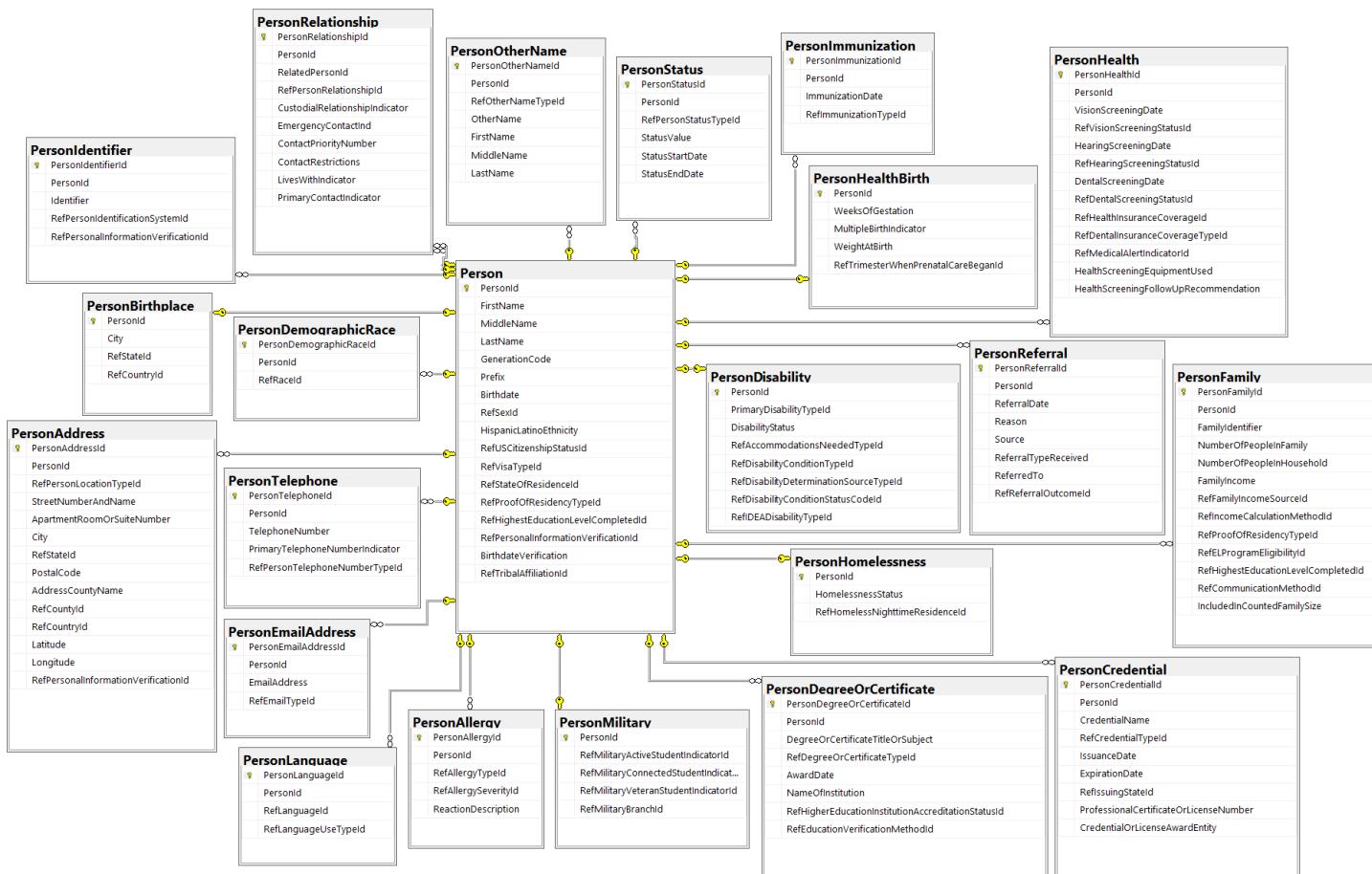
The star schema data warehouse is just one kind of enterprise / web-scale architecture for reporting. There are emerging web-scale architectures, including those using “NoSQL” databases, that also may be aligned with CEDS at the element level.

APPENDIX A: NDS ENTITY RELATIONSHIP DIAGRAMS

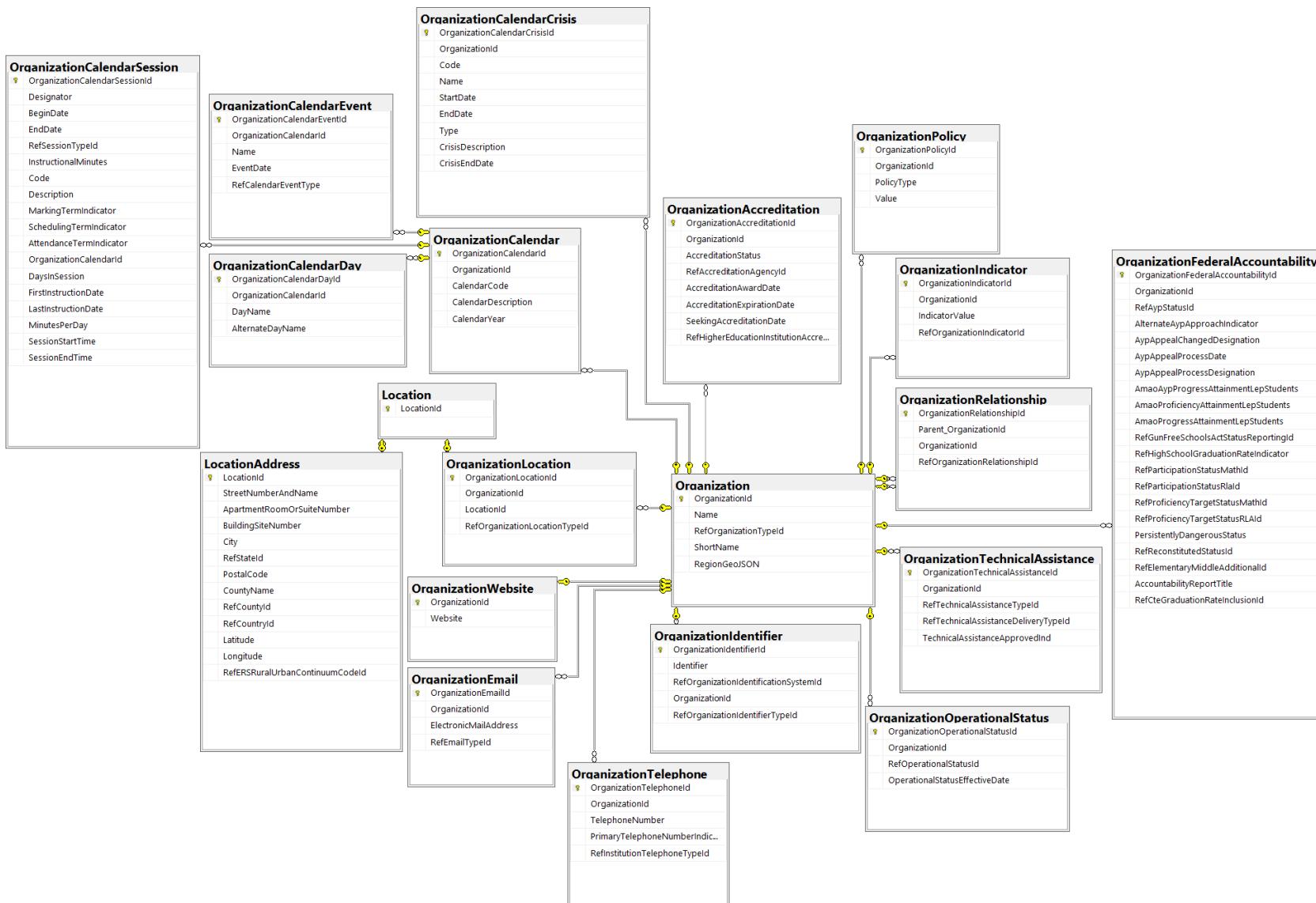
The following entity relationships diagrams (ERDs) provide visual representations of the CEDS Normalized Data Schema (NDS) organized by the high-level concepts of people, organizations, and roles/relationships between people and organizations, and by the Domains including Early Learning, K12, Postsecondary, Assessments, Competencies and Credentials.

Common: Person

Elements modeled here represent multiple use cases for locally used unit-level data. This model normalizes Person data apart from the person's connection to a Role with an Organization (e.g., EL Child, K12 Student, PS Student, PS Staff, Parent, etc.). The applicable personal attributes will vary with age and participation; for example, information shown in the PersonHealthBirth table is used only to support early learning programs, and MilitaryVeteranStudentIndicator will apply only to adults. This is a reference framework and is not intended to imply that these data should exist in any particular system.

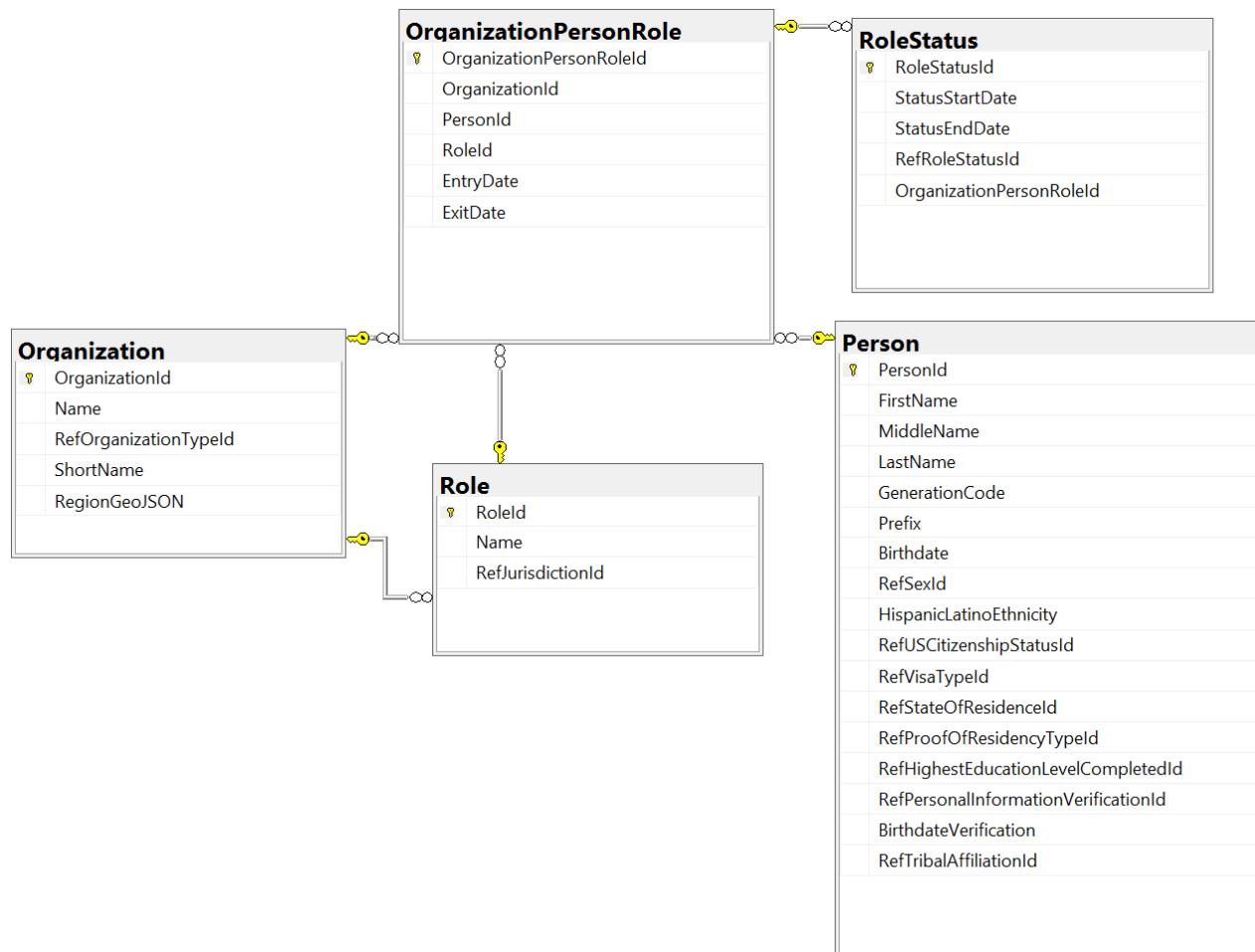


Common: Organization

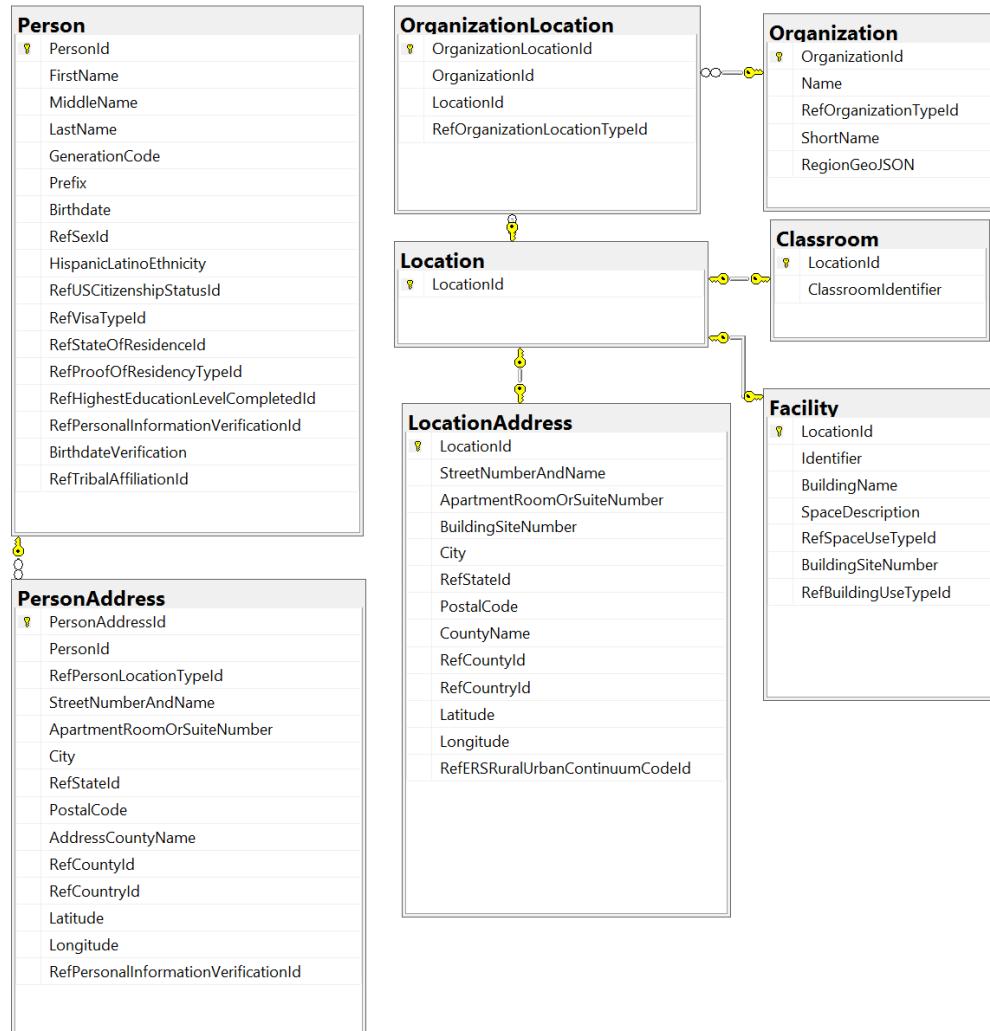


Common: Role

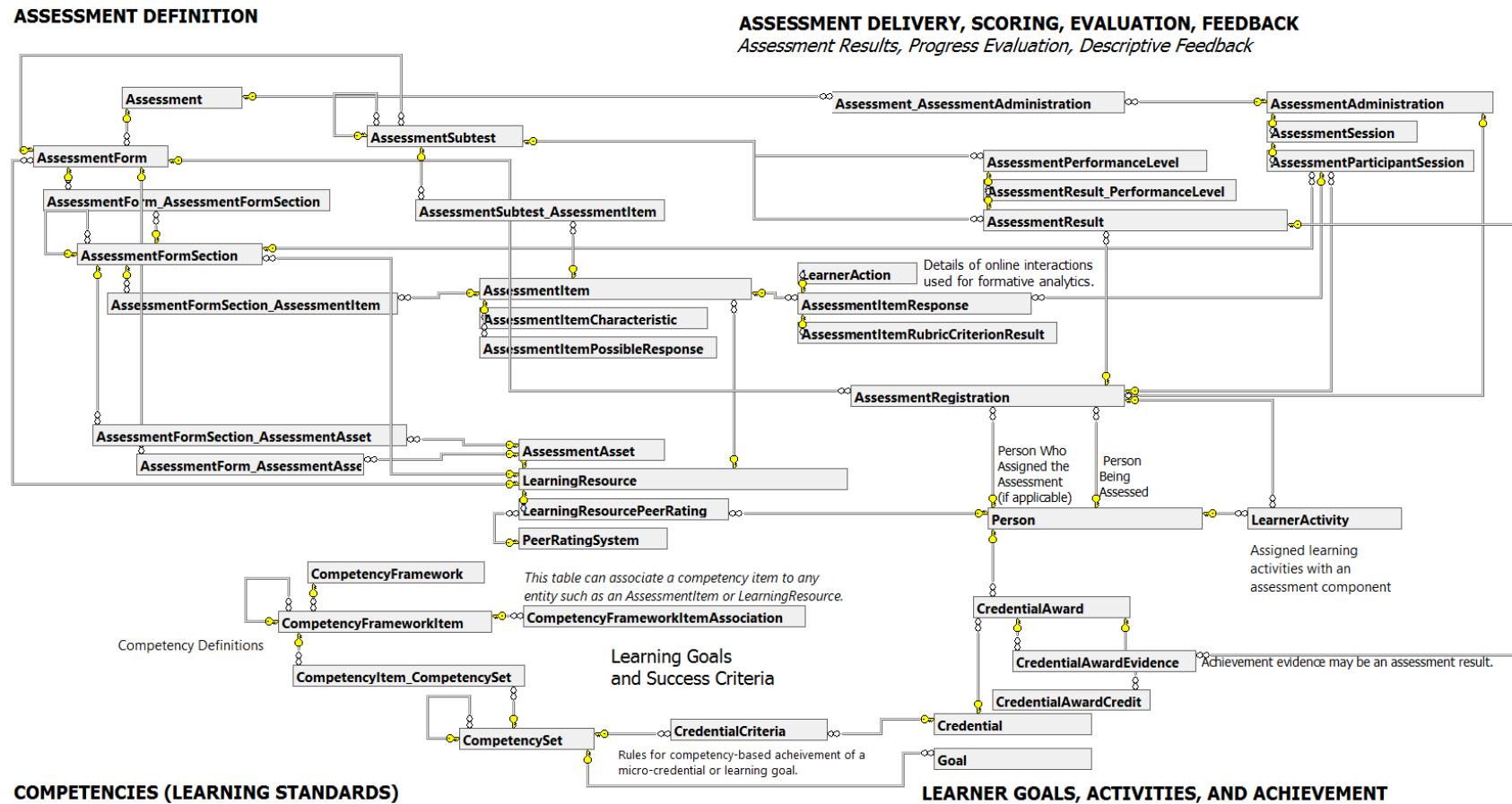
The Role represents a Person's role within an Organization. Example roles include a *child* enrolled in an early learning program; a *student* enrolled in a school or course section; *staff* employment and assignment; and a *person* participating in a workforce program. RoleStatus supports cases such as when a student "applied" for enrollment in a Course Section, Program, or School/Institution, was "accepted," and then was "enrolled."



Common: Location



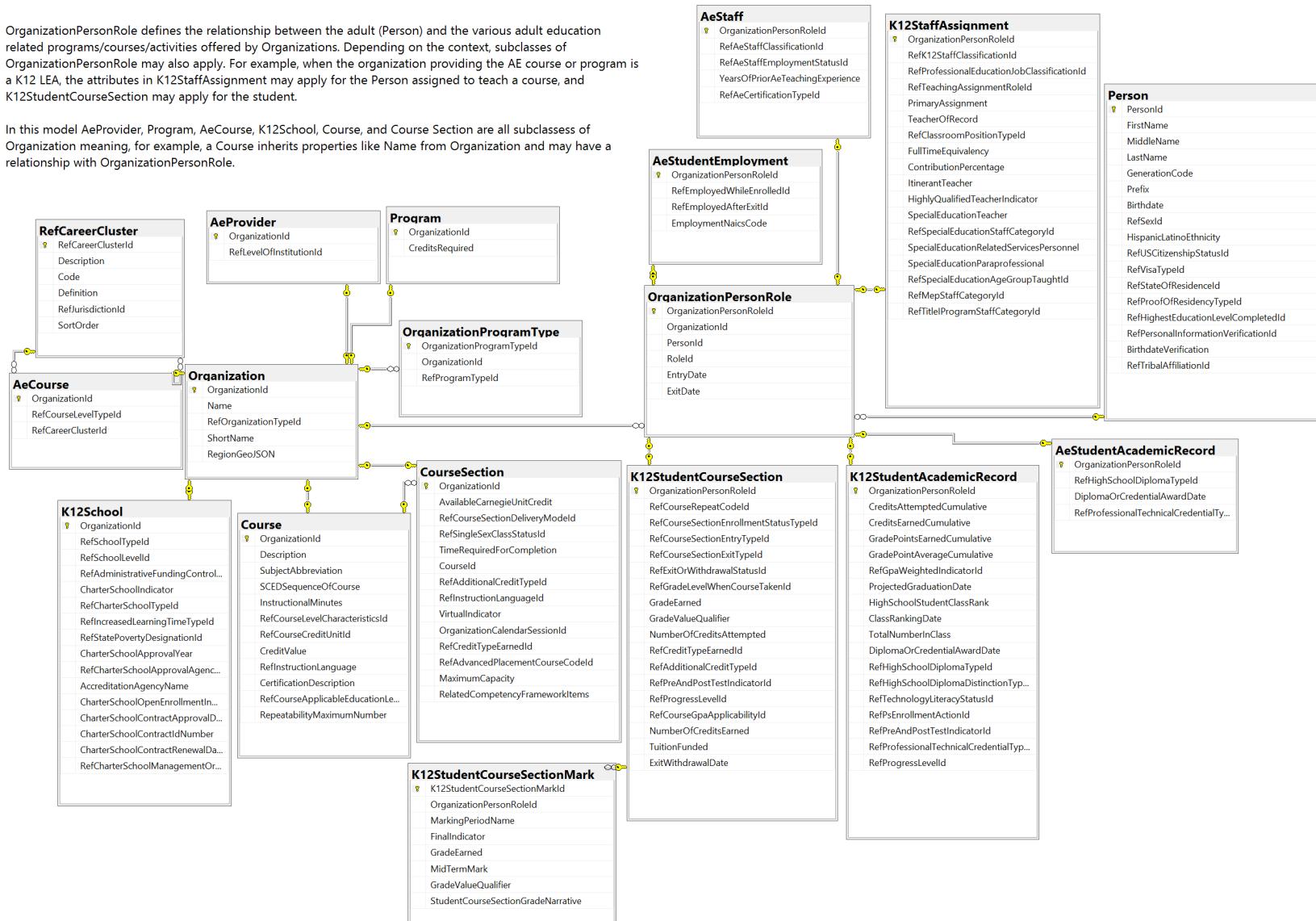
Common: Formative Assessment Process



Adult Education

OrganizationPersonRole defines the relationship between the adult (Person) and the various adult education related programs/courses/activities offered by Organizations. Depending on the context, subclasses of OrganizationPersonRole may also apply. For example, when the organization providing the AE course or program is a K12 LEA, the attributes in K12StaffAssignment may apply for the Person assigned to teach a course, and K12StudentCourseSection may apply for the student.

In this model AeProvider, Program, AeCourse, K12School, Course, and Course Section are all subclasses of Organization meaning, for example, a Course inherits properties like Name from Organization and may have a relationship with OrganizationPersonRole.



Assessment Delivery

Information related to a specific person registered for an Assessment Administration, assigned a specific Assessment Form for participation in one or more Assessment Sessions.

AssessmentRegistration	
AssessmentRegistrationId	
CreationDate	
DaysOfInstructionPriorToAssessment	
ScorePublishDate	
TestAttemptIdentifier	
RetestIndicator	
CourseSectionOrganizationId	
RefAssessmentParticipationIndicatorId	
TestingIndicator	
RefAssessmentPurposeId	
RefAssessmentReasonNotTestedId	
RefAssessmentReasonNotCompletingId	
RefGradeLevelToBeAssessedId	
RefGradeLevelWhenAssessedId	
PersonId	
AssessmentFormId	
OrganizationId	
SchoolOrganizationId	
LeaOrganizationId	
AssessmentAdministrationId	
AssignedByPersonId	
AssessmentRegistrationCompletionStatusDateTime	
RefAssessmentRegistrationCompletionStatusId	
LEAFullAcademicYear	
SchoolFullAcademicYear	
StateFullAcademicYear	

Information for an assessment event or administration period.

AssessmentAdministration	
AssessmentAdministrationId	
AssessmentId	
Name	
Code	
StartDate	
StartTime	
FinishDate	
FinishTime	
RefAssessmentReportingMethodId	
AssessmentSecureIndicator	
AssessmentAdministrationPeriodDescri...	

*Related tables include information about a person's results from an assessment. (See "Assessment Results")

Information about a specific person's participation in an Assessment Session.*

AssessmentParticipantSession	
AssessmentParticipantSessionId	
ActualStartTime	
ActualEndTime	
TimeAssessed	
RefAssessmentPlatformTypeId	
DeliveryDeviceDetails	
SecurityIssue	
RefAssessmentSessionSpecialCircumstanceTypeId	
SpecialEventDescription	
LocationId	
RefLanguageId	
AssessmentFormSectionId	
AssessmentSessionId	
AssessmentRegistrationId	
AssessmentParticipantSessionDatabaseName	
AssessmentParticipantSessionGUID	
PlatformUserAgent	

Information related to an instance of delivering an assessment during a specific period of time.

AssessmentSession	
AssessmentSessionId	
AssessmentAdministrationId	
ScheduledStartTime	
ScheduledEndTime	
ActualStartTime	
ActualEndTime	
AllottedTime	
RefAssessmentSessionType	
SecurityIssue	
RefAssessmentSessionSpecialCircumstanceTypeId	
SpecialEventDescription	
Location	
OrganizationId	
Lea_OrganizationId	
School_OrganizationId	

Person taking the test and person(s) administering, scoring, assigning, proctoring, etc.

Person	
PersonId	
FirstName	
MiddleName	
LastName	
GenerationCode	
Prefix	
Birthdate	
RefSexId	
HispanicLatinoEthnicity	
RefUSCitizenshipStatusId	
RefVisaType	
RefStateOfResidenceId	
RefProofOfResidencyType	
RefHighestEducationLevelCompletedId	
RefPersonalInformationVerificationId	
BirthdateVerification	
RefTribalAffiliationId	

Roles served related to the administration of an assessment session.

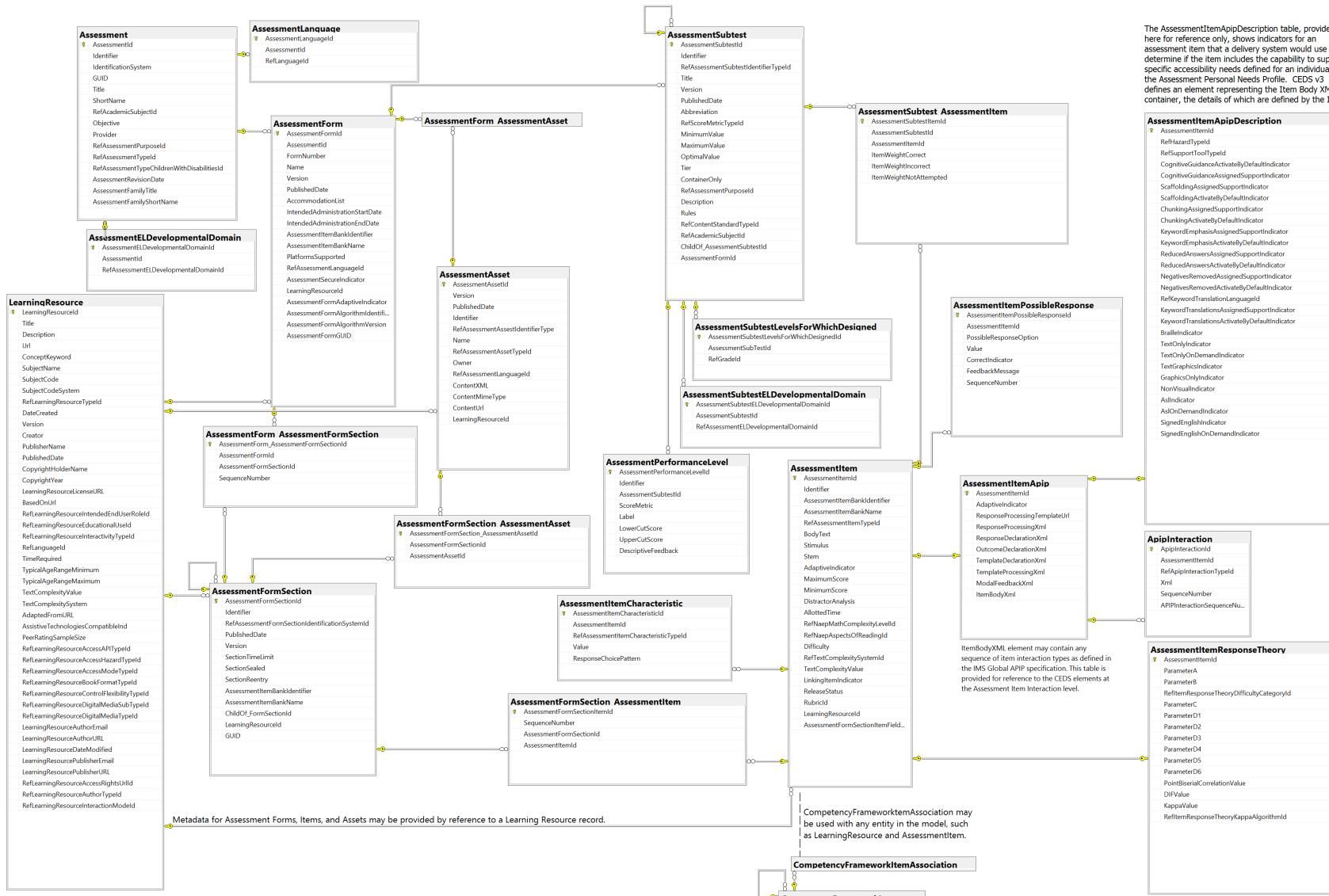
AssessmentSessionStaffRole	
AssessmentSessionStaffRoleId	
RefAssessmentSessionStaffRoleType	
PersonId	
AssessmentSessionId	
AssessmentParticipantSessionId	

AssessmentPersonalNeedsProfile

AssessmentPersonalNeedsProfile	
AssessmentPersonalNeedsProfileId	
AssessmentNeedType	
AssignedSupportFlag	
ActivateByDefault	

See additional tables that fully support AIF and IMS Global specifications.

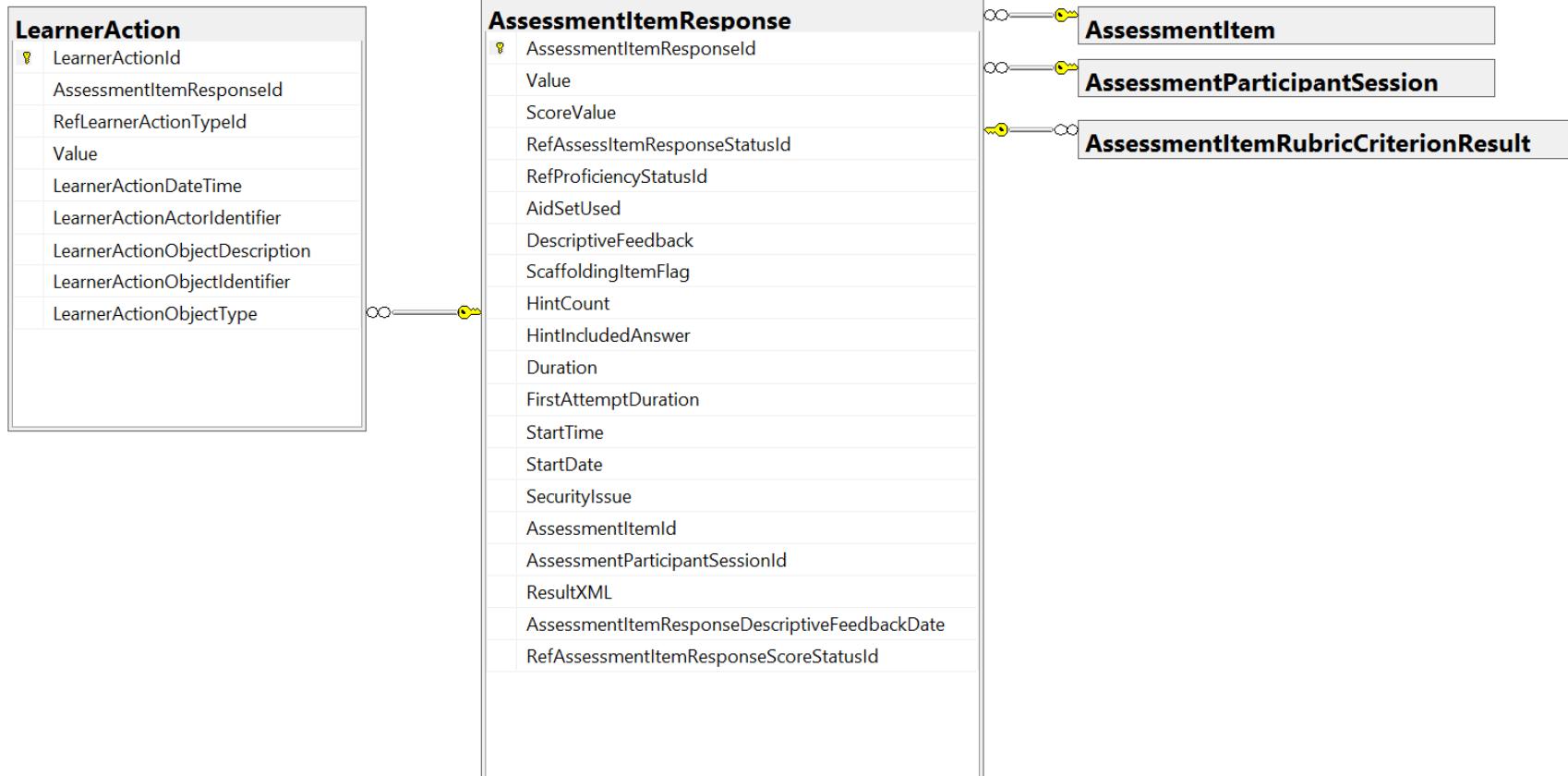
Assessment Design



Assessment Item Response and Learner Action

LearnerAction is designed to handle clickstream data for online assessments and other experiences such as is used by intelligent tutoring systems. The model is compatible with the structure of data found in Experience API (xAPI) specification.

AssessmentItemResponse includes information about a learner response and subsequent information about feedback and scoring of the response. Some properties like DescriptiveFeedback are for support of a formative assessment process. Some properties are used within intelligent tutoring systems such as HintCount and ScaffoldingItemFlag.

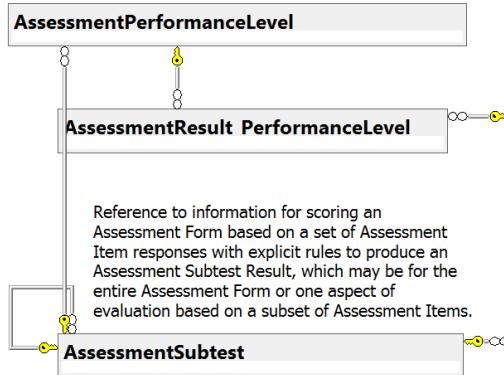


Assessment Results

Assessment Results

Reference to information about the performance levels that may be assigned to an Assessment Subtest Result and specifications for selecting the performance level based on a score. Four styles are supported:

- 1) specification of performance level by lower and upper cut score,
- 2) specification of performance level by lower cut score only,
- 3) specification of performance level without any mapping to scores, and
- 4) Specification of performance level by mapping to other scores.



An entity that includes information about a person's results from an assessment which may be for the entire assessment or one aspect of evaluation. The scoring method is defined by the related Assessment Subtest. The entity includes the score value and information about the score, such as a diagnostic statement.

AssessmentResult
AssessmentResultId
ScoreValue
RefScoreMetricTypeid
PreliminaryIndicator
RefAssessmentPretestOutcomeld
NumberOfResponses
DiagnosticStatement
DiagnosticStatementSource
DescriptiveFeedback
DescriptiveFeedbackSource
InstructionalRecommendation
IncludedInAypCalculation
DateUpdated
DateCreated
AssessmentSubtestId
AssessmentRegistrationId
RefELOutcomeMeasurementLevelId
RefOutcomeTimePointId
AssessmentResultDescriptiveFeedbackDate...
AssessmentResultScoreStandardError
RefAssessmentResultDataTypeld
RefAssessmentResultScoreTypeld

Reference to delivery data for evaluation of results.

AssessmentParticipantSession

Reference to the assessment item design element for evaluation of the results.

AssessmentItem

An entity with information about detailed actions taken by a learner while engaging in learning activities, such as asking for a hint when taking an online formative assessment.

LearnerAction

LearnerAction
LearnerActionId
AssessmentItemResponseId
RefLearnerActionTypeid
Value
LearnerActionDateTime
LearnerActionActorIdentifier
LearnerActionObjectDescription
LearnerActionObjectTypeIdentifier
LearnerActionObjectType

An entity with information related to a specific response to an assessment item by the person being assessed. The entity includes the response, a score or indication that the response was correct or incorrect, and other information such as response time.

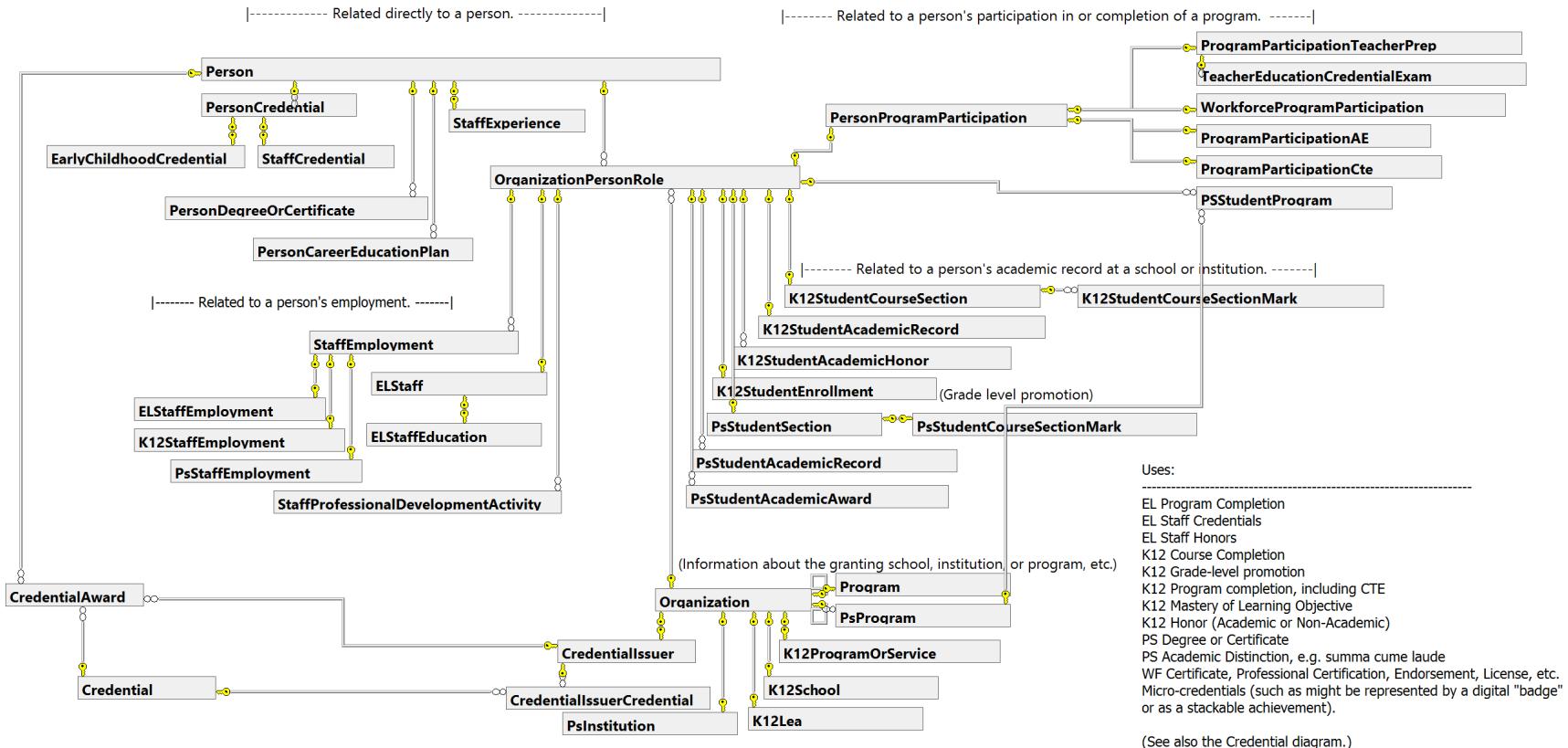
AssessmentItemResponse

AssessmentItemResponse
AssessmentItemResponseId
Value
ScoreValue
RefAssessItemResponseStatusId
RefProficiencyStatusId
AidSetUsed
DescriptiveFeedback
ScaffoldingItemFlag
HintCount
HintIncludedAnswer
Duration
FirstAttemptDuration
StartTime
StartDate
SecurityIssue
AssessmentItemId
AssessmentParticipantSessionId
ResultXML
AssessmentItemResponseDescriptiveFeedbackDate
RefAssessmentItemResponseScoreStatusId

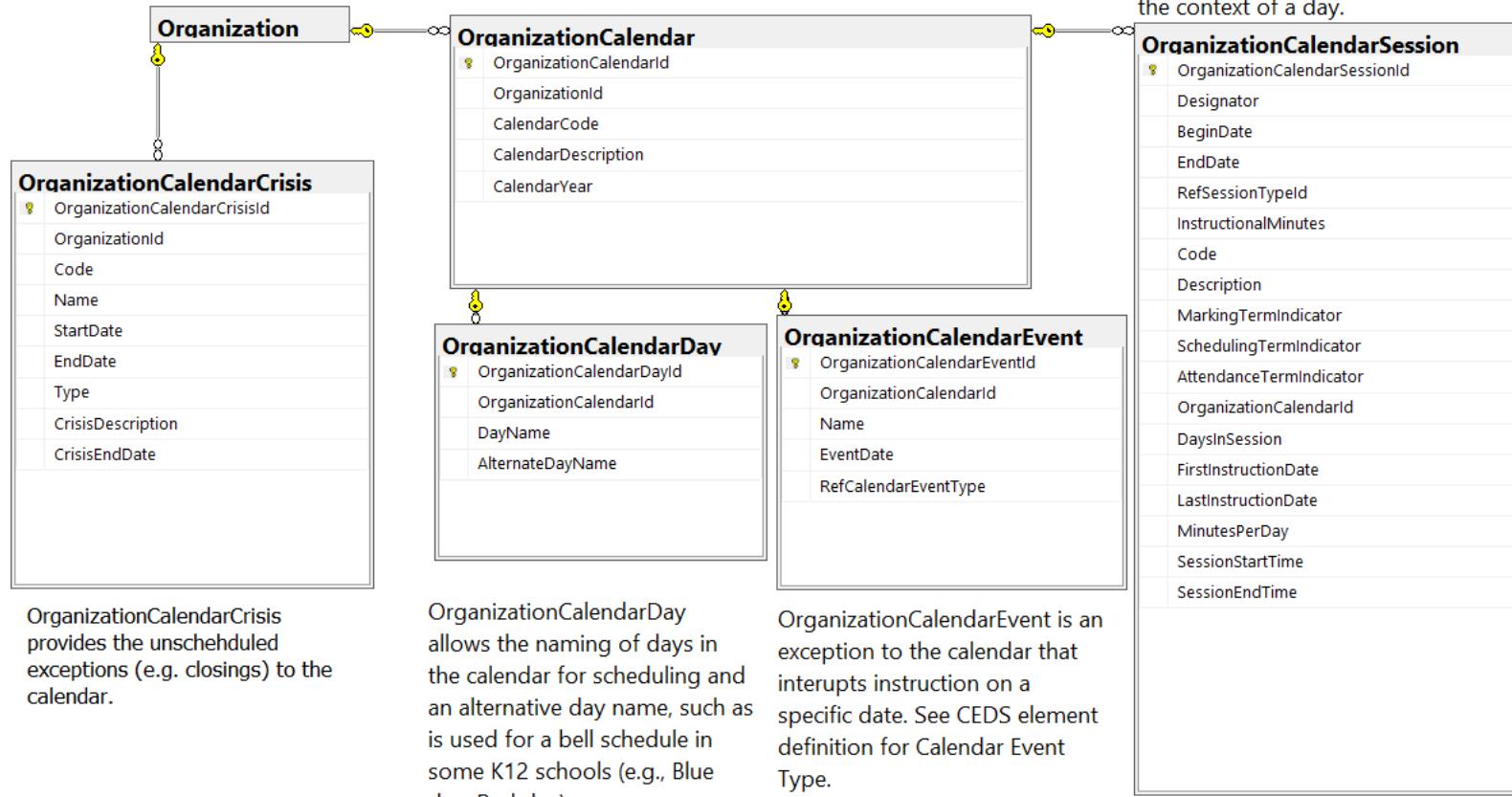
AssessmentRegistration

Results are linked via Assessment Registration and by reference to other assessment delivery information.

Awards Honors Credentials

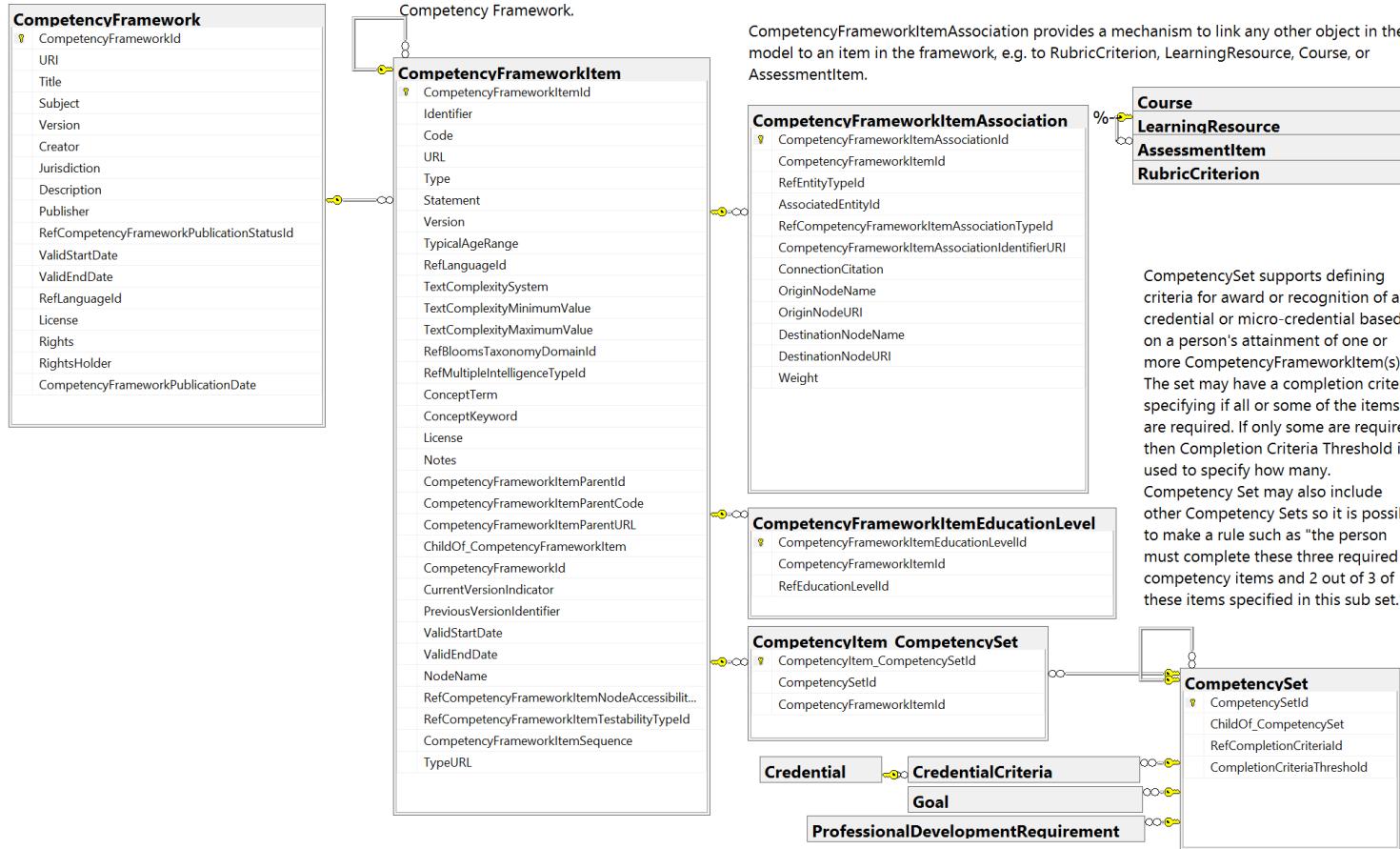


Calendar



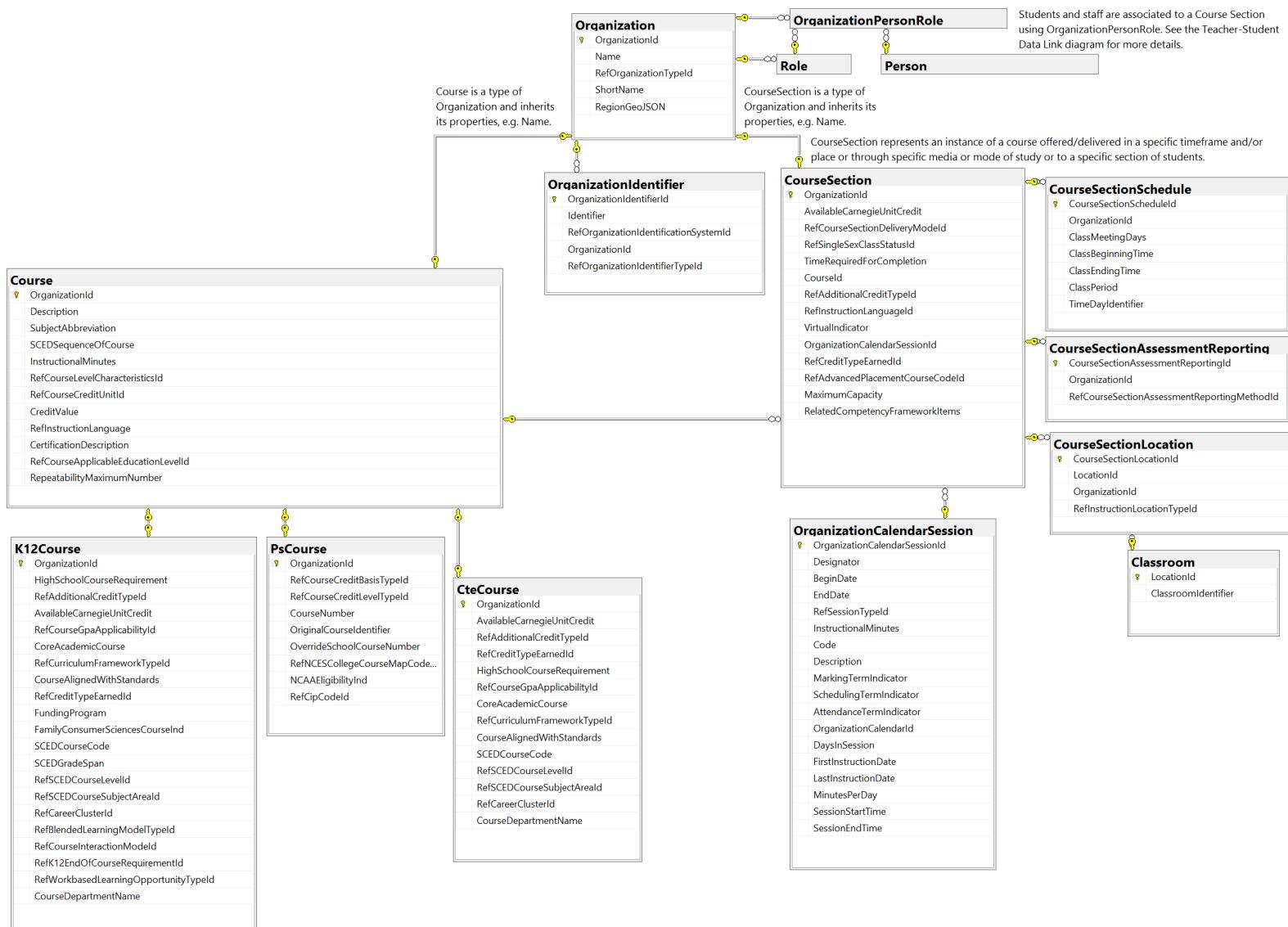
Competencies

A collection of items, typically arranged in a hierarchical structure or classification scheme, reflecting expectations of learner competencies within a single subject area covering one or more levels. (examples: Head Start Child Outcomes Framework, Common Core State Standards for Mathematics, Accountability Criteria for National Health Care Cluster Foundation Standards)

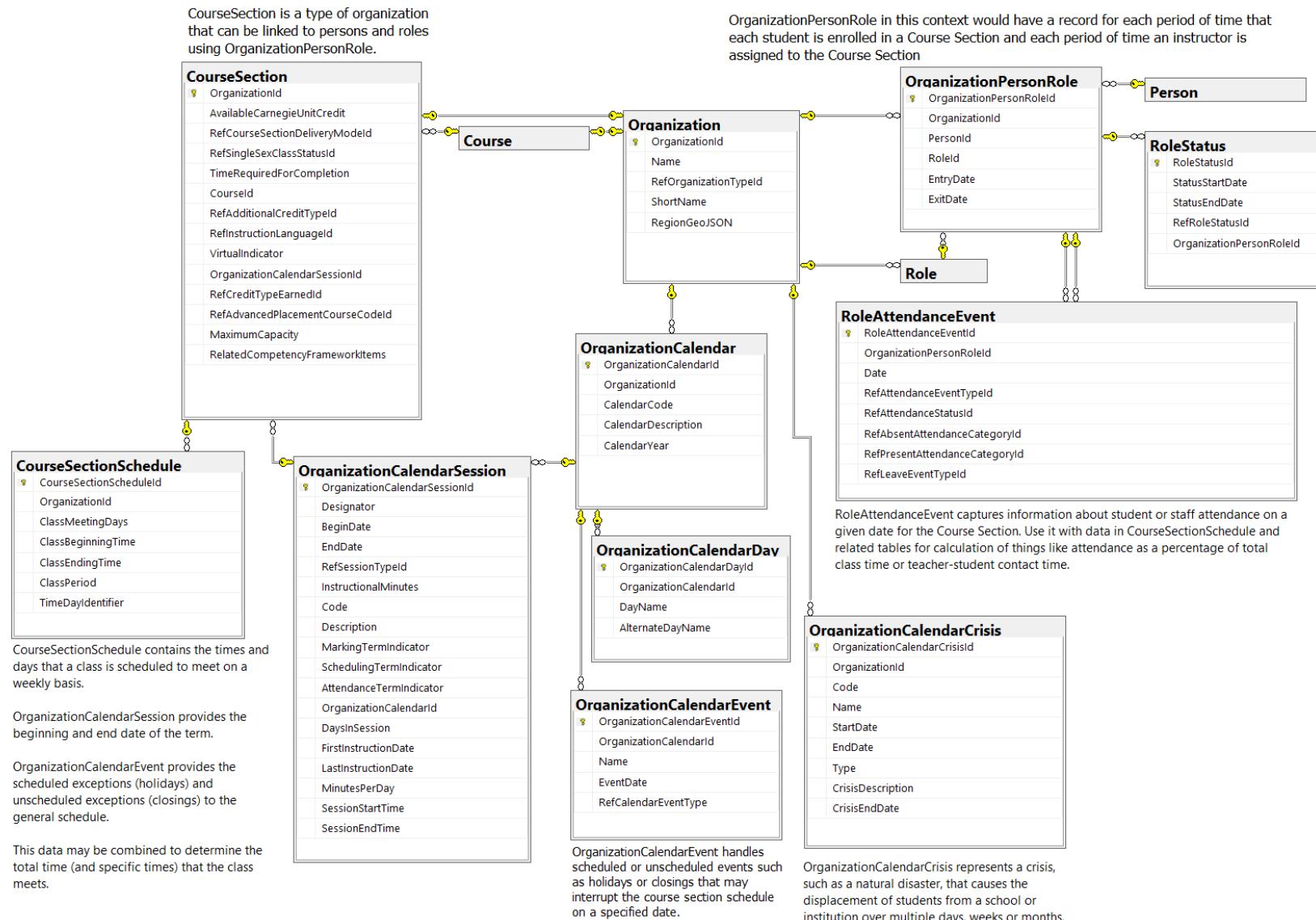


(See also diagrams for Credential, Learning Goal, and Professional Development.)

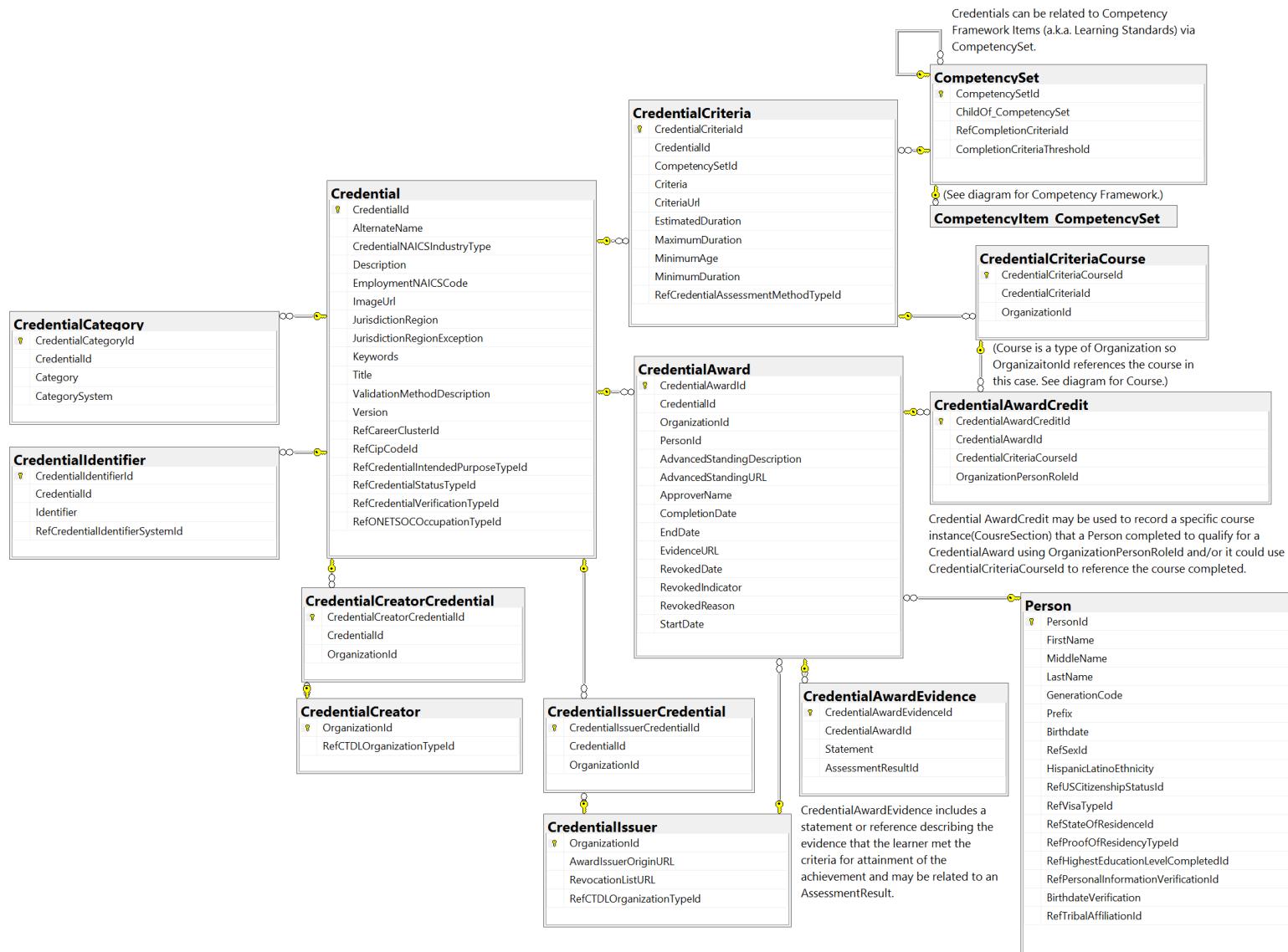
Course Section



Course Section Attendance

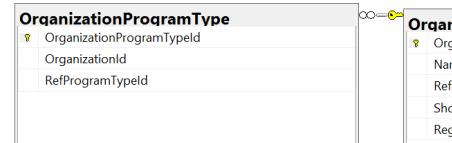


Credential



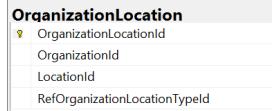
Career and Technical Education (CTE)

|----- About the CTE Program -----|

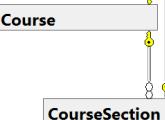
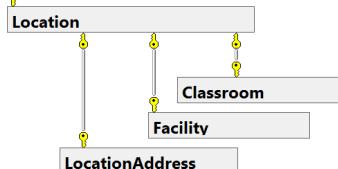


Organizations that offer CTE have:
Program Type = "Career and Technical Education"
(RefProgramTypeId)

One or more locations may be associated with the CTE program.



See diagram Common: Location for details.

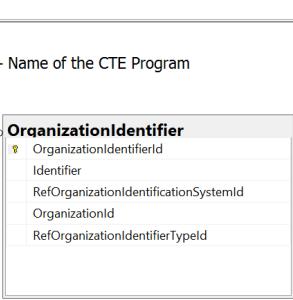


Note: CTE-specific elements having to do with a student's participation in the program are handled in ProgramParticipationCte. General information about the program as an organization is normalized to Organization.

CourseSection

See the Course Section diagram for more details.

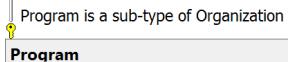
|----- About student participation in the CTE Program -----|



Name of the CTE Program

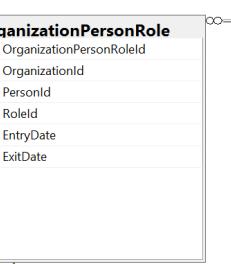


Multiple identifiers may be associated with the CTE Program, e.g. identifiers issued by a state or local agency.

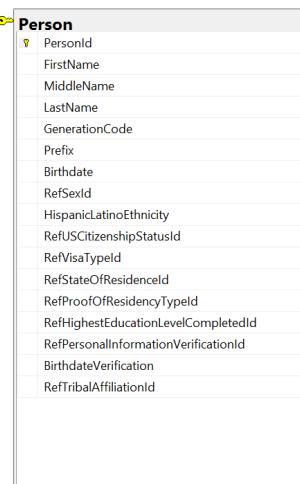
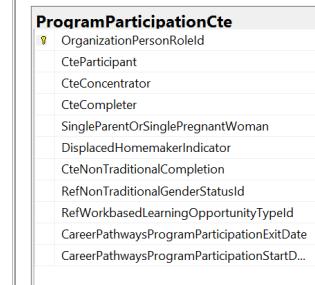


Program is a sub-type of Organization
Note: CTE-specific elements having to do with a student's participation in the program are handled in ProgramParticipationCte. General information about the program as an organization is normalized to Organization.
A person's enrollment in a CTE Course is modeled using OrganizationPersonRole. CTE spans domains, so depending on the context the enrollment may also use domain-specific tables, e.g. K12StudentCourseSection or PsStudentSection.

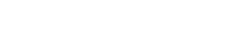
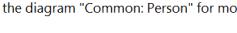
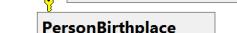
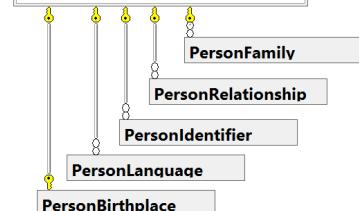
K12StudentCourseSection



ProgramParticipationCTE is a sub-type of OrganizationPersonRole with attributes unique to a person participating in a CTE program.



See the diagram "Common: Person" for more details.



Daily Attendance

OrganizationCalendarSession defines a period of time such as a semester or term. It specifies the begin and end date. It may be flagged as an "attendance term". It may include a value for DaysInSession, or the specific days applicable for attendance may be derived using OrganizationCalendarEvent.

OrganizationCalendarSession
OrganizationCalendarSessionId
Designator
BeginDate
EndDate
RefSessionTypeld
InstructionalMinutes
Code
Description
MarkingTermIndicator
SchedulingTermIndicator
AttendanceTermIndicator
OrganizationCalendarId
DaysInSession
FirstInstructionDate
LastInstructionDate
MinutesPerDay
SessionStartTime
SessionEndTime

OrganizationCalendarEvent handles scheduled or unscheduled events such as holidays or closings on a specified date.

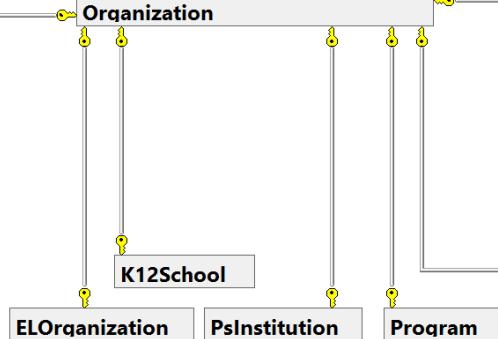
OrganizationCalendarEvent
OrganizationCalendarEventId
OrganizationCalendarId
Name
EventDate
RefCalendarEventType

OrganizationCalendarDay is for naming days within the regular schedule.

OrganizationCalendarDay
OrganizationCalendarDayId
OrganizationCalendarId
DayName
AlternateDayName

OrganizationCalendarCrisis
OrganizationCalendarCrisisId
OrganizationId
Code
Name
StartDate
EndDate
Type
CrisisDescription
CrisisEndDate

OrganizationCalendar
OrganizationCalendarId
OrganizationId
CalendarCode
CalendarDescription
CalendarYear



RoleAttendanceEvent

RoleAttendanceEventId
OrganizationPersonRoleld
Date
RefAttendanceEventTypeld
RefAttendanceStatusId
RefAbsentAttendanceCategoryld
RefPresentAttendanceCategoryld
RefLeaveEventTypeld

RoleAttendanceEvent captures information about student or staff attendance on a given date. Use it with data in OrganizationCalendar information to calculate attendance rate.

OrganizationPersonRole would be the student enrollment or staff employment/assignment record to which the daily attendance information applies

OrganizationPersonRole

OrganizationPersonRoleId
OrganizationId
PersonId
RoleId
EntryDate
ExitDate

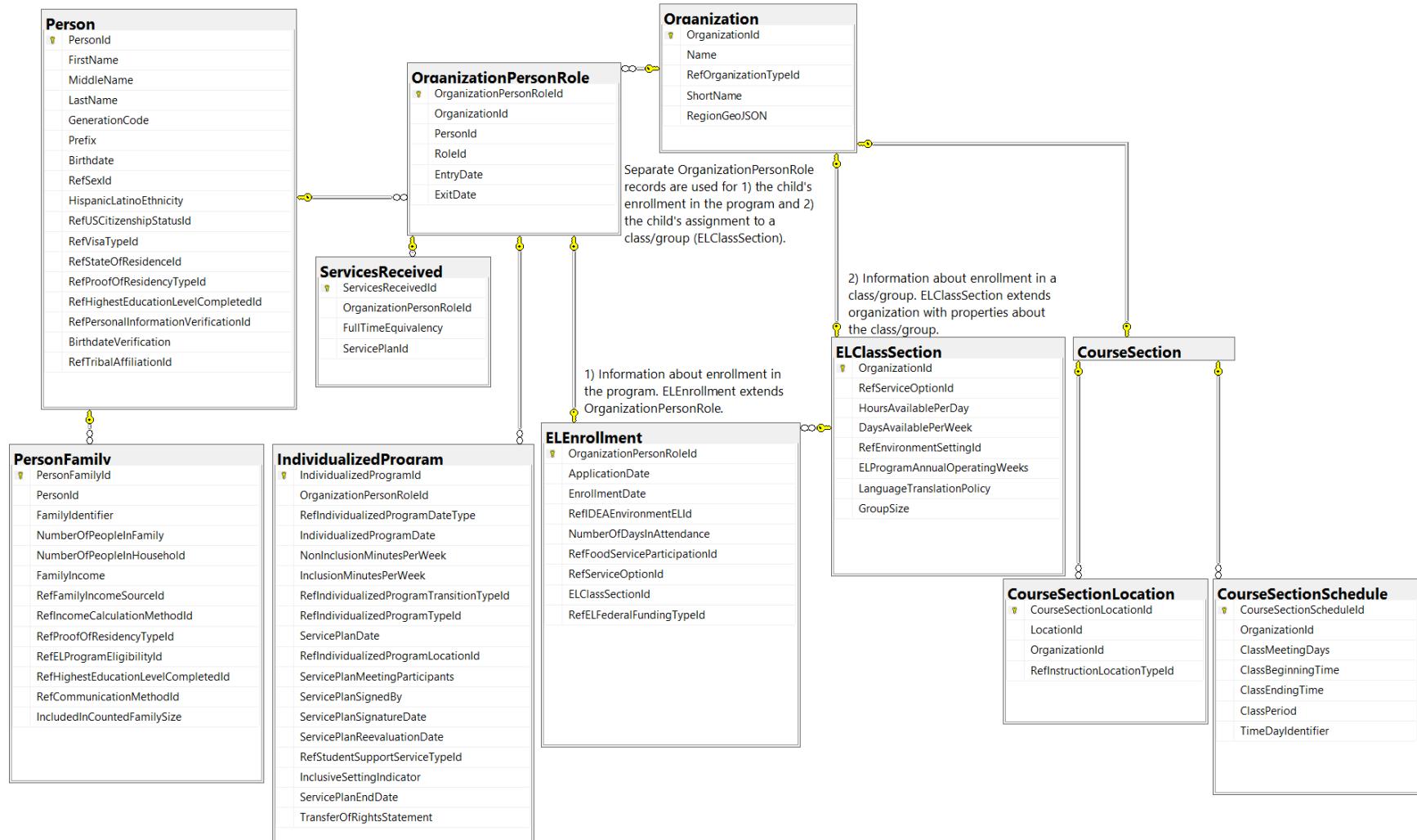
e.g. Student, Staff

K12School

PSInstitution

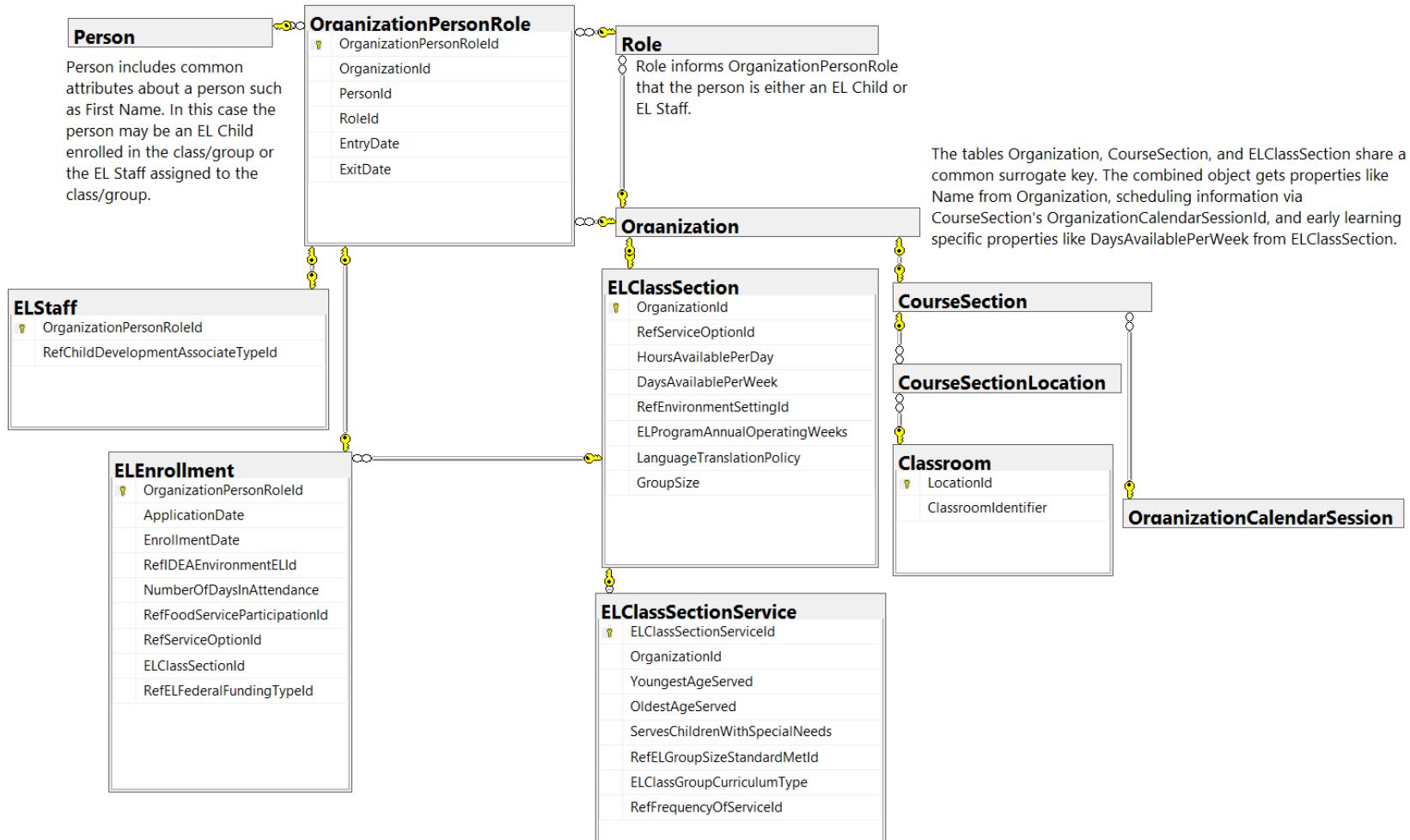
Program

Early Learning: Child Enrollment

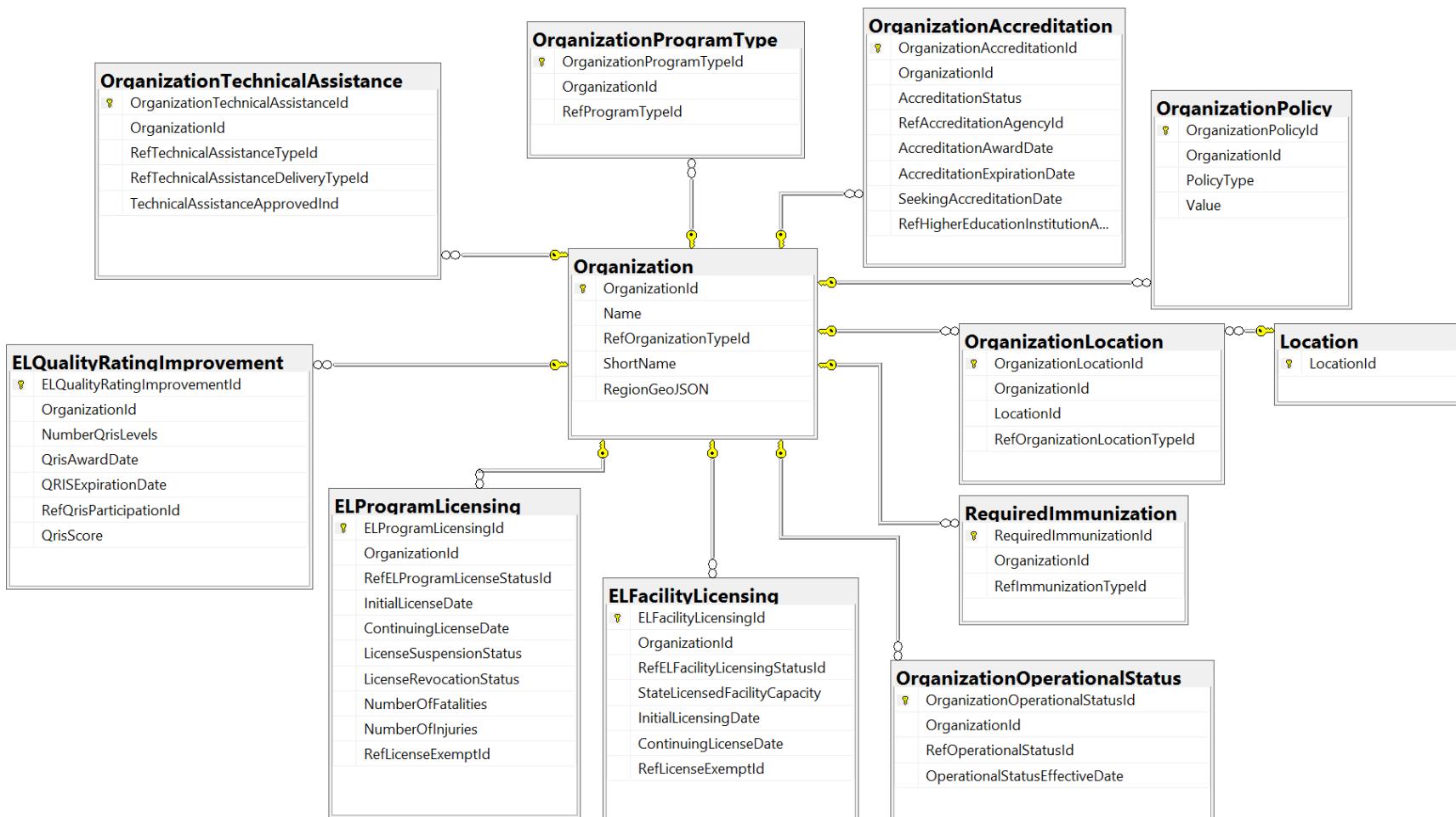


Early Learning: Class Group

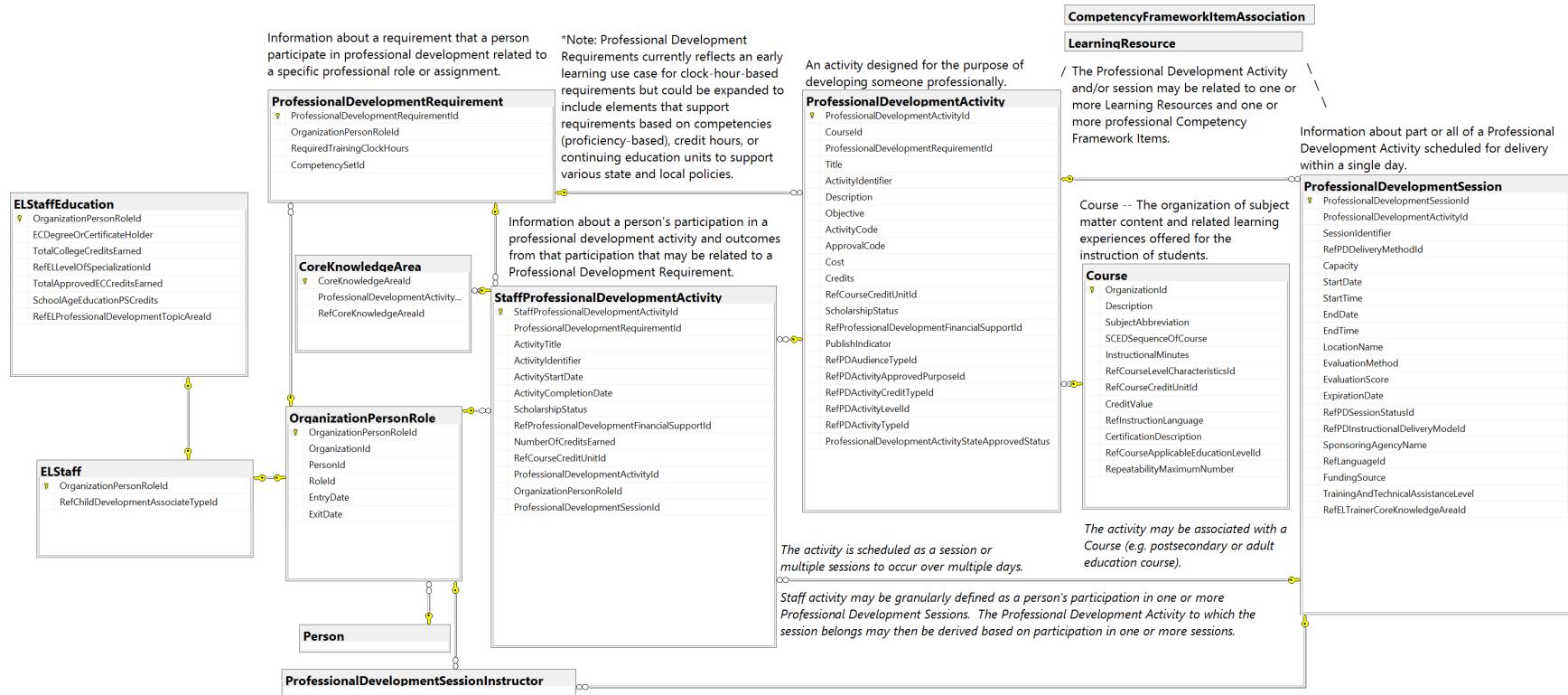
OrganizationPersonRole handles participation information, i.e. each record represents a child enrollment or staff assignment to the class/group. It includes start and end dates for each person.



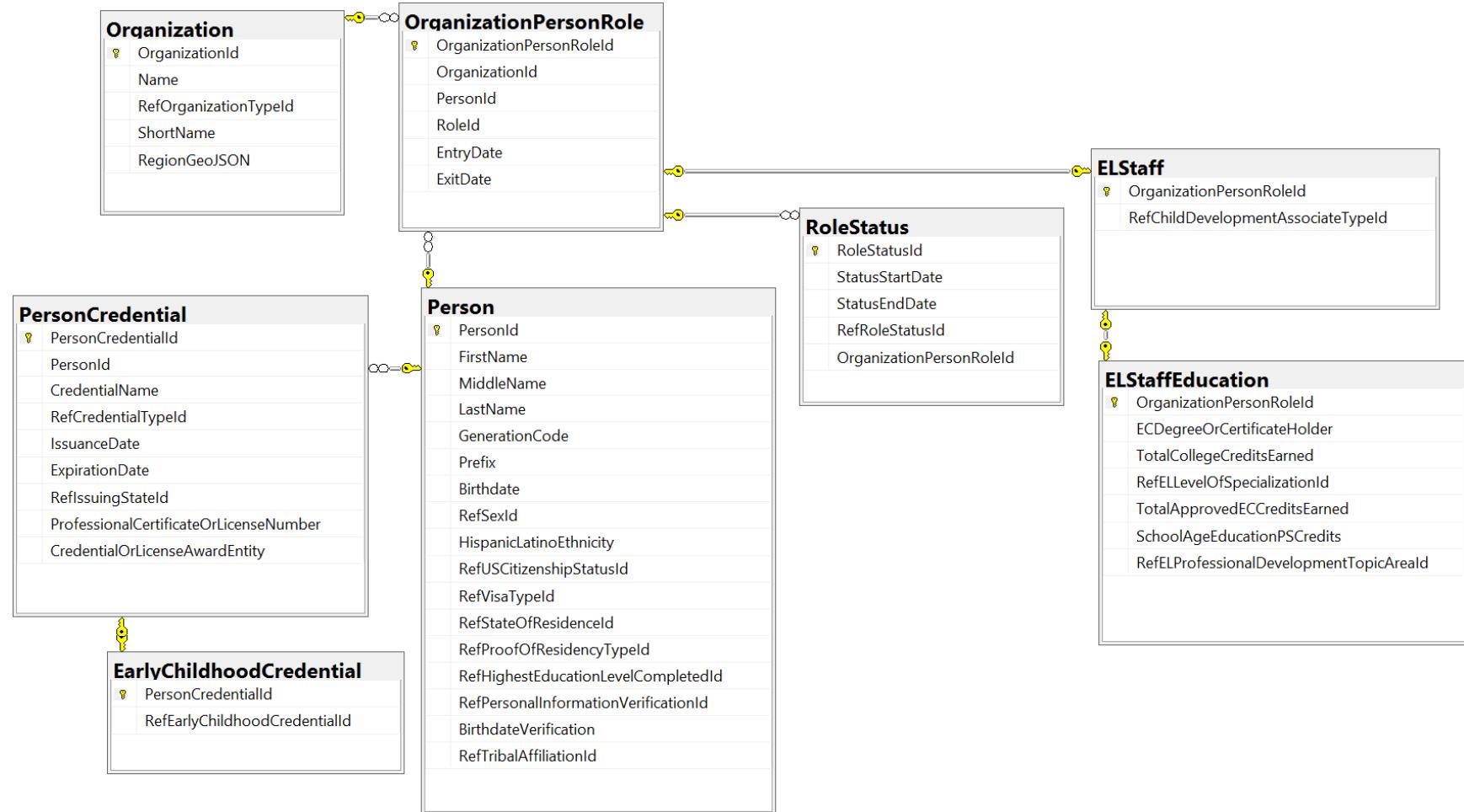
Early Learning: Organization



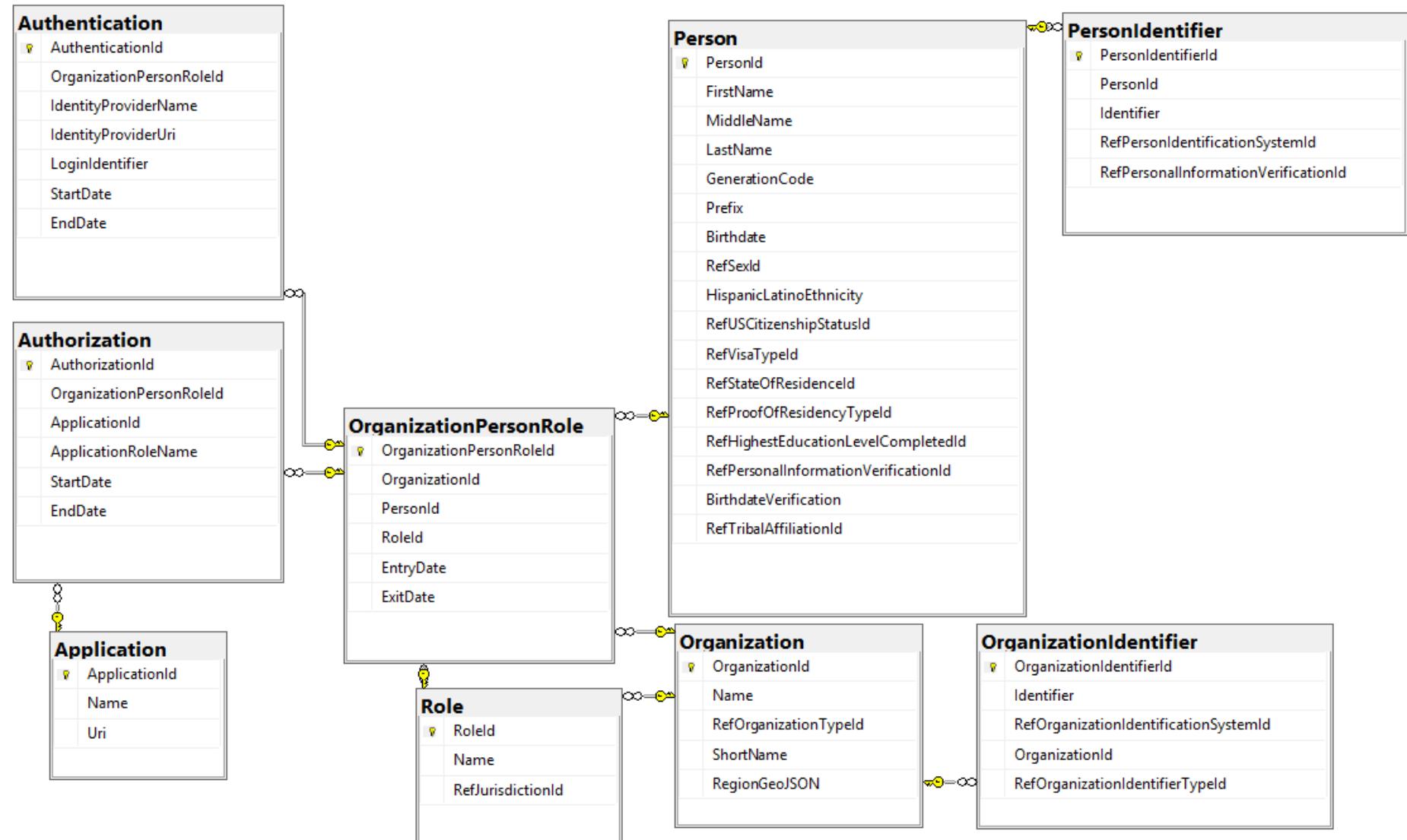
Early Learning: Professional Development



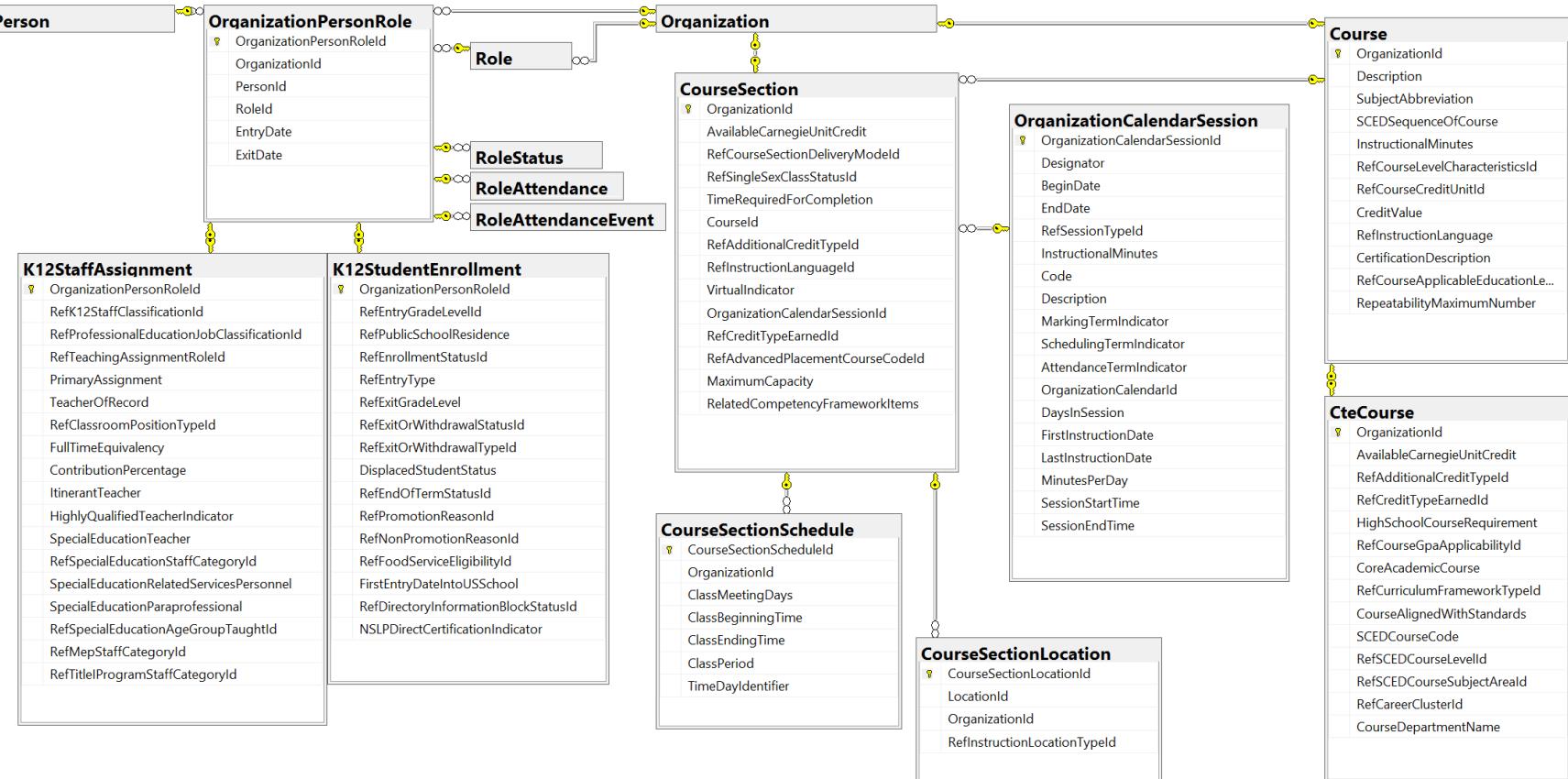
Early Learning: Staff



Identity Authentication and Authorization

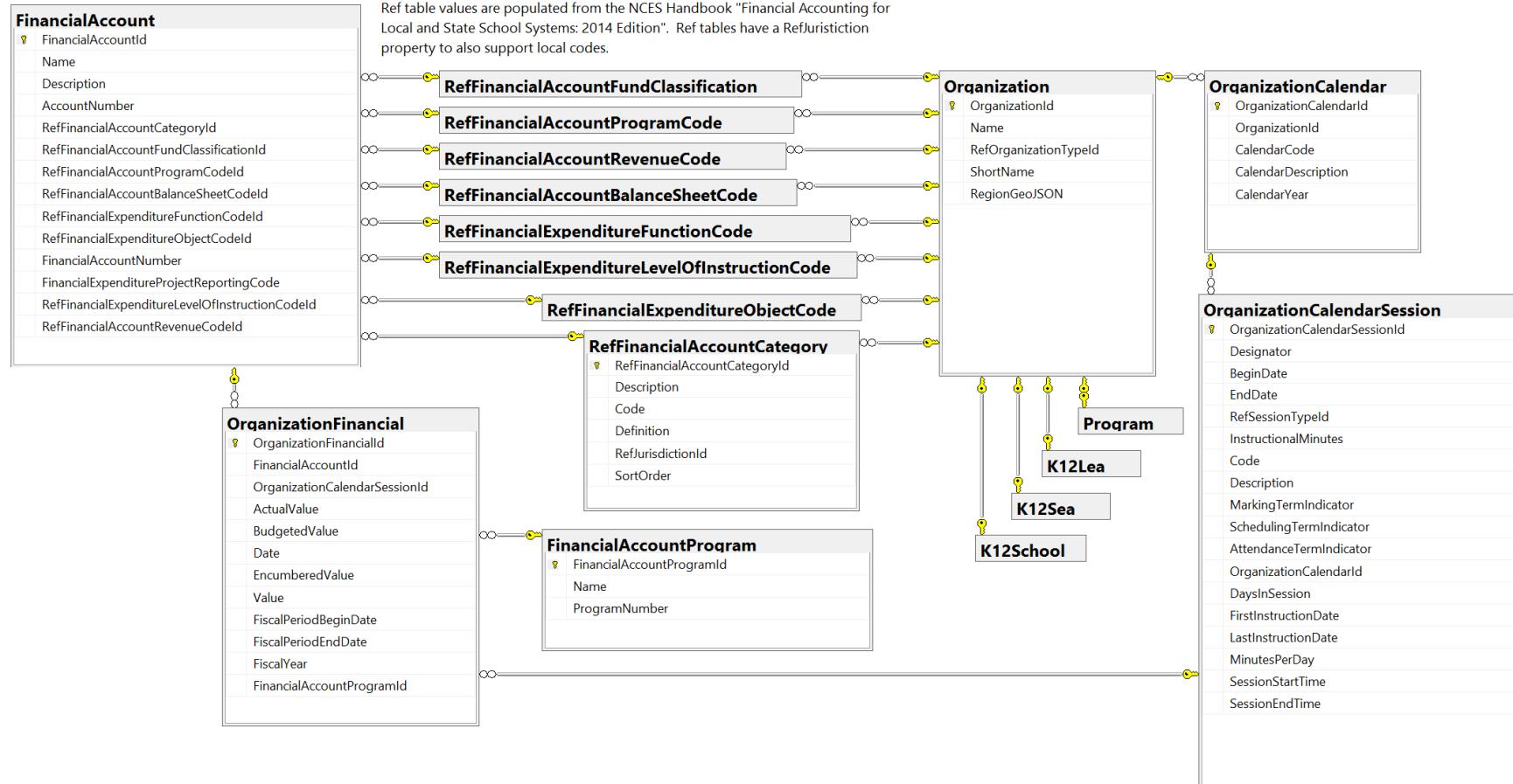


K12: Course Section



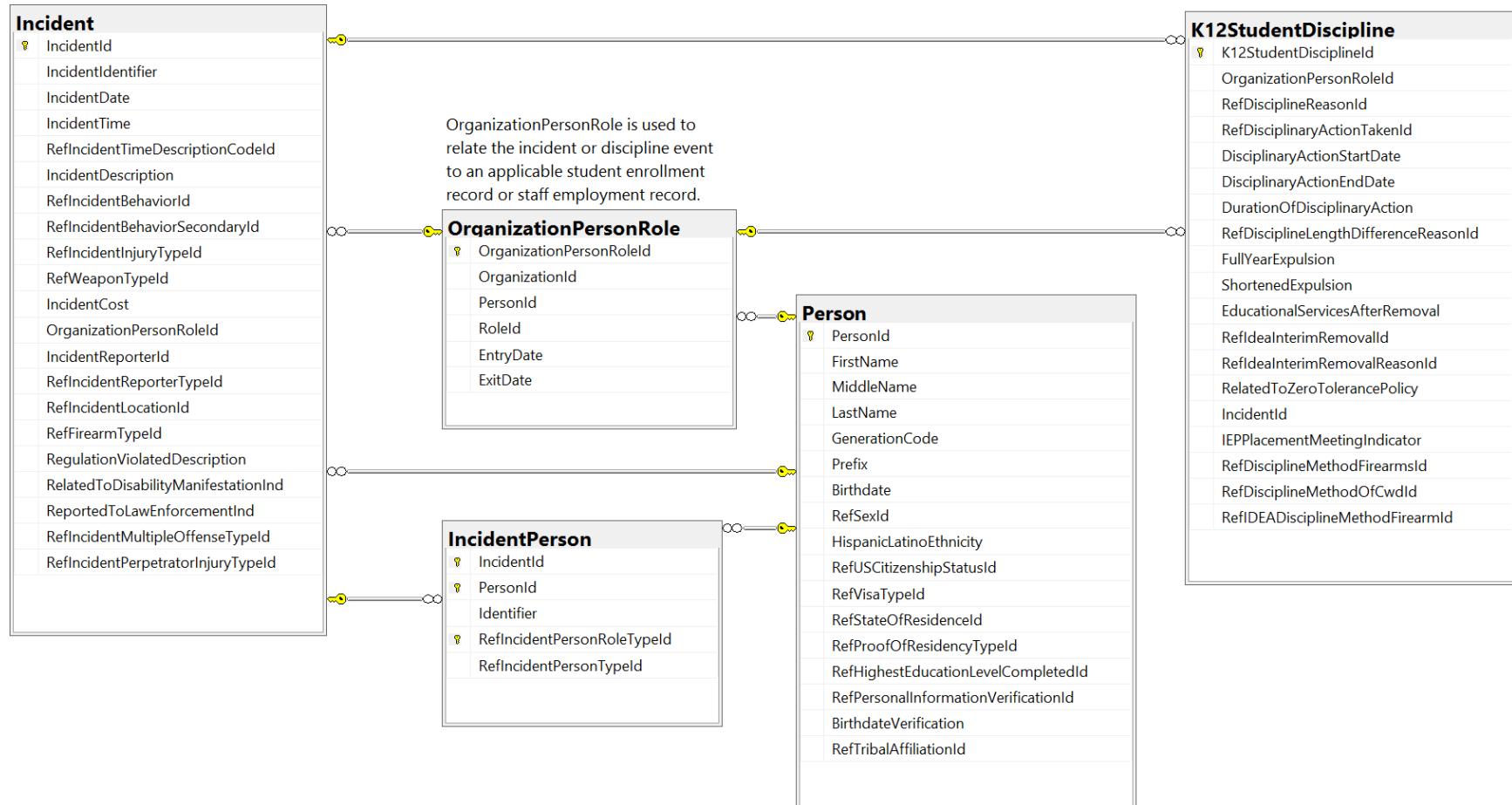
K12: Financial

CEDS Financial elements support financial reporting use cases. In this model, each record in the table "OrganizationFinancial" represents values for the period—e.g., ActualValue, BudgetedValue, and EncumberedValue—or a single "Value" for an account balance or transaction.



See the NCES Handbook [Financial Accounting for Local and State School Systems: 2014 Edition](http://nces.ed.gov/pubs2015/fin_acct/chapter6_3.asp) (http://nces.ed.gov/pubs2015/fin_acct/chapter6_3.asp).

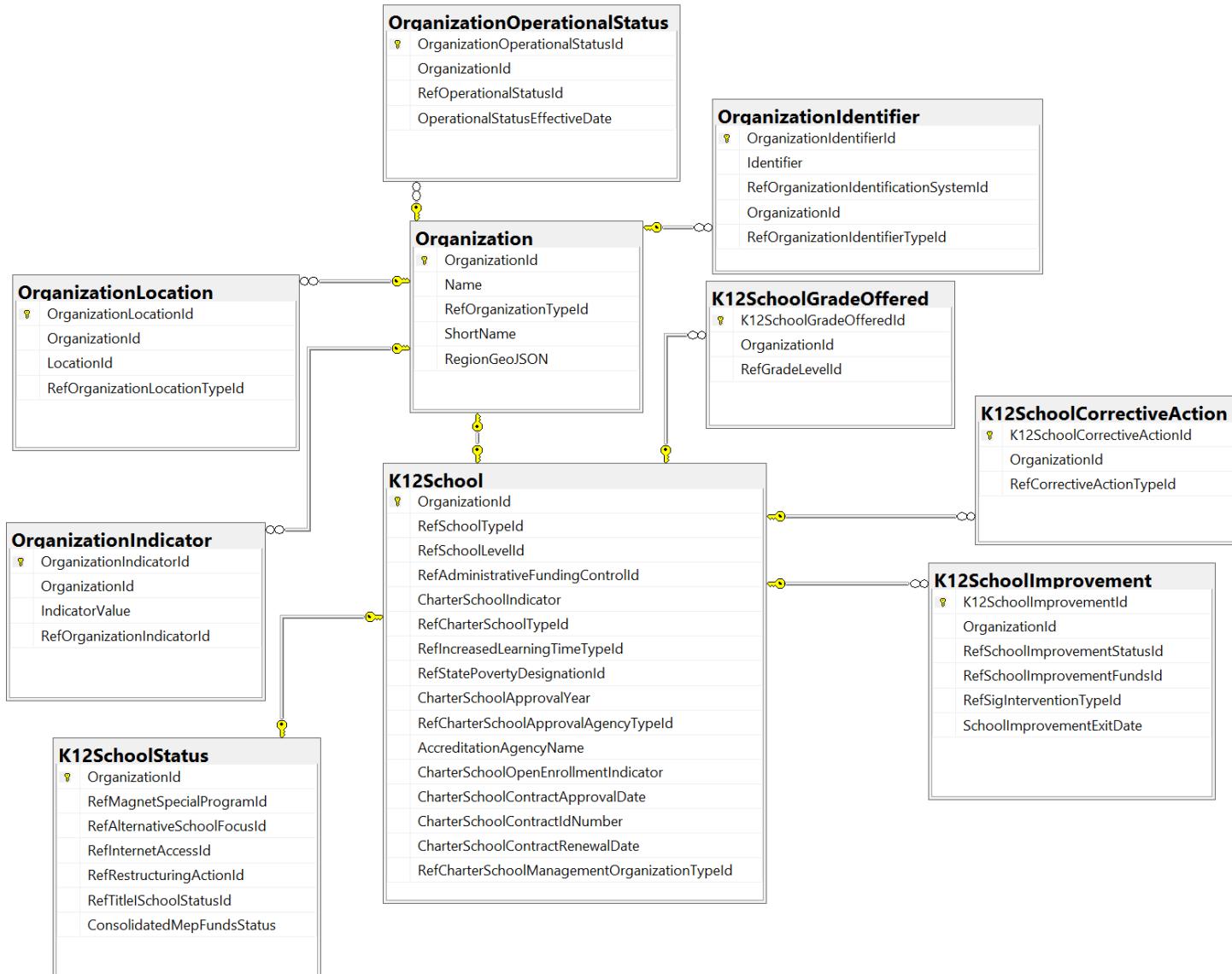
K12: Incident and Discipline



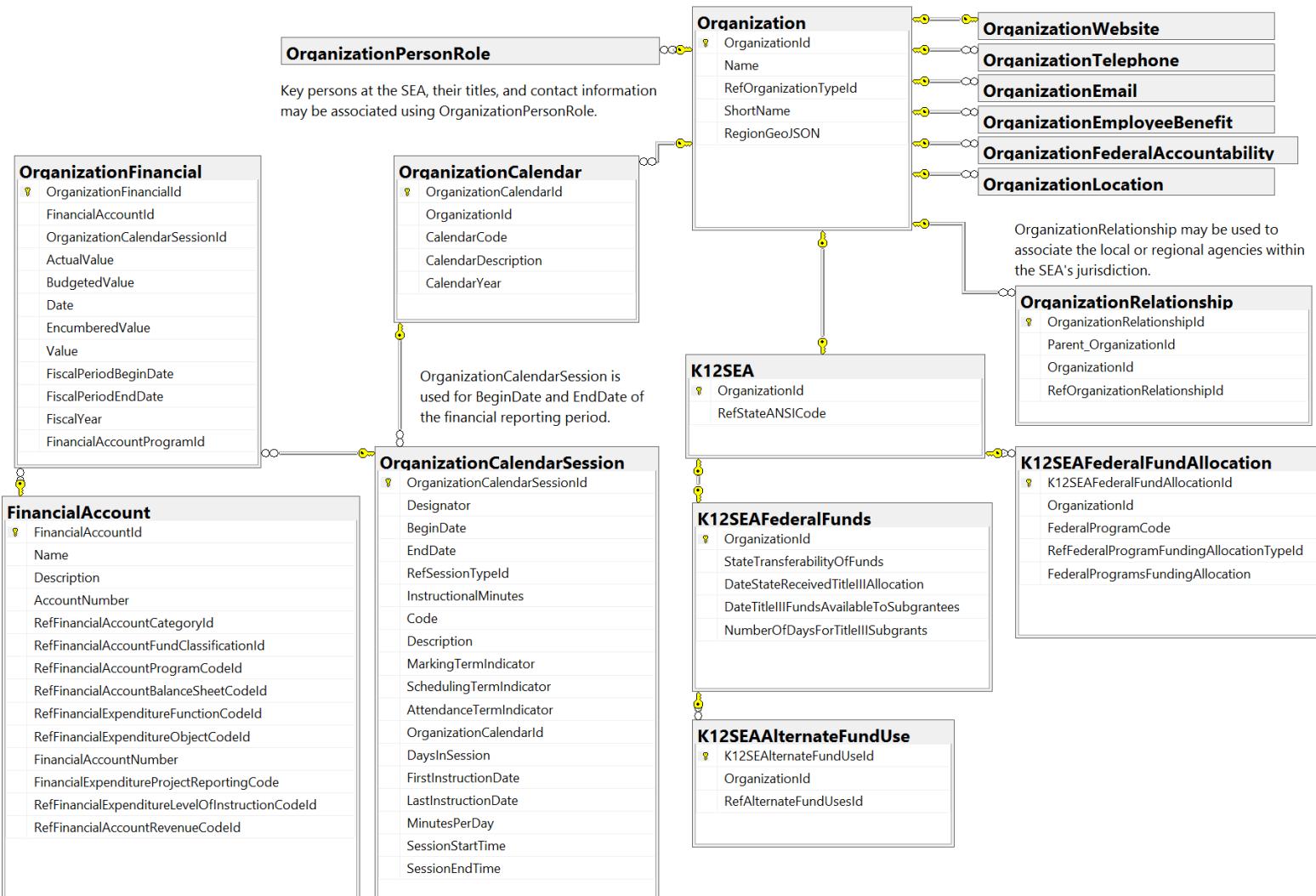
K12: LEA



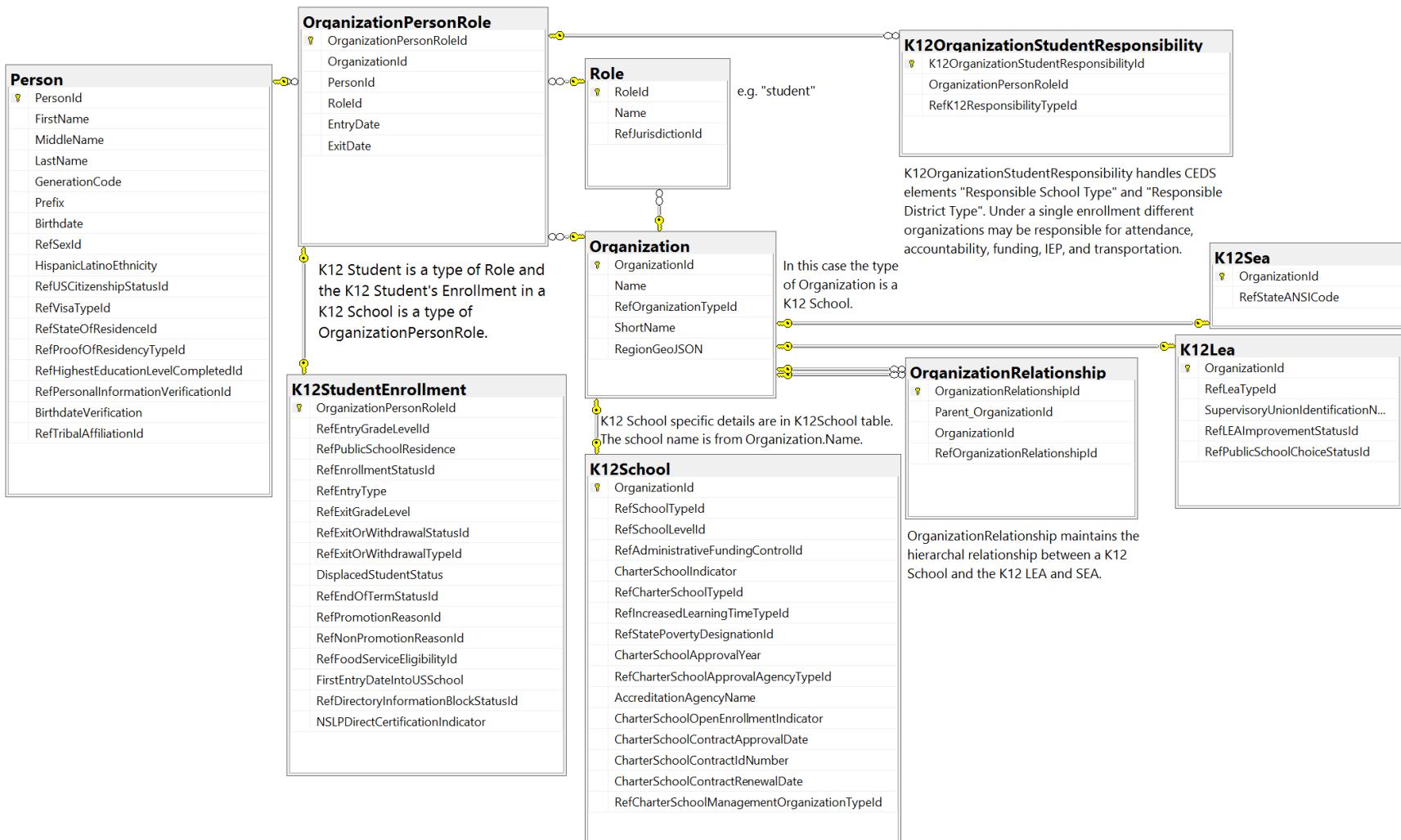
K12: School



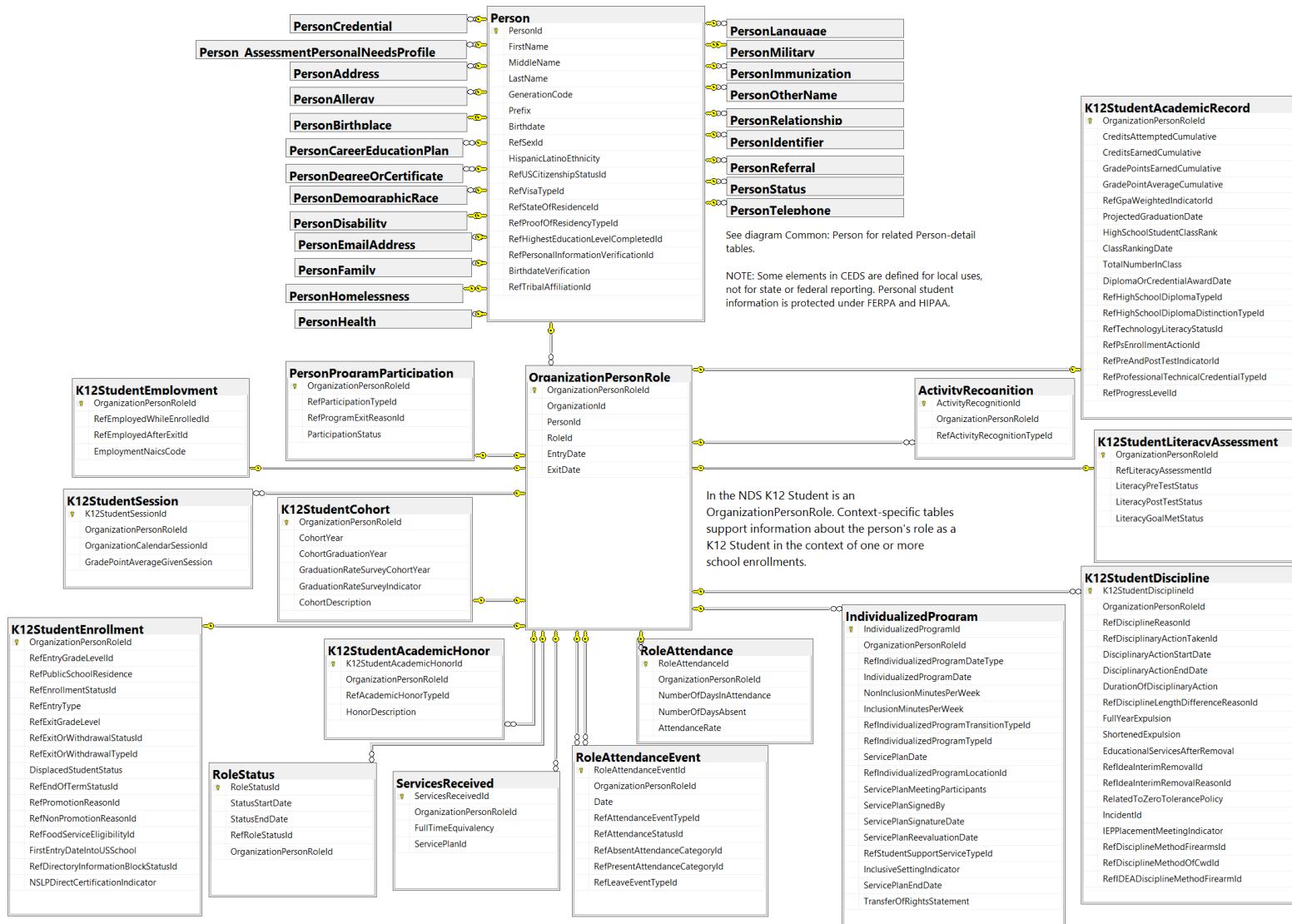
K12: SEA



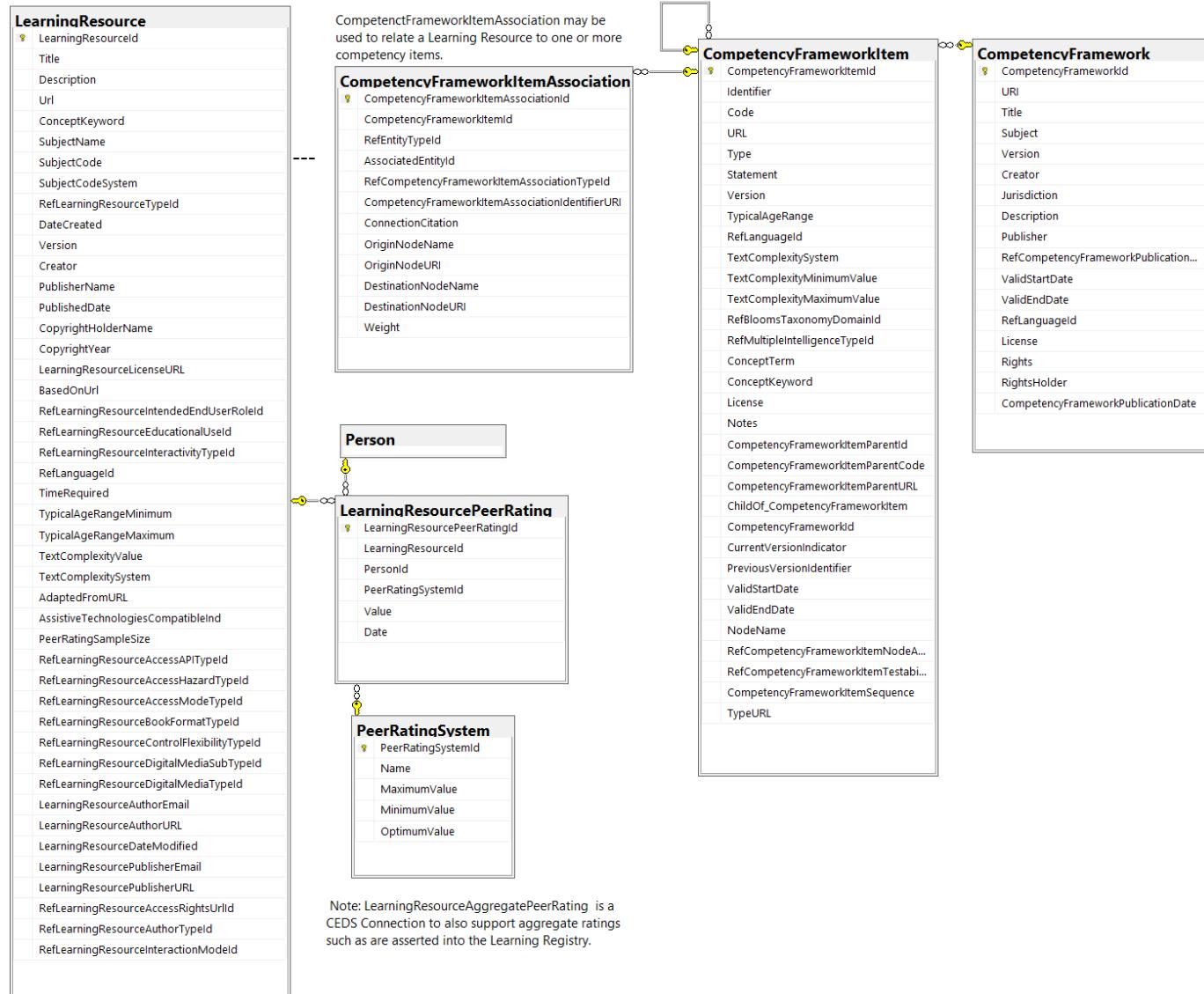
K12: Student Enrollment



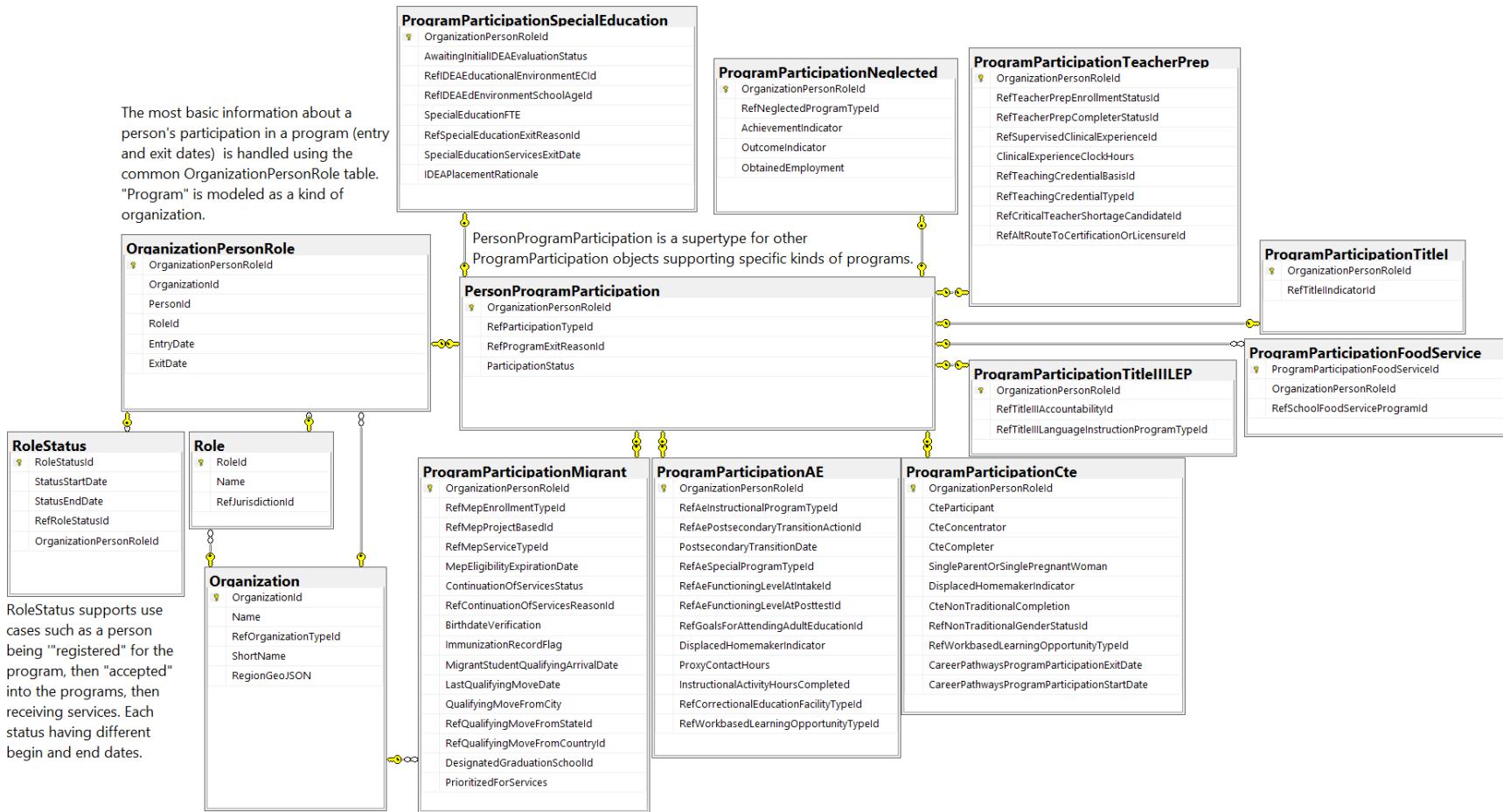
K12: Student



Learning Resources

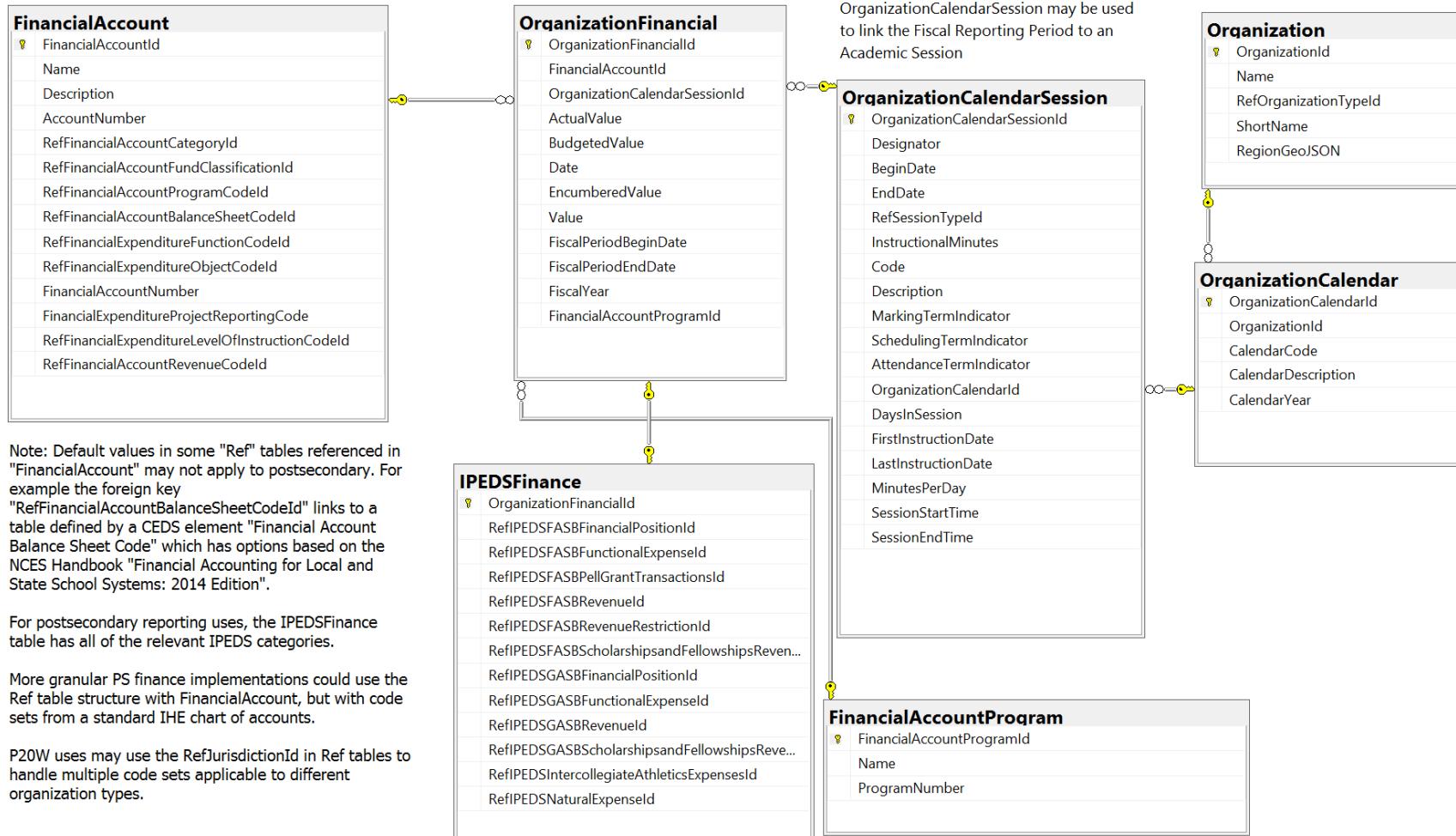


Person Program Participation

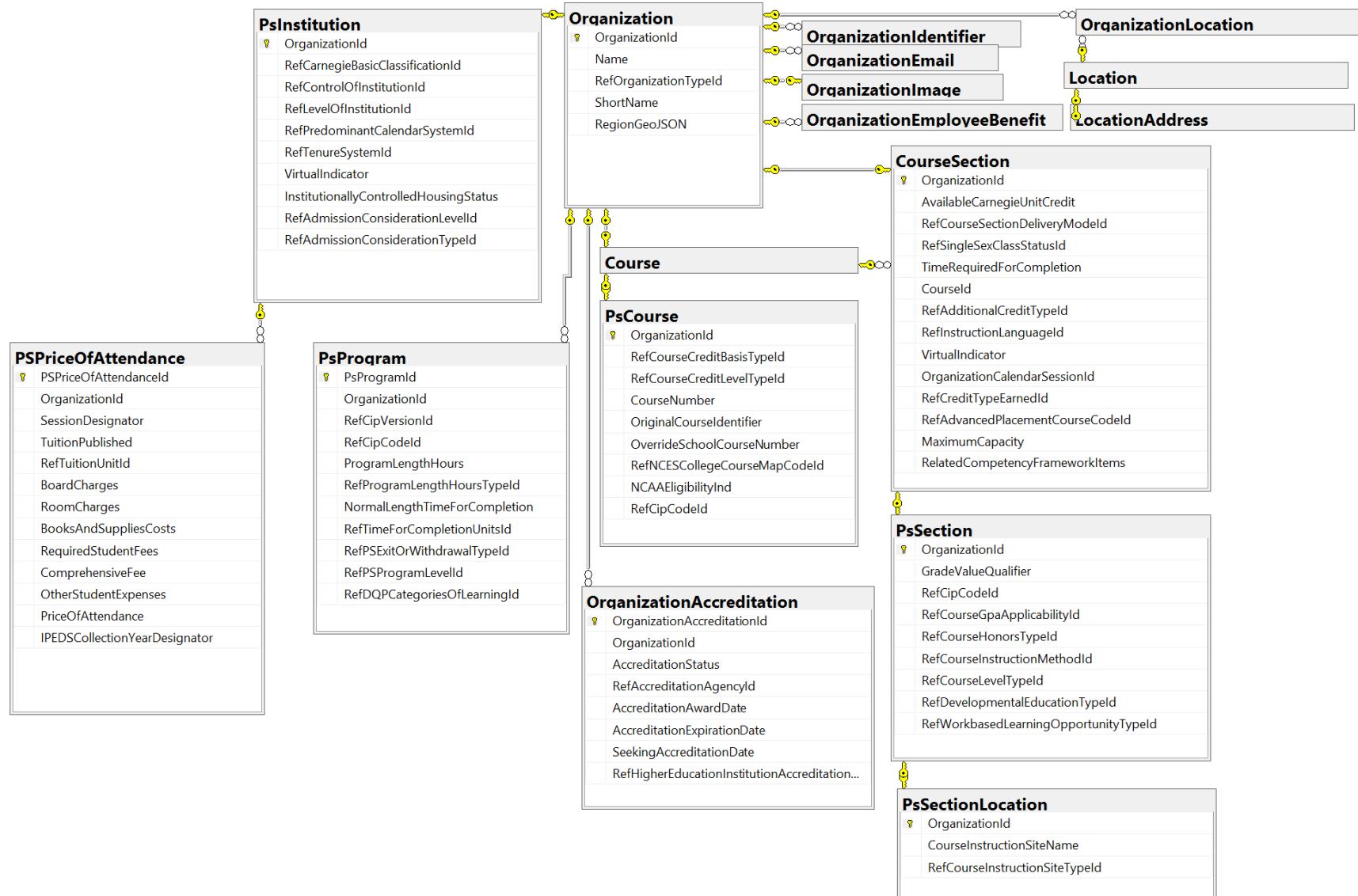


Postsecondary: Finance – IPEDS Reporting

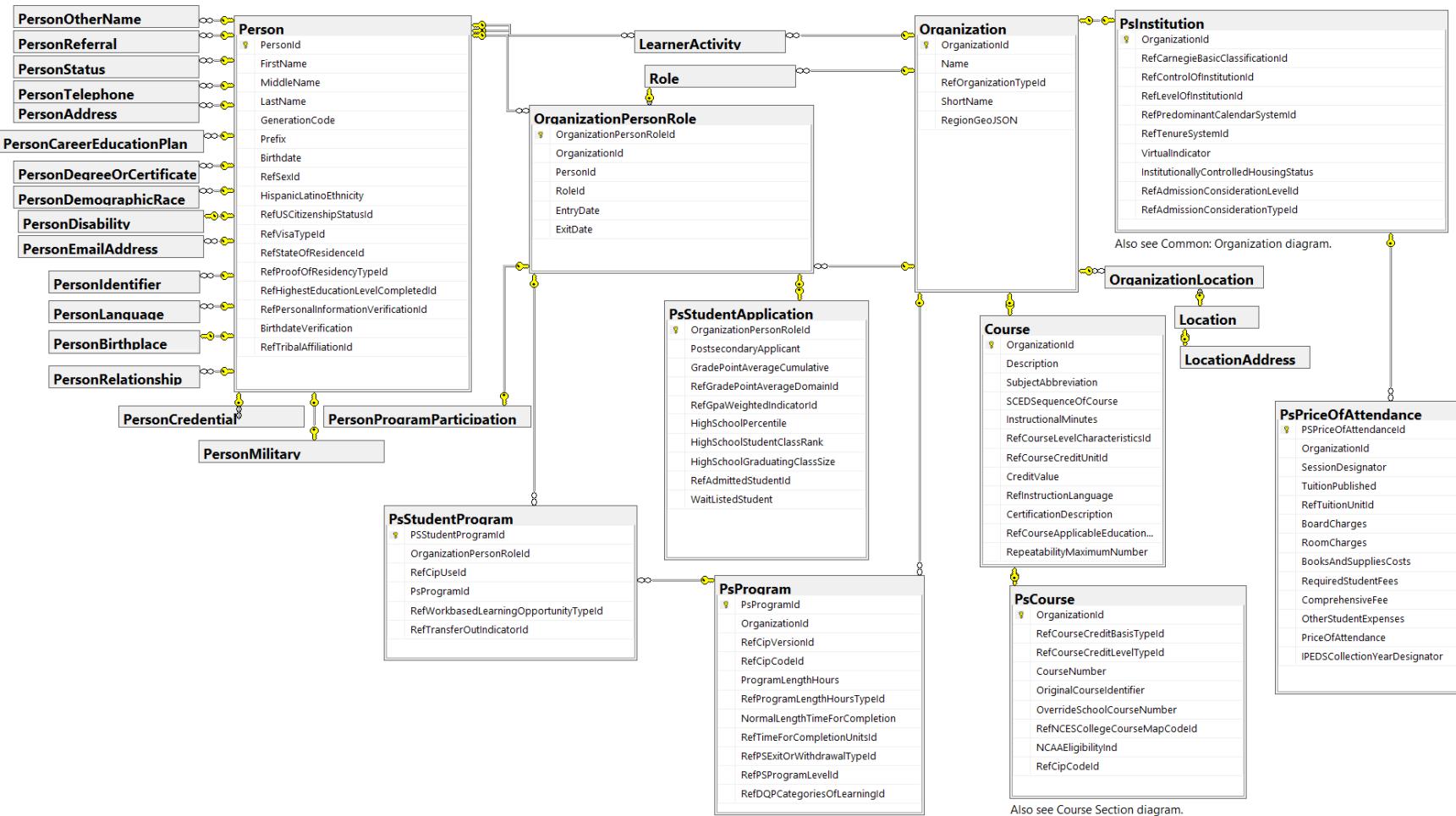
CEDS Financial elements support financial reporting use cases. In this model, each record in the table "OrganizationFinancial" represents values for the period—e.g., ActualValue, BudgetedValue, and EncumberedValue—or a single "Value" for an account balance or transaction.



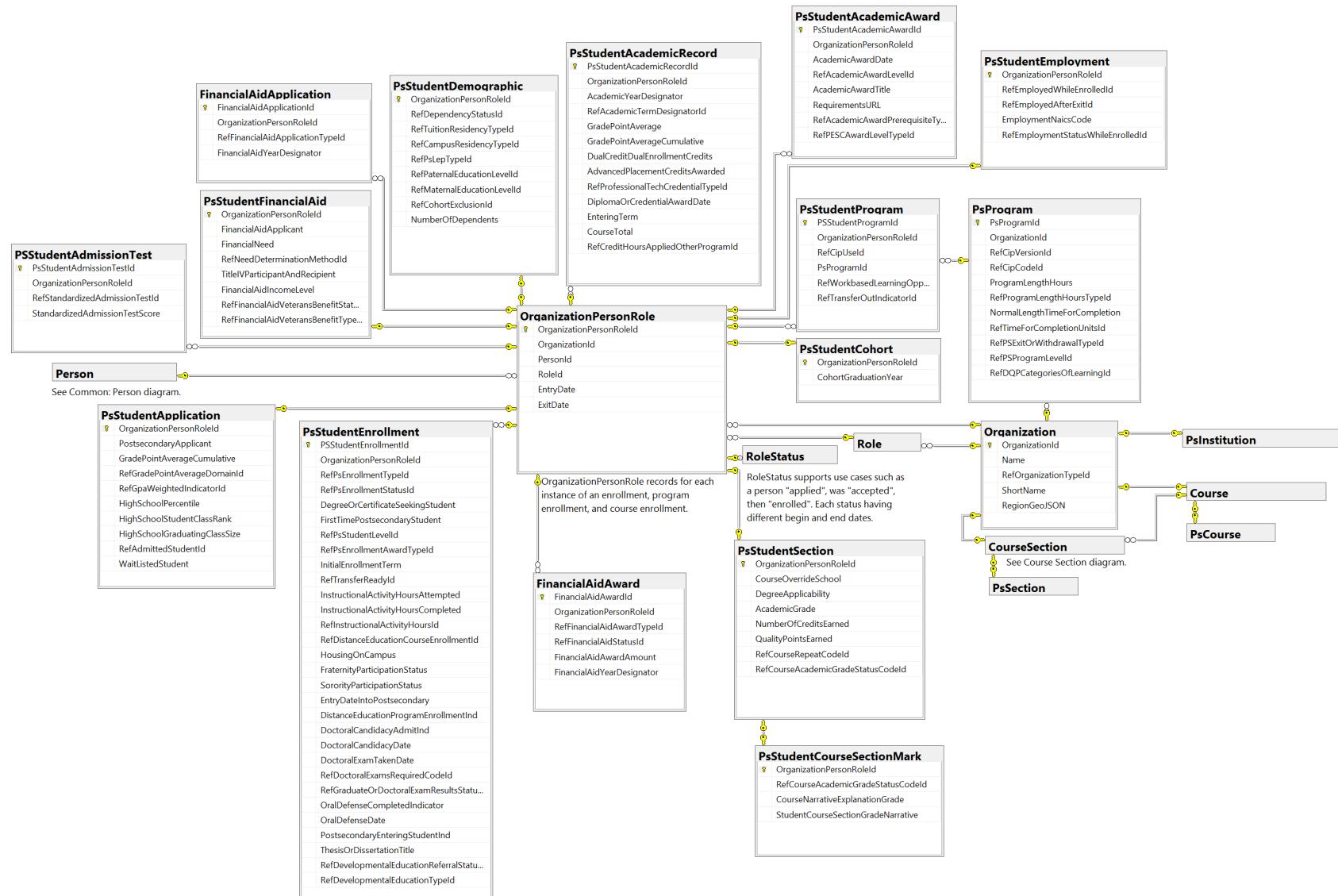
Postsecondary: Institution



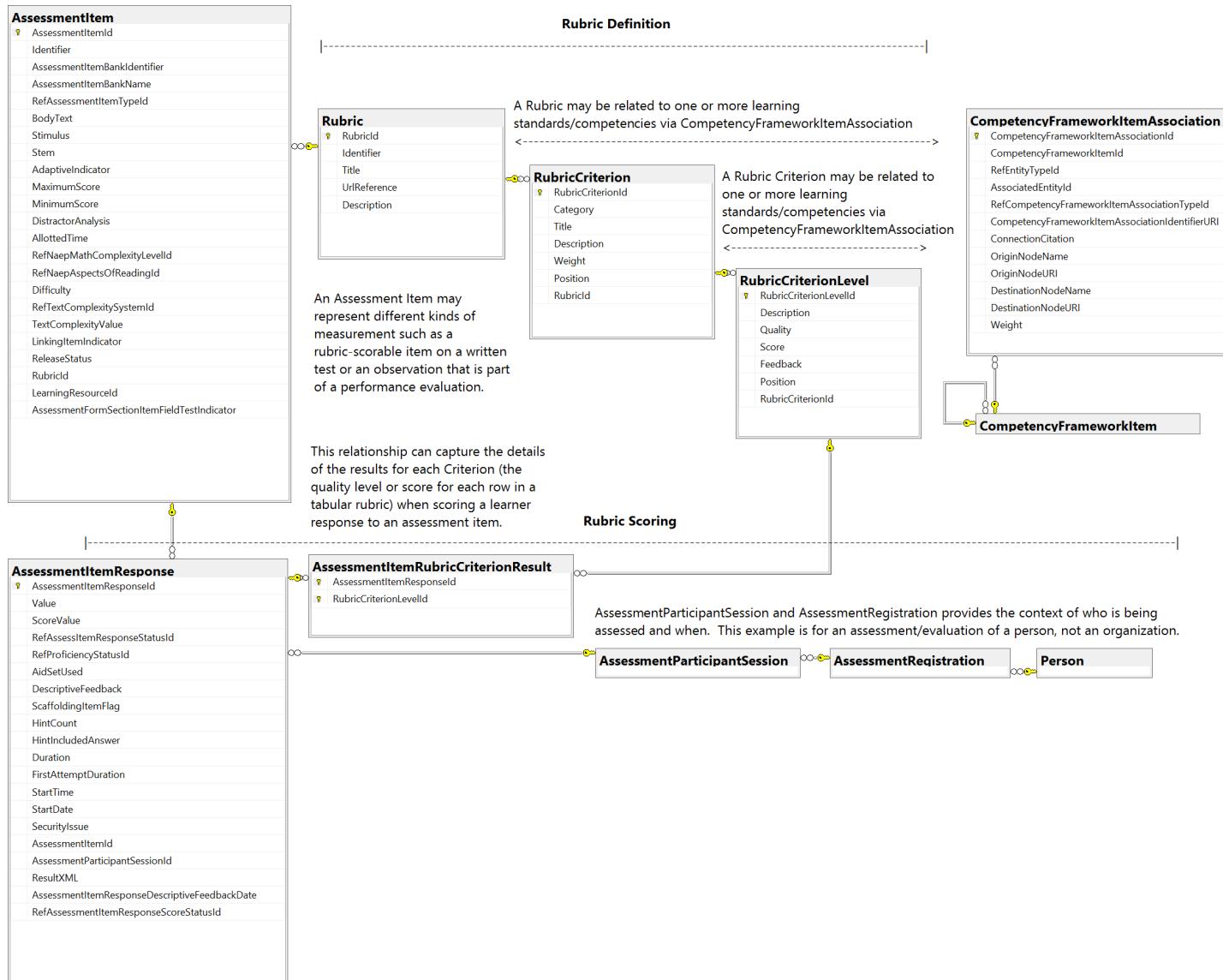
Postsecondary: Overview



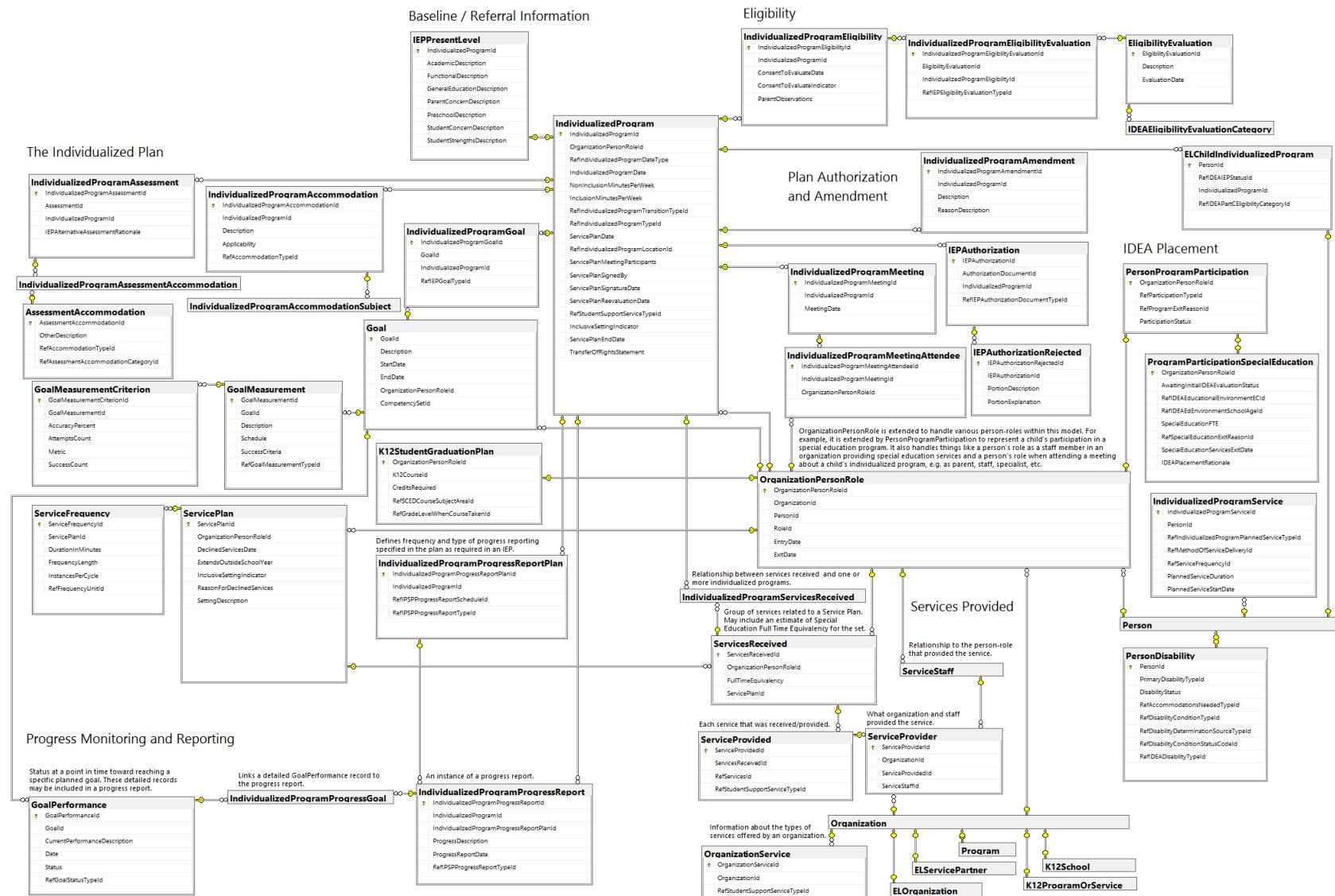
Postsecondary: Student



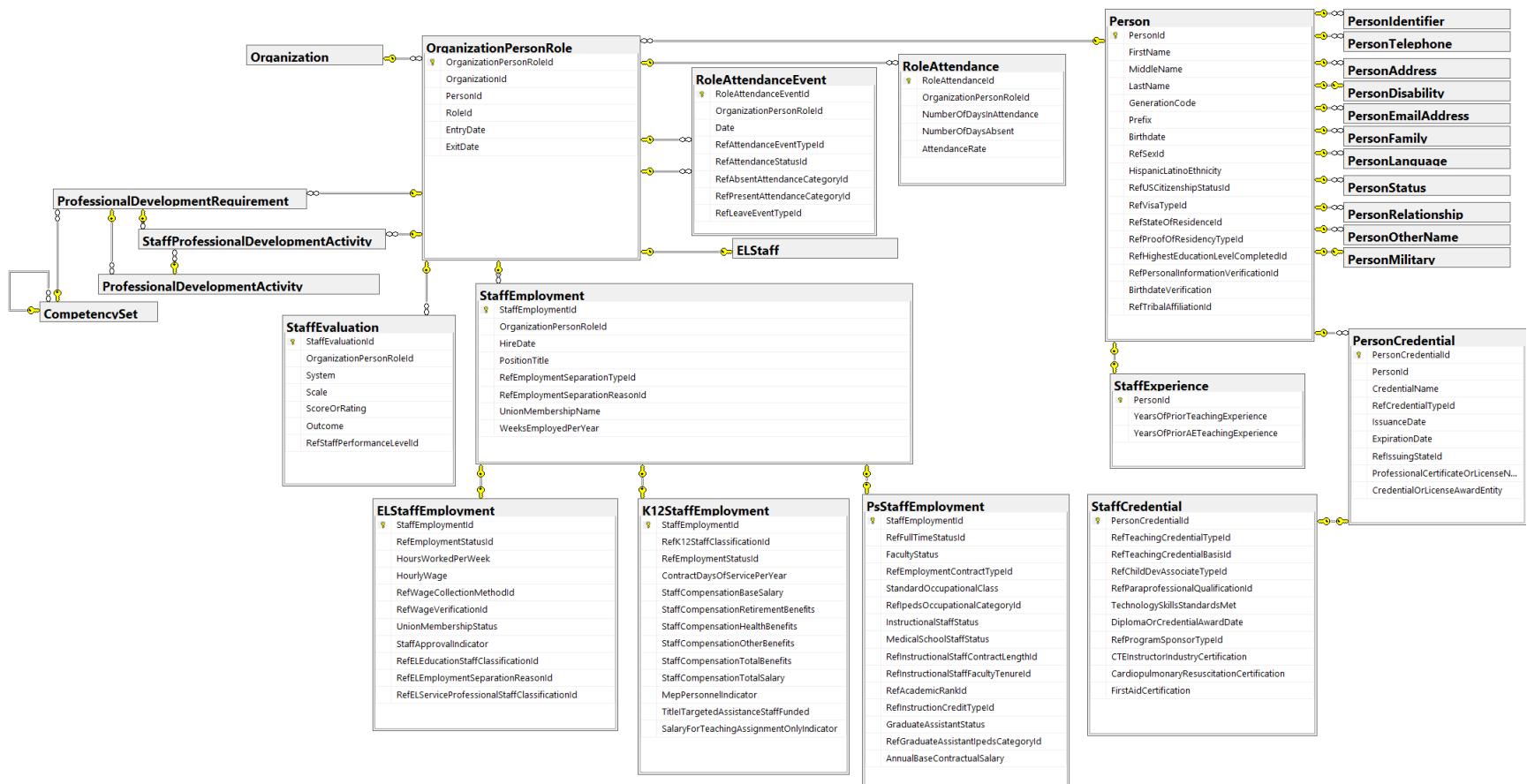
Rubric



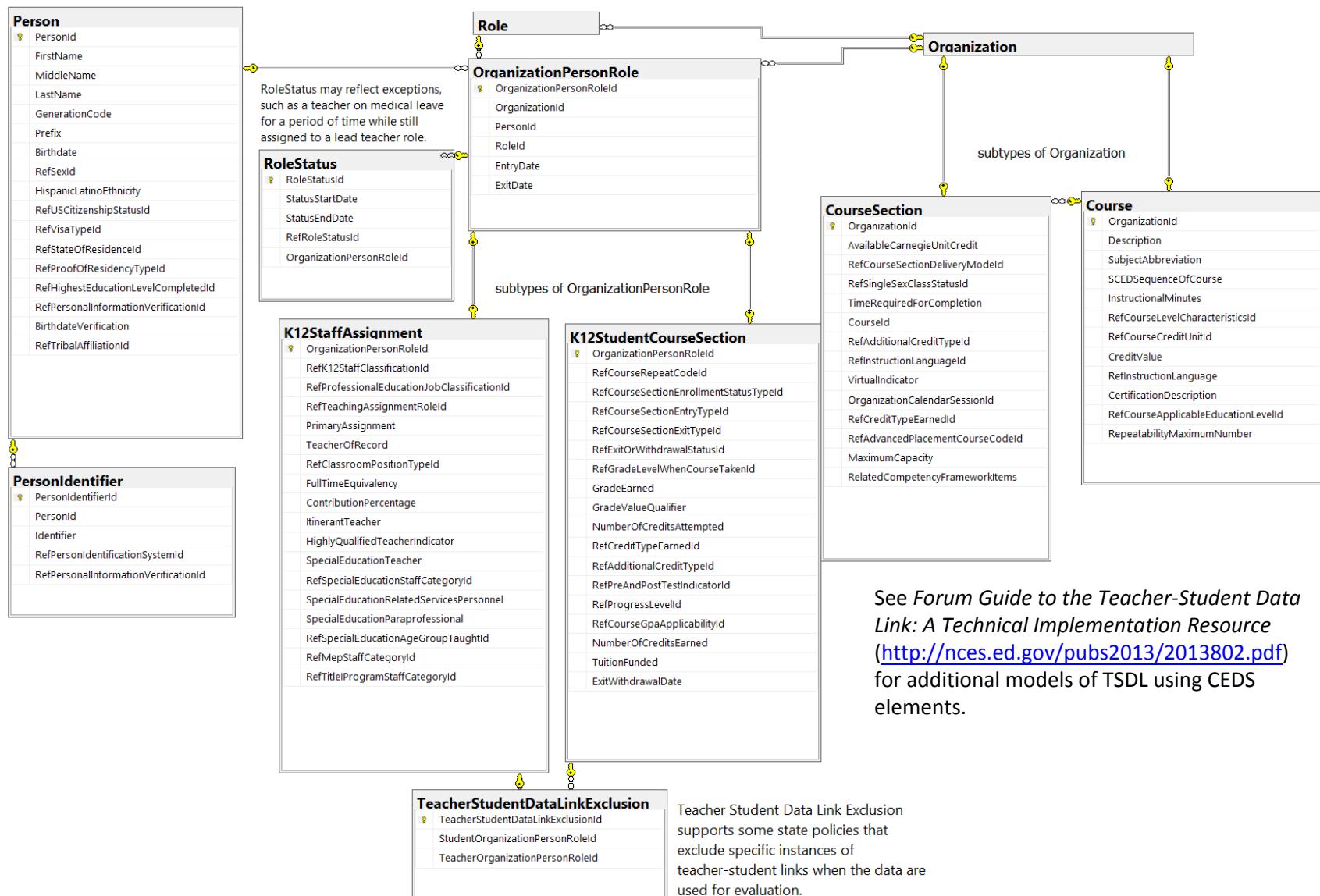
Special Education – Individualized Education Program



Staff



Teacher-Student Data Link



See *Forum Guide to the Teacher-Student Data Link: A Technical Implementation Resource* (<http://nces.ed.gov/pubs2013/2013802.pdf>) for additional models of TSDL using CEDS elements.

Workforce

