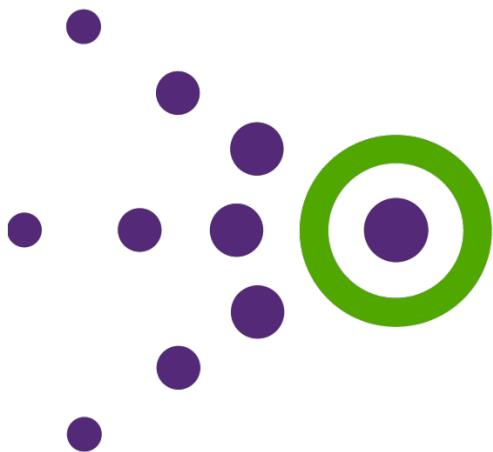


Common Education Data Standards (CEDS) Version 5 Data Model Guide

January 2015



CONTENTS

Introduction.....	1
About This Document	2
The Domain Entity Schema (DES).....	2
The Normalized Data Schema (NDS).....	2
Naming Conventions and Key Terms	3
Entity Terms.....	4
Property Terms	4
Representation Terms	4
Qualifiers (Optional)	5
Element Identifiers.....	5
CEDS Domain Entity Schema	6
Domain Entity Schema (DES) Structure.....	6
Domains	7
Entities	8
Early Learning (EL)	8
Elementary and Secondary (K12)	10
Postsecondary (PS)	12
Career and Technical Education (CTE).....	12
Adult Education (AE).....	13
Workforce (WF)	14
Assessments	14
Learning Standards	16
Learning Resources.....	16
Authentication and Authorization	16
CEDS Normalized Data Schema (NDS)	17
NDS Core Structure Logic	17
NDS Entity Relationship Model	19
A High-Level Logical Model.....	19
Common Model.....	21
Understanding the NDS Entity Relationship Diagrams	21

NDS Table and Field Syntax	21
Finding CEDS Elements in the NDS Model	23
CEDS Use within P-20W Enterprise and Web-Scaled Architectures	24
Case Study #1: The Teacher-Student Data Link—Data to Analyze Student Growth and Teacher Preparation.....	24
From Source System to Operational Data Store.....	25
Moving to the Data Warehouse	27
Case Study #2: Data Warehouse Star Schema for Student Enrollment.....	30
Appendix A: NDS Entity Relationship Diagrams.....	32
Common: Person.....	33
Common: Organization	34
Common: Role.....	35
Common: Location	36
Early Learning: Organization	37
Early Learning: Participation	38
Early Learning: Staff	39
Early Learning: Class Group.....	40
Early Learning: Professional Development	41
K12: SEA	42
K12: LEA	43
K12: School.....	44
K12: Course Section	45
K12: Student.....	46
Postsecondary: Institution	47
Postsecondary: Student	48
Achievement	49
Adult Education.....	50
Assessment: Design.....	51
Assessment: Delivery	52
Assessment: Results	53
Awards, Honors, Credentials.....	54
Calendar	55

Career and Technical Education	56
Financial Reporting	57
Formative Assessment Process	58
Identity, Authentication, and Authorization	59
K12 Incident and Discipline Reporting	60
K12 Student Enrollment (School Enrollment)	61
Learner Action (Assessment Item Response).....	62
Learning Resource Metadata	63
Learning Standards (Competency and Competency Framework Definitions)	64
Program Participation	65
Rubrics.....	66
Teacher-Student Data Link.....	67
Staff-Student Contact Hours / Attendance (Early Learning Context).....	68
Workforce	69

INTRODUCTION

CEDS Version 5 includes a broad scope of elements spanning much of the P-20W spectrum and provides a context for understanding the standards' interrelationships and practical utility. CEDS focuses on data elements and modeling in the Early Learning, K12, Postsecondary, Career and Technical Education (CTE), Adult Education, and Workforce sectors, and it has data domains for Assessments, Learning Standards, 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 comprised 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 three 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 Alignment Tool](#) allows users to load their organization's data dictionary and compare it, in detail, to CEDS and the data dictionaries of other users.

ABOUT THIS DOCUMENT

This document describes how to use the CEDS Data Model Version 5, as published on the CEDS website. The CEDS Data Model includes a hierarchical schema of nontechnical domains and entities, with each CEDS element 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 5 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
- Learning Standards
- 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 data sets, 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 workforce learning programs.

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

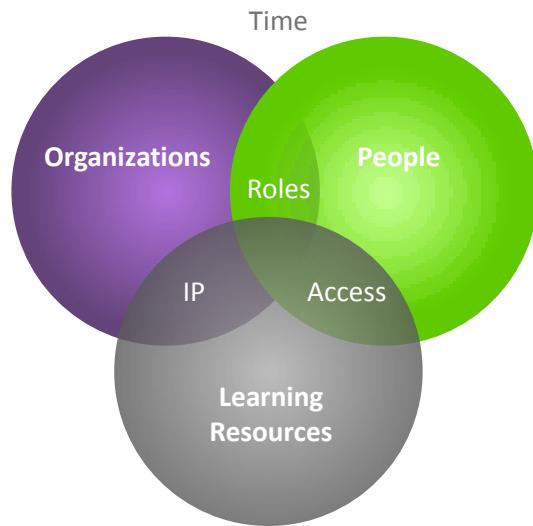
The NDS is a Third Normal Form* structure organized around the key concepts of organization, person, role, and learning resources (see the diagram). The NDS was developed with the goal of supporting physical implementations that could function as an “operational data store” for integrated P-20W data,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

CEDS NDS Conceptual Model



Naming Conventions and Key Terms

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

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

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

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

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.”

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

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.

Qualifiers (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.

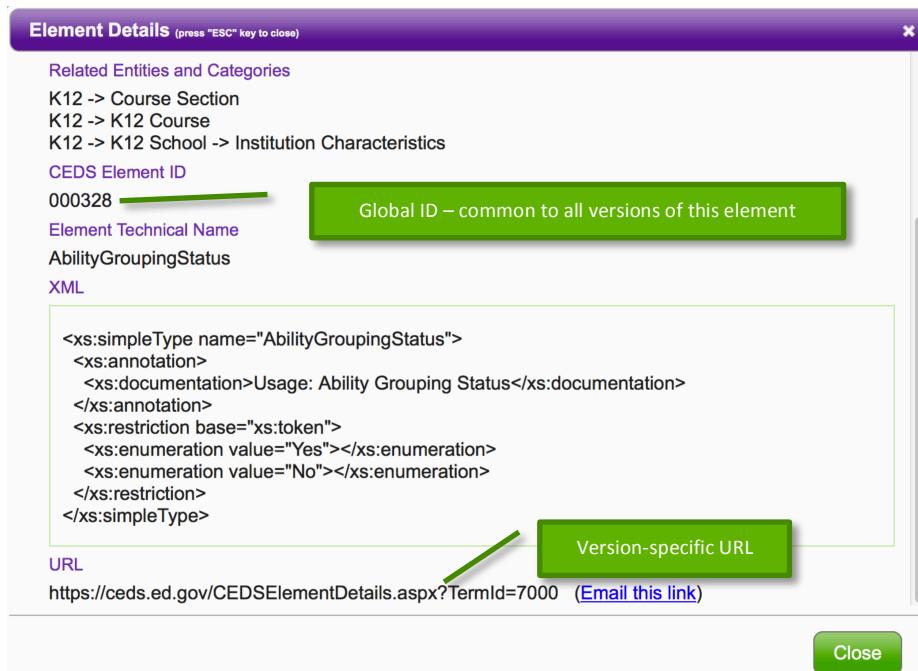
Qualifier terms may appear before or after an entity term, as appropriate to convey meaning.

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 (e.g., 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).



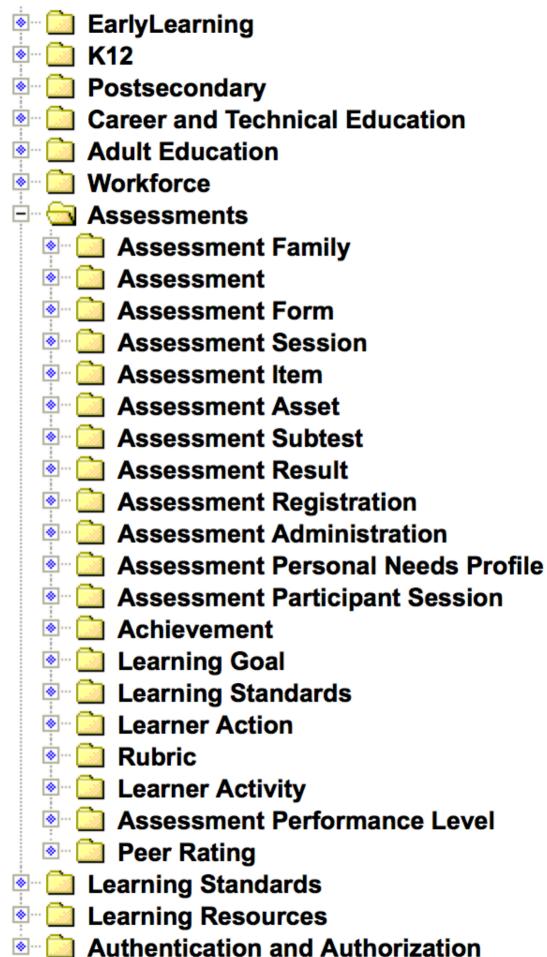
CEDS DOMAIN ENTITY SCHEMA

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:

1. The DES is a hierarchy of domains, entities, attribute categories, and attributes.
2. It is used primarily as an index to search, map, and organize elements.
3. CEDS elements may exist in more than one place in the DES.
4. It contains strong constraints specific to the subtype.
5. The DES contains (mostly) unit-level elements, and some derived/aggregated attributes.
6. 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 according to CEDS stakeholder direction. 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 Domain Entity Schema on the CEDS site, when a user enters the “Element Details” page for a particular element, the user can 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 this is different from the URL using “TermId=”; this references an element definition apart from a specific 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.

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	Programs for people in 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]).

Domain		Definition
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 of, the administration of, and the scoring or evaluating the results of assessments used to measure one or more people's mastery of one or more learning objects.
Learning Standards		Entities and elements that define learner competencies that are established in learning standards documents, that may be adopted as expectations by education agencies, and that may exist within the structure of a taxonomy or within competency-based pathways.
Learning Resources		Materials that support teaching and learning.
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 grouped by domain.

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 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 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 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.

Entity	Description
Staff Credential	An active certificate, license, permit, or other documentation held by an individual that authorizes the holder to perform certain functions, or to make certain claims about his or her competencies in employment or assignment. Credentials are issued by a state agency (or in some cases by other organizations), a postsecondary institution, or a professional association, based on education and training completed, experience, assessment, background verification, and/or other requirements.
Staff Professional Development Activity	A person's participation in a professional development activity, and outcomes from that participation that may be related to a Professional Development Requirement. (This entity may also be more granularly defined as a person's participation in a specific Professional Development Session entity, indicated by reference.)
Professional Development Requirement	A requirement that a person participate in professional development related to a specific professional role or assignment.
Professional Development Activity	An activity designed for the purpose of developing someone professionally. (This entity is scheduled as one or more Professional Development Sessions that may occur over multiple days. Information about a staff member's participation in a session or activity is included in the Staff Professional Development Activity entity.)
Professional Development Session	Part or all of a Professional Development Activity entity that is (or was) scheduled for delivery within a single day.
Technical Assistance	Technical assistance provided to a person or organization. (Note that "Technical Assistance" is also a type of Professional Development Activity; see Professional Development Activity Type.)
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.
Assessments	Elements that support the design of, the administration of, and the scoring or evaluating the results of assessments used to measure one or more people's mastery of one or more learning objectives.
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 defined 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.)
Learning Goal	The learning that is intended for an individual learner, and the success criteria used to indicate progress toward the learning goal. In the formative assessment process, a learning goal exists within the framework of a Learning Progression / Competency-Based Pathway defined within the context of Learning Standards.
Learning Resource	Materials that support teaching and learning.

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)	An administrative unit within K12 education at the local level that exists primarily to operate schools or to contract for educational services. These units may or may not be co-extensive with county, city, or town boundaries.
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.)
Assessments	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.)
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 defined 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.
Learning Resource	Materials that support teaching and learning.
Financial Account	One item in a chart of accounts for which money or the equivalent is spent or received.
Organization Account Value	Budgeted and/or actual values for the specified Financial Account and specified accounting period or academic Session.

Entity	Description
Session	A period of time.
Rubric	An instrument used to communicate expectations of quality around a task, product, or performance and/or used to delineate consistent criteria for grading.
Rubric Criterion	The criteria that must be met to demonstrate quality for a product, process, or performance task.
Rubric Criterion Level	A degree of achievement on a product, process, or performance task, and the benchmarks or qualitative indicators attributed to that degree of achievement.
Allergy	A person's reaction to an allergen.
Staff Credential	An active certificate, license, permit, or other documentation held by an individual that authorizes the holder to perform certain functions or to make certain claims about his or her competencies in employment or assignment. Credentials are issued by a state agency (or in some cases by other organizations), a postsecondary institution, or a professional association based on education and training completed, experience, assessment, background verification, and/or other requirements.
Staff Professional Development Activity	A person's participation in a professional development activity, and outcomes from that participation that may be related to a Professional Development Requirement. (This entity may also be more granularly defined as a person's participation in a specific Professional Development Session entity, indicated by reference.)
Professional Development Requirement	A requirement that a person participate in professional development related to a specific professional role or assignment.
Professional Development Activity	An activity designed for the purpose of developing someone professionally. (This entity is scheduled as one or more Professional Development Sessions that may occur over multiple days. Information about a staff member's participation in a session or activity is included in the Staff Professional Development Activity entity.)
Professional Development Session	Part or all of a Professional Development Activity scheduled for delivery within a single day.
Technical Assistance	Technical assistance provided to a person or organization. (Note that "Technical Assistance" is also a type of Professional Development Activity; see Professional Development Activity Type.)
Learning Goal	The learning that is intended for an individual learner, and the success criteria used to indicate progress toward the learning goal. In the formative assessment process, a learning goal exists within the framework of a Learning Progression / Competency-Based Pathway, defined within the context of Learning Standards.
Achievement	Achievement earned by a learner upon fulfilling a specified criteria, which may be defined by a related Competency Set.
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.
Authentication	An application or service that can authenticate the identity of a person. This is 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 the authentication of a person's identity.
Authorization	The CEDS entity that includes information about a data system or application that an authenticated person may access.
Learner Action	An action taken by or on behalf of a learner, describing a single event in a learning experience.

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 the parental or legal guardianship responsibility for a learner.
Assessment	The elements to support the design of, the administration of, and the scoring or evaluating of the results of assessments used to measure one or more people's mastery of one or more learning objectives.
Learning Resource	The CEDS entity that includes information about materials that support teaching and learning.
Learning Goal	The learning that is intended for an individual learner and the success criteria used to indicate progress toward the learning goal. In the formative assessment process, a learning goal exists within the framework of a Learning Progression / Competency-Based Pathway defined within the context of Learning Standards.
Authentication	An application or service that can authenticate the identity of a person. This includes information about an authentication provider, the login identifier used to authenticate a person's identity, and other information related to the authentication of a person's identity.
Authorization	The CEDS entity that includes information about a data system or application that an authenticated person may access.

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.

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

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

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

Assessments

Assessments is the CEDS domain on entities and elements that support the design of, the administration of, and the scoring or evaluating the results of assessments used to measure one or more people's mastery of one or more learning objects.

Entity	Description
Assessment Family	A set of assessments with a common name, jurisdiction, or focus (e.g., SAT, GRE, NAEP).
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 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	Content used to compose an assessment item, something that is referenced by an item but not part of the item content itself, or content 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	The scoring of 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 for one aspect of evaluation based on a subset of Assessment Items.
Assessment Result	A person's results from an assessment. This may be for the entire assessment or for one aspect of evaluation. This includes the score value and information about the score, such as a diagnostic statement. (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.)

Entity	Description
Assessment Registration	A specific person who is registered for an Assessment Administration and assigned a specific Assessment Form for participation in one or more Assessment Sessions.
Assessment Administration	An assessment event or administration period. This includes information related to the time period of the administration and the place(s) of the administration.
Assessment Personal Needs Profile	The personal needs and preferences for assessment participants, based on the IMS Global (R) Accessible Portable Item Protocol.
Assessment Participant Session	A specific person's participation in an Assessment Session.
Achievement	An achievement earned by a learner upon fulfilling a specified criteria, which may be defined by a related Competency Set.
Learning Goal	The learning intended for an individual learner and the success criteria used to indicate progress toward the learning goal. In the formative assessment process, a learning goal exists within the framework of a Learning Progression / Competency-Based Pathway defined within the context of Learning Standards.
Learner Action	Detailed actions taken by a learner while engaging in learning activities, such as asking for a hint when taking an online formative assessment.
Learner Activity	The work assigned to a learner and/or performed by a learner. This can comprise interaction with learning resources, as well as assessments.
Assessment Performance Level	<p>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> <ul 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 is 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>
Assessment Item Response	Information related to the specific response to an assessment item by the person being assessed. This includes the response, a score or indication that the response was correct or incorrect, and other information such as response time.
Assessment Form Subtest	An Assessment Item associated with an Assessment Form Subtest, including weights to apply to items for scoring.
Assessment Item	
Assessment Item Body	The rendering of an Assessment Item as one or more interactions with the person being assessed.
Learning Standard Item Association	The relation of learning standard items to other learning standard items to support competency maps using competency to prerequisite-competency assertions, and to relate learning standard Items to other objects such as learning resources.

Learning Standards

Learning Standards is the CEDS domain on entities and elements that define learner competencies that are established in learning standards documents, that may be adopted as expectations by education agencies, and that may exist within the structure of a taxonomy or within competency-based pathways.

Entity	Description
Learning Standard Document	A collection of learning standard 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, and the Accountability Criteria for National Health Care Cluster Foundation Standards.)
Learning Standard Item	Content that either describes a specific competency (a learning objective) or describes a grouping of competencies within the taxonomy of a Learning Standards Document. (Use the Learning Standard Item Type element to indicate the level of grouping in a hierarchy, e.g., "Subject," "Strand," or "Competency." A competency may have child learning standard items of type "Indicator" used to describe how that competency may be assessed. The elements Learning Standard Item Statement and Learning Standard Item Notes may be used to describe a procedure for an observation-based assessment of learning and any citations or notes supporting the method. Learning Standard Items may be associated with other entities, such as Assessment Items, using "Learning Standard Item Association." [See the CEDS Data Model Guide for example uses of the Learning Standard Item framework.]
Learning Standard Item Association	The relation of learning standard items to other learning standard items to support competency maps, and to relate learning standard items to other objects such as learning resources.
Competency Set	The supporting of the definition of a set of competencies that represent the 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.

Learning Resources

Learning Resources is the CEDS domain on 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

The CEDS domain for information used in authenticating a person's identity for restricting or granting access to data systems or information 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	The CEDS entity that includes information about a data system or application, which 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 ideas, within a data model pertain to each other. The Normalized Data Schema is available in PDF format and as an SQL script for import into data modeling tools. Also, a spreadsheet is included as an appendix to this document—Appendix B: Normalized Data Schema (NDS) Tables.

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 (*table*, *fields*) as opposed to the terms *entity* and *element*, which are used for CEDS definitions. Additionally, since the terms *entity* and *element* are used within the DES, using the physical terms when discussing the ERD 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.” 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 utilized.

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/modules can be more easily shared across organizations;
- there is centralized or baselined design documentation; and
- resources can be shared.

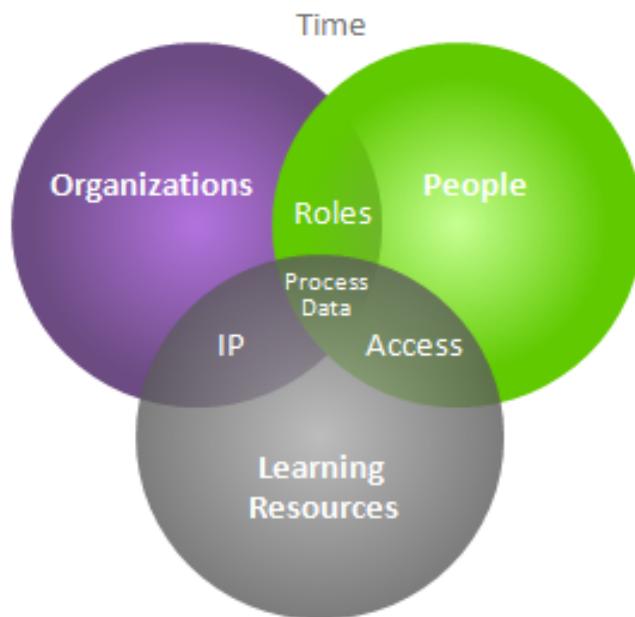
Traceability largely addresses the internal aspects of a P-20 system. It ensures that the data surrounding a person’s education can be persistently stored and accurately retrieved.

To provide a data model that promotes comparability and traceability across the P-20W spectrum, the data abstraction process must reconcile a myriad of sources, interpretations, and definitions for each data structure. Creating a highly normalized data model best 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, which is based upon 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.

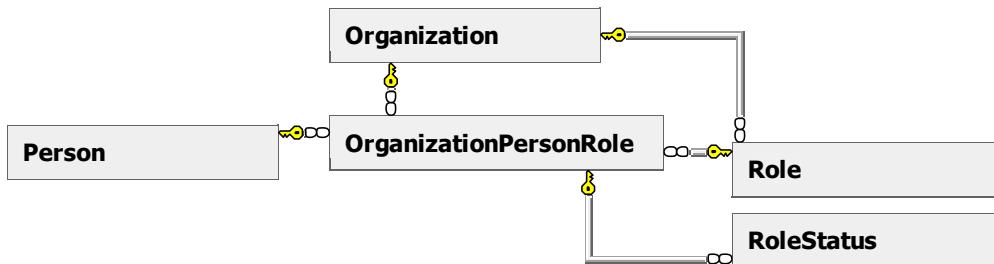


Note that people in the NDS only have roles in relationship to a specific organization and a designated date range. Persistent information about a person is modeled separate to the person's role and relationship to an organization.

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 exists, as defined in the **option set** of a CEDS element, the model uses a reference table. In the data model, reference tables use 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, 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**—Any thing 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

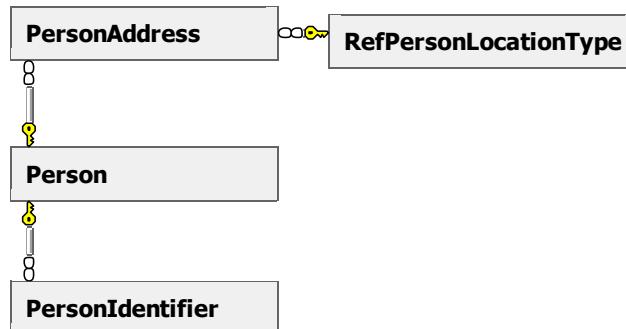
Tables are represented as a rectangle. The surrogate key is indicated by a key  symbol. This is shown in the image to the right.

TableName
SurrogateKey
FieldName

The function of the surrogate key is to uniquely identify one record from all other records within the same table. The CEDS model has utilized 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:



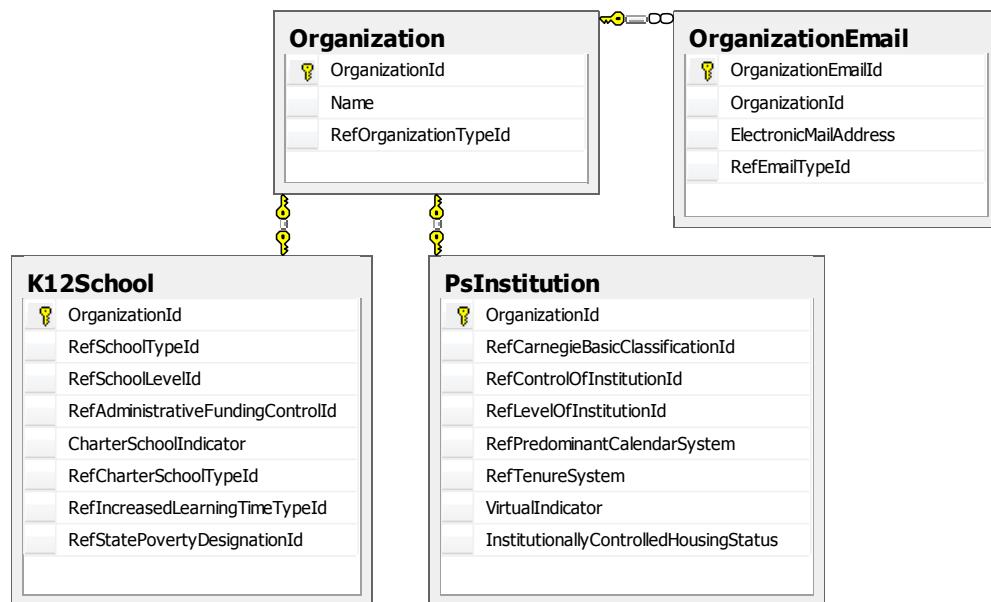
This diagram tells us that a Person may have an Address and an Identifier. The infinity  symbol tells us that there may be more than one Address and Identifier for a Person. We also know by the “Ref” table that the PersonLocationType field in the PersonAddress table uses a CEDS-controlled vocabulary.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

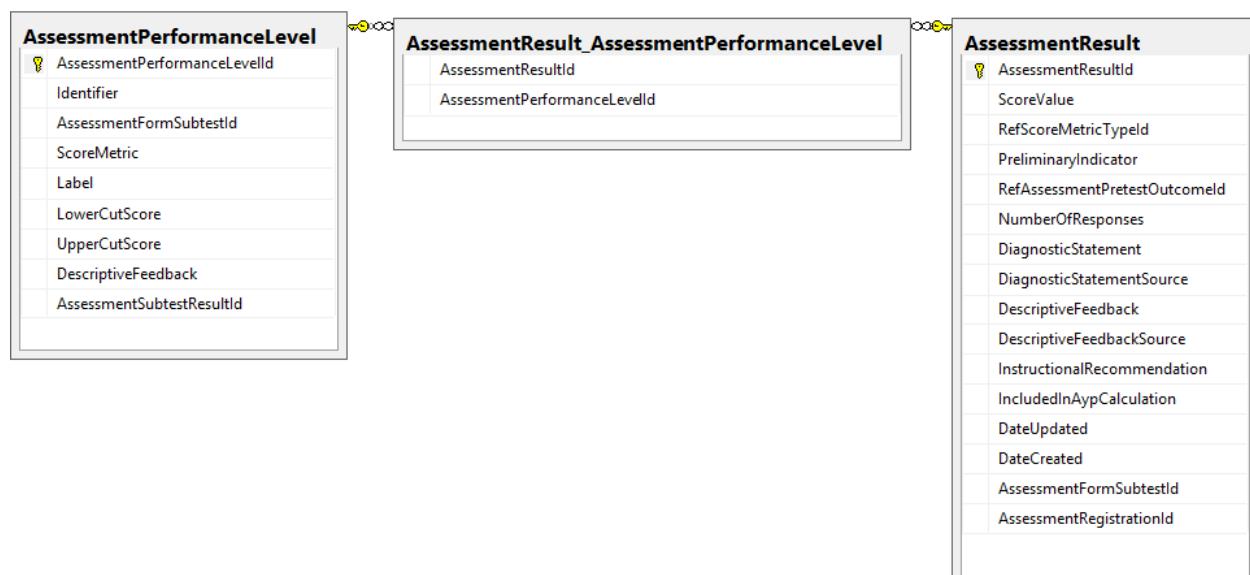
Definition

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 on the next page. 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.



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.

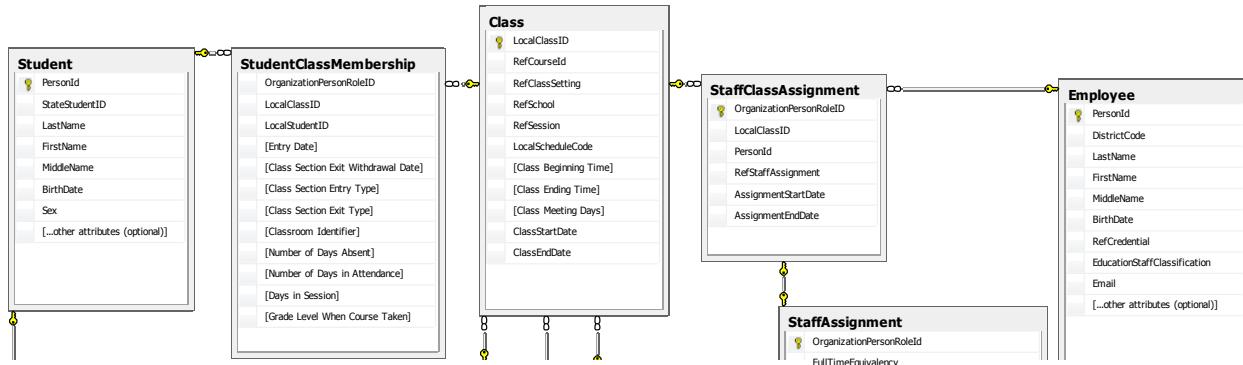
Case Study #1: The Teacher-Student Data Link—Data to Analyze Student Growth and Teacher Preparation

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 educator prep program effectiveness. 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 necessary issues 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.

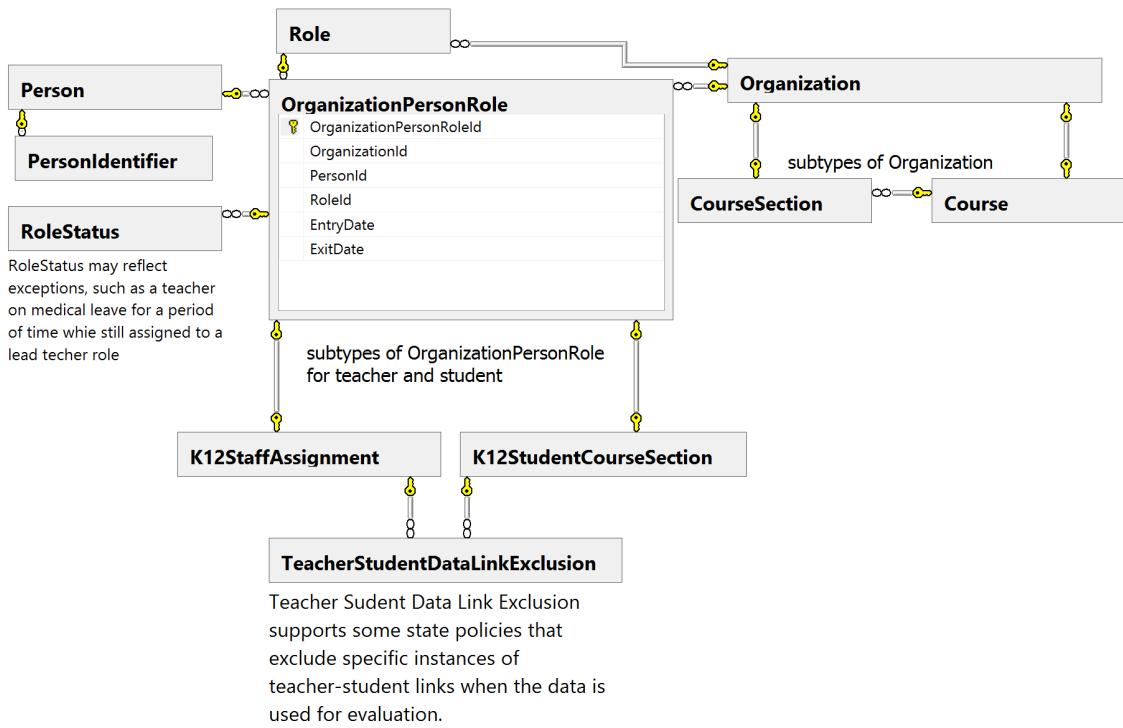
For more information, refer to the National Forum for Education Statistics’ document titled *Forum Guide to the Teacher-Student Data Link: A Technical Implementation Resource*, available at http://nces.ed.gov/forum/pub_2013802.asp. For information about teacher-student data link implementation, see the 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 Normalized Data Schema (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 prep 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.)

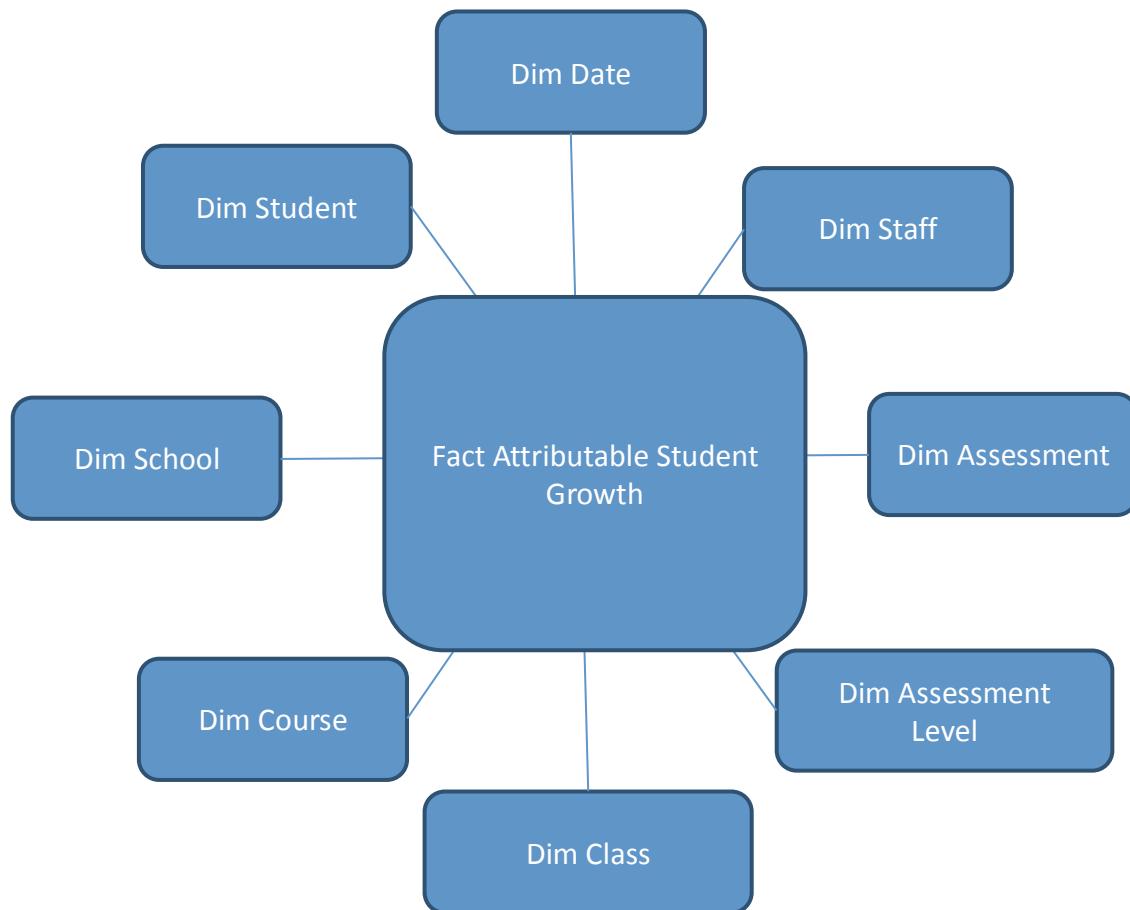
To transform the data from the K12 source system to the P-20W operational data schema, these actions must be taken:

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.

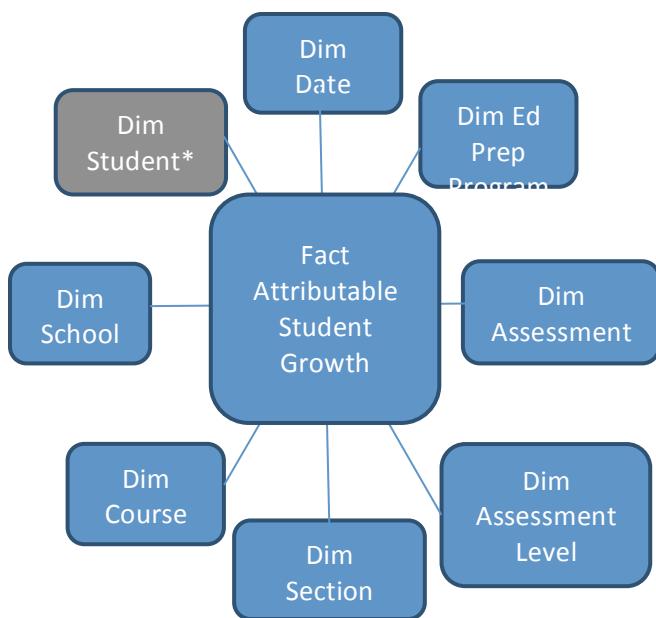
This example star schema, like the source system, is organized by a person's role (student, staff) in the context of a course section—i.e., the student enrolled in a course and the staff member assigned to a course. (The figure assumes that one growth or value-add methodology is used, but adding a “Dim

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.

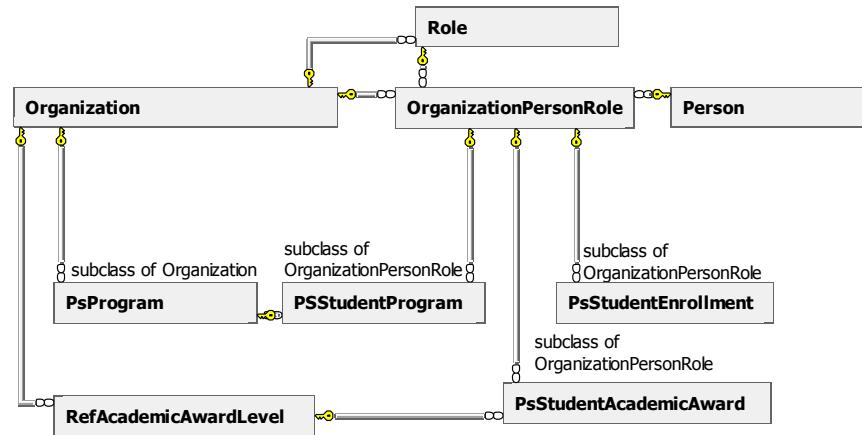
Since a teacher may have multiple degrees from multiple institutions, all being a part of his or her teacher preparation experience, we could redesign the star schema with a Dim Educator Prep Program.



* 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 so as 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).

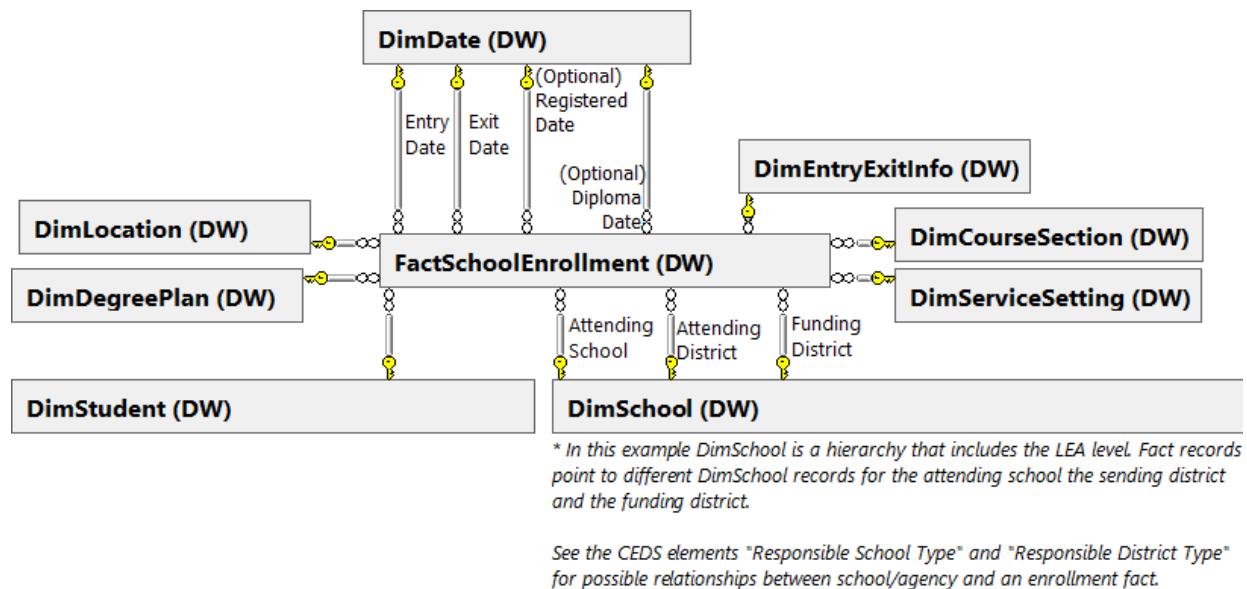
Case Study #2: Data Warehouse Star Schema for Student Enrollment

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. By optimized performance we meant that a database engine is able 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 in part by making the Fact tables “narrow.” Fact records are “narrow” in that they are limited to non-string values 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.

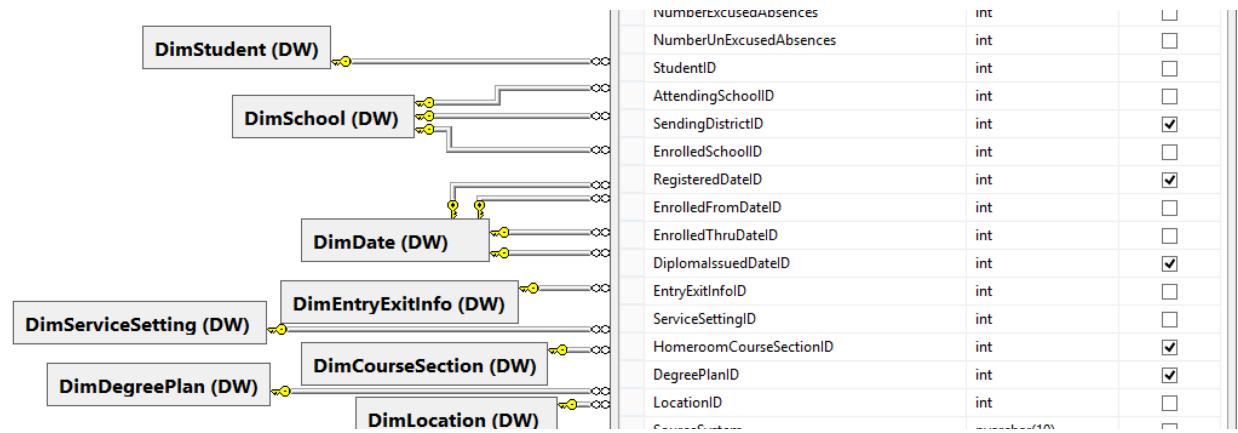
By designing the Fact table to store data at a granular level, the model maximizes flexibility for ad-hoc queries, i.e., the model is not designed for a limited number of predefined queries, but can sort and select aggregations of the granular measurements based on the selection of any number of attributes 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 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 may also be aligned with CEDS at the element level.

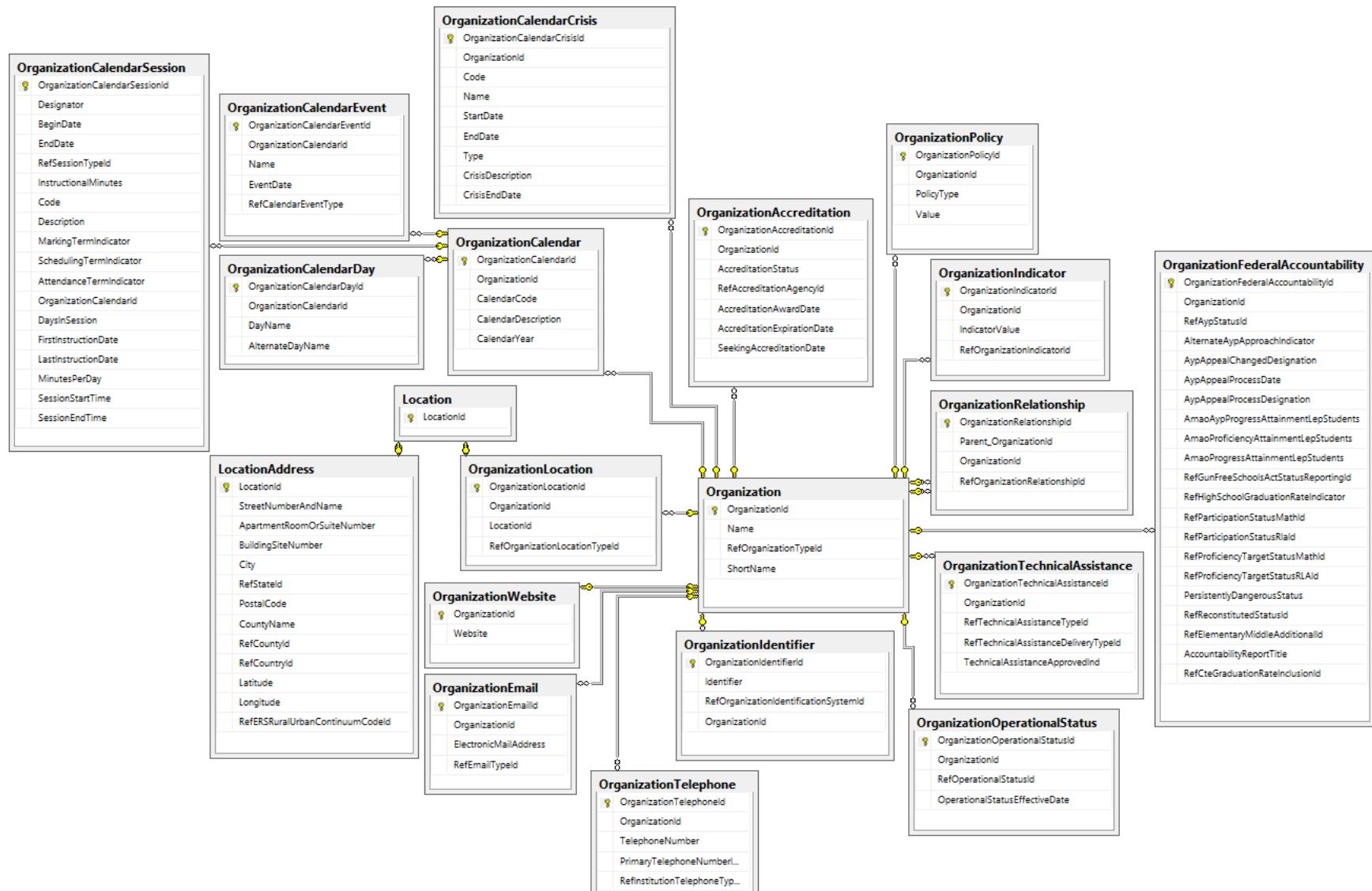
APPENDIX A: NDS ENTITY RELATIONSHIP DIAGRAMS

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

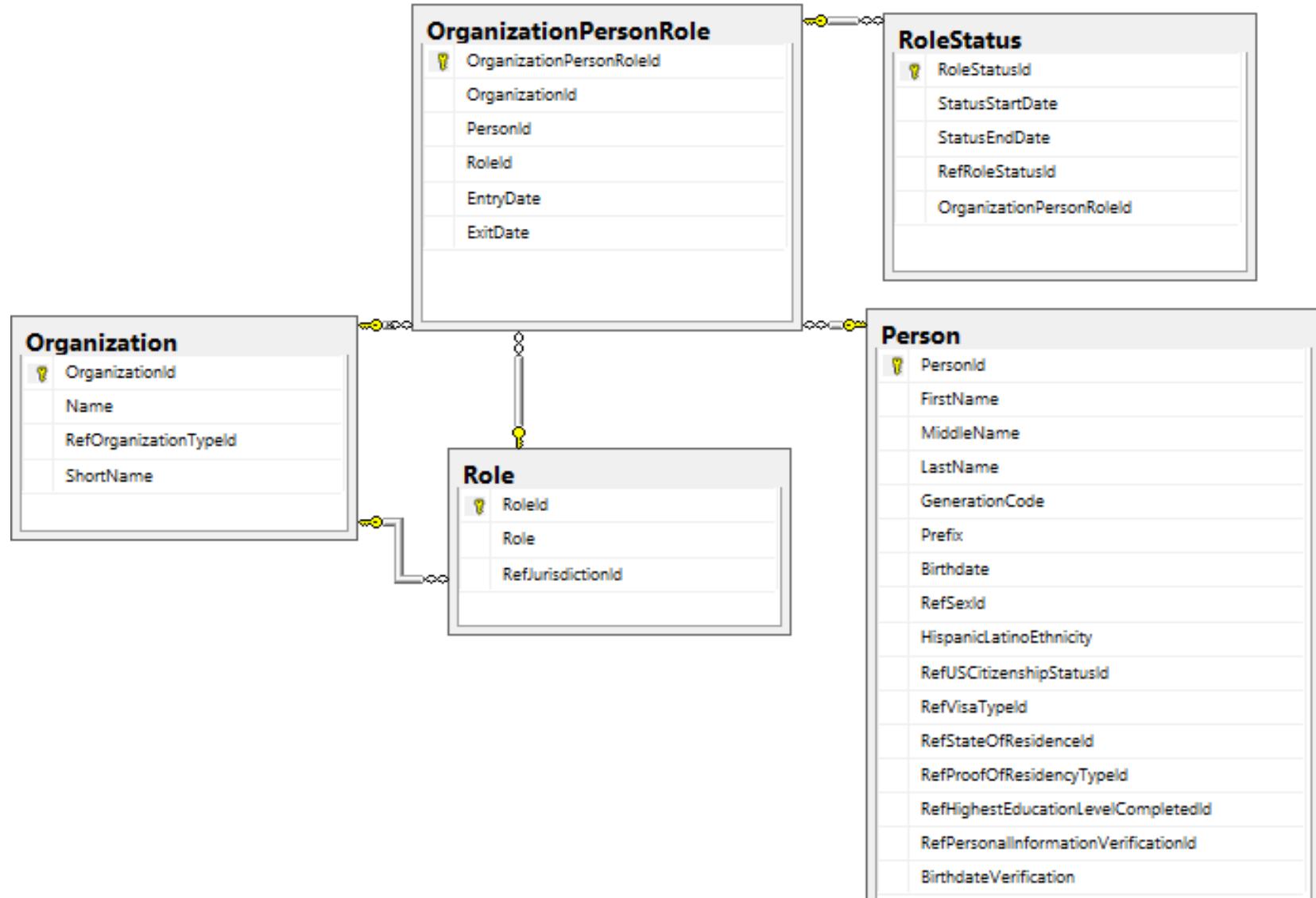
Common: Person



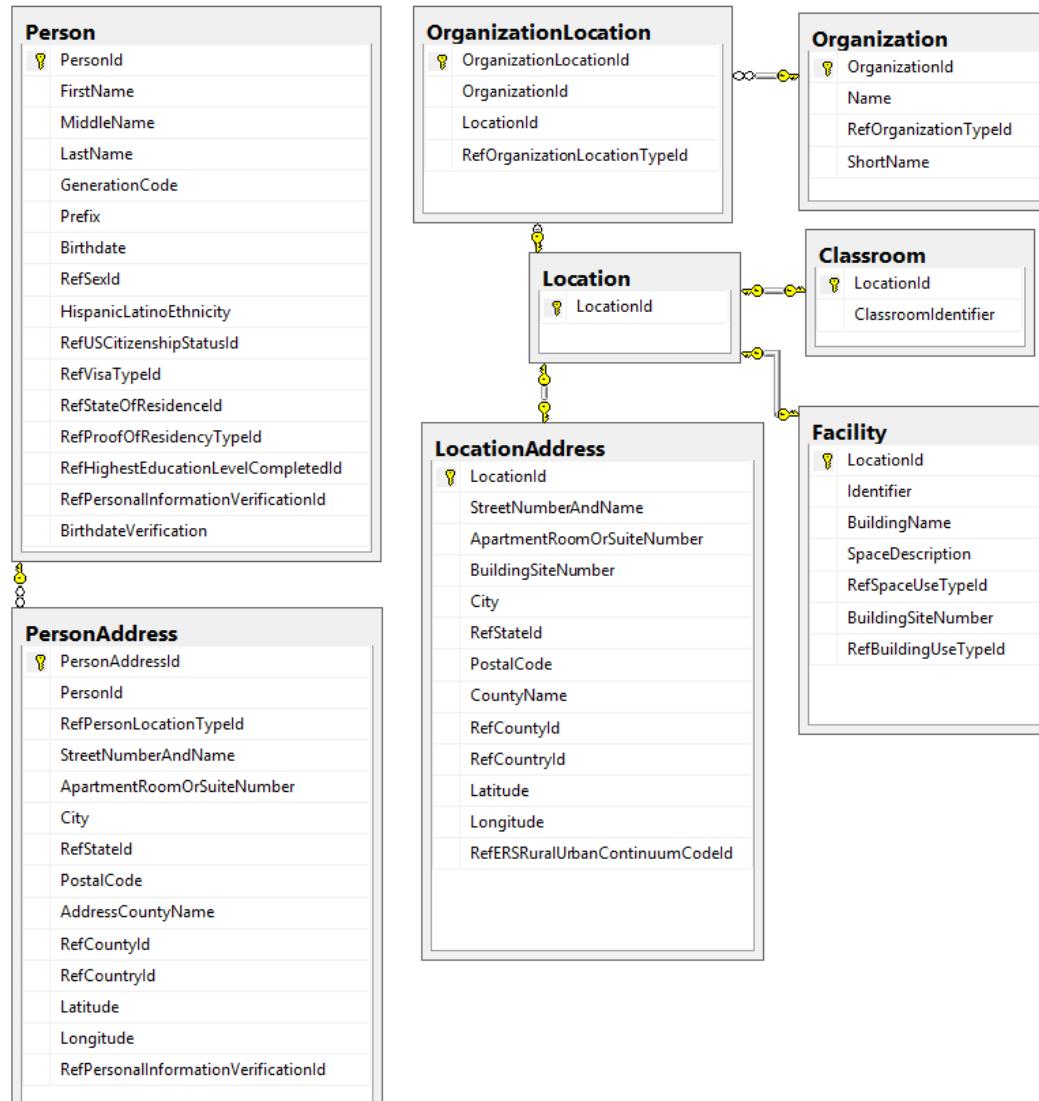
Common: Organization



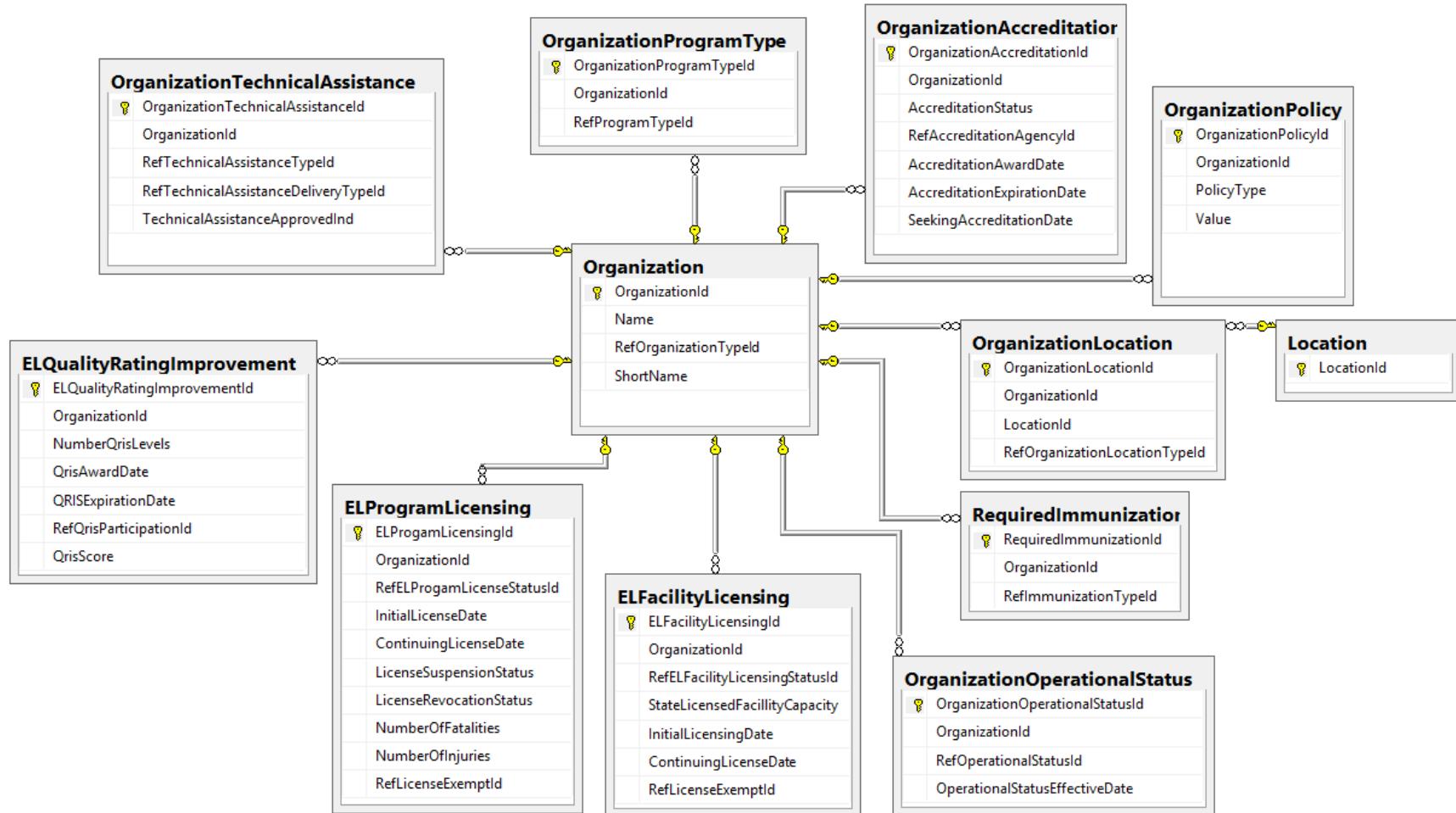
Common: Role



Common: Location

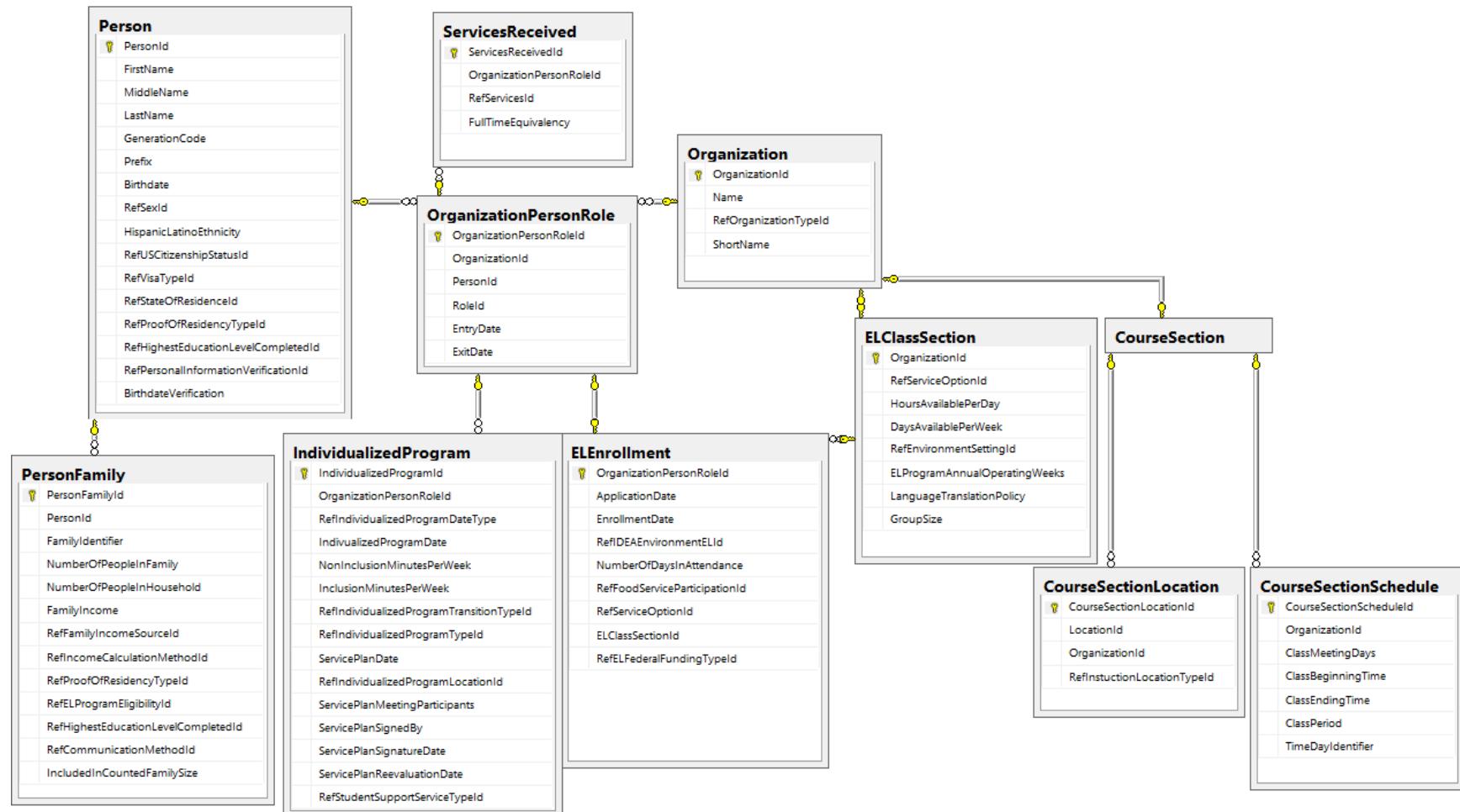


Early Learning: Organization

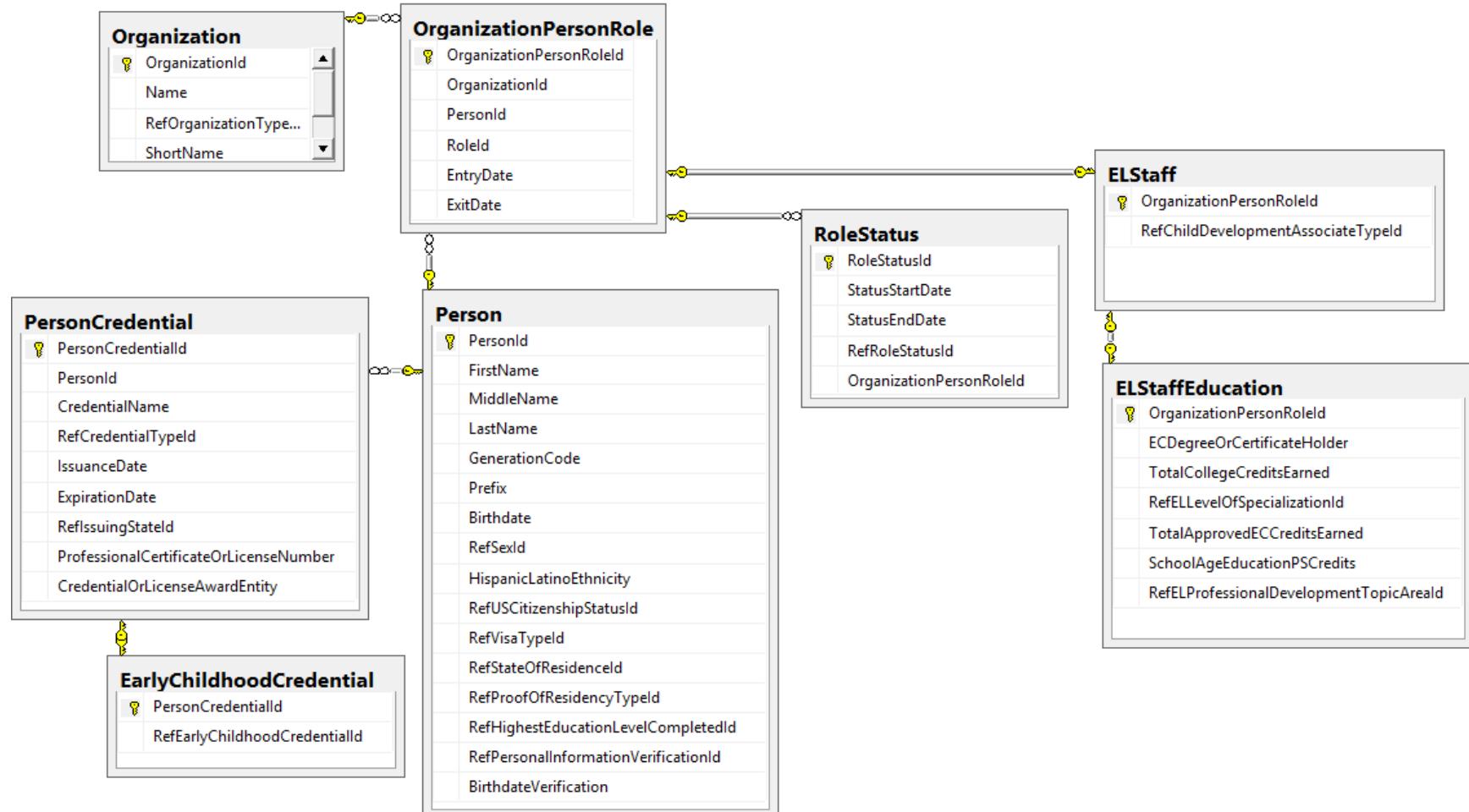


Early Learning: Participation

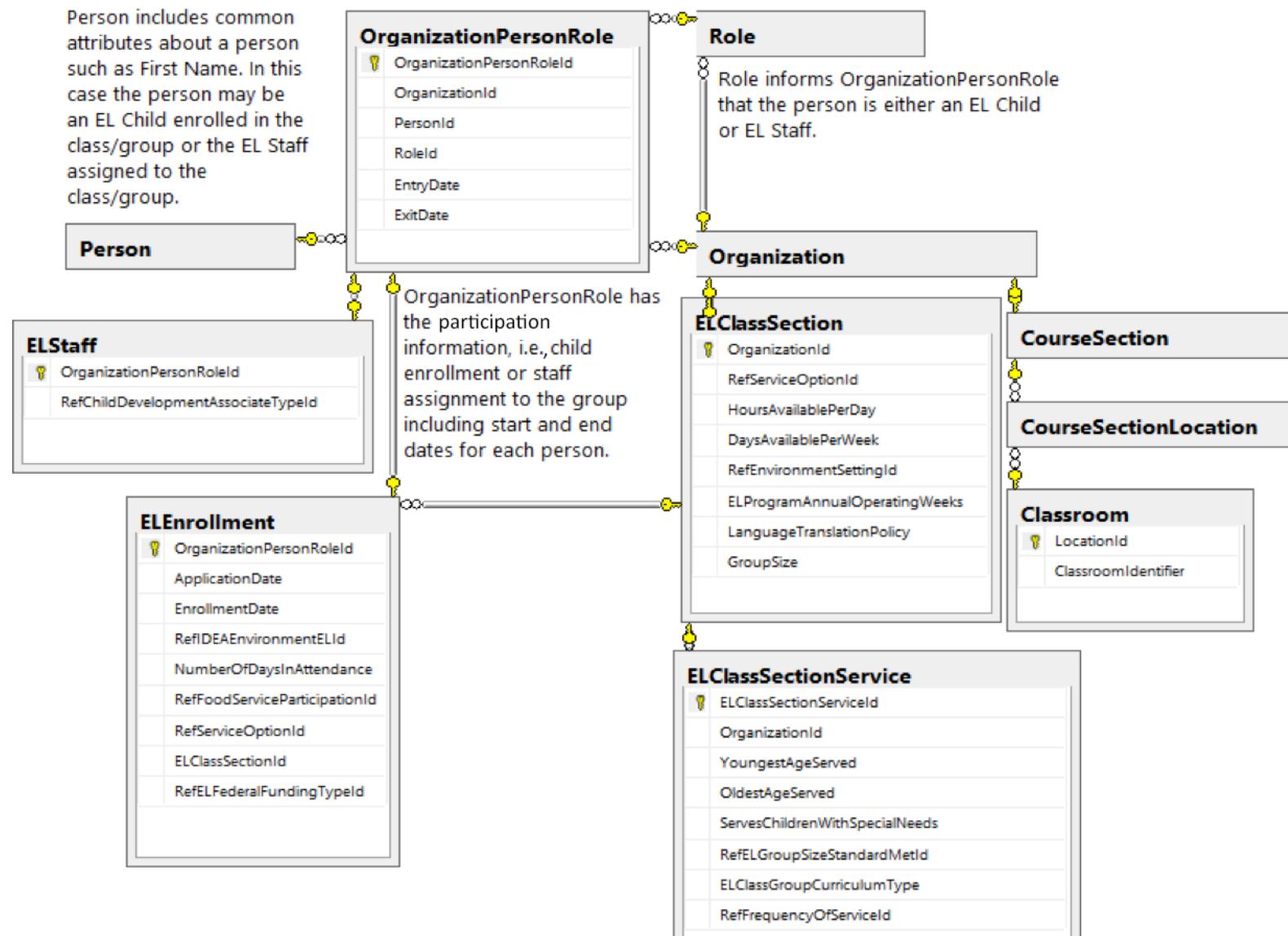
Early Learning Participant



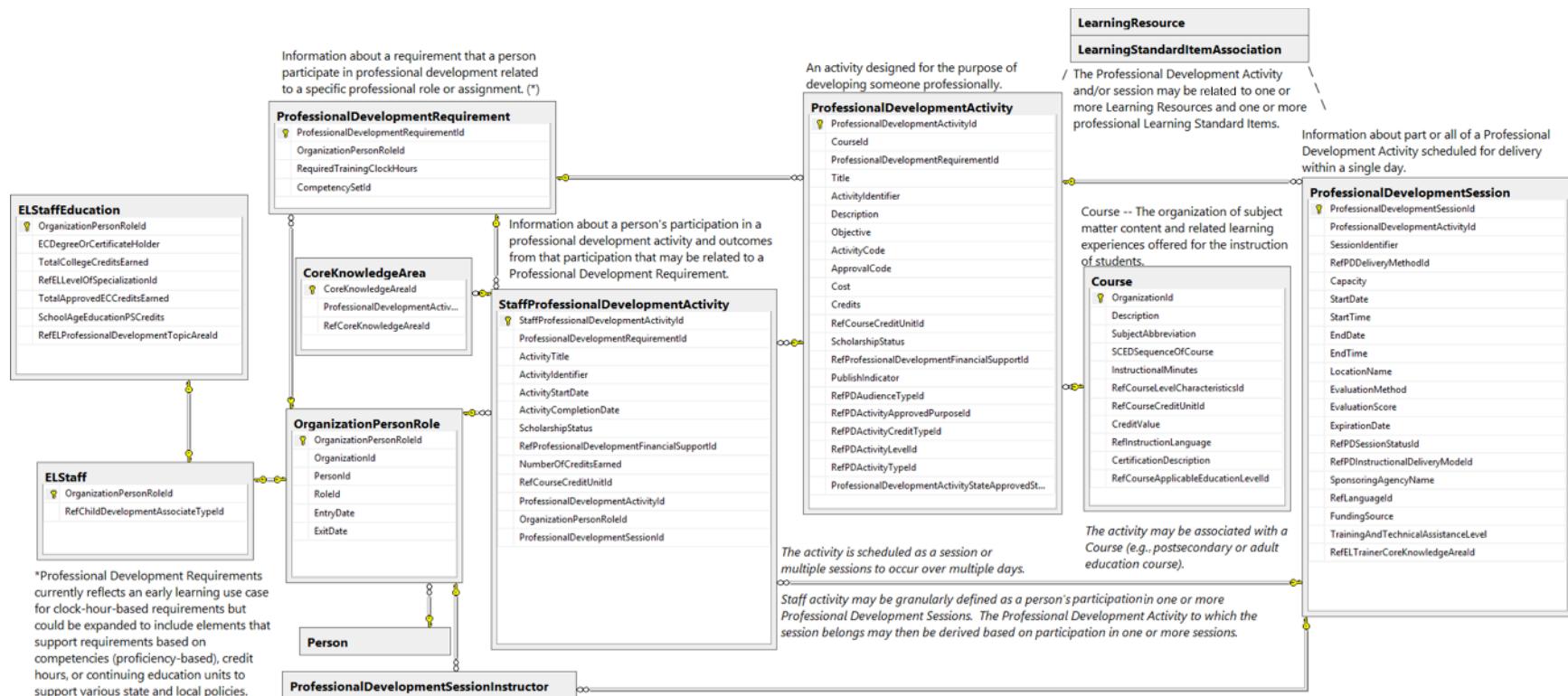
Early Learning: Staff



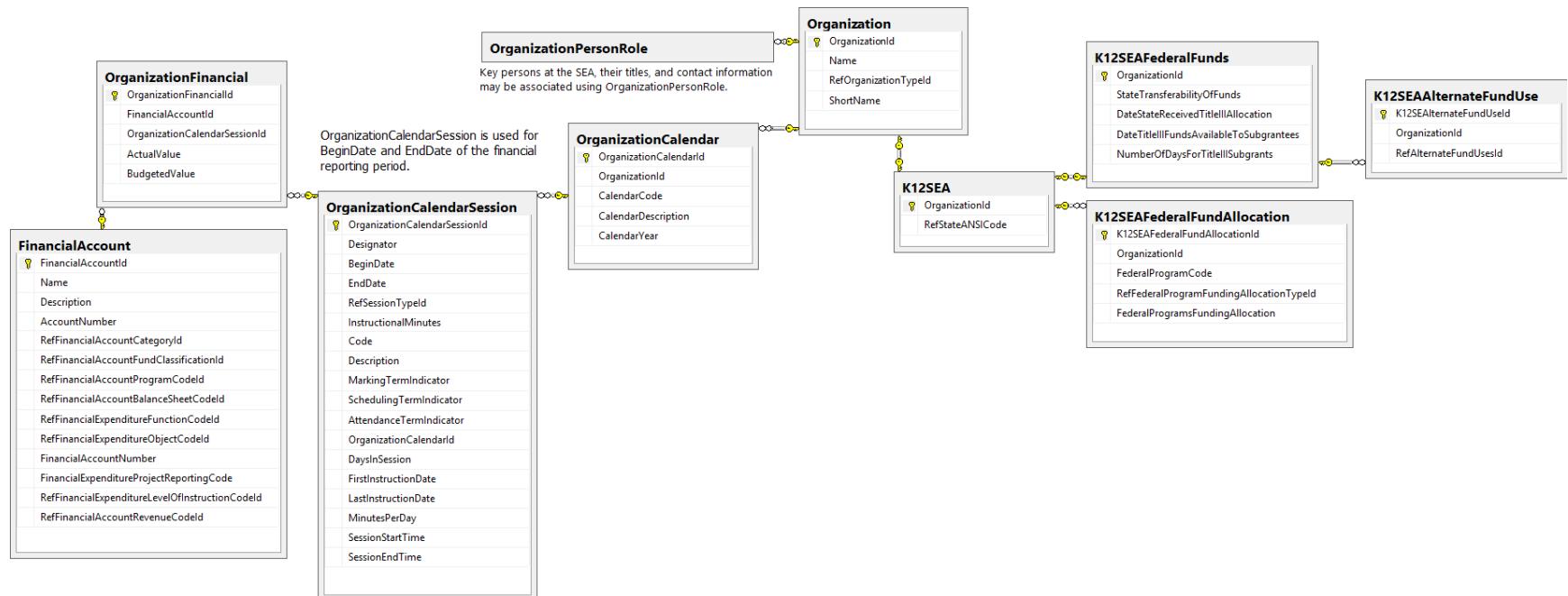
Early Learning: Class Group



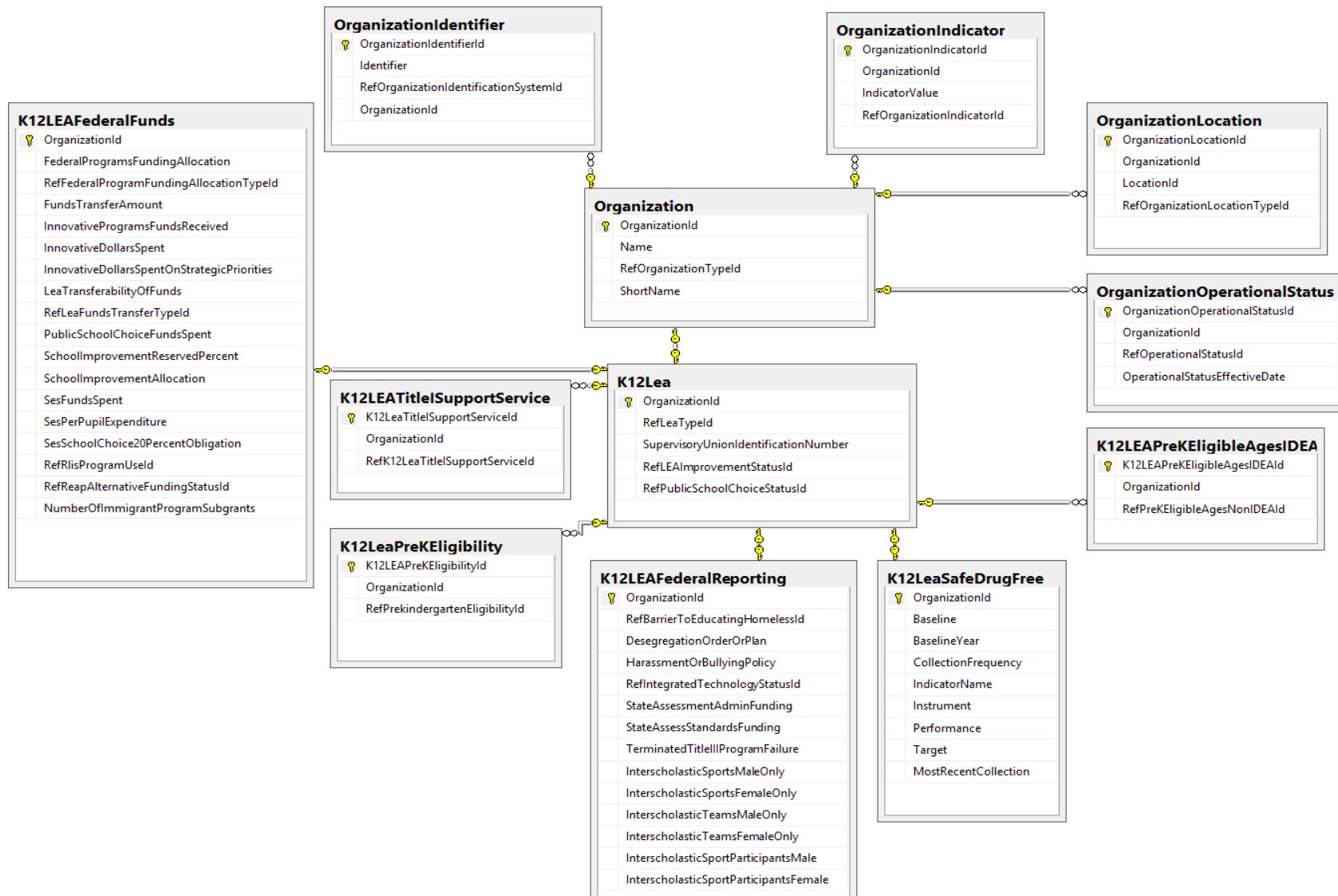
Early Learning: Professional Development



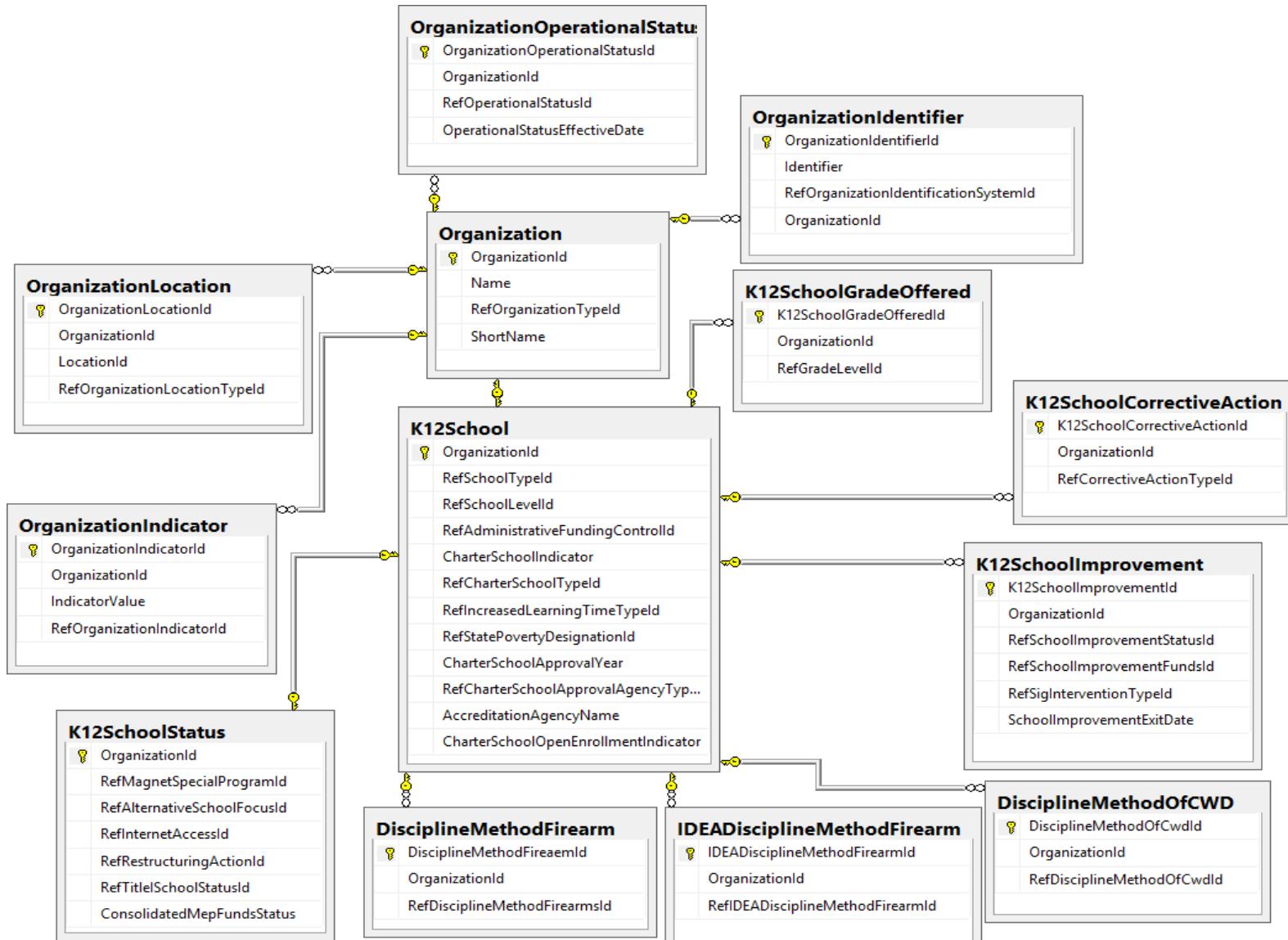
K12: SEA



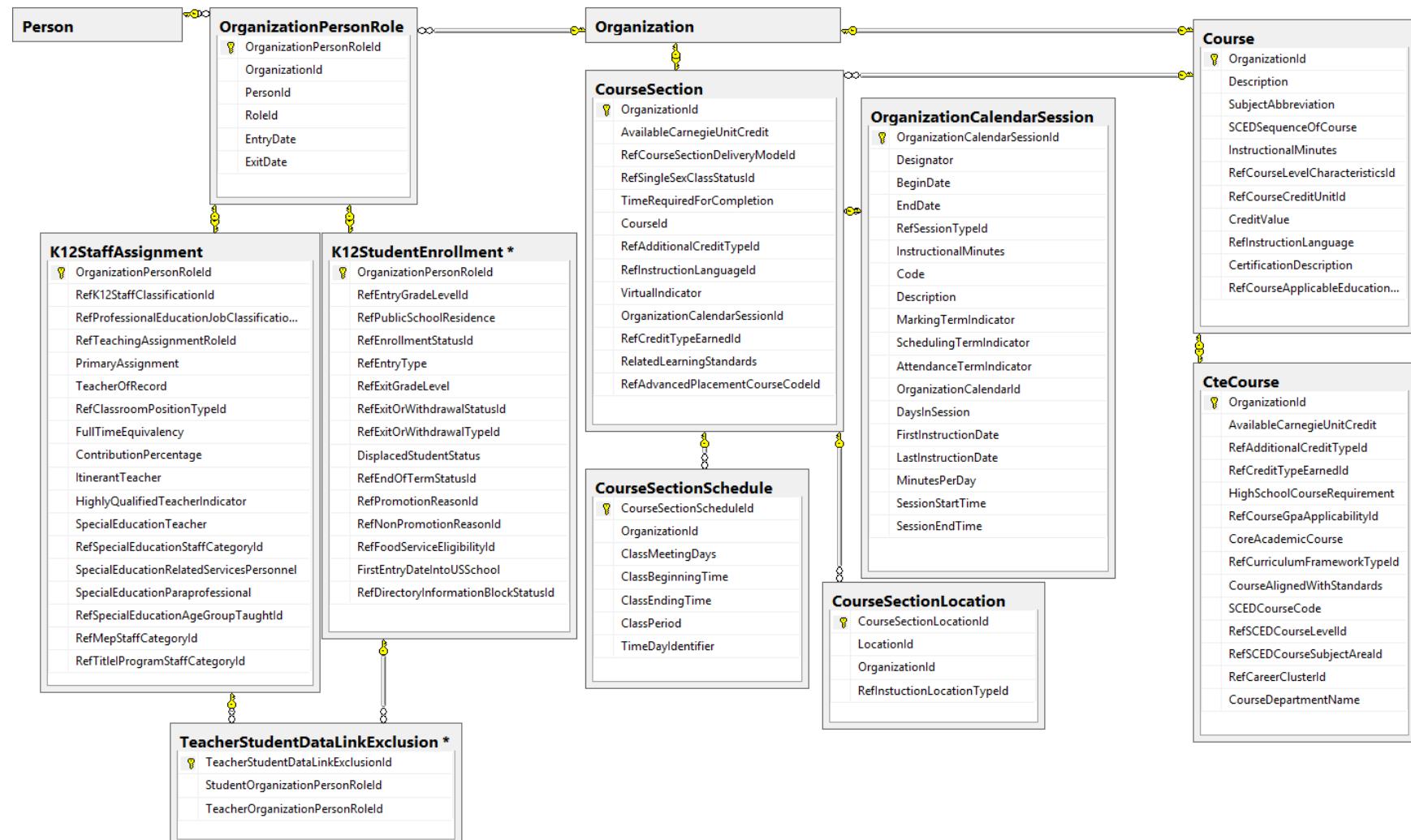
K12: LEA



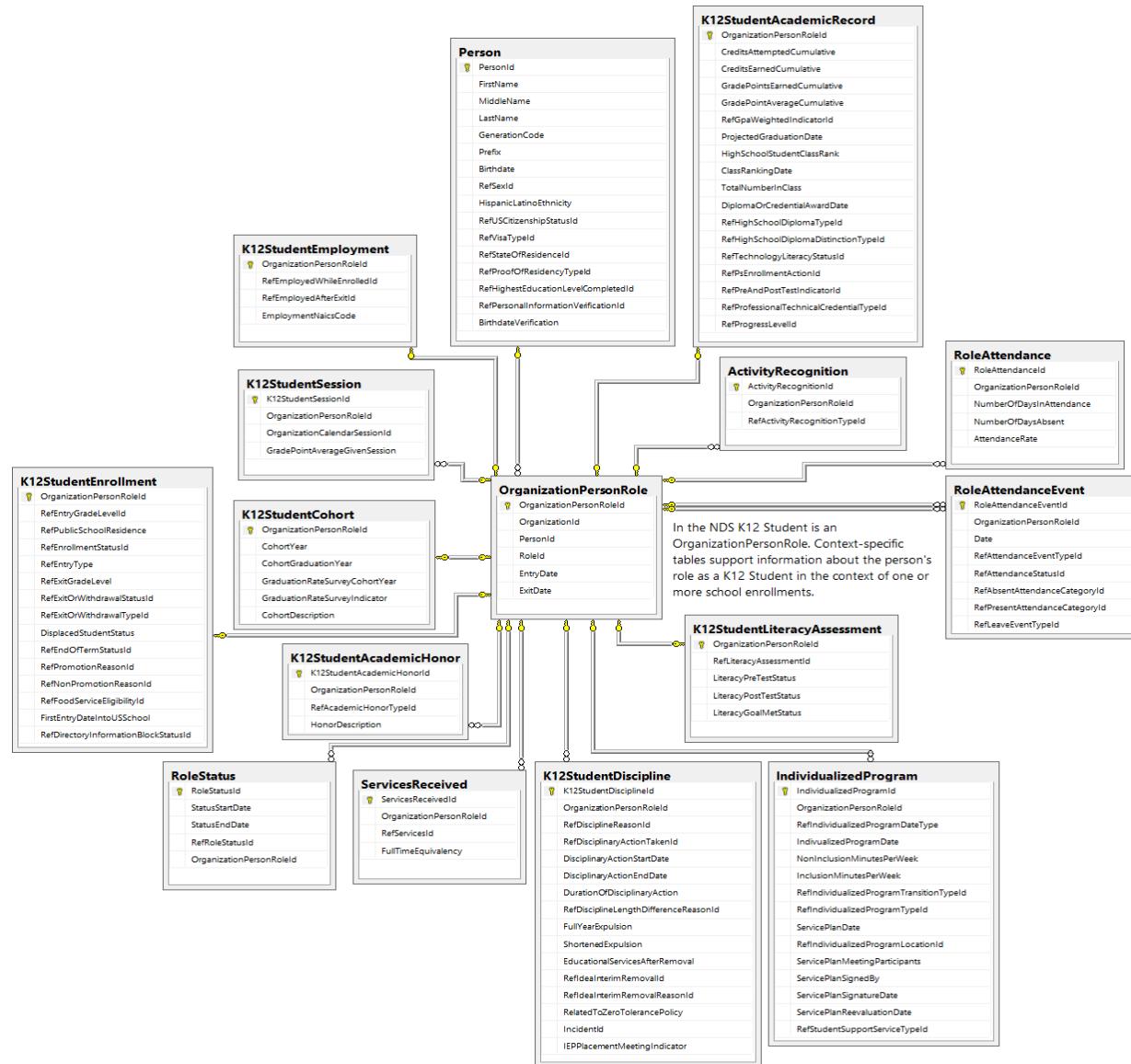
K12: School



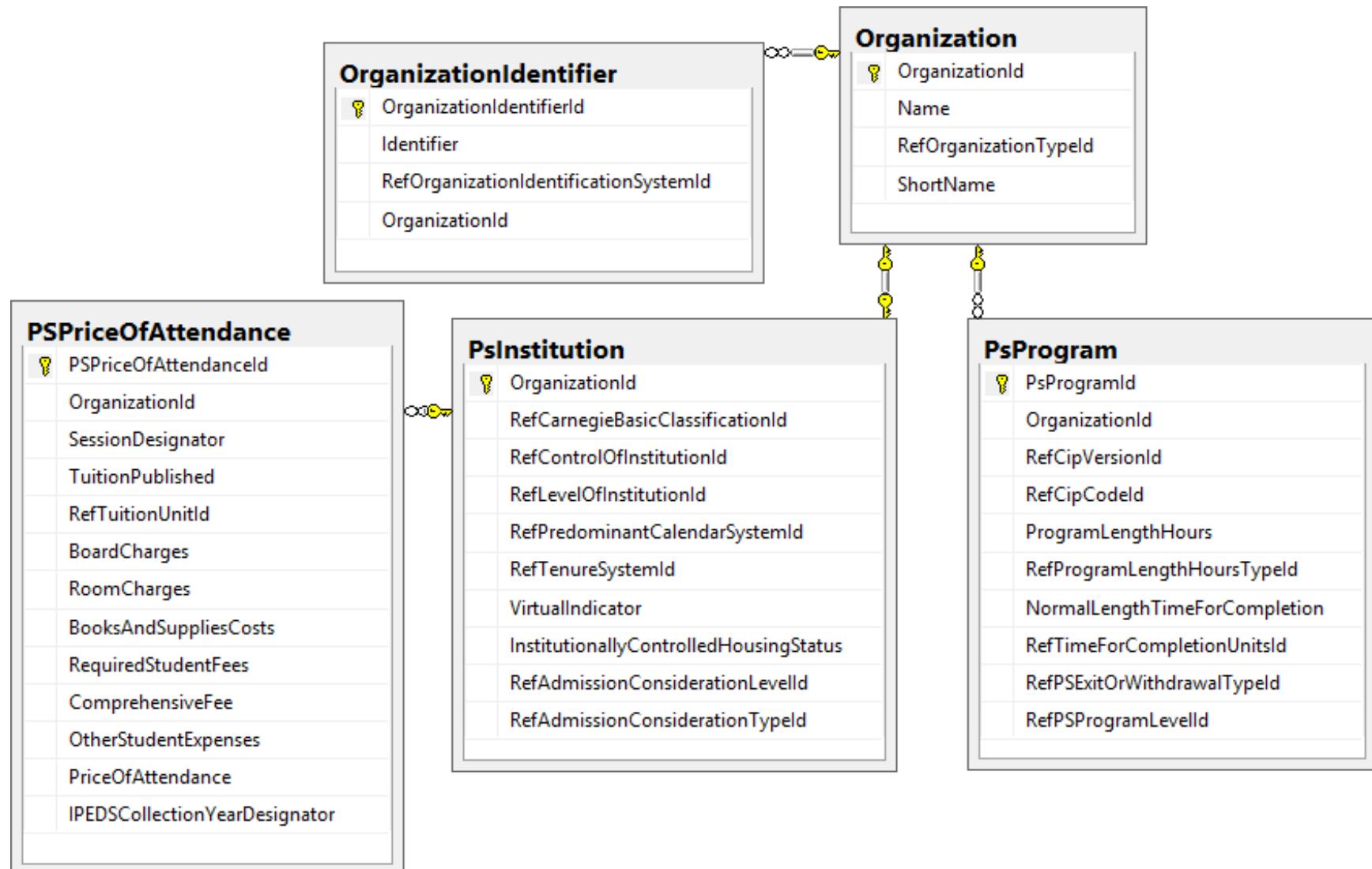
K12: Course Section



K12: Student



Postsecondary: Institution



Postsecondary: Student

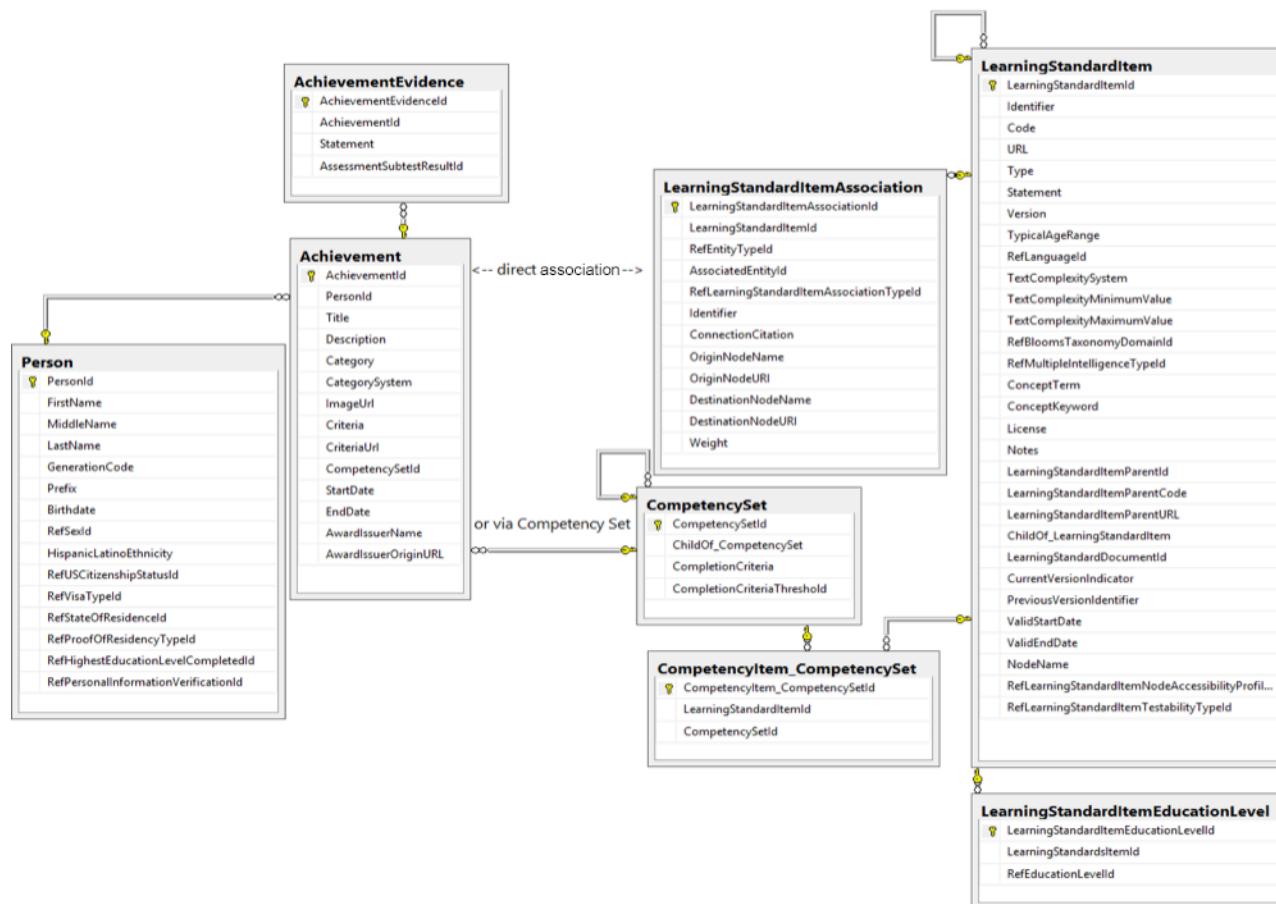


Achievement

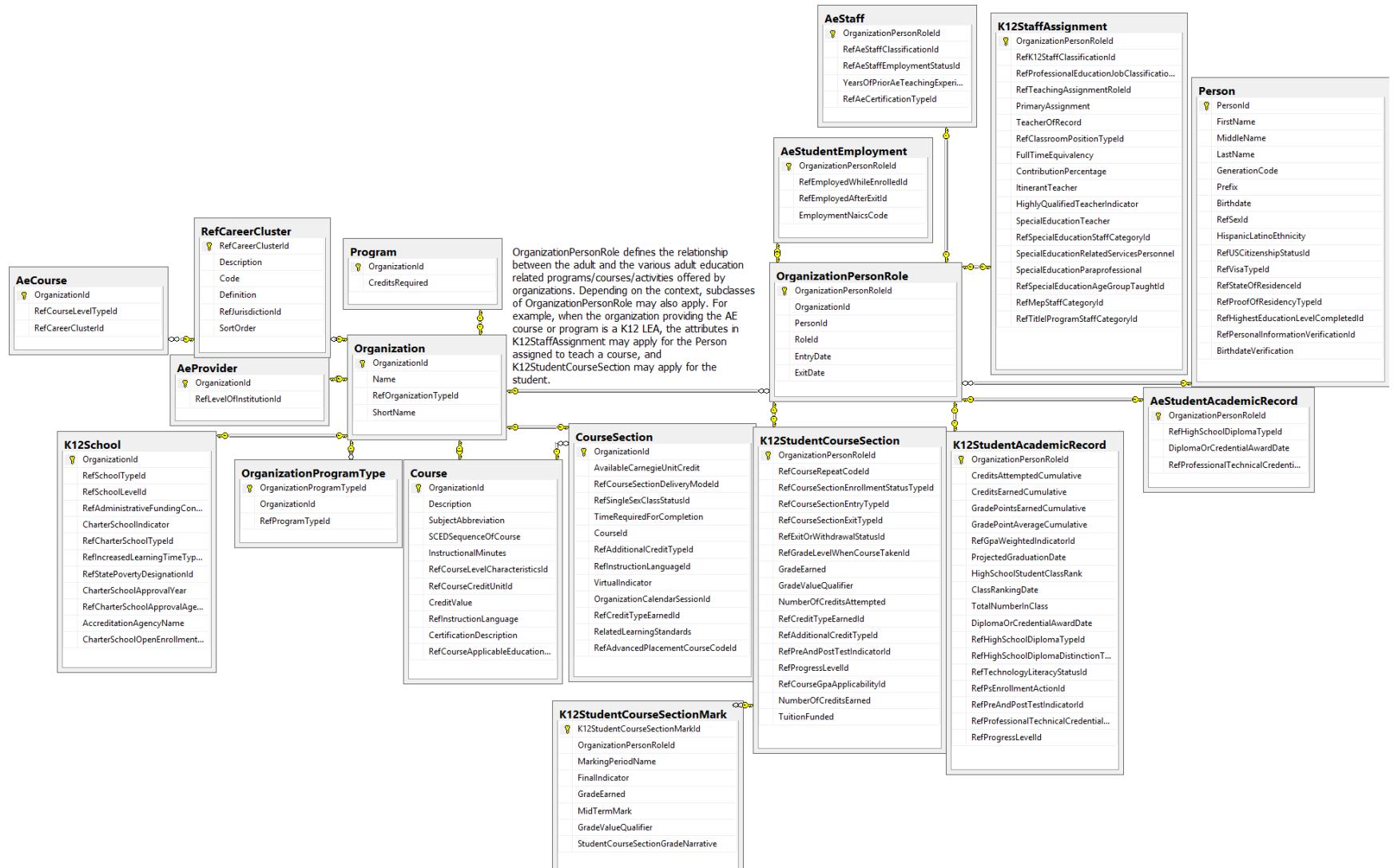
In CEDS an "Achievement" is a recognition earned by a learner upon fulfilling a specified criteria. It could be specific, such as the ability to add two digit numbers, or more summative, such as meeting all proficiency requirements for a professional license. CEDS data elements defined for an Achievement are compatible with the metadata used for digital badges, e.g., the Mozilla Foundation's OpenBadges.

Achievements are associated with one or more Learning Standard Item(s), a.k.a. Competencies, and may include criteria logic when the achievement represents a set of competencies. The data model supports competencies as nodes in an educational framework or pathways in a learning progression.

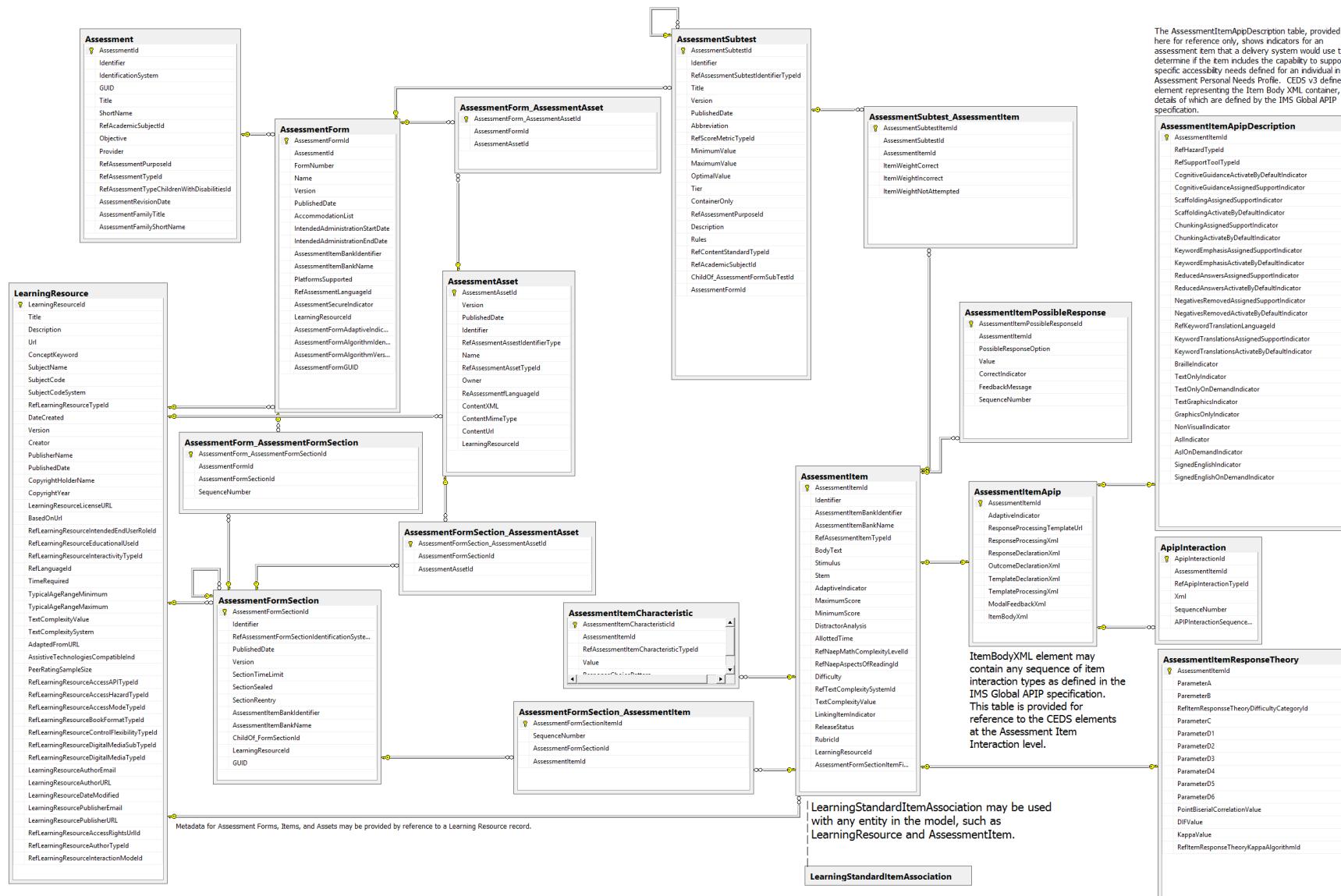
An Achievement is associated with evidence, e.g., one or more assessment results.



Adult Education



Assessment: Design



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	
RefAssessmentPurposelId	
RefAssessmentReasonNotTestedId	
RefAssessmentReasonNotCompletingId	
RefGradeLevelToBeAssessedId	
RefGradeLevelWhenAssessedId	
PersonId	
AssessmentFormId	
OrganizationId	
SchoolOrganizationId	
LeaOrganizationId	
AssessmentAdministrationId	
AssignedByPersonId	
AssessmentRegistrationCompletionStatusDateTime	
RefAssessmentRegistrationCompletionStatusId	

Information for an assessment event or administration period.

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

*Related tables include information about a person's results from an assessment. (See "Assessment Results"), accommodations, and personal needs profile.

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	

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

Person	
PersonId	
FirstName	
MiddleName	
LastName	
GenerationCode	
Prefix	
Birthdate	
RefSexId	
HispanicLatinoEthnicity	
RefUSCitizenshipStatusId	
RefVisaTypeid	
RefStateOfResidenceId	
RefProofOfResidencyTypeid	
RefHighestEducationLevelCompletedId	
RefPersonalInformationVerificationId	
BirthdateVerification	

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

AssessmentSession	
AssessmentSessionId	
AssessmentAdministrationId	
ScheduledStartTime	
ScheduledEndTime	
ActualStartTime	
ActualEndTime	
AllottedTime	
RefAssessmentSessionTypeid	
SecurityIssue	
RefAssessmentSessionSpecialCircumstanceTypeid	
SpecialEventDescription	
Location	
OrganizationId	
Lea_OrganizationId	
School_OrganizationId	

Roles served related to the administration of an assessment session.

AssessmentSessionStaffRole	
AssessmentSessionStaffRoleId	
RefAssessmentSessionStaffRoleTypeid	
PersonId	
AssessmentSessionId	
AssessmentParticipantSessionId	

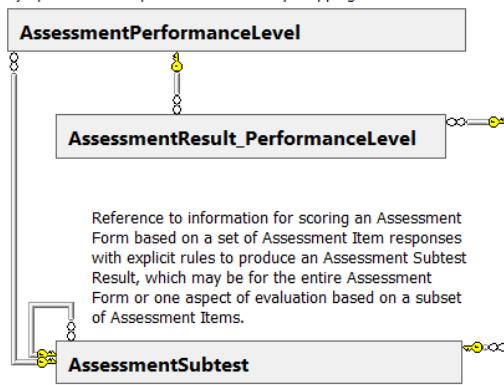
AssessmentPersonalNeedsProfile	
AssessmentPersonalNeedsProfileId	
AssessmentNeedType	
AssignedSupportFlag	
ActivateByDefault	

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

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
- 4) Specification of performance level by mapping to other scores



Reference to 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.

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
RefScoreMetricTypeld
PreliminaryIndicator
RefAssessmentPretestOutcomeld
NumberOfResponses
DiagnosticStatement
DiagnosticStatementSource
DescriptiveFeedback
DescriptiveFeedbackSource
InstructionalRecommendation
IncludedInAypCalculation
DateUpdated
DateCreated
AssessmentFormSubtestld
AssessmentRegistrationId
RefELOutcomeMeasurementLevelld
RefOutcomeTimePointld
AssessmentResultDescriptiveFeedbackDa...
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

LearnerActionId
AssessmentItemResponseld
RefLearnerActionTypeld
Value
Time
Date
LearnerActionActorIdentifier
LearnerActionObjectDescription
LearnerActionObjectIdentifier
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.

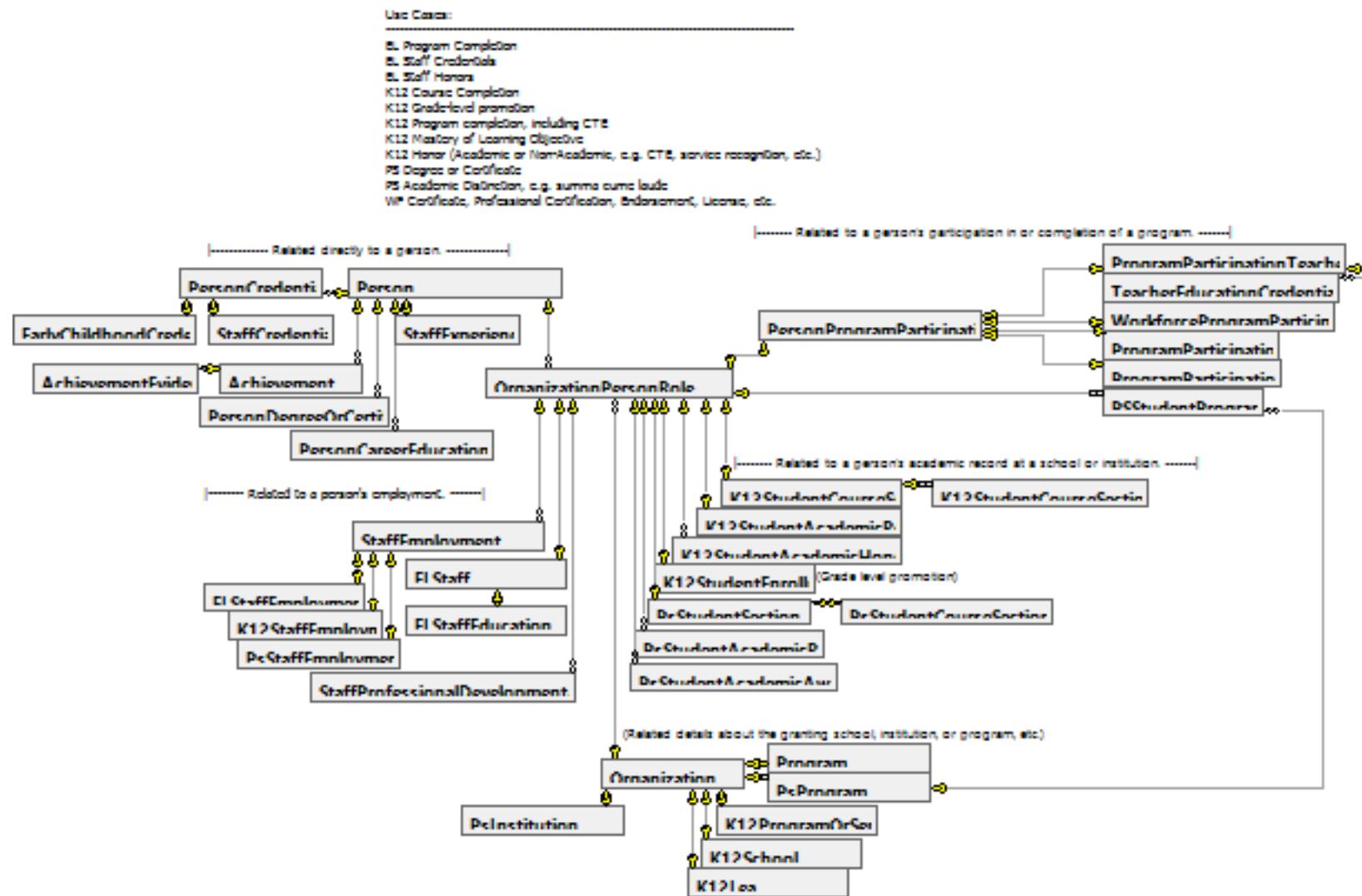
AssessmentItemResponse

AssessmentItemResponseld
Value
ScoreValue
RefAssessmentItemResponseStatusId
RefProficiencyStatusId
AidSetUsed
DescriptiveFeedback
ScaffoldingItemFlag
HintCount
HintIncludedAnswer
Duration
FirstAttemptDuration
StartTime
StartDate
SecurityIssue
AssessmentItemld
AssessmentParticipantSessionId
ResultXML
AssessmentItemResponseDescriptiveFeedbackDate
RefAssessmentItemResponseScoreStatusId

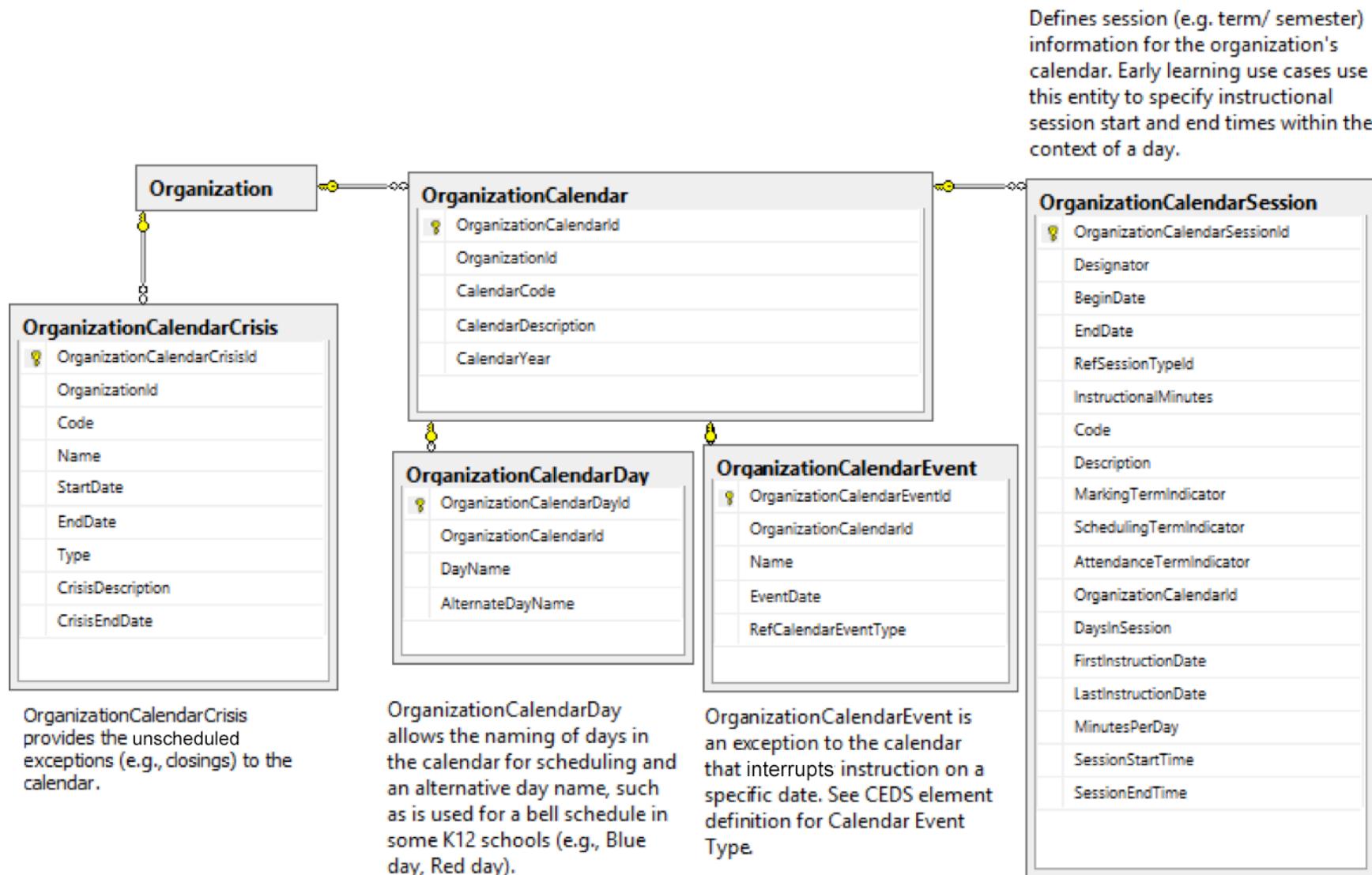
AssessmentRegistration

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

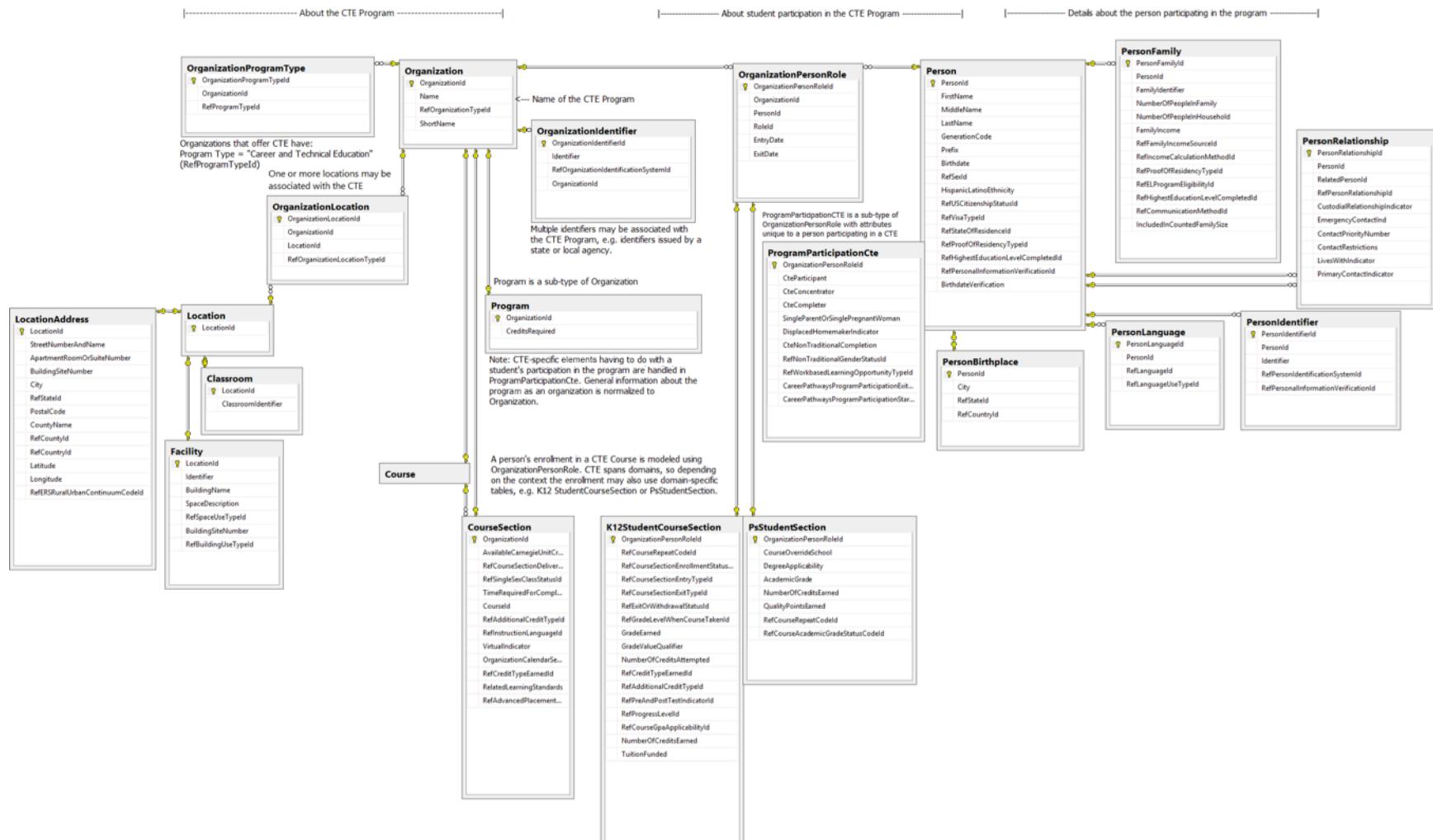
Awards, Honors, Credentials



Calendar

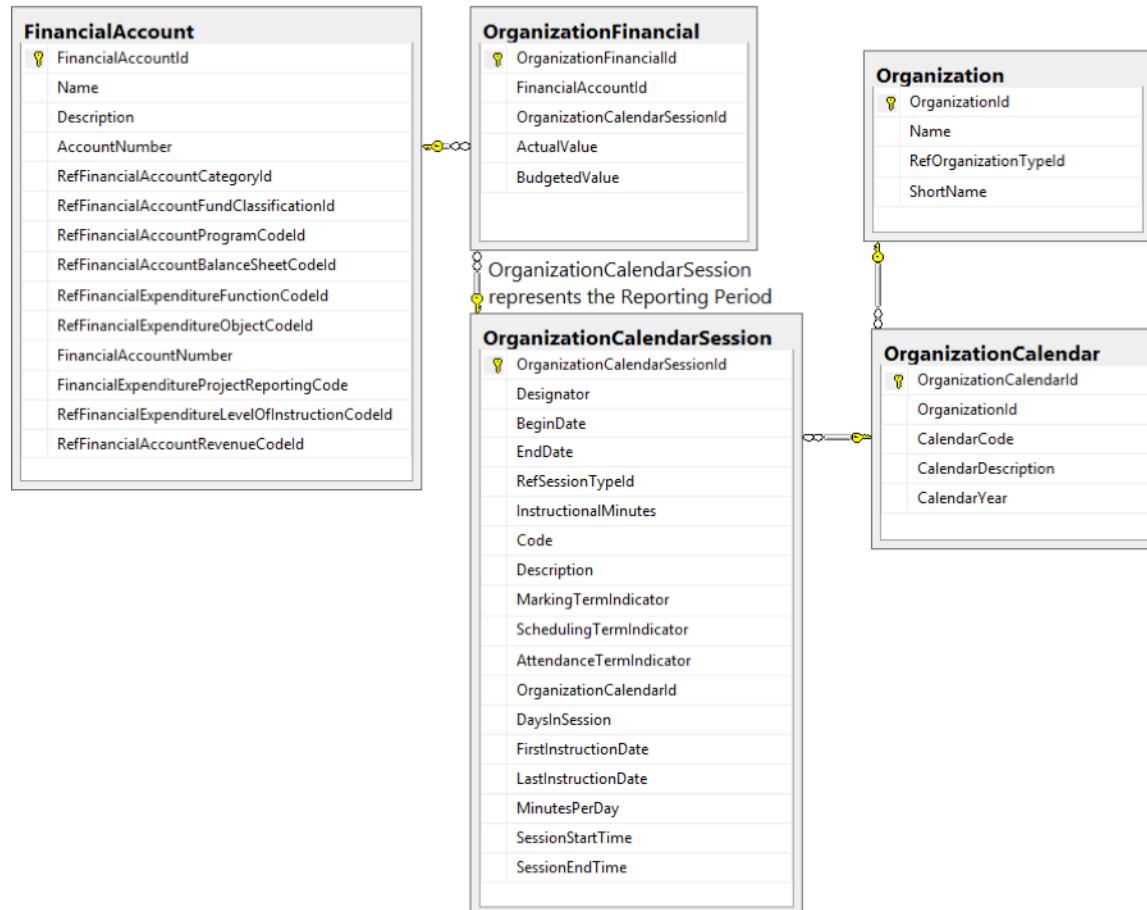


Career and Technical Education



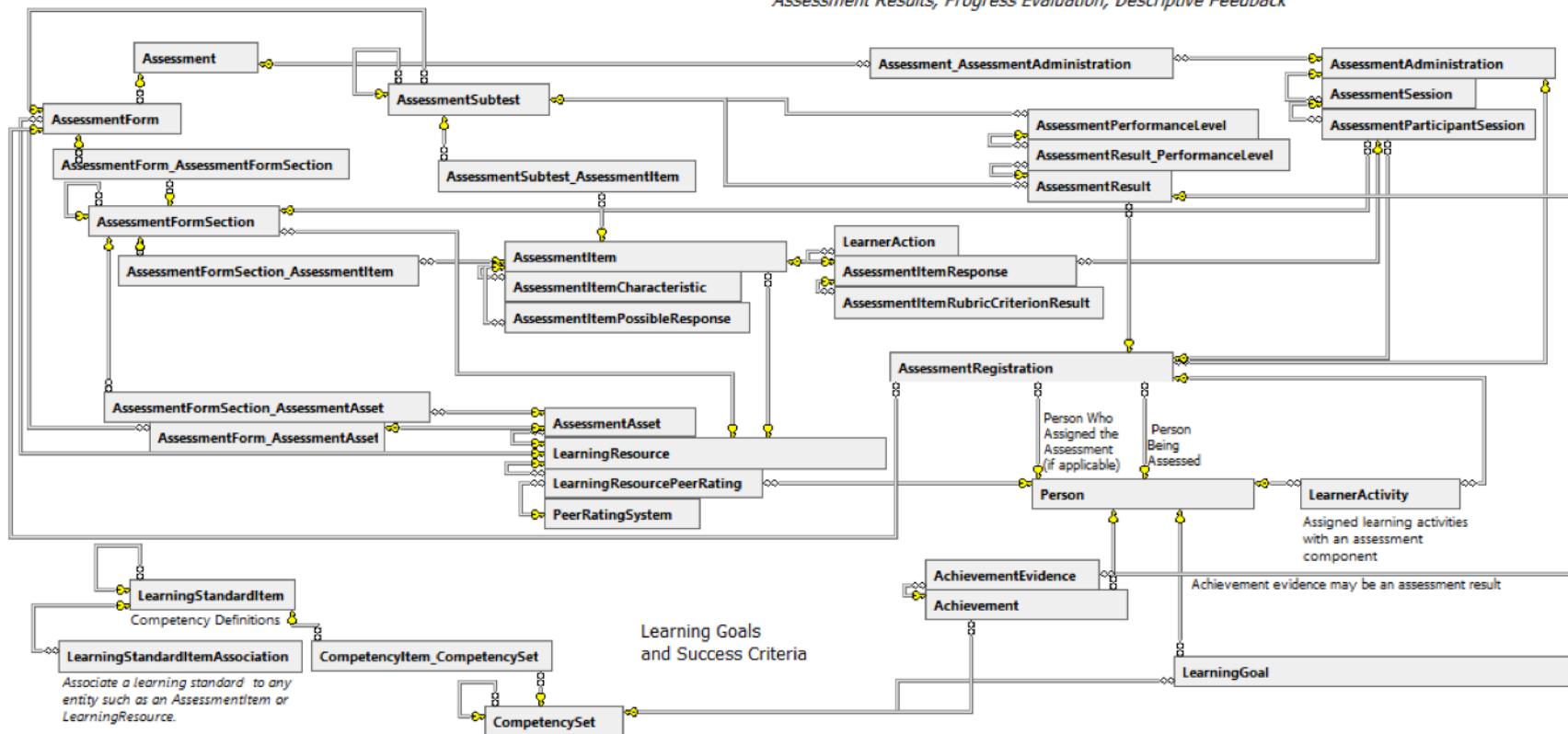
Financial Reporting

OrganizationFinancial includes the CEDS elements "Financial Accounting Period Actual Value" and "Financial Accounting Period Budgeted Value".
The values represent amounts reported by an organization for a reporting period specified by the related OrganizationCalendarSession.

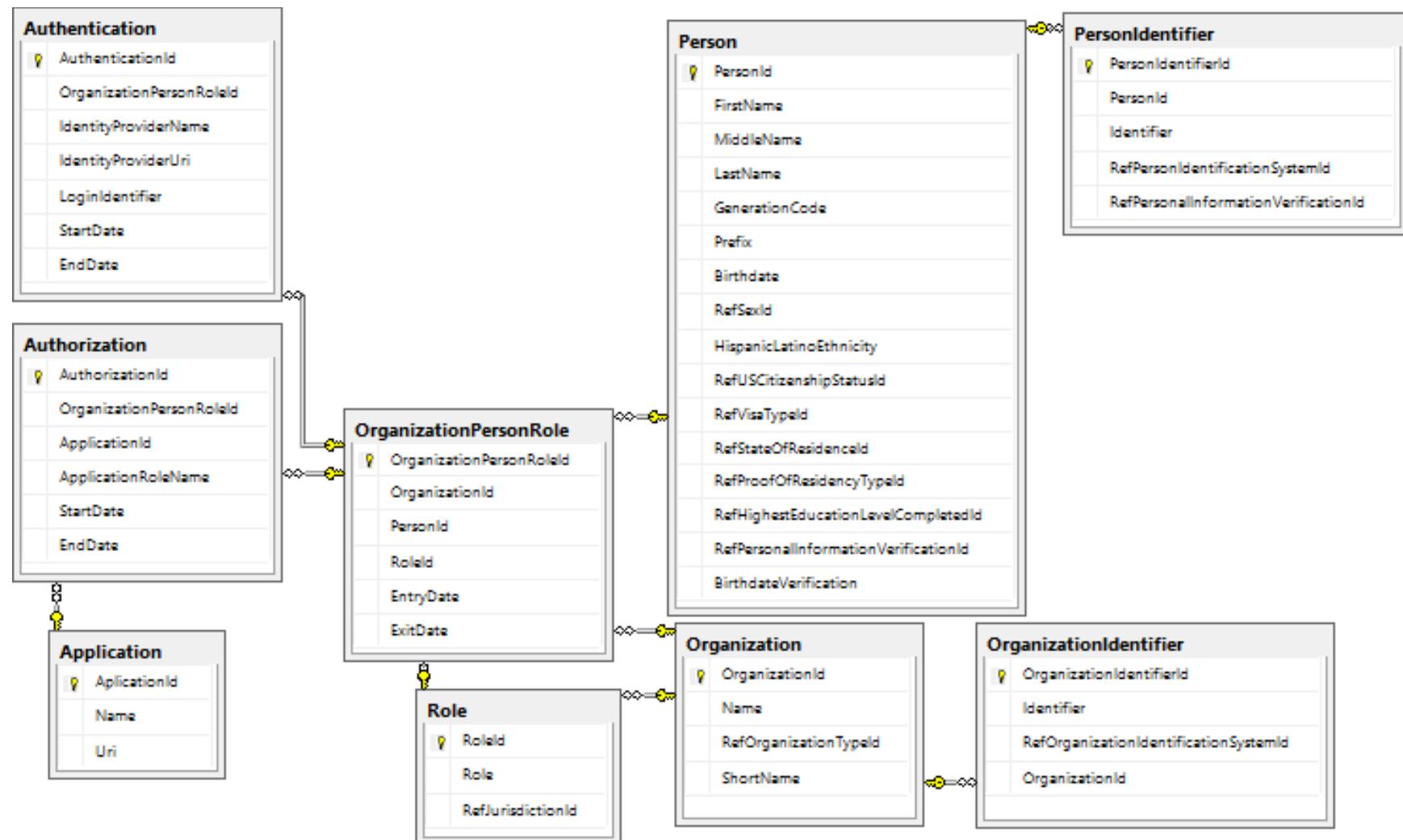


Formative Assessment Process

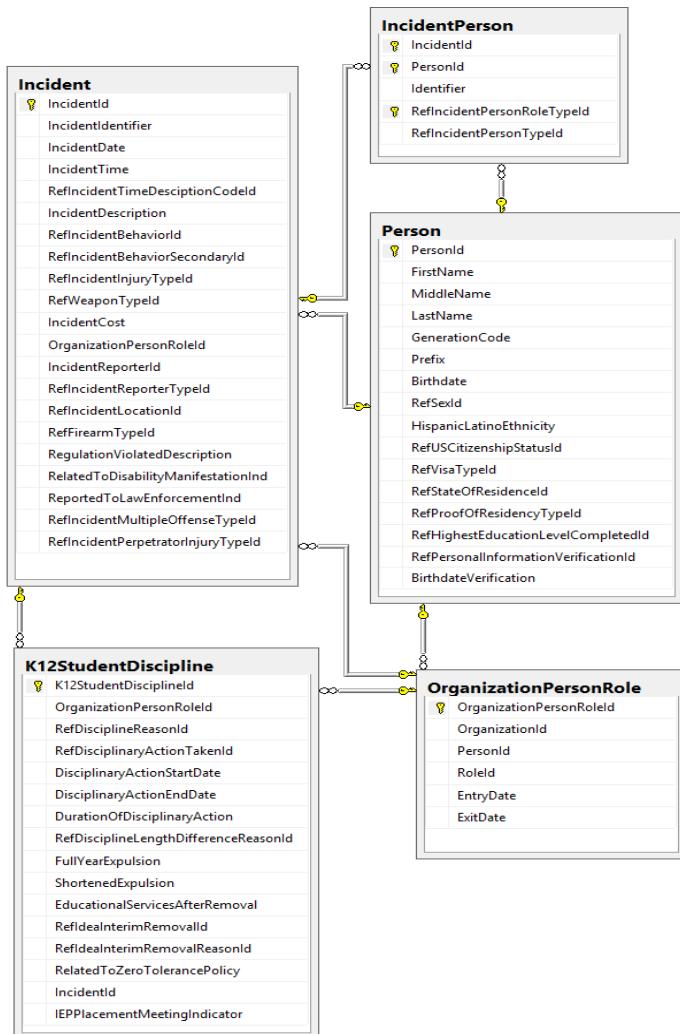
ASSESSMENT DEFINITION



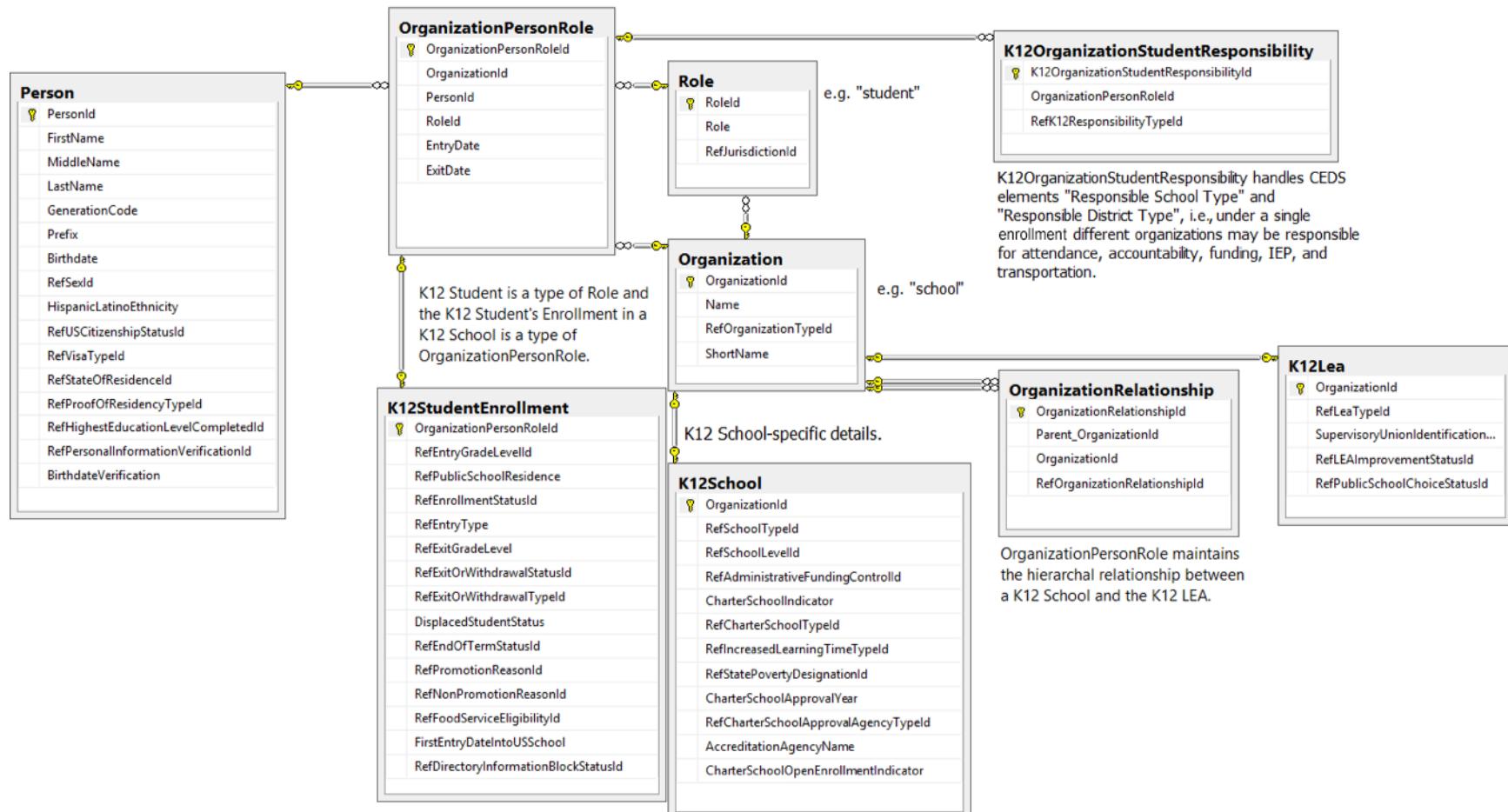
Identity, Authentication, and Authorization



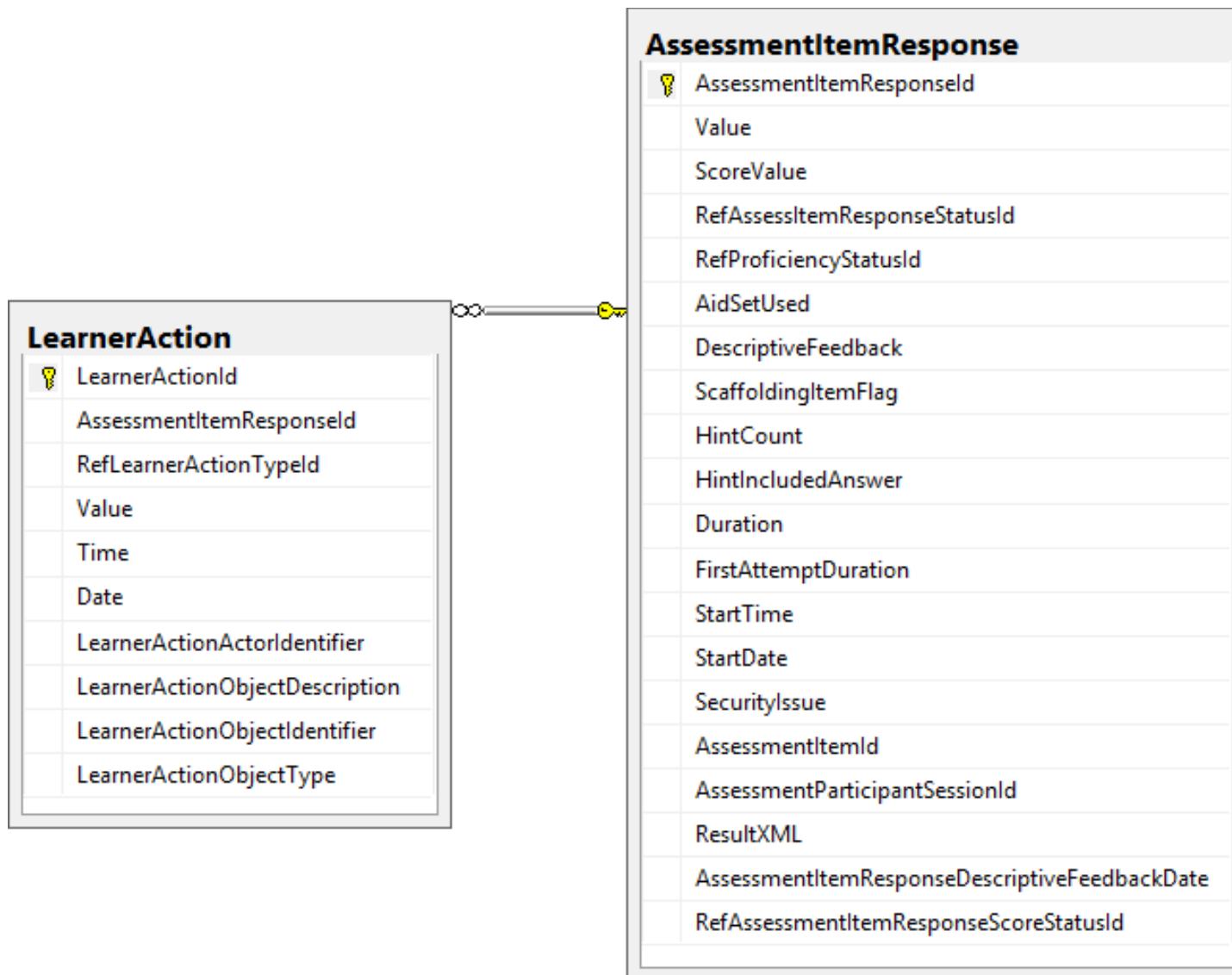
K12 Incident and Discipline Reporting



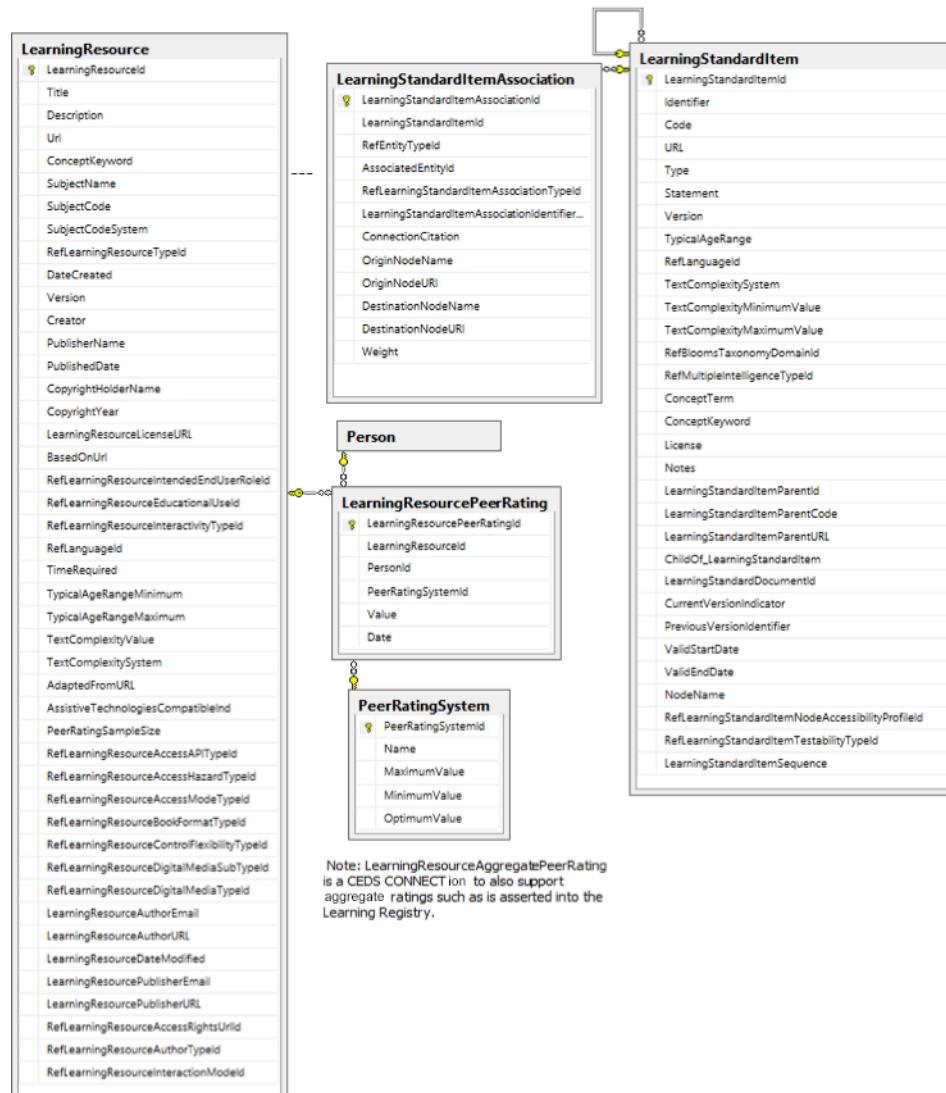
K12 Student Enrollment (School Enrollment)



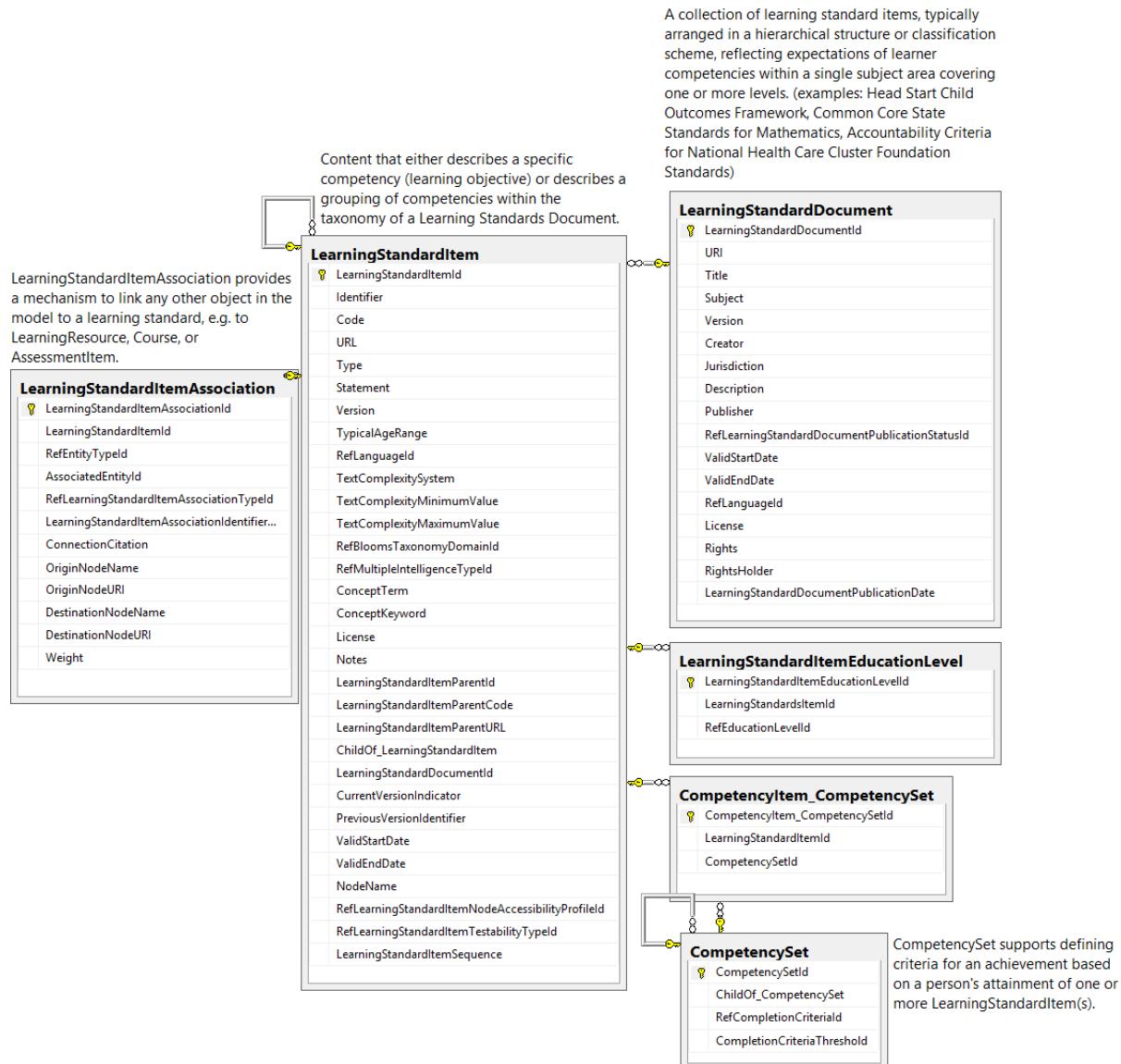
Learner Action (Assessment Item Response)



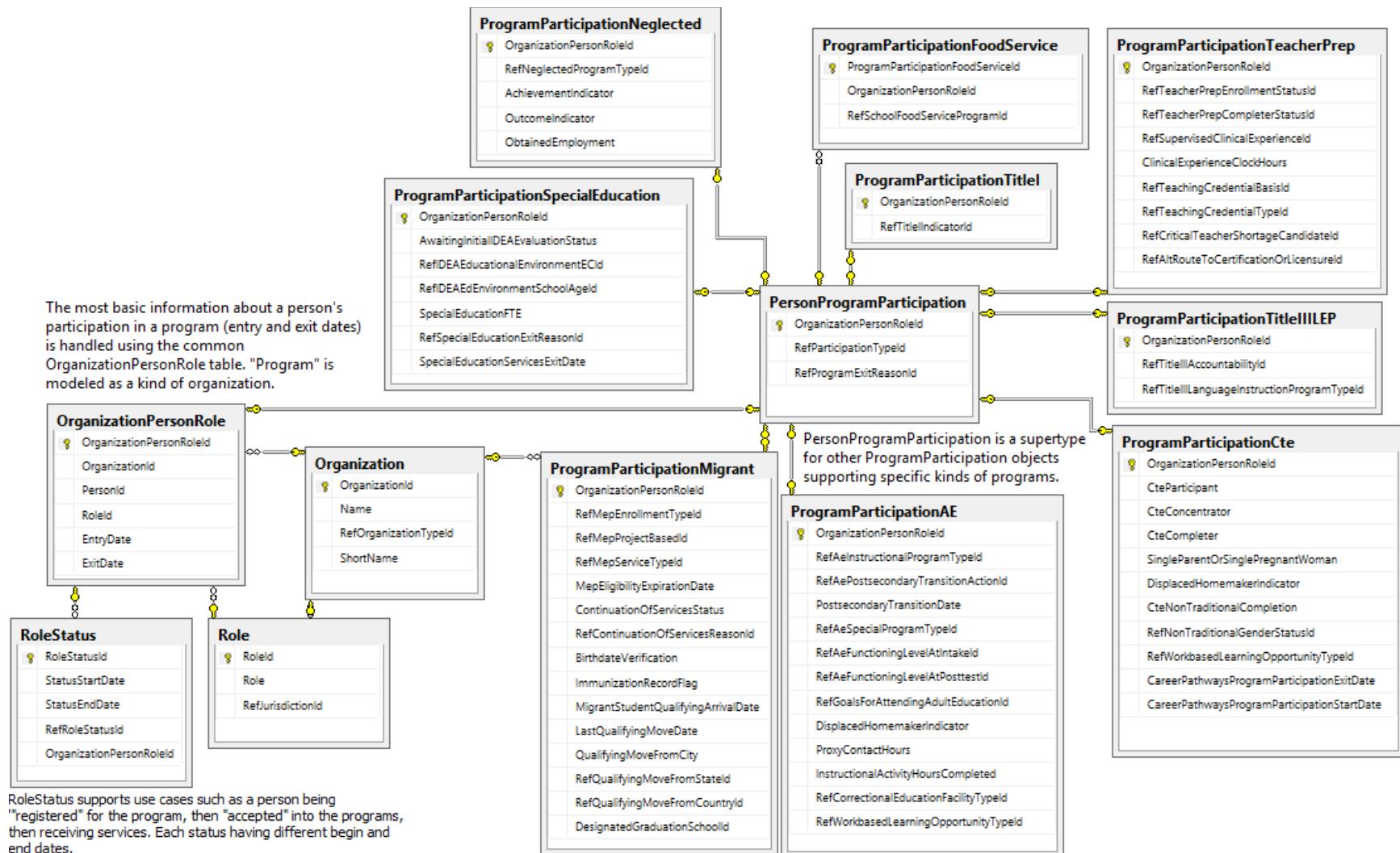
Learning Resource Metadata



Learning Standards (Competency and Competency Framework Definitions)

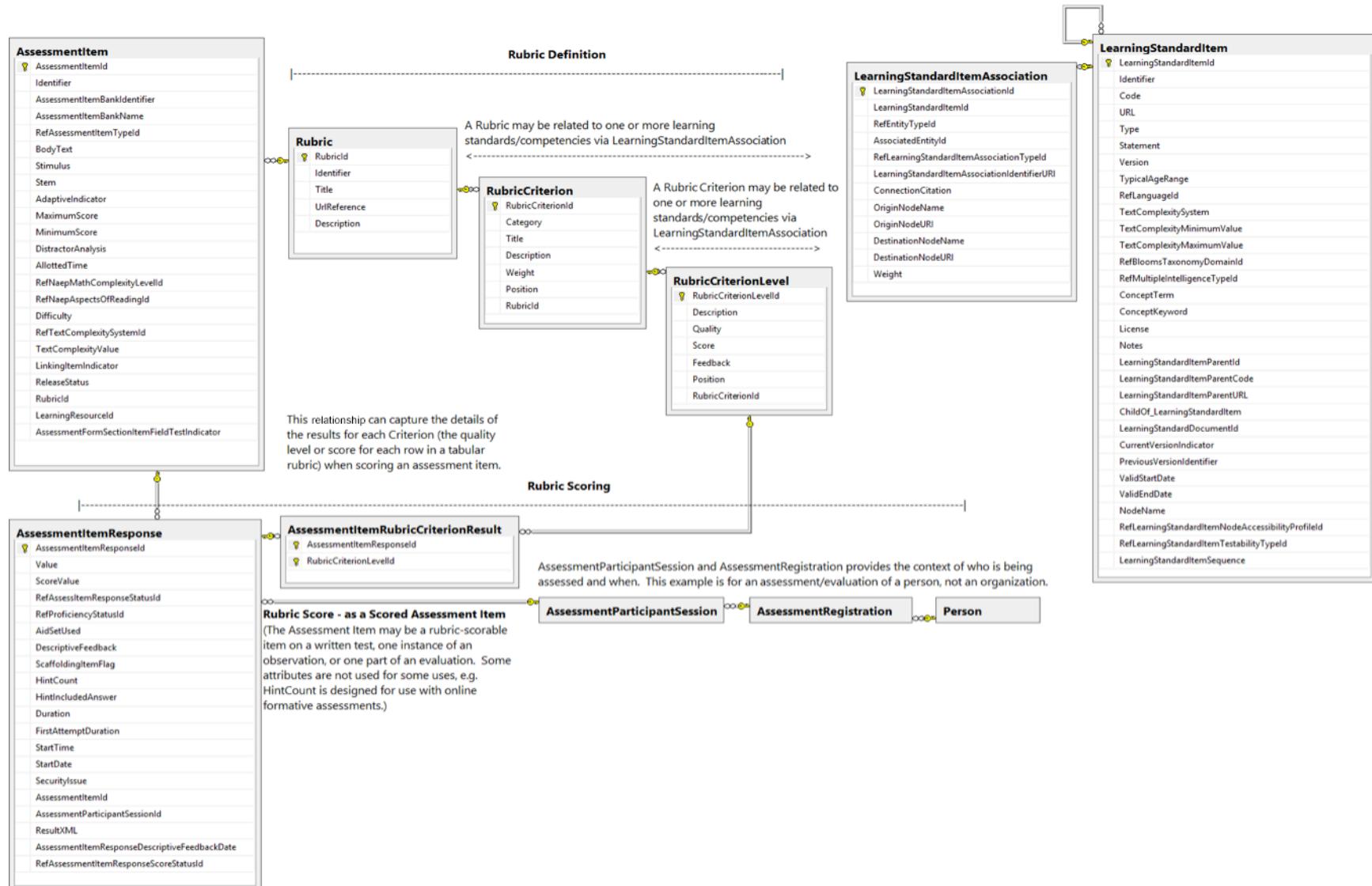


Program Participation

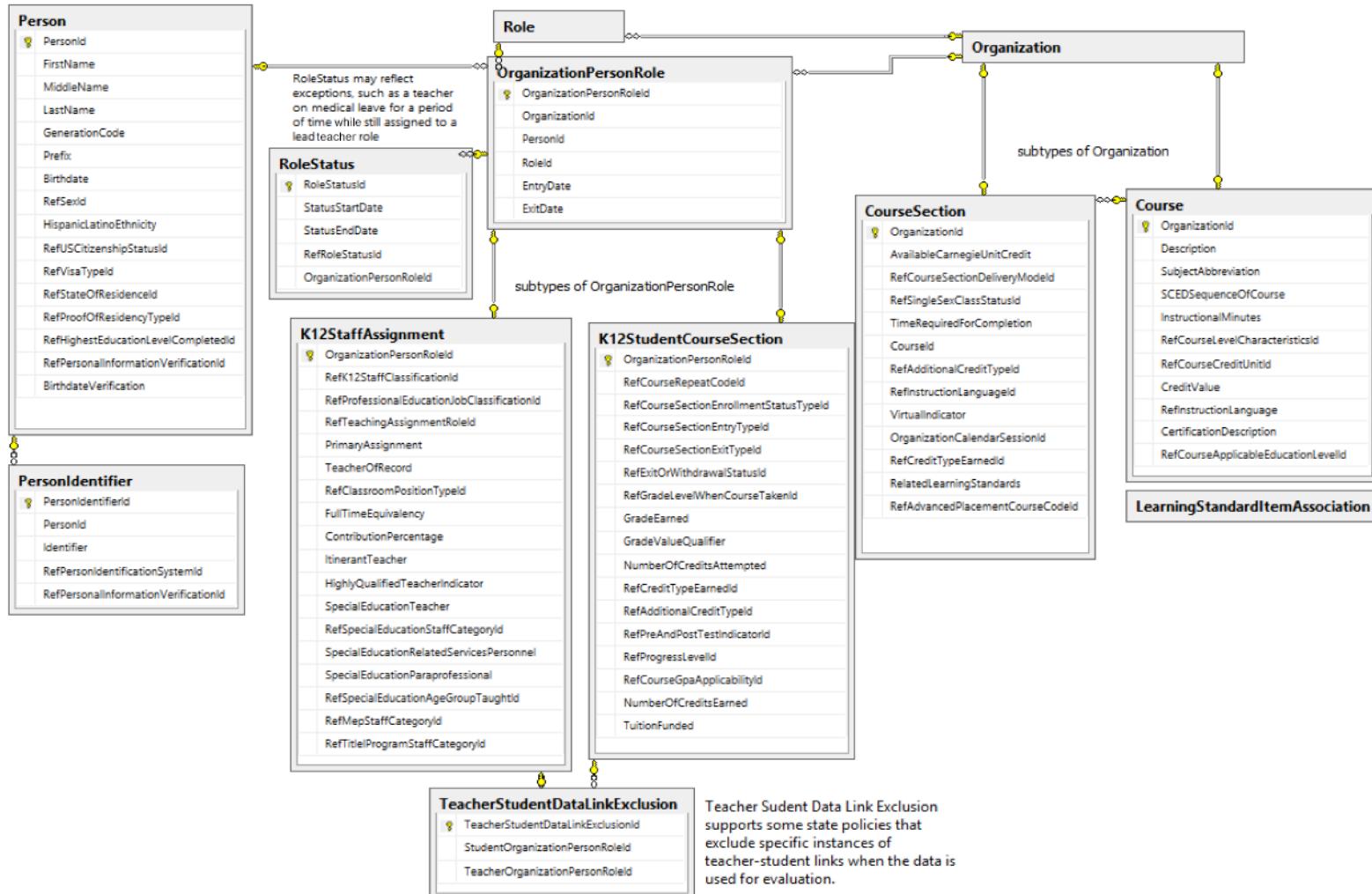


RoleStatus supports use cases such as a person being "registered" for the program, then "accepted" into the programs, then receiving services. Each status having different begin and end dates.

Rubrics



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.

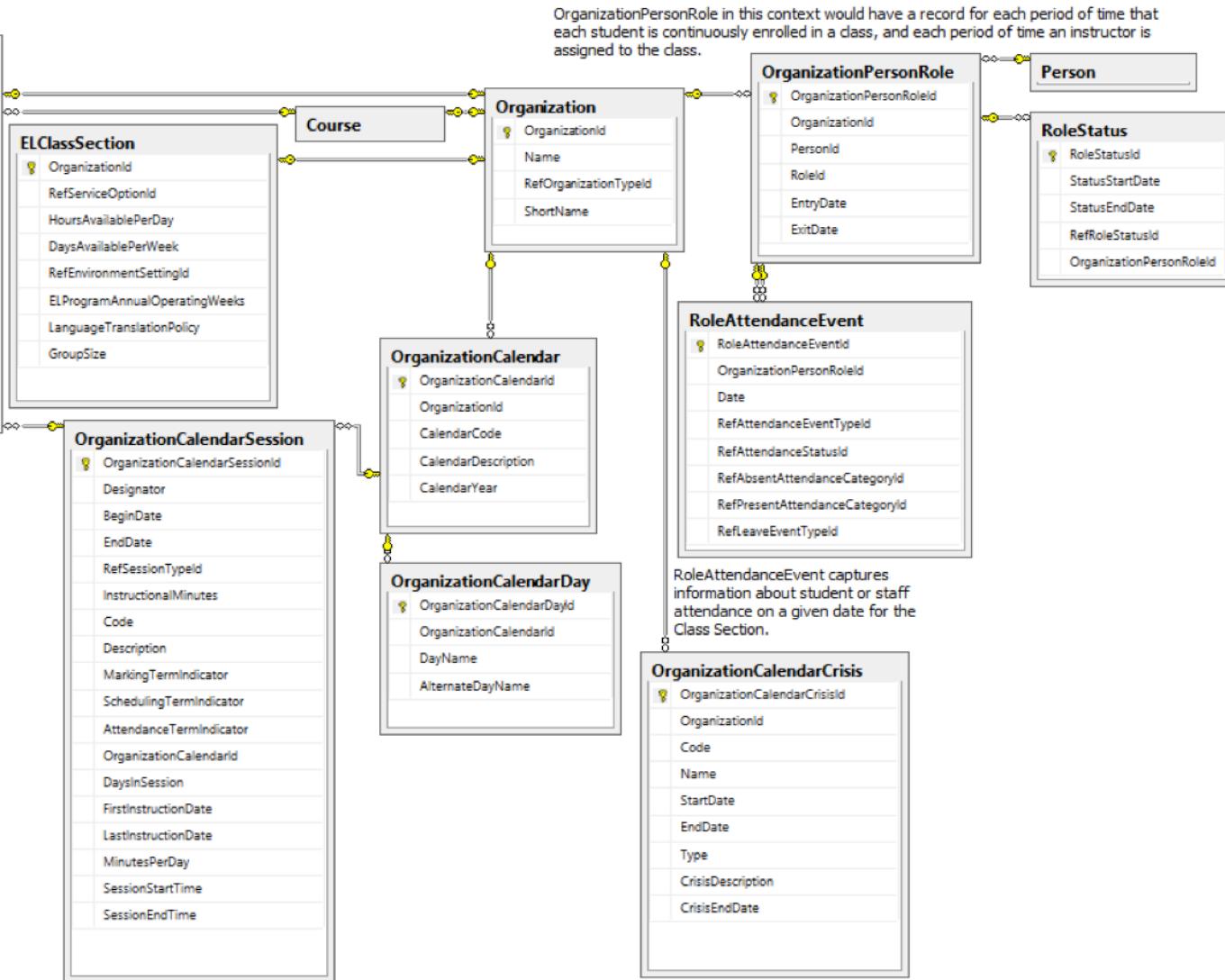
Staff-Student Contact Hours / Attendance (Early Learning Context)

CourseSection is a type of organization that can be linked to persons and roles.

CourseSection
OrganizationId
AvailableCarnegieUnitCredit
RefCourseSectionDeliveryModelId
RefSingleSexClassStatusId
TimeRequiredForCompletion
CourseId
RefAdditionalCreditTypeId
RefInstructionLanguageId
VirtualIndicator
OrganizationCalendarSessionId
RefCreditTypeEarnedId
RelatedLearningStandards
RefAdvancedPlacementCourseCodeId

CourseSectionSchedule
CourseSectionScheduleId
OrganizationId
ClassMeetingDays
ClassBeginningTime
ClassEndingTime
ClassPeriod
TimeDayIdentifier

The ClassSchedule contains the times and days that a class is scheduled to meet on a weekly basis. Session provides the beginning and end date of the term. SessionDay and OrganizationCalendarCrisis provide the scheduled exceptions (holidays) and unscheduled exceptions (dosings) to the general schedule. This data may be combined to determine the total time (and specific times) that the class meets.



Workforce

