

## A Simple Example Implementation

### A. Local Schemas in RDBMS

Department	department_id	department_name	mgr_id
------------	---------------	-----------------	--------

Teacher	teacher_id	teacher_name	dept_id	rank	sex	birthdate	phone	office	email
---------	------------	--------------	---------	------	-----	-----------	-------	--------	-------

Student	student_id	student_name	sex	dept_id	class	birthdate	phone	address	email
---------	------------	--------------	-----	---------	-------	-----------	-------	---------	-------

Course	course_id	course_name	credit	t_id	ta_id
--------	-----------	-------------	--------	------	-------

Study	student_id	course_id	required	markup
-------	------------	-----------	----------	--------

TeachingAssistant	ta_id	ta_name
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### B. Local Schemas in Native XML Database

- Course.TSD

```
<?xml version = "1.0" encoding = "UTF-8"?>
<xs:schema xmlns:tsd = "http://namespaces.softwareag.com/tamino/TaminoSchemaDefinition"
xmlns:xs = "http://www.w3.org/2001/XMLSchema">
  <xs:annotation>
    <xs:appinfo>
      <tsd:schemaInfo name = "Course">
        <tsd:collection name = "University"></tsd:collection>
        <tsd:doctype name = "Course">
          <tsd:logical>
            <tsd:content>closed</tsd:content>
          </tsd:logical>
        </tsd:doctype>
      </tsd:schemaInfo>
    </xs:appinfo>
  </xs:annotation>
</xs:schema>
```

```

    </tsd:schemaInfo>
  </xs:appinfo>
</xs:annotation>
  <xs:element name = "Course">
    <xs:complexType>
      <xs:sequence>
        <xs:element name = "cname" type = "xs:string"></xs:element>
        <xs:element name = "cno" type = "xs:string"></xs:element>
        <xs:element name = "description" type = "xs:string"></xs:element>
        <xs:element name = "offer_by" type = "xs:string"></xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>

```

### ● Department.TSD

```

<?xml version = "1.0" encoding = "UTF-8"?>
<xs:schema xmlns:tsd = "http://namespaces.softwareag.com/tamino/TaminoSchemaDefinition"
  xmlns:xs = "http://www.w3.org/2001/XMLSchema">
  <xs:annotation>
    <xs:appinfo>
      <tsd:schemaInfo name = "Department">
        <tsd:collection name = "University"></tsd:collection>
        <tsd:doctype name = "Department">
          <tsd:logical>
            <tsd:content>closed</tsd:content>
          </tsd:logical>
        </tsd:doctype>
      </tsd:schemaInfo>
    </xs:appinfo>
  </xs:annotation>
  <xs:element name = "Department">
    <xs:complexType>
      <xs:sequence>
        <xs:element name = "dname" type = "xs:string"></xs:element>
        <xs:element name = "dphone" type = "xs:string" maxOccurs =
          "unbounded"></xs:element>
        <xs:element name = "doffice" type = "xs:string"></xs:element>
        <xs:element name = "college" type = "xs:string"></xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>

```

```

    <xs:element name = "chair" type = "xs:string"></xs:element>
  </xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>
● Faculty.TSD
<?xml version = "1.0" encoding = "UTF-8"?>
<xs:schema xmlns:tsd = "http://namespaces.softwareag.com/tamino/TaminoSchemaDefinition"
  xmlns:xs = "http://www.w3.org/2001/XMLSchema">
  <xs:annotation>
    <xs:appinfo>
      <tsd:schemaInfo name = "Faculty">
        <tsd:collection name = "University"></tsd:collection>
        <tsd:doctype name = "Faculty">
          <tsd:logical>
            <tsd:content>closed</tsd:content>
          </tsd:logical>
        </tsd:doctype>
      </tsd:schemaInfo>
    </xs:appinfo>
  </xs:annotation>
  <xs:element name = "Faculty">
    <xs:complexType>
      <xs:sequence>
        <xs:element name = "name" type = "xs:string"></xs:element>
        <xs:element name = "faculty_id" type = "xs:string"></xs:element>
        <xs:element name = "ssn" type = "xs:string"></xs:element>
        <xs:element name = "birthdate" type = "xs:date" minOccurs = "0"></xs:element>
        <xs:element name = "sex">
          <xs:simpleType>
            <xs:restriction base = "xs:string">
              <xs:enumeration value = "M"></xs:enumeration>
              <xs:enumeration value = "F"></xs:enumeration>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name = "address" minOccurs = "0" maxOccurs = "unbounded">
          <xs:complexType>

```

```

    <xs:sequence>
      <xs:element name = "no" type = "xs:short"></xs:element>
      <xs:element name = "street" type = "xs:string"></xs:element>
      <xs:element name = "city" type = "xs:string"></xs:element>
      <xs:element name = "zip" type = "xs:short"></xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>

<xs:element name = "rank" type = "xs:string"></xs:element>
<xs:element name = "salary" type = "xs:float"></xs:element>
<xs:element name = "office" type = "xs:string"></xs:element>
<xs:element name = "phone" type = "xs:string" maxOccurs = "unbounded"></xs:element>
<xs:element name = "works_in" type = "xs:string"></xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>

```

● Student.TSD

```

<?xml version = "1.0" encoding = "UTF-8"?>
<xs:schema xmlns:tsd = "http://namespaces.softwareag.com/tamino/TaminoSchemaDefinition"
  xmlns:xs = "http://www.w3.org/2001/XMLSchema">
  <xs:annotation>
    <xs:appinfo>
      <tsd:schemaInfo name = "Student">
        <tsd:collection name = "University"></tsd:collection>
        <tsd:doctype name = "Student">
          <tsd:logical>
            <tsd:content>closed</tsd:content>
          </tsd:logical>
        </tsd:doctype>
      </tsd:schemaInfo>
    </xs:appinfo>
  </xs:annotation>
  <xs:element name = "Student">
    <xs:complexType>
      <xs:sequence>
        <xs:element name = "name" type = "xs:string"></xs:element>
        <xs:element name = "student_id" type = "xs:string"></xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>

```

```

<xs:element name = "ssn" type = "xs:string"></xs:element>
<xs:element name = "birthdate" type = "xs:date" minOccurs = "0"></xs:element>
<xs:element name = "sex">
  <xs:simpleType>
    <xs:restriction base = "xs:string">
      <xs:enumeration value = "M"></xs:enumeration>
      <xs:enumeration value = "F"></xs:enumeration>
    </xs:restriction>
  </xs:simpleType>
</xs:element>
<xs:element name = "address" minOccurs = "0" maxOccurs = "unbounded">
  <xs:complexType>
    <xs:sequence>
      <xs:element name = "no" type = "xs:short"></xs:element>
      <xs:element name = "street" type = "xs:string"></xs:element>
      <xs:element name = "city" type = "xs:string"></xs:element>
      <xs:element name = "zip" type = "xs:short"></xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name = "class" type = "xs:string"></xs:element>
<xs:element name = "majors_in" type = "xs:string"></xs:element>
<xs:element name = "minors_in" type = "xs:string" minOccurs = "0" maxOccurs =
  "unbounded"></xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>

```

### ● GradStudent.TSD

```

<?xml version = "1.0" encoding = "UTF-8"?>
<xs:schema xmlns:tsd = "http://namespaces.softwareag.com/tamino/TaminoSchemaDefinition"
  xmlns:xs = "http://www.w3.org/2001/XMLSchema">
  <xs:annotation>
    <xs:appinfo>
      <tsd:schemaInfo name = "GradStudent">
        <tsd:collection name = "University"></tsd:collection>
        <tsd:doctype name = "GradStudent">
          <tsd:logical>

```

```

    <tsd:content>closed</tsd:content>
  </tsd:logical>
</tsd:doctype>
</tsd:schemaInfo>
</xs:appinfo>
</xs:annotation>
<xs:element name = "GradStudent">
  <xs:complexType>
    <xs:sequence>
      <xs:element name = "name" type = "xs:string"></xs:element>
      <xs:element name = "student_id" type = "xs:string"></xs:element>
      <xs:element name = "ssn" type = "xs:string"></xs:element>
      <xs:element name = "birthdate" type = "xs:date" minOccurs = "0"></xs:element>
      <xs:element name = "sex">
        <xs:simpleType>
          <xs:restriction base = "xs:string">
            <xs:enumeration value = "M"></xs:enumeration>
            <xs:enumeration value = "F"></xs:enumeration>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name = "address" minOccurs = "0" maxOccurs = "unbounded">
        <xs:complexType>
          <xs:sequence>
            <xs:element name = "no" type = "xs:short"></xs:element>
            <xs:element name = "street" type = "xs:string"></xs:element>
            <xs:element name = "city" type = "xs:string"></xs:element>
            <xs:element name = "zip" type = "xs:short"></xs:element>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
      <xs:element name = "class" type = "xs:string"></xs:element>
      <xs:element name = "majors_in" type = "xs:string"></xs:element>
      <xs:element name = "minors_in" type = "xs:string" minOccurs = "0" maxOccurs =
        "unbounded"></xs:element>
      <xs:element name = "Degree">
        <xs:complexType>
          <xs:sequence>

```

```

    <xs:element name = "college" type = "xs:string"></xs:element>
    <xs:element name = "degree" type = "xs:string"></xs:element>
    <xs:element name = "year" type = "xs:string"></xs:element>
  </xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name = "advisor" type = "xs:string" minOccurs = "1" maxOccurs =
  "unbounded"></xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>

```

### ● Publication.TSD

```

<?xml version = "1.0" encoding = "UTF-8"?>
<xs:schema xmlns:tsd = "http://namespaces.softwareag.com/tamino/TaminoSchemaDefinition"
  xmlns:xs = "http://www.w3.org/2001/XMLSchema">
  <xs:annotation>
    <xs:appinfo>
      <tsd:schemaInfo name = "Publication">
        <tsd:collection name = "University"></tsd:collection>
        <tsd:doctype name = "Publication">
          <tsd:logical>
            <tsd:content>closed</tsd:content>
          </tsd:logical>
        </tsd:doctype>
      </tsd:schemaInfo>
    </xs:appinfo>
  </xs:annotation>
  <xs:element name = "Publication">
    <xs:complexType>
      <xs:sequence>
        <xs:element name = "isbn" type = "xs:string"/>
        <xs:element name = "title" type = "xs:string"></xs:element>
        <xs:element name = "author" type = "xs:string" minOccurs = "1" maxOccurs =
          "unbounded"></xs:element>
        <xs:element name = "p_type" type = "xs:string"></xs:element>
        <xs:element name = "p_year" type = "xs:date"></xs:element>
        <xs:element name = "p_source" type = "xs:string"></xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>

```

```

<xs:element name = "abstract" type = "xs:string" minOccurs = "0" maxOccurs =
  "1"></xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>

```

### C. Relational Schema in the Form of XML Schema

```

<?xml version="1.0" encoding="UTF-8" ?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:element name="Course">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="course_id" type="xs:string" />
        <xs:element name="course_name" type="xs:string" />
        <xs:element name="credit" type="xs:integer" />
        <xs:element name="t_id" type="xs:string" />
        <xs:element name="ta_id" type="xs:string" />
      </xs:sequence>
    </xs:complexType>
    <xs:key name="Course_PrimaryKey">
      <xs:selector xpath="." />
      <xs:field xpath="course_id" />
    </xs:key>
    <xs:keyref name="Course_To_Teacher"
      refer="Teacher_PrimaryKey">
      <xs:selector xpath="." />
      <xs:field xpath="t_id" />
    </xs:keyref>
    <xs:keyref name="Course_To_TeachingAssistant"
      refer="TeachingAssistant_PrimaryKey">
      <xs:selector xpath="." />
      <xs:field xpath="ta_id" />
    </xs:keyref>
  </xs:element>
  <xs:element name="Department">

```



```

    <xs:complexType>
      <xs:sequence>
        <xs:element name="department_id" type="xs:string" />
        <xs:element name="department_name" type="xs:string" />
        <xs:element name="mgr_id" type="xs:string" />
      </xs:sequence>
    </xs:complexType>
    <xs:key name="Department_PrimaryKey">
      <xs:selector xpath="." />
      <xs:field xpath="department_id" />
    </xs:key>
    <xs:keyref name="Department_To_Teacher"
      refer="Teacher_PrimaryKey">
      <xs:selector xpath="." />
      <xs:field xpath="mgr_id" />
    </xs:keyref>
  </xs:element>
  <xs:element name="Student">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="student_id" type="xs:string" />
        <xs:element name="student_name" type="xs:string" />
        <xs:element name="sex" type="xs:string" />
        <xs:element name="dept_id" type="xs:string" />
        <xs:element name="class" type="xs:string" />
        <xs:element name="birthdate" type="xs:date" />
        <xs:element name="phone" type="xs:string" />
        <xs:element name="address" type="xs:string" />
        <xs:element name="email" type="xs:string" />
      </xs:sequence>
    </xs:complexType>
    <xs:key name="Student_PrimaryKey">
      <xs:selector xpath="." />
      <xs:field xpath="student_id" />
    </xs:key>
    <xs:keyref name="Student_To_Department"
      refer="Department_PrimaryKey">
      <xs:selector xpath="." />

```

```

<xs:field xpath="dept_id" />
</xs:keyref>
</xs:element>
<xs:element name="Study">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="student_id" type="xs:string" />
      <xs:element name="course_id" type="xs:string" />
      <xs:element name="required" type="xs:string" />
      <xs:element name="markup" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
  <xs:key name="Study_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="student_id" />
    <xs:field xpath="course_id" />
  </xs:key>
  <xs:keyref name="Study_To_Course" refer="Course_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="course_id" />
  </xs:keyref>
  <xs:keyref name="Study_To_Student" refer="Student_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="student_id" />
  </xs:keyref>
</xs:element>
<xs:element name="Teacher">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="teacher_id" type="xs:string" />
      <xs:element name="teacher_name" type="xs:string" />
      <xs:element name="dept_id" type="xs:string" />
      <xs:element name="rank" type="xs:string" />
      <xs:element name="sex" type="xs:string" />
      <xs:element name="birthdate" type="xs:date" />
      <xs:element name="phone" type="xs:string" />
      <xs:element name="office" type="xs:string" />
      <xs:element name="email" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
</xs:element>

```

```

</xs:sequence>
</xs:complexType>
  = <xs:key name="Teacher_PrimaryKey">
<xs:selector xpath="." />
<xs:field xpath="teacher_id" />
</xs:key>
  = <xs:keyref name="Teacher_To_Department"
    refer="Department_PrimaryKey">
<xs:selector xpath="." />
<xs:field xpath="dept_id" />
</xs:keyref>
</xs:element>
  = <xs:element name="TeachingAssistant">
    = <xs:complexType>
      = <xs:sequence>
<xs:element name="ta_id" type="xs:string" />
<xs:element name="ta_name" type="xs:string" />
</xs:sequence>
</xs:complexType>
    = <xs:key name="TeachingAssistant_PrimaryKey">
<xs:selector xpath="." />
<xs:field xpath="ta_id" />
</xs:key>
</xs:element>
</xs:schema>

```

#### D. Global Schema (in XML Schema)

```

<?xml version="1.0" encoding="UTF-8" ?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:sql="urn:schemas-microsoft-com:mapping-schema"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  = <xs:element name="GSROOT">
    = <xs:complexType>
      = <xs:sequence>
        <xs:element ref="Department" minOccurs="0"
          maxOccurs="unbounded" />
        <xs:element ref="Faculty" minOccurs="0" maxOccurs="unbounded" />

```

```

    <xs:element ref="Student" minOccurs="0" maxOccurs="unbounded" />
    <xs:element ref="GradStudent" minOccurs="0"
maxOccurs="unbounded" />
    <xs:element ref="Course" minOccurs="0" maxOccurs="unbounded" />
    <xs:element ref="Study" minOccurs="0" maxOccurs="unbounded" />
    <xs:element ref="Publication" minOccurs="0"
maxOccurs="unbounded" />
    <xs:element ref="TeachingAssistant" minOccurs="0"
maxOccurs="unbounded" />
</xs:sequence>
</xs:complexType>
</xs:element>
= <xs:element name="Course">
  = <xs:complexType>
    = <xs:sequence>
      <xs:element name="course_id" type="xs:string" />
      <xs:element name="cname" type="xs:string" />
      <xs:element name="credit" type="xs:string" />
      <xs:element name="description" type="xs:string" />
      <xs:element name="offer_by" type="xs:string" />
      <xs:element name="t_id" type="xs:string" />
      <xs:element name="ta_id" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
  = <xs:key name="Course_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="course_id" />
  </xs:key>
  = <xs:keyref name="Course_To_Department"
    refer="Department_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="offer_by" />
  </xs:keyref>
  = <xs:keyref name="Course_To_Faculty" refer="Faculty_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="t_id" />
  </xs:keyref>
  = <xs:keyref name="Course_To_TeachingAssistant"

```

```

    refer="TeachingAssistant_PrimaryKey">
<xs:selector xpath="." />
<xs:field xpath="ta_id" />
</xs:keyref>
</xs:element>
= <xs:element name="Department">
= <xs:complexType>
= <xs:sequence>
<xs:element name="department_id" type="xs:string" />
<xs:element name="dname" type="xs:string" />
    <xs:element name="dphone" type="xs:string"
        maxOccurs="unbounded" />
<xs:element name="doffice" type="xs:string" />
<xs:element name="college" type="xs:string" />
<xs:element name="chair" type="xs:string" />
</xs:sequence>
</xs:complexType>
= <xs:key name="Department_PrimaryKey">
<xs:selector xpath="." />
<xs:field xpath="department_id" />
</xs:key>
= <xs:keyref name="Department_To_Faculty"
    refer="Faculty_PrimaryKey">
<xs:selector xpath="." />
<xs:field xpath="chair" />
</xs:keyref>
</xs:element>
= <xs:element name="Student">
= <xs:complexType>
= <xs:complexContent>
= <xs:extension base="Person">
= <xs:sequence>
<xs:element name="student_id" type="xs:string" />
<xs:element name="class" type="xs:string" />
    <xs:element name="phone" type="xs:string"
        maxOccurs="unbounded" />
<xs:element name="email" type="xs:string" />
    <xs:element name="majors_in" type="xs:string"

```

```

        maxOccurs="unbounded" />
        <xs:element name="minors_in" type="xs:string" minOccurs="0"
        maxOccurs="unbounded" />
    </xs:sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:key name="Student_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="student_id" />
</xs:key>
<xs:keyref name="Student_MajorsIn_Department"
    refer="Department_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="majors_in" />
</xs:keyref>
<xs:keyref name="Student_MinorsIn_Department"
    refer="Department_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="minors_in" />
</xs:keyref>
</xs:element>
<xs:element name="GradStudent">
    <xs:complexType>
        <xs:complexContent>
            <xs:extension base="Person">
                <xs:sequence>
                    <xs:element name="student_id" type="xs:string" />
                    <xs:element name="class" type="xs:string" />
                    <xs:element name="majors_in" type="xs:string"
                    maxOccurs="unbounded" />
                    <xs:element name="minors_in" type="xs:string" minOccurs="0"
                    maxOccurs="unbounded" />
                    <xs:element name="Degree">
                        <xs:complexType>
                            <xs:sequence>
                                <xs:element name="college" type="xs:string" />
                                <xs:element name="degree" type="xs:string" />

```

```

<xs:element name="year" type="xs:string" />
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="advisor" type="xs:string" />
</xs:sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
= <xs:key name="GradStudent_PrimaryKey">
  <xs:selector xpath="." />
  <xs:field xpath="student_id" />
</xs:key>
= <xs:keyref name="GradStudent_MajorsIn_Department"
  refer="Department_PrimaryKey">
  <xs:selector xpath="." />
  <xs:field xpath="majors_in" />
</xs:keyref>
= <xs:keyref name="GradStudent_MinorsIn_Department"
  refer="Department_PrimaryKey">
  <xs:selector xpath="." />
  <xs:field xpath="minors_in" />
</xs:keyref>
= <xs:keyref name="GradStudent_To_Faculty"
  refer="Faculty_PrimaryKey">
  <xs:selector xpath="." />
  <xs:field xpath="advisor" />
</xs:keyref>
</xs:element>
= <xs:element name="Study">
  = <xs:complexType>
    = <xs:sequence>
      <xs:element name="student_id" type="xs:string" />
      <xs:element name="course_id" type="xs:string" />
      <xs:element name="required" type="xs:string" />
      <xs:element name="markup" type="xs:string" />
    </xs:sequence>
  </xs:complexType>

```

```

=> <xs:key name="Study_PrimaryKey">
  <xs:selector xpath="." />
  <xs:field xpath="student_id" />
  <xs:field xpath="course_id" />
</xs:key>

=> <xs:keyref name="Study_To_Course" refer="Course_PrimaryKey">
  <xs:selector xpath="." />
  <xs:field xpath="course_id" />
</xs:keyref>

=> <xs:keyref name="Study_To_Student" refer="Student_PrimaryKey">
  <xs:selector xpath="." />
  <xs:field xpath="student_id" />
</xs:keyref>
</xs:element>

=> <xs:element name="Faculty">
  => <xs:complexType>
    => <xs:complexContent>
      => <xs:extension base="Person">
        => <xs:sequence>
          <xs:element name="faculty_id" type="xs:string" />
          <xs:element name="rank" type="xs:string" />
          <xs:element name="salary" type="xs:float" />
          <xs:element name="phone" type="xs:string"
            maxOccurs="unbounded" />
          <xs:element name="office" type="xs:string" />
          <xs:element name="email" type="xs:string" />
          <xs:element name="works_in" type="xs:string" />
        </xs:sequence>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>

  => <xs:key name="Faculty_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="faculty_id" />
  </xs:key>

  => <xs:keyref name="Faculty_To_Department"
    refer="Department_PrimaryKey">
    <xs:selector xpath="." />

```



```

<xs:field xpath="works_in" />
</xs:keyref>
</xs:element>
= <xs:element name="TeachingAssistant">
  = <xs:complexType>
    = <xs:sequence>
      <xs:element name="ta_id" />
      <xs:element name="ta_name" />
    </xs:sequence>
  </xs:complexType>
  = <xs:key name="TeachingAssistant_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="ta_id" />
  </xs:key>
</xs:element>
= <xs:element name="Publication">
  = <xs:complexType>
    = <xs:sequence>
      <xs:element name="isbn" type="xs:string" />
      <xs:element name="title" type="xs:string" />
      <xs:element name="author" type="xs:string"
        maxOccurs="unbounded" />
      <xs:element name="p_type" type="xs:string" />
      <xs:element name="p_year" type="xs:string" />
      <xs:element name="p_source" type="xs:string" />
      <xs:element name="abstract" type="xs:string" minOccurs="0" />
    </xs:sequence>
  </xs:complexType>
  = <xs:key name="Publication_PrimaryKey">
    <xs:selector xpath="." />
    <xs:field xpath="isbn" />
  </xs:key>
</xs:element>
= <xs:complexType name="Person">
  = <xs:sequence>
    <xs:element name="name" type="xs:string" />
    <xs:element name="uid" type="xs:string" />
    <xs:element name="birthdate" type="xs:date" />

```

```

=> <xs:element name="sex">
  => <xs:simpleType>
    => <xs:restriction base="xs:string">
      <xs:enumeration value="M" />
      <xs:enumeration value="F" />
    </xs:restriction>
  </xs:simpleType>
</xs:element>

=> <xs:element name="address">
  => <xs:complexType>
    => <xs:sequence>
      <xs:element name="no" type="xs:short" />
      <xs:element name="street" type="xs:string" />
      <xs:element name="city" type="xs:string" />
      <xs:element name="zip" type="xs:short" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:schema>

```

### E. Global Schema (in XML Document)

```

<?xml version="1.0" encoding="UTF-8" ?>
=> <GSROOT
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  => <Department>
    <department_id />
    <lname />
    <dphone />
    <doffice />
    <college />
    <chair />
  </Department>
  => <Faculty>
    <name />

```

```
<uid />
<birthdate />
<sex />
  = <address>
<no />
<street />
<city />
<zip />
</address>
<email />
<faculty_id />
<rank />
<salary />
<phone />
<office />
<works_in />
</Faculty>
= <Student>
  <name />
  <uid />
  <birthdate />
  <sex />
  = <address>
  <no />
  <street />
  <city />
  <zip />
  </address>
  <email />
  <student_id />
  <class />
  <phone />
  <majors_in />
  <minors_in />
</Student>
= <GradStudent>
  <name />
  <uid />
```

```
<birthdate />
<sex />
  = <address>
    <no />
    <street />
    <city />
    <zip />
  </address>
<student_id />
<class />
<majors_in />
<minors_in />
  = <Degree>
    <college />
    <degree />
    <year />
  </Degree>
<advisor />
</GradStudent>
= <Course>
  <course_id />
  <cname />
  <credit />
  <description />
  <offer_by />
  <t_id />
  <ta_id />
</Course>
= <Study>
  <student_id />
  <course_id />
  <required />
  <markup />
</Study>
= <Publication>
  <isbn />
  <title />
  <author />
```

```

<p_type />
<p_year />
<p_source />
<abstract />
</Publication>
= <TeachingAssistant>
  <ta_id />
  <ta_name />
</TeachingAssistant>
</GSROOT>

```

## F. Ontology (in OWL)

```

<?xml version="1.0" ?>
= <rdf:RDF xmlns=http://a.com/ontology#
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xml:base="http://a.com/ontology">
  <owl:Ontology rdf:about="" />
= <owl:Class rdf:ID="ResearchAssistant">
  = <rdfs:subClassOf>
    <owl:Class rdf:ID="Assistant" />
  </rdfs:subClassOf>
  = <rdfs:subClassOf>
    = <owl:Class>
      = <owl:intersectionOf rdf:parseType="Collection">
        = <owl:Restriction>
          = <owl:onProperty>
            <owl:ObjectProperty rdf:about="#worksFor" />
          </owl:onProperty>
            = <owl:someValuesFrom>
              <owl:Class rdf:about="#ResearchGroup" />
            </owl:someValuesFrom>
          </owl:Restriction>
        <owl:Class rdf:ID="Person" />
      </owl:intersectionOf>

```

```

</owl:Class>
</rdfs:subClassOf>
</owl:Class>
= <owl:Class rdf:ID="Department">
  = <rdfs:subClassOf>
    <owl:Class rdf:ID="Organization" />
  </rdfs:subClassOf>
</owl:Class>
= <owl:Class rdf:ID="PostDoc">
  = <rdfs:subClassOf>
    <owl:Class rdf:about="#Faculty" />
  </rdfs:subClassOf>
</owl:Class>
= <owl:Class rdf:ID="Professor">
  = <rdfs:subClassOf>
    <owl:Class rdf:about="#Faculty" />
  </rdfs:subClassOf>
</owl:Class>
= <owl:Class rdf:ID="ResearchGroup">
  <rdfs:subClassOf rdf:resource="#Organization" />
</owl:Class>
= <owl:Class rdf:ID="University">
  <rdfs:subClassOf rdf:resource="#Organization" />
</owl:Class>
= <owl:Class rdf:ID="Faculty">
  = <rdfs:subClassOf>
    <owl:Class rdf:about="#Employee" />
  </rdfs:subClassOf>
</owl:Class>
= <owl:Class rdf:ID="Chair">
  <rdfs:subClassOf rdf:resource="#Professor" />
  = <rdfs:subClassOf>
    = <owl:Class>
      = <owl:intersectionOf rdf:parseType="Collection">
        = <owl:Restriction>
          = <owl:onProperty>
            <owl:ObjectProperty rdf:about="#headOf" />
          </owl:onProperty>

```

```

    <owl:someValuesFrom rdf:resource="#Department" />
  </owl:Restriction>
  <owl:Class rdf:about="#Person" />
</owl:intersectionOf>
</owl:Class>
</rdfs:subClassOf>
</owl:Class>
= <owl:Class rdf:ID="Article">
  = <rdfs:subClassOf>
    <owl:Class rdf:ID="Publication" />
  </rdfs:subClassOf>
</owl:Class>
= <owl:Class rdf:ID="GraduateCourse">
  = <rdfs:subClassOf>
    <owl:Class rdf:about="#Course" />
  </rdfs:subClassOf>
</owl:Class>
= <owl:Class rdf:ID="College">
  <rdfs:subClassOf rdf:resource="#Organization" />
</owl:Class>
= <owl:Class rdf:ID="FullProfessor">
  <rdfs:subClassOf rdf:resource="#Professor" />
</owl:Class>
= <owl:Class rdf:ID="Research">
  = <rdfs:subClassOf>
    <owl:Class rdf:ID="Work" />
  </rdfs:subClassOf>
</owl:Class>
= <owl:Class rdf:ID="Student">
  = <rdfs:subClassOf>
    = <owl:Class>
      = <owl:intersectionOf rdf:parseType="Collection">
        = <owl:Restriction>
          = <owl:someValuesFrom>
            <owl:Class rdf:about="#Course" />
          </owl:someValuesFrom>
        = <owl:onProperty>
          <owl:ObjectProperty rdf:ID="takesCourse" />

```

```

</owl:onProperty>
</owl:Restriction>
<owl:Class rdf:about="#Person" />
</owl:intersectionOf>
</owl:Class>
</rdfs:subClassOf>
</owl:Class>
= <owl:Class rdf:ID="AssociateProfessor">
  <rdfs:subClassOf rdf:resource="#Professor" />
</owl:Class>
= <owl:Class rdf:ID="AdministrativeStaff">
  = <rdfs:subClassOf>
  <owl:Class rdf:about="#Employee" />
</rdfs:subClassOf>
</owl:Class>
= <owl:Class rdf:ID="JournalArticle">
  <rdfs:subClassOf rdf:resource="#Article" />
</owl:Class>
= <owl:Class rdf:ID="Course">
  <rdfs:subClassOf rdf:resource="#Work" />
</owl:Class>
= <owl:Class rdf:ID="Institute">
  <rdfs:subClassOf rdf:resource="#Organization" />
</owl:Class>
= <owl:Class rdf:ID="ConferencePaper">
  <rdfs:subClassOf rdf:resource="#Article" />
</owl:Class>
<owl:Class rdf:ID="Schedule" />
= <owl:Class rdf:ID="Book">
  <rdfs:subClassOf rdf:resource="#Publication" />
</owl:Class>
= <owl:Class rdf:ID="TechnicalReport">
  <rdfs:subClassOf rdf:resource="#Article" />
</owl:Class>
= <owl:Class rdf:ID="GraduateStudent">
  <rdfs:subClassOf rdf:resource="#Student" />
  </owl:Class>
= <owl:Class rdf:ID="Software">

```



```

    <rdfs:subClassOf rdf:resource="#Publication" />
  </owl:Class>
  = <owl:Class rdf:ID="VisitingProfessor">
    <rdfs:subClassOf rdf:resource="#Professor" />
  </owl:Class>
  = <owl:Class rdf:ID="UnofficialPublication">
    <rdfs:subClassOf rdf:resource="#Publication" />
  </owl:Class>
  = <owl:Class rdf:ID="Dean">
    <rdfs:subClassOf rdf:resource="#Professor" />
    = <rdfs:subClassOf>
      = <owl:Class>
        = <owl:intersectionOf rdf:parseType="Collection">
          = <owl:Restriction>
            = <owl:onProperty>
              <owl:ObjectProperty rdf:about="#headOf" />
            </owl:onProperty>
          <owl:someValuesFrom rdf:resource="#College" />
        </owl:Restriction>
      <owl:Class rdf:about="#Person" />
    </owl:intersectionOf>
  </owl:Class>
</rdfs:subClassOf>
</owl:Class>
  = <owl:Class rdf:ID="UndergraduateStudent">
    <rdfs:subClassOf rdf:resource="#Student" />
  </owl:Class>
  = <owl:Class rdf:ID="TeachingAssistant">
    = <rdfs:subClassOf>
      = <owl:Restriction>
        = <owl:onProperty>
          <owl:ObjectProperty rdf:ID="mustbe" />
        </owl:onProperty>
      <owl:allValuesFrom rdf:resource="#GraduateStudent" />
    </owl:Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf rdf:resource="#Assistant" />
  = <rdfs:subClassOf>

```

```

    = <owl:Class>
      = <owl:intersectionOf rdf:parseType="Collection">
        = <owl:Restriction>
<owl:someValuesFrom rdf:resource="#Course" />
          = <owl:onProperty>
<owl:ObjectProperty rdf:about="#teachingAssistantOf" />
</owl:onProperty>
</owl:Restriction>
<owl:Class rdf:about="#Person" />
</owl:intersectionOf>
</owl:Class>
</rdfs:subClassOf>
  </owl:Class>
  = <owl:Class rdf:ID="Lecturer">
    <rdfs:subClassOf rdf:resource="#Faculty" />
  </owl:Class>
  = <owl:Class rdf:ID="Employee">
    = <rdfs:subClassOf>
      = <owl:Class>
        = <owl:intersectionOf rdf:parseType="Collection">
          = <owl:Restriction>
            = <owl:onProperty>
<owl:ObjectProperty rdf:about="#worksFor" />
</owl:onProperty>
<owl:someValuesFrom rdf:resource="#Organization" />
</owl:Restriction>
<owl:Class rdf:about="#Person" />
</owl:intersectionOf>
</owl:Class>
</rdfs:subClassOf>
  </owl:Class>
  = <owl:Class rdf:ID="Specification">
    <rdfs:subClassOf rdf:resource="#Publication" />
  </owl:Class>
  = <owl:Class rdf:ID="ClericalStaff">
    <rdfs:subClassOf rdf:resource="#AdministrativeStaff" />
  </owl:Class>
  = <owl:Class rdf:ID="AssistantProfessor">

```

```

<rdfs:subClassOf rdf:resource="#Professor" />
</owl:Class>
= <owl:Class rdf:ID="SystemStaff">
  <rdfs:subClassOf rdf:resource="#AdministrativeStaff" />
</owl:Class>
= <owl:Class rdf:ID="Manual">
  <rdfs:subClassOf rdf:resource="#Publication" />
</owl:Class>
= <owl:ObjectProperty rdf:ID="member">
  <rdfs:domain rdf:resource="#Organization" />
  = <owl:inverseOf>
    <owl:ObjectProperty rdf:about="#memberOf" />
  </owl:inverseOf>
  <rdfs:range rdf:resource="#Person" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="teachingAssistantOf">
  <rdfs:range rdf:resource="#Course" />
  <rdfs:domain rdf:resource="#TeachingAssistant" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="affiliateOf">
  <rdfs:domain rdf:resource="#Organization" />
  <rdfs:range rdf:resource="#Person" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="title">
  <rdfs:domain rdf:resource="#Person" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="telephone">
  <rdfs:domain rdf:resource="#Person" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="masterDegreeFrom">
  <rdfs:domain rdf:resource="#Person" />
  <rdfs:range rdf:resource="#University" />
  = <rdfs:subPropertyOf>
    <owl:ObjectProperty rdf:about="#degreeFrom" />
  </rdfs:subPropertyOf>
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="softwareDocumentation">
  <rdfs:range rdf:resource="#Publication" />

```

```

<rdfs:domain rdf:resource="#Software" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="doctoralDegreeFrom">
<rdfs:domain rdf:resource="#Person" />
  = <rdfs:subPropertyOf>
<owl:ObjectProperty rdf:about="#degreeFrom" />
</rdfs:subPropertyOf>
<rdfs:range rdf:resource="#University" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="softwareVersion">
  <rdfs:domain rdf:resource="#Software" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="bachelorDegreeFrom">
  <rdfs:domain rdf:resource="#Person" />
  = <rdfs:subPropertyOf>
<owl:ObjectProperty rdf:about="#degreeFrom" />
</rdfs:subPropertyOf>
<rdfs:range rdf:resource="#University" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="teacherOf">
<rdfs:range rdf:resource="#Course" />
<rdfs:domain rdf:resource="#Faculty" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="advisor">
<rdfs:domain rdf:resource="#Person" />
<rdfs:range rdf:resource="#Professor" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="hasAlumnus">
  = <owl:inverseOf>
<owl:ObjectProperty rdf:about="#degreeFrom" />
</owl:inverseOf>
<rdfs:domain rdf:resource="#University" />
<rdfs:range rdf:resource="#Person" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="worksFor">
  = <rdfs:subPropertyOf>
<owl:ObjectProperty rdf:about="#memberOf" />
</rdfs:subPropertyOf>

```

```

</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="researchProject">
  <rdfs:domain rdf:resource="#ResearchGroup" />
  <rdfs:range rdf:resource="#Research" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="affiliatedOrganizationOf">
  <rdfs:domain rdf:resource="#Organization" />
  <rdfs:range rdf:resource="#Organization" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="listedCourse">
  <rdfs:domain rdf:resource="#Schedule" />
  <rdfs:range rdf:resource="#Course" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="memberOf">
  <owl:inverseOf rdf:resource="#member" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="orgPublication">
  <rdfs:range rdf:resource="#Publication" />
  <rdfs:domain rdf:resource="#Organization" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="tenure">
  <rdfs:domain rdf:resource="#FullProfessor" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="degreeFrom">
  <rdfs:range rdf:resource="#University" />
  <rdfs:domain rdf:resource="#Person" />
  <owl:inverseOf rdf:resource="#hasAlumnus" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="publicationResearch">
  <rdfs:range rdf:resource="#Research" />
  <rdfs:domain rdf:resource="#Publication" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="headOf">
  <rdfs:subPropertyOf rdf:resource="#worksFor" />
</owl:ObjectProperty>
= <owl:ObjectProperty rdf:ID="publicationAuthor">
  <rdfs:domain rdf:resource="#Publication" />
  <rdfs:range rdf:resource="#Person" />

```

```

</owl:ObjectProperty>
= <owl:DatatypeProperty rdf:ID="emailAddress">
  <rdfs:range
    rdf:resource="http://www.w3.org/2001/XMLSchema#string" />
  <rdfs:domain rdf:resource="#Person" />
</owl:DatatypeProperty>
= <owl:DatatypeProperty rdf:ID="officeNumber">
  <rdfs:range
    rdf:resource="http://www.w3.org/2001/XMLSchema#string" />
</owl:DatatypeProperty>
= <owl:DatatypeProperty rdf:ID="name">
  <rdfs:range
    rdf:resource="http://www.w3.org/2001/XMLSchema#string" />
</owl:DatatypeProperty>
= <owl:DatatypeProperty rdf:ID="age">
  <rdfs:domain rdf:resource="#Person" />
  <rdfs:range
    rdf:resource="http://www.w3.org/2001/XMLSchema#integer" />
</owl:DatatypeProperty>
= <owl:DatatypeProperty rdf:ID="researchInterest">
  <rdfs:range
    rdf:resource="http://www.w3.org/2001/XMLSchema#string" />
</owl:DatatypeProperty>
= <owl:DatatypeProperty rdf:ID="publicationDate">
  <rdfs:range
    rdf:resource="http://www.w3.org/2001/XMLSchema#date" />
</owl:DatatypeProperty>
= <owl:TransitiveProperty rdf:ID="subOrganizationOf">
  <rdfs:domain rdf:resource="#Organization" />
  <rdfs:range rdf:resource="#Organization" />
  <rdf:type
    rdf:resource="http://www.w3.org/2002/07/owl#ObjectProperty" />
</owl:TransitiveProperty>
<Department rdf:ID="schema_Department" />
<GraduateStudent rdf:ID="schema_GradStudent" />
<Publication rdf:ID="schema_Publication" />
<Course rdf:ID="schema_Course" />
<UndergraduateStudent rdf:ID="schema_Student" />

```

```
= <TeachingAssistant rdf:ID="schema_TeachingAssistant">
  <teachingAssistantOf rdf:resource="#schema_Course" />
</TeachingAssistant>
= <Faculty rdf:ID="schema_Faculty">
  <teacherOf rdf:resource="#schema_Course" />
</Faculty>
</rdf:RDF>
- <!--
Created with Protege (with OWL Plugin 1.0, Build 72) http://protege.stanford.edu
-->
```