

Intermediate Education Ontology

Project Code

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Intermediate Education Ontology

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Abstract:

Intermediate Education ontology represents the knowledge about Intermediate level education in Pakistan - Punjab province. Ontology will describe the semantics of data about Intermediate education. In Pakistan, students after matric are not very well aware of programs at the intermediate level. They get confused while selecting Inter programs. Ontology is aimed to provide students with appropriate knowledge representation of the intermediate programs and 2 years' time span information in one place.

Keywords: Intermediate, education, examination, boards, curriculum, programs, results.

1. Introduction:

We usually see *students confused while choosing their 2-year intermediate programs*. We are going to develop this ontology *to clear the students' queries about inter- programs, before and after, they join college*. Intermediate education consists of 11th and 12th classes. Students mostly opt for 2 years programs for their intermediate education. Students in Punjab can take admission to different available programs. Some key programs that we will discuss in this scenario are FSC, ICS, I.com, and FA. College-level institutes (private and govt.) offer these programs for students. They require students to take admission to college at certain criteria. Students choose a program of their choice. They can choose among many programs. Punjab Boards offer FSC Pre Medical, FSC Pre Engineering, ICS Physics, ICS Economics, ICS Statistics, I.Com, FA General Sciences, and FA IT. Students get registered in BISE boards. After choosing any program, students take 1st year and then 2nd year's examination after a whole year's preparations. They also take practicals of scientific subjects. Boards are regularized by Higher Education Department Panjab. They provide admission, examination schedules, fees, and information related to scholarships and facilities. The Board of Intermediate and Secondary education (BISE) works under the province. This institute is responsible for adding subjects to the curriculum, conducting examinations, and announcing results for the intermediate students. The result is announced for each 1st and 2nd-year class. We will cover all the above-mentioned aspects in our ontology. (Admission, Examination, Results, Academics, Non-academics, and relevant Institutes)

Several ontologies exist related to the education domain but there is no comprehensive work previously done regarding intermediate education in ontology and specifically in Pakistan Education system. *The previous ontologies were engineered specifically for institutes and other countries' education systems; they either do not reassemble the education system in Pakistan and its provinces at Primary, Intermediate, and Higher levels; or are mostly covering a single aspect of the educational domain*. I.e. University, college, and courses separately, *from the all aspects that we will cover*. The purpose of this paper is to describe the main aspects of ontology. This ontology emphasizes these aspects: intermediate program selection, academics, and facilities i.e. scholarships, examination, and results (2-year academic duration).

We will gather non-ontological resources from the Punjab Curriculum and Text Board, Higher Education Department Punjab, and the Board of Intermediate and Secondary Education websites. (If required, from colleges also). We require PCs for installing the software tools. We require MS office,

Graphics Editor, Protégé, Additional Software and websites: Github, Web-vowel, and WIDOCO. Different IDEs are available for ontology development; we have searched NeOn Toolkit and Protégé.

- *NeOn toolkit*: Provides explicit support for developing ontologies following the proposed methodology.
- *Protégé*: It has a graphical user interface; easy to use, and has owl based user interface that we will use in ontology engineering.

We will use Protégé for ontology development. Other helpful tools that we will use in our ontology include:

- *Owl*: Owl language will be used to implement the ontology.
- *Web-vowel*: Web vowel will be used for interactive visualization of ontology.
- *GitHub*: Online platform for publishing the ontology.
- *WIDOCO*: WIDOCO will be used for ontology documentation.
- *SPARQL*: SPARQL language will be applied to query the ontology.

2. Related Work

In this section, we explore other ontologies that are similar to our project and focus on education. These ontologies provide useful guidance for building our Intermediate education ontology. By studying these existing frameworks, we can gain insights on how to structure our own ontology, define concepts, and establish relationships. This analysis helps us lay a strong foundation for accurately representing the educational aspects at the Intermediate level. Here are the ontologies that have been found after the search:

Conventional database systems face challenges in efficiently organizing extensive volumes of unstructured data related to academic programs. As a result, prospective students may find it challenging to gather the necessary information to make informed decisions considering factors such as personal preferences and available options. This study proposes a comprehensive framework that leverages state-of-the-art semantic ontology-based technologies. By employing this framework, the system can effectively extract user-specific constraints from clear queries, enabling the retrieval of more accurate data. [1]

In the domain of higher education, ontologies play a crucial role in modeling knowledge management for online learning. This study emphasizes the importance of ontologies as representations of current domain knowledge. Universities, recognizing students as active knowledge consumers, utilize an ontological framework to integrate knowledge management processes and technology architecture for online learning. By using ontologies, this framework enables structured representation of knowledge, facilitating its organization and retrieval. It serves as a valuable resource for knowledge management practitioners, educators, and researchers in higher education. The integration of advanced technology further enhances knowledge management efficiency in the online learning environment. [2]. The ontology is the foundation of the semantic web. This paper shows, how to build an ontology in the field of education. A course ontology is developed that incorporates all the information about the numerous courses the institution offers. Depending on their current qualifications, students can use the course ontology as a reference when choosing a future course. The Protégé 4.0 alpha tool is used to develop the course ontology [3]. The paper concentrates on using Protégé to build a university ontology. The Rajiv

Gandhi Technical University in Bhopal, India, has been used as an example for the development of an ontology. Many different aspects, including the superclass and subclass hierarchy, the creation of subclass instances for class illustrations, the visualization of the query retrieval process, and the graph view, have all been shown. The Paper describes all the aspects of Rajiv Gandhi University like examinations, departments, and programs as ontological terms [4].

The Bologna declaration seeks to address the issues and difficulties faced in European higher education. One of its key objectives is the creation of a uniform system of transparent and comparable degrees that will guarantee the acceptance of people's knowledge and credentials throughout the European Union. This study will explore an ontology-based paradigm that encourages the development of trustworthy knowledge assessment and the construction of transparent curriculum material (Educational Ontology) [5]. This paper focuses on several ontological relationships among various concepts in university. The study is divided into four sections: the introduction, the explanation of our work, the conclusion, and suggestions for further research. The University of Palestine, a private Palestinian higher education institution, located in Al-Zahra' (south of Gaza City) [11, 12], is the case study in this paper. It was founded in 2005. Every concept is mostly centered on the student, teacher, and course [6].

3. Design Methodology

Design Methodology is the sequence of steps we take to engineer/re-engineer our ontology. Different methodologies are available for ontology engineering. Here are three methodologies that we have searched:

1. Sensus
2. Uschold and King
3. NeOn

1. Sensus: This technique creates domain-specific ontologies out of big ontologies. It was created by Information Sciences Institute Natural Language Group. The top-down approach is used in this practice. Below are the steps in the process:

1. The *seed*, or important phrases, are identified.
2. Using Ontosarus to manually *link* the phrases
3. All ideas are present, from the root to the seed phrase.
4. Including a *new relatable term* that isn't already there.
5. Including *sub-trees* in the finished ontology [7].

2. Uschold and King: Uschold and King proposed the first ontology development technique in 1995. The experience of creating an ontology for enterprise modeling procedures served as the foundation for this methodology. There are four steps to it:

- Step 1*: Selecting the purpose, uses, domain and intended users is the first step.
- Step 2*: Engineering ontology is the second step.

Step 3: Ontology Evaluation

Step 4: Ontology documentation [7]

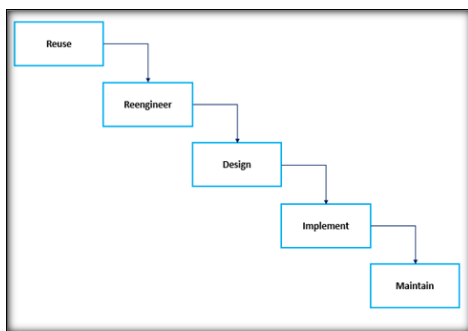
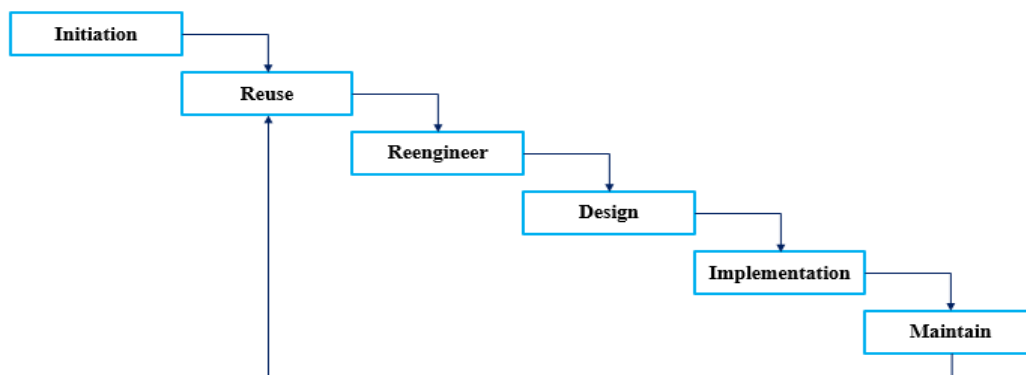
3. NeOn Methodology: The NeOn technique provides several pathways for creating ontologies; it is flexible rather than outlining a predetermined course of action. It has no application dependencies. It provides definitions for *nine scenarios*, a *glossary of terms* related to processes and activities, two ontology *life cycle models* (the waterfall and iterative-incremental models), as well as a list of methodological guidelines for various processes and activities. [8]

We selected NeOn Methodology for our project.

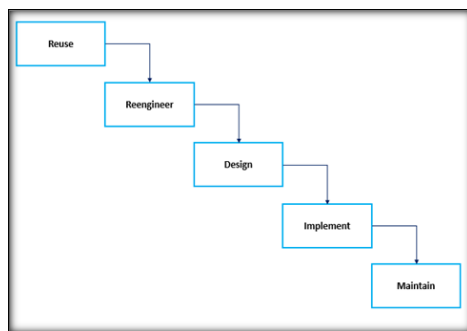
4. Development:

For the development of the Intermediate Education Ontology, we opted to use the NeOn Methodology. In our selection process, we thoroughly assessed both the Waterfall and Iterative life cycles offered by NeOn. We decided to adopt the Iterative Incremental life cycle model, consisting of six distinct phases. This model aligns well with the requirements of our ontology development project and provides a structured approach to ensure iterative progress and continuous improvement throughout the development process.

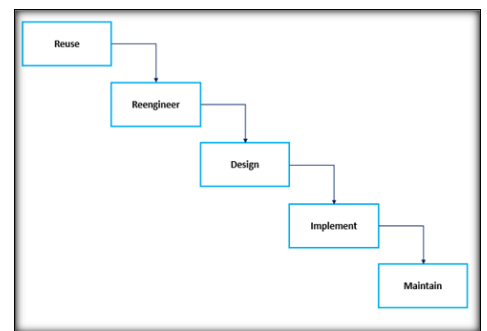
We will use the following phases:



Iteration 1



Iteration 2



Iteration 3

Figure 1: Iterative Incremental Life Cycle Model - NeOn

4.1 Initiation:

We developed an ontology requirement specification document for intermediate education that covers the following topics: Purpose, scope, implementation language, and functional and non-functional needs. Competency Question Groups are used to categorize Functional Requirements. The Competency Question Groups are Admission, Facilities & Non-Academic Aspects, Boards, Institutional Requirements, Curriculum, Examination, and Results.

4.2 Reuse:

The reuse section includes ontological and non-ontological resources that we searched for and reused in this ontology.

- *Admission:* No resources were reused in this section.
- *Facilities & Non-Academic Aspects:* No resources were reused.
- *Boards:* Non-ontological resources taken from Punjab Higher Education Department Website [9]. No ontological resources were reused.
- *Institutional Requirements:* No non-ontological or ontological resources reused.
- *Curriculum (Academics):* Non-ontological resources taken from Punjab Curriculum and Textbook Board Website [10]. No ontological resources were reused.
- *Examination:* Non-ontological resources taken from Boards of Intermediate and Secondary Education Websites [11]. No ontological resources were reused.
- *Result:* Non-ontological resources taken from Boards of Intermediate and Secondary Education Websites [11]. No ontological resources or Design patterns were reused.

4.3 Re-engineering:

In re-engineering phase, we converted the non-ontological resources that we searched in reuse phase; into conceptual models. This section had some paper work to draw the relations and identify the entities that could be used as classes, object properties, instances and the data properties from searched non-ontological resources.

4.4 Design:

We did not reuse any ontological resources. Ontology was engineered from scratch with help of available non-ontological resources that we converted into ontological ones. We created following modules in design phase:

1. Admission
2. Exam
3. Result
4. Academics
5. Non-Academics
6. Places
7. Institution
8. Person
9. Finance

10. Events

11. Supportive Entities

Conceptual models created during reengineering phases were used as input for the design phase. This phase also included some paper work to draw relationships among classes.

4.5 Implementation:

Ontology was implemented in OWL Language using Protégé, followed by evaluation.

4.6 Maintenance:

Maintenance phases mainly deals with error detection. If some error is detected, we start reworking from the Reuse phase.

Summary of Ontology Requirements Specification Document

1. Purpose

The purpose of the Intermediate Education ontology is to provide students with knowledge representation of their inter programs.

2. Scope

Intermediate Education ontology is specific to the Intermediate level (11th and 12th classes). The ontology includes knowledge related to Intermediate courses only. It does not include knowledge about other levels' (Primary, Secondary, A/O Levels, and Higher). It limits to Intermediate Education in the Punjab province of Pakistan (students under BISE-Punjab). Does not include federal boards.

3. Implementation Language

Owl language will be used to implement the ontology.

4. Intended Users:

Sr. No.	User
<u>User 1:</u>	Students
<u>User 2:</u>	Parents
<u>User 3:</u>	Teachers
<u>User 4:</u>	Colleges
<u>User 5:</u>	Punjab Text and Curriculum Board
<u>User 6:</u>	Punjab Higher Education Department
<u>User 7:</u>	Board of Intermediate and Secondary Education

5. Intended Uses:

Sr. No.	Use
<u>Use 1:</u>	To get information about admissions.
<u>Use 2:</u>	To guide children about choices of degrees.
<u>Use 3:</u>	To guide students about board registration.
<u>Use 4:</u>	To guide students in Academics.
<u>Use 5:</u>	To guide students about scholarships.
<u>Use 6:</u>	To guide students about the result announcement.
<u>Use 7:</u>	To guide the students about program selection.

6. Ontology Requirements

6.1 Non-Functional Requirements

- **Performance:** Ontology should meet all the aspects of Intermediate Education (as per the defined scope).
- **Reusability:** Ontology should be flexible enough to be reused.

6.2 Functional Requirements (Competency Question Groups)

G1: Admission and Available Degree Programs

- ☆ G1-A: What are the attributes in the admission form?
- ☆ G1-B: Which institutes offer the intended program?
- ☆ G1-C: What is the duration of Inter program?
- ☆ G1-D: Which/How many programs are available for Inter students?
- ☆ G1-E: Which degree is prerequisite for intermediate?
- ☆ G1-F: How much marks in previous degree, are necessary to get admission?
- ☆ G1-G: What is admissions' opening date in each college?
- ☆ G1-H: What is admissions' closing date in each college?

G2: Institutions

- ☆ G2-A: Which boards in Punjab are offering the Intermediate Programs?
- ☆ G2-B: Which attributes are there in the board registration form?
- ☆ G2-C: How many students are registered in each board?
- ☆ G2-D: When are Intermediate programs' classes starting?
- ☆ G2-E: When Intermediate programs' classes End?
- ☆ G2-F: What is college class timing?
- ☆ G2-G: How many subjects are taught in a day?
- ☆ G2-H: What is colleges' procedure to prepare the students for board exams?

G3: Non-Academic

- ☆ G3-A: Which facilities are given to students in college?
- ☆ G3-B: Which co-curricular functions take place at colleges?
- ☆ G3-C: What is procedure to migrate from a college to other?
- ☆ G3-D: What is the summer and winter vacations' duration?

G4: Academics

- ☆ G4-A: What are the contents of the Syllabus for 1st and 2nd years?
- ☆ G4-B: Who is responsible for approving the subjects for intermediate?
- ☆ G4-C: Who is responsible for preparing and approving the syllabus for intermediate?
- ☆ G4-D: Which subjects are there in each inter-program?
- ☆ G4-E: Which subjects are elective?
- ☆ G4-F: Which subjects are compulsory?
- ☆ G4-G: What are language choices for students?

G5: Examination

- ☆ G5-A: Who is responsible to conduct the examinations in Punjab?
- ☆ G5-B: Who is responsible for deciding the subjects for intermediate?
- ☆ G5-C: Who issues roll no slip?
- ☆ G5-D: What attributes does roll number slip include?
- ☆ G5-E: Which subjects' practical is taken?
- ☆ G5-F: What is exams starting date?
- ☆ G5-G: What is exams ending date?
- ☆ G5-H: Which subjects' exams are on same date?

G6: Result

- ☆ G6-A: Who/when announces the result?
- ☆ G6-B: What attributes does the result sheet include?
- ☆ G6-C: What are the passing criteria for students of intermediate?
- ☆ G6-D: What are the fail/pass criteria for students of intermediate?

G7: Finance

- ☆ G7-A: What is 2 year fee in college?
- ☆ G7-B: Which college has highest/lowest fee?
- ☆ G7-C: How much marks required to get concession?
- ☆ G7-D: How much concession is given?
- ☆ G7-E: Which scholarships are available?
- ☆ G7-F: Which sources will be used to acquire scholarships?
- ☆ G7-G: On what basis scholarships are awarded to students?

G8: Processes

- ☆ G8-A: What is process to get admission in college?
- ☆ G8-B: What is process to get registered in board?
- ☆ G8-C: What is process to take exams?
- ☆ G8-D: What is process to check the result?

Pre Glossary of Terms

Education, intermediate, program, examination, practical, scholarships, college, admission, vacations, subjects, compulsory, elective, roll number slip, pass, fail, result, board, BISE, PTCB, PEB, syllabus, registration, medium.

5. Ontology Modules:

The details of the ontology modules that we developed during the design phase are covered in this section.

Next, we describe the key features of each module.

Based on the classes provided, here's a possible way to describe them as modules within an ontology:

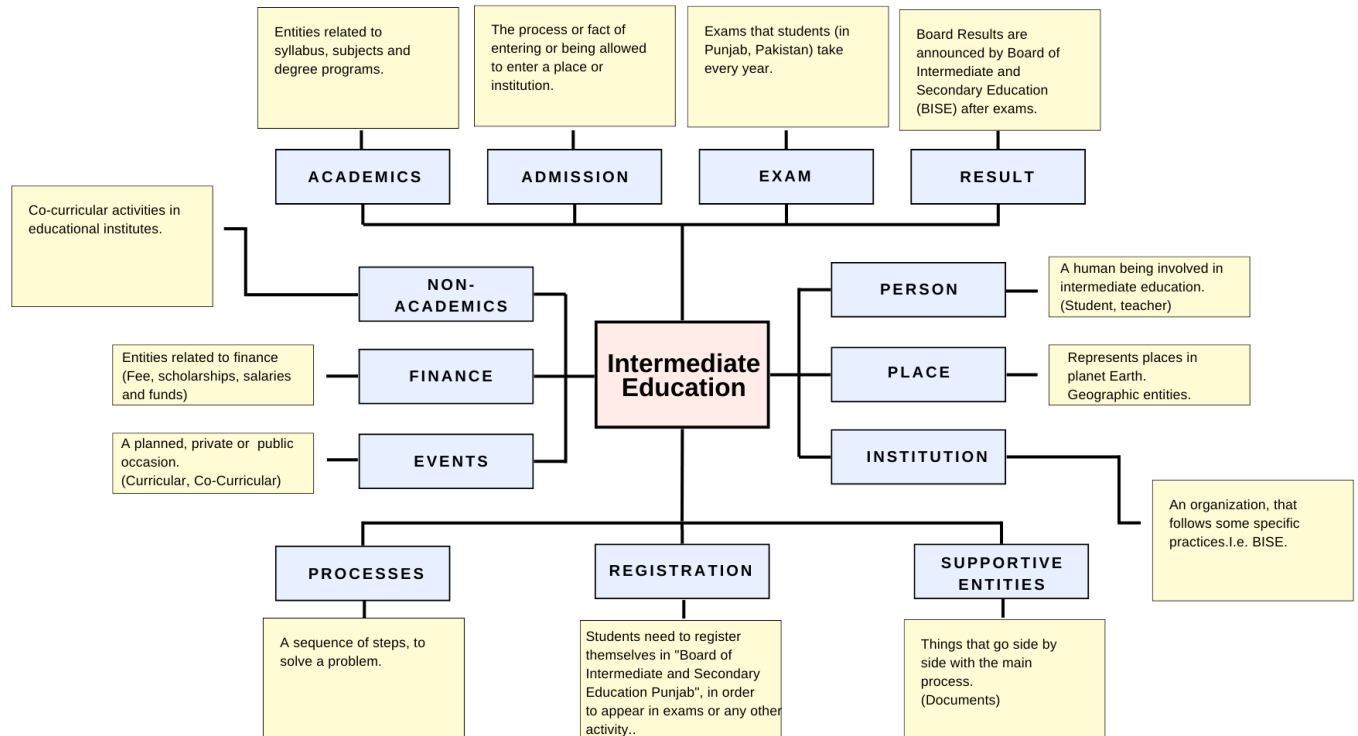


Figure 2: Conceptual Model – Intermediate Education

5.1 Academics:

The Academics module handles all the aspects of studying. It includes information about the courses available, what student will learn in each course, the syllabus required for studying, and the academic language student need to follow.

SPARQL Query for a question in this module:

G4-D: Which subjects are there in each inter-program?

PREFIX rdf: <<http://www.w3.org/1999/02/22-rdf-syntax-ns#>>

PREFIX owl: <<http://www.w3.org/2002/07/owl#>>

PREFIX rdfs: <<http://www.w3.org/2000/01/rdf-schema#>>

PREFIX xsd: <<http://www.w3.org/2001/XMLSchema#>>

```

PREFIX ksr: <http://www.semanticweb.org/sehrish/ontologies/2023/1/interedu#>
SELECT ?Program (STR(?subjects) AS ?Subjects)
WHERE {
  ?Program a ksr:ICS;
  ksr:Subject_NameI ?subjects.
}

```

5.2 Admission:

The admission module focuses on managing the process of admitting students to an institution. It includes properties like application management, eligibility criteria and enrollment.

SPARQL Query for a question in this module:

G1-A: What are the attributes in the admission form?

```

PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX ksr: <http://www.semanticweb.org/sehrish/ontologies/2023/1/interedu#>
SELECT ?Admission_Form_Entities (STR(?attributes) as ?Attributes)
WHERE {
  ksr:FSc_Admission_Form ?Admission_Form_Entities ?attributes.
  FILTER(isLiteral(?attributes))
}

```

5.3 Events:

The Events class emphasizes different activities held within the institution, including conferences, seminars, workshops, and cultural events.

SPARQL Query for a question in this module:

G3-B: Which co-curricular functions take place at colleges?

```

PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX ksr: <http://www.semanticweb.org/sehrish/ontologies/2023/1/interedu#>
SELECT ?Events
WHERE {
  ?Events a ksr:Co_Curricular_Events.
}

```

5.4 Exam:

The exam class describes aspects related to examinations. It includes the information about annual, supply and practical exams.

SPARQL Query for a question in this module:

G5-F: What is exams starting date?

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX ksr: <http://www.semanticweb.org/sehrish/ontologies/2023/1/interedu#>
SELECT ?Class (STR(?date) as ?ExamCommencementDate)
{
  ?Class a ksr:Annual_Exams ;
  ksr:Exam_Commencement_Date ?date.
}
```

5.5 Finance:

The finance module gives information about financial aspects like Students fee and scholarships.

SPARQL Query for a question in this module:

G7-D: How much concession is given?

- Student fill admission form for college admission
- The students' obtained marks = 928 and total marks= 1100 are taken from the Class "College_Admission_Form", "FSc_Admission_Form" individual
- Percentage is calculated
- Total fee is taken from Fee_Structure class, "Punjab_College_Fee" Individual
- Cocession is granted if percentage match concession packagees
- Here we have done it for Punjab College, if student write 84% marks in admission form

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX ksr: <http://www.semanticweb.org/sehrish/ontologies/2023/1/interedu#>
SELECT (STR(?studentName) as ?StudentName) (STR(?totalFeeValue) AS ?TotalFee)
(STR(?marksPercentage) as ?MarksPercentage) (STR(?formattedFeeConcession) AS ?FeeConcession)
(STR(?fee) AS ?YourConcessionedFee)
WHERE
{
  ksr:FSc_Admission_Form a ksr:College_Admission_Form ;
  ksr:Student_Name_A ?studentName ;
  ksr:Student_Matric_Total_Marks_A ?totalMarks ;
  ksr:Student_Matric_Obtained_Marks_A ?obtainedMarks .
  BIND((?obtainedMarks / ?totalMarks) * 100 AS ?marksPercentage)
  {
    SELECT ?totalFee WHERE {
      ?totalFeeInstance a ksr:Fee_Structure ;
      ksr:Total_Fee ?totalFee .
    }
  }
}
```

```

FILTER (?totalFeeInstance = ksr:Punjab_College_Fee)
} }

```

```

BIND(IF(?marksPercentage >= 80 && ?marksPercentage <= 89, "10,000", "0") AS
?formattedFeeConcession)
BIND(STR(IF(?marksPercentage >= 80 && ?marksPercentage <= 89, ?totalFee - 10000, ?totalFee)) AS
?fee)
BIND(STR(?totalFee) AS ?totalFeeValue)
}

```

5.6 Institution:

The institution class represents the overall information related to the educational and non-educational institutions, including their name, location and affiliation. Includes Colleges and Boards.

SPARQL Query for a question in this module:

G4-C: Who is responsible for preparing and approving the syllabus for intermediate?

```

PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX ksr: <http://www.semanticweb.org/sehrish/ontologies/2023/1/interedu#>
SELECT ?Syllabus ?Prepared_by_Institute
WHERE {
  ?Prepared_by_Institute a ksr: Punjab_Curriculum_and_Textbook_Board;
  ksr:Makes ?Syllabus.
}

```

5.7 Non-Academics:

The non-academics covers non-academic activities and services provided by the colleges, such as extracurricular activities and facilities management.

SPARQL Query for a question in this module:

G3-D: What is the summer and winter vacations' duration?

```

PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX ksr: <http://www.semanticweb.org/sehrish/ontologies/2023/1/interedu#>
SELECT (STR(?label) as ?Label) (STR(?duration) as ?Duration)
WHERE {
  {
    ksr:Winter a ksr:Holidays ;
    ksr:Duration_H ?duration .
    OPTIONAL { ksr:Winter rdfs:label ?label }
  }
  UNION

```

```
{
  ksr:Summer a ksr:Holidays ;
    ksr:Duration_H ?duration .
  OPTIONAL { ksr:Summer rdfs:label ?label }
}
```

5.8 Person:

The person class represents individuals associated with the intermediate education, such as students, faculty, staff, and administrators. It includes their personal details, roles, and relationships.

5.9 Place:

The place class represents physical locations of the institutions, such as Country, Province and Division.

5.10 Process:

The process module captures the various processes and workflows related to intermediate education, such as admission processes and exam processes.

SPARQL Query for a question in this module:

G8-A: What is process to get admission in college?

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX ksr: <http://www.semanticweb.org/sehrish/ontologies/2023/1/interedu#>
SELECT (STR(?process) as ?ProcessofAdmissionInCollege)
WHERE {
  ksr:Admission_Process a ksr:Process ;
    ?ProcessName ?process .
  FILTER (isLiteral(?process)) }
order by asc(?process)
```

5.11 Registration:

The registration class handles the registration process for courses, events, and other activities in the institutions.

SPARQL Query for a question in this module:

G2-B: Which attributes are there in the board registration form?

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
```

```

PREFIX ksr: <http://www.semanticweb.org/sehrish/ontologies/2023/1/interedu#>
SELECT ?Registration_Entities (STR(?attributes) as ?Attributes)
WHERE {
ksr:Ali_Registration_Form ?Registration_Entities ?attributes.
FILTER(isLiteral(?attributes)) }
order by asc(?Registration_Entities)

```

5.12 Result:

The result module manages the storage and retrieval of examination results. It includes features like storing result cards, grade calculation, and result analysis.

SPARQL Query for a question in this module:

G6-D: What are the fail/pass criteria for students of intermediate?

```

PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX ksr: <http://www.semanticweb.org/sehrish/ontologies/2023/1/interedu#>
SELECT (STR(?name) AS ?StudentName) (STR(?RollNo) AS ?StudentRollNo) (STR(?total) as ?Total)
(STR(?obtained) as ?Obtained) (STR(?percentage) AS ?Percentage) (IF(?percentage > 40, "Pass", "Fail")
AS ?Result)
WHERE {
?individual a ksr:Result_Card_11th;
ksr:Roll_No_Rc ?RollNo ;
ksr:Candidate_Name_Rc ?name ;
ksr:Total_Obtained_Marks_Rc ?obtained ;
ksr:Total_Marks_Rc ?total .
BIND((?obtained / ?total) * 100 AS ?percentage)
}

```

5.13 Supportive Entities Module:

The supportive entities module represents additional entities or resources that support the students such as forms, cards, documents, academic calendar.

SPARQL Query for a question in this module:

G7-E: Which scholarships are available?

```

PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX ksr: <http://www.semanticweb.org/sehrish/ontologies/2023/1/interedu#>

SELECT ?Scholarships
WHERE {
?Scholarships a ksr:Scholarships. }

```

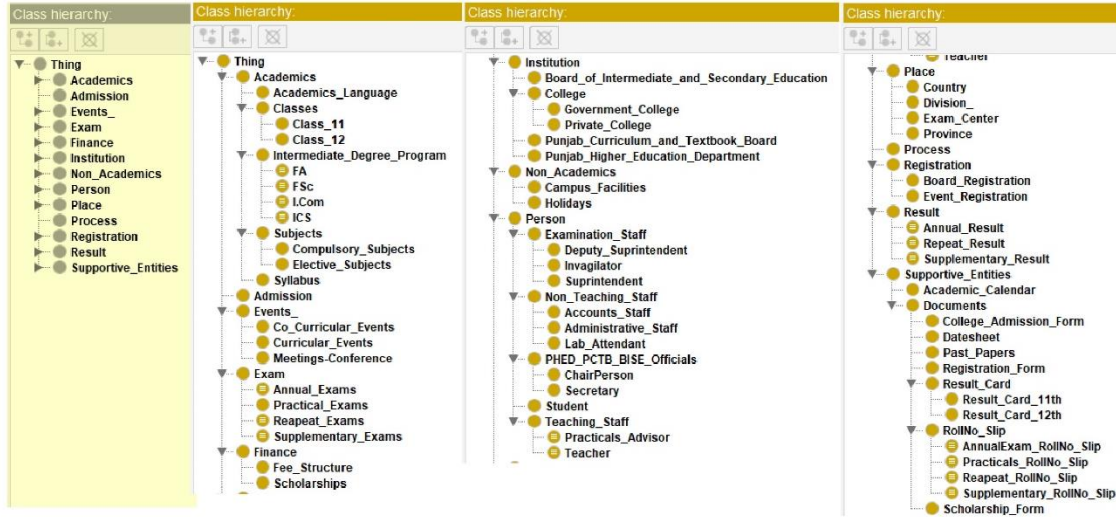



Figure 3: Intermediate Education Classes - Protege



Figure 4: Intermediate Education Object Properties - Protege

6. Evaluation

The ontology was thoroughly evaluated using the OOPS pitfall scanner, ontology metrics, and quality attribute assessment. This evaluation provided valuable insights into its strengths and weaknesses, ensuring its robustness and usability in the intended domain.

6.1 OOPS pitfall scanner Results

Only gives minor pitfalls.

Evaluation results

It is obvious that not all the pitfalls are equally important; their impact in the ontology will depend on multiple factors. For this reason, each pitfall has an importance level attached indicating how important it is. We have identified three levels:

- **Critical** 🛑 : It is crucial to correct the pitfall. Otherwise, it could affect the ontology consistency, reasoning, applicability, etc.
- **Important** ⚠️ : Though not critical for ontology function, it is important to correct this type of pitfall.
- **Minor** 🟡 : It is not really a problem, but by correcting it we will make the ontology nicer.

[Expand All] | [Collapse All]

Results for P02: Creating synonyms as classes.	11 cases Minor 🟡
Results for P07: Merging different concepts in the same class.	2 cases Minor 🟡
Results for P13: Inverse relationships not explicitly declared.	33 cases Minor 🟡
Results for P22: Using different naming conventions in the ontology.	ontology* Minor 🟡
Results for P32: Several classes with the same label.	2 cases Minor 🟡

Figure 5: OOPS Evaluation – OPPS Pitfall Scanner

6.2 Ontology Metrics

The fundamental metrics of the ontology, such as the number of axioms, classes, properties, and individuals, were obtained through extraction from Protégé.

6.2.1 Metrics

Metric	Count
Axiom	3152
Logical axiom count	2097
Declaration axioms count	494
Class count	83
Object property count	41
Data property count	186
Individual count	184
Annotation Property count	4

6.2.2 Class Axioms

Metric	Count
SubClassOf	103
EquivalentClasses	19
DisjointClasses	1
GCI count	0
Hidden GCI Count	16

6.2.3 Object Property Axioms

Metric	Count
SubObjectPropertyOf	0
EquivalentObjectProperties	0
InverseObjectProperties	4
DisjointObjectProperties	0
FunctionalObjectProperty	0
InverseFunctionalObjectProperty	8
TransitiveObjectProperty	0
SymmetricObjectProperty	0
AsymmetricObjectProperty	0
ReflexiveObjectProperty	0
IrreflexiveObjectProperty	0
ObjectPropertyDomain	41
ObjectPropertyRange	41
SubPropertyChainOf	0

6.2.4 Data Property Axioms

Metric	Count
SubDataPropertyOf	130
EquivalentDataProperties	0
DisjointDataProperties	0
FunctionalDataProperty	0
DataPropertyDomain	185
DataPropertyRange	185

6.2.5 Individual Axioms

Metric	Count
ClassAssertion	229
ObjectPropertyAssertion	326
DataPropertyAssertion	825
NegativeObjectPropertyAssertion	0
NegativeDataPropertyAssertion	0
SameIndividual	0
DifferentIndividuals	0

6.2.6 Annotation Axioms

Metric	Count
AnnotationAssertion	561
AnnotationPropertyDomain	0
AnnotationPropertyRangeOf	0

6.3 Ontology Quality Attributes

6.3.1 Accuracy:

The Intermediate Education Ontology ensures accurate and reliable information by gathering data from trusted sources, following a development process, and undergoing all kinds of testing and review. It provides students in Punjab, Pakistan, with precise knowledge representation of intermediate education programs, admission processes, curriculum, examinations, and results. [12]

6.3.2 Efficiency:

The Intermediate Education Ontology prioritizes efficiency through optimized data handling and fast information retrieval. It integrates easily with existing BISE educational system, enhancing overall system efficiency. [13]

6.3.3 Conciseness:

The Intermediate Education Ontology is concise and focused, including relevant knowledge from specific sources while excluding irrelevant information. This ensures efficient data representation and analysis. [12]

7. Conclusion and Future Work

The research paper introduces the Intermediate Education Ontology, emphasizing its effectiveness in representing educational information accurately, clearly, efficiently, consistently, and concisely. The evaluation showcases its potential in improving data interoperability and decision-making in intermediate education. The ontology is a valuable resource for students, educators, researchers, and policymakers, encouraging advancements in educational practices.

Future work may involve refining and expanding the ontology while incorporating emerging technologies. Like it can expand to primary, metric, university levels and schema can be implemented.

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Usefull Links:

<https://github.com/sehrishnoreen31/Interedu>
