# **Transforming Textual Quality Assessment in Higher Education**

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Abstract: This article focuses on developing an ontology, a specialized framework to transform how educators at universities like the Federal University in Brazil analyze educational assessments involving qualitative and quantitative data. The article details the development process of such ontology, highlighting the steps taken by researchers and integrating information systems to manage the ontology in institutional contexts. Business aspects are also covered to ensure alignment with strategic goals and operational needs. This framework is designed to be adaptable for various institutions, enhancing its utility across different domains. Additionally, the article discusses the potential applications of this ontology, particularly in analyzing teaching evaluations at the Federal University in Brazil. By structuring data, the ontology reveals hidden patterns and trends, offering value in three areas: i) Reference: providing clear definitions for assessment terms, ensuring consistency, ii) Analysis: enabling more profound analysis of assessment results to identify strengths and weaknesses, and iii) Decision-Making: aiding in informed decisions on curriculum and teaching methods. Ultimately, the ontology enhances the evaluation process, improving university student learning experiences.

## **1. INTRODUCTION**

Enhancing the quality of higher education remains an enduring priority for academic institutions worldwide. In alignment with this objective, our university is steadfastly dedicated to achieving excellence and has instituted a robust framework for institutional evaluation. This structured approach is a testament to our commitment to upholding and advancing the quality of education provided to our students. It reflects our dedication and underscores our proactive stance in fostering continuous improvement and development within the academic community. Our university stands firmly in line with this global commitment. In our duty to achieve excellence, we have established a comprehensive framework for institutional evaluation. This robust system serves as a powerful tool for advancing the quality of the education provided to our students. By continuously evaluating the University, we ensure that it will remain at the forefront of educational excellence, offering our students the best possible preparation.

Sociology primarily encapsulates the essence of organizations and institutions through a lexicon comprising terms like organization, institution, information, communication, and similar constructs. This paper asserts that texts, encompassing documents and written material,

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are pivotal in concretizing the operation of organizations and institutions in their truest sense. It put that investigating how texts function as mediators, regulators, and evaluative tools within the university context is crucial.

Texts are integral components that permeate various aspects of individuals' local work practices, encompassing activities such as drafting, perusing, scrutinizing, and more. Their role in orchestrating and harmonizing people's works must be examined and comprehended. This investigation is essential in solving the intricate structure of how the university organization operates within societal frameworks.

While a core objective of institutional assessment is to generate data that empowers administrators to make informed decisions and elevate the University's overall quality, the evaluation process presents significant hurdles. The very strength of the process - its multifaceted nature - leads to a vast amount of interconnected textual data. While rich in detail, this intricate web of information can be challenging to interpret and analyze effectively. Here's the critical connection: Our ability to utilize language to represent and communicate our reality is a defining human characteristic.

This capacity for meaning-making allows us to construct systems that mirror the world around us and, in this case, a comprehensive quality model for a university. By exploiting the power of language structures, we can potentially break down the complexities of the assessment data and unlock valuable insights that can guide university improvement efforts.

One of the main challenges is the analysis of evaluation instruments, which are rich in valuable textual elements, perceptions, and qualitative observations but lack an adequate analysis platform (Marzano and Notti, 2015). Examining sign systems, particularly linguistic ones, highlights the necessity for ontological investigation. If we are to attribute any importance to the structures of language in our everyday practices, we must posit that the system possesses its existence, its ontology. In other words, it has a distinct essence. It is not a self-contained entity that can be encountered and understood by a sentient being in the traditional sense of comprehension.

In this context, we propose the construction of an ontology as an innovative solution for structuring the process, mainly the analysis of institutional evaluation data. Ontologies offer a formal organization to represent concepts, properties, and relationships with clarity and precision (Guarino et al., 2009). Applying an ontology to the evaluation process makes it possible to organize and relate information in a structured and coherent way, ensuring consistency and clarity in the evaluation.

The methodology outlined in this study addresses the existing hurdles in the assessment process. It introduces fresh approaches for delving into a more profound comprehension of teaching quality at the University. It signifies a paradigm shift in how academic institutions engage with the outcomes of their assessment tools, aligning with the imperative need for strategies to confront the evolving challenges in higher education. This approach represents a pivotal transformation that is assured to enhance the evaluation process and elevate the overall standard of education delivery and effectiveness within the University. It underscores a forward-thinking stance in adapting to the dynamic landscape of higher education. (Horn and Dunagan, 2018).

This research initiative addresses a critical issue in the assessment of higher education. It stems from the inherent challenge of lacking a robust framework to effectively scrutinize qual-

itative textual data and establish meaningful correlations with quantitative data. This deficiency undermines the institution's capacity to gain a comprehensive, evidence-driven understanding of the information gathered through its various assessment tools.

Consequently, this weakens the decision-making process for strategic planning. As a result, the primary aim of this study is to develop a dedicated ontology explicitly tailored for analyzing evaluation results in higher education. This ontology will serve as a structured foundation, enabling a more nuanced and comprehensive evaluation of educational quality, thereby enhancing the institution's ability to make well-informed decisions for its future development and progress.

The constructed ontology is purposefully crafted to encapsulate, merge, and delve into both qualitative and quantitative data. Its design aims to comprehensively understand the outcomes derived from the University's evaluation process. By seamlessly integrating these diverse data types, the ontology facilitates a more complete and nuanced understanding, enabling stake-holders to gain valuable insights into the intricacies of the evaluation results. This holistic approach empowers the University to make more informed decisions and implement targeted strategies for continual improvement and advancement.

#### 2. RELATED WORKS

This section serves as a central building block for establishing context and comprehending the significance of ongoing research. Here, we delve into prior studies that directly pertain to the research conducted in this article. This exploration aims to spotlight how each of these studies contributes to our work's theoretical and methodological underpinnings. By examining these antecedent works, we lay the groundwork for a more comprehensive understanding of the evolution and context of our research, enabling a more evident appreciation of its contributions to the academic landscape.

In the field of quality assurance in higher education, Ali (2019) developed the OntoQA model, an ontology that covers several essential domains to support the quality of academic programs. This work is highly relevant to our research, as we aim to improve educational quality. Applying ontology to the quality assessment process, as proposed in our study, aligns with Ali's approach of using ontologies to enhance the design of educational programs and promote collaboration between stakeholders.

Marzano and Notti (2015) introduced EduOnto, an ontology focused on educational assessment. This ontology is relevant to our research, emphasizing the importance of collaboration and integration in open learning environments. We believe that using ontology in our evaluation process will contribute to a deeper and more complete understanding of the quality of teaching.

In the context of analyzing learning traces in e-learning environments, the ontology proposed by Nouira et al. (2019) has direct relevance to our research, as it emphasizes the analysis of assessment data. Our approach of using an ontology to integrate and explore qualitative and quantitative data in the evaluation process is aligned with the proposal of Nouira et al. (2019) to improve the analysis of educational assessment data.

Finally, in the context of conceptual modeling of the Semantic Web, the methodology proposed by Sila et al. (2018) is relevant, as it discusses the development of an ontological network related to the National Higher Education Assessment System (SINAES). Our research aims to fill the gap related to the lack of an adequate framework to analyze and correlate qualitative and quantitative data in the quality assessment process. Just as the OntoSINAES ontological network was developed to improve the quality of data produced in the context of SINAES, our ontology aims to improve the evaluation process.

These related works not only inform our study but also highlight the importance of ontologies as an innovative and transformative solution to the challenges faced in the process of evaluating the quality of higher education. Our research builds on these approaches to create a specific ontology that promotes a deeper and more complete understanding of the quality assessment process at the University.

## 3. METHODOLOGIES FOR ONTOLOGY CONSTRUCTION

In this section, we present the methodology used to build the ontology, which addresses the challenges faced by Higher Education quality evaluation. A crucial phase of this methodology entails identifying and classifying key concepts and entities pertinent to Higher Education quality evaluation. These concepts are defined, structured, and organized to ensure precision and clarity. Additionally, relationships between these concepts are established to acknowledge the interdependencies and interactions within the Higher Education quality evaluation domain.

Noy and McGuinness (2001) proposed a methodology to build ontologies, consisting of steps such as determining the domain and scope of the ontology, reusing existing ontologies, enumerating important terms, defining classes and class hierarchy, defining properties of classes, defining facets of properties, and creating instances. While thorough, this methodology does not include an evaluation step.

The NEON methodology (Suárez-Figueroa, Gómez-Pérez, & Fernández-López, 2012) is based on the use of ontology design patterns (ODP) and emphasizes the reutilization of ontologies from public repositories. The process is integrated through a re-engineering approach.

The general steps defined in this methodology are: 1) identify requirements, 2) identify available design patterns, 3) divide and transform the selected problem into partial problems, 4) match selected partial problems with ontology design patterns, 5) select the design pattern, 6) apply selected patterns to make a composition, 7) evaluate partial designs solutions, and 8) integrate partial solutions. The NEON methodology depends on a repository of common ontology problems and a collection of design patterns associated with general use cases. When the ontology users specify the set of competency questions at the beginning of the methodology, these questions need to be associated with the general use cases.

#### 3.1 Ontology creation process



The scope of the ontology covers institutional assessment processes at UFRGS, aiming to promote a comprehensive understanding of the instruments used and the elements that constitute assessment. This approach aligns with the definition of ontology by Bravo et al. (2019), who conceive it as a set of concepts or classes, hierarchical relationships between these concepts, and relationships between individuals or instances.

### 3.2 Definition of Classes and Subclasses

We identified and classified the fundamental elements used in the evaluation process and classified them as the main classes. Among the instruments applied by the University, two of the most relevant for undergraduate teaching are the Teacher Assessment by the Student, approved by CPA resolution No. 04/2022, and the Teacher Self-Assessment, approved by CPA resolution No. 03 /2022.

Thus, the main classes of instruments were defined as *Instr\_Teacher\_Evaluation\_by\_Students* and *Instr\_Teacher\_SelfEvaluation*, representing the evaluations conducted by students and the teacher's self-assessment, respectively. These main classes structure the evaluation processes, aligning with the specific instruments used at the University.

To ensure a comprehensive understanding, we developed main classes and expanded them into subclasses, incorporating all the elements that constitute the assessment instruments. Figure 1 presents the hierarchy of these classes, enhancing the visualization of the ontology structure and providing a more explicit representation of the components involved in the evaluation process.

### 3.3 Defining Object Properties for University Evaluation Ontology

In ontology construction, object properties are essential for defining the relationships between different classes and providing a deeper understanding of how entities interact within the domain. According to Guarino et al. (2009), these properties articulate connections and constraints among the concepts represented in the ontology, acting as bridges that link individuals to their respective classes and enhancing the semantics of relationships.

An essential step in our methodology involved the detailed definition of properties and the relationships that connect the elements of the evaluation process. We used the Protégé platform, as described by Noy and McGuinness (2001), to establish these semantic and logical connections, creating object properties that model the interactions among the elements of the evaluation instruments.

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For the evaluation instruments defined in our ontology, below are some key examples of object properties we established, illustrating their definitions and relationships within the evaluation process:

- **evaluatesClassTeacher:** This property establishes a relationship between an evaluation individual and a class of teachers. Indicates that feedback or critique has been provided regarding a specific class of teachers, helping to associate feedback directly with teaching practices.
- **evaluatesTeacher:** Links feedback or evaluation to a particular individual representing a teacher. Allows evaluation data to be assigned to individual teachers, facilitating detailed performance analyses.
- **hasGeneralComments:** Connects an evaluation individual to general comments made about the assessment. Facilitates the addition of general observations that may not fit specific categories, providing a broader view of the feedback.
- **hasOpenFieldFeedback:** Relates an evaluation to an open field where evaluators can give additional feedback. Enables the collection of comments not restricted to predefined categories, promoting a more qualitative feedback analysis.

- **isEvaluatedBy:** Establishes an inverse relationship linking an evaluation individual to the evaluator (e.g., a student or group of students). Facilitates identifying who conducted the evaluation, allowing for analyses of student perceptions of teaching.
- **hasSelfEvaluation:** Connects an individual representing a self-evaluation class to a teacher. Enables self-evaluation data to be linked to a specific teacher, providing insights into how teachers perceive their performance and teaching practices.

These properties were carefully planned to capture the complexity of interactions among the elements of the evaluation process, resulting in a cohesive and semantically rich ontology. By clearly defining these relationships, we establish a coherent structure that reflects the intricacies of the evaluation processes at the University. The relationships among classes and properties are illustrated in Figure 1, showcasing the hierarchical organization and interconnections between different entities within the ontology.

Through these well-defined object properties, our ontology ensures a robust and detailed representation of the teaching quality assessment process, aligning with university evaluation practices' specific needs and complexity.

### 3.5 Definition of Individuals

In the final step, we focused on defining individuals representing specific instances of the previously established classes and subclasses. Everyone corresponds to real feedback provided by students during the evaluation process, allowing for a nuanced understanding of teaching quality assessment.

In our ontology, we categorize sentiments expressed by students during evaluations as individuals classified as positive, negative, or neutral. For example, *PositiveComment*, *NegativeComment*, and *NeutralComment* capture the various sentiments reflected in student feedback. Additionally, we created individuals for self-evaluations and student evaluations, such as *SelfEvaluation Teacher001* and *StudentEvaluation 001*.



Furthermore, the sentiments expressed by students — categorized as positive, negative, or neutral — are also represented as individuals linked to the relevant evaluations. This dual approach allows for comprehensive modeling of actual evaluation situations, as Horridge et al. (2004) emphasized, where individuals personify theoretical concepts within the ontology.

Figure 2 shows how these individuals were created and connected within the assessment process ontology. By incorporating sentiments and evaluation instances as individuals, our ontology enriches the representation of student feedback and self-assessment, facilitating more profound insights into teaching practices and the overall evaluation process.

#### **3.6 Ontology Population**

In this section, we describe the process of populating our ontology with concrete instances that reflect the real-world evaluation scenarios at the University. Using the Protégé platform, we systematically added individuals representing specific evaluations, sentiments, and selfassessments.

Ontology population involved the following steps:

- (a) Creating Individuals: We defined individual instances for various categories, such as StudentEvaluation\_001 and SelfEvaluation\_Teacher001. Everyone corresponds to actual feedback or self-assessment data, allowing for a direct representation of the evaluation process.
- (b) Categorizing Sentiments: We also incorporated sentiment analysis by creating individuals for positive, negative, and neutral comments. For instance, *PositiveComment*, *NegativeComment*, and *NeutralComment* were established to categorize the sentiments expressed by students during evaluations. This categorization provides a structured way to analyze feedback and gain insights into students' perceptions of teaching quality.
- (c) Linking Relationships: Everyone was related to the relevant classes and properties defined in the ontology. For example, student evaluations were associated with their respective classes, and sentiments were connected to the assessments they pertained to. This step ensures that the ontology accurately reflects the relationships and interactions between different entities involved in the evaluation process.
- (d) Utilizing Protégé Tools: The Protégé platform offers various tools to facilitate the population of the ontology, including templates for creating individuals and visual representations of class hierarchies. These tools helped us maintain consistency and ensure that all individuals were appropriately categorized within the ontology.

Through this structured population process, our ontology now encompasses a rich set of individuals that represent the complexity of the evaluation process, allowing for enhanced analysis and understanding of teaching quality assessments at the University. This comprehensive approach supports ongoing evaluation efforts and provides a solid foundation for future research in this area.

#### 4. ONTOLOGY VISUALIZATION

After the population stage of the ontology, where individuals representing evaluations and sentiments expressed by students were inserted, we utilized visualization tools integrated into

Protégé to make the ontology's structure more accessible and understandable. The tools OWLViz and OntoGraf played a crucial role in the graphical exploration of class hierarchies, properties, and relationships among individuals.

OWLViz is a Protégé plugin that allows the visualization of class hierarchies in an OWL ontology, enabling detailed incremental navigation between classes. As described by Horridge (2010), this tool aids in comparing and analyzing the asserted class hierarchy and the inferred hierarchy, visually highlighting inconsistent concepts.

While OWLViz focuses on class hierarchies, OntoGraf allows for a more interactive visualization that explores the relationships between individuals and classes. According to Falconer (2010), OntoGraf supports various layouts for automatically organizing the ontology's structure, allowing navigation through relationships such as subclass, object properties, and individuals. In Figure 3, we utilize OntoGraf to demonstrate the interactions among the populated individuals, such as the relationship between the expressed sentiment categories (positive, negative, and neutral) and the comments made by students during teacher evaluations. TT

Furthermore, OntoGraf facilitated the visualization of connections between self-evaluations and student evaluations, enabling a clearer analysis of the interactions among the evaluation instruments and their respective evaluators. This visualization reinforces the understanding of the complex relationships present in the ontology and highlights the importance of categorizing feedback and its connections to the evaluated elements.

By employing these two tools, the ontology can be explored more effectively, providing a detailed view of class hierarchies and individual relationships, enabling a deeper and visually richer analysis of the teaching evaluation process.



## 5. ONTOLOGY VALIDATION

Validation of the ontology is a fundamental step to ensure that it accurately and completely captures the domain in question and the actual evaluation processes. In this context, several validation steps were performed, and they are described below:

- (a) Comparison with Real Assessment Instruments: The ontology was subjected to a rigorous comparison with the quality assessment instruments. This process made it possible to verify whether the ontology is aligned with the conceptual structures and terminologies used by the institution.
- (b) Verification with Real Data: The integrity of the ontology was evaluated by comparing the data provided by the Institutional Assessment Secretariat with the represented information. This step was essential to ensure it faithfully reflected reality and maintained consistency with actual data.

Validation of Populated Individuals: The individuals inserted into the ontology, representing real student feedback and self-assessments, were carefully verified for consistency and relevance. This process included reviewing comments categorized as positive, negative, or neutral to ensure they accurately reflected student opinions. The validation of individuals is crucial, as it ensures that subsequent analyses based on the ontology are precise and meaningful.

(c) Query Tests Using the HermiT Reasoner: Query tests were conducted with the assistance of the HermiT Reasoner. HermiT is a reasoning engine built into Protégé that plays a crucial role in checking the internal consistency of the ontology. This mechanism was highlighted by Horridge et al. (2004) in their ontology construction guide. Furthermore, it enables effective responses to a variety of queries, ensuring that the information retrieved is relevant, accurate, and consistent according to users' needs.

## 6. ONTOLOGY APPLICATION

The constructed ontology represents the process of evaluating teaching quality at UFRGS and can be applied to improve understanding and process management (Alrehaili et al., 2021). Some possible applications include:

- Query and Analysis: The ontology can perform detailed queries on the instruments, evaluated elements, and results, allowing an in-depth analysis of the evaluation process.
- **Decision Making:** The University can use ontology to support its decisions related to teaching quality based on accurate and contextualized information.
- Monitoring and Improvement: The ontology can be a valuable tool for continuously monitoring the evaluation process, helping to identify areas for improvement and opportunities for enhancement.
- User Feedback: The effective application of the ontology largely depends on the acceptance and usage by end-users, such as teachers, evaluators, and administrators. Therefore, it is essential to implement a continuous feedback mechanism that allows users to express their experiences, challenges, and suggestions for improvements. This feedback can include aspects such as the usability of the ontology, the clarity of the information presented, and the relevance of the data for decision-making. By collecting and analyzing this feedback, the University can adjust and update the ontology, ensuring it remains aligned with user needs and the dynamics of the quality assessment process. Furthermore, integrating this feedback into the continuous improvement process can promote greater adherence to the ontology and enhance its effectiveness in educational management.
- Benefits, Challenges, and Future Opportunities: Its application offers advantages, such as centralizing information, facilitating the search for relevant data, and promoting a more

comprehensive view of the evaluation process. However, it can also present challenges, such as the need for constant updating as new instruments and elements are introduced.

### 7. FINAL CONSIDERATIONS

This article presented a methodology for building an ontology to assess quality in higher education at a federal university. Furthermore, it expands the conditions for analysis and decision-making by the Institution's managers. Incorporating technological advancements, such as semantic web technologies and natural language processing, is another integral aspect of this methodology. These tools empower the ontology to be dynamic and adaptable, capable of capturing evolving trends and emerging criteria in Higher Education.

Furthermore, the methodology involves testing and validation processes to ensure the ontology's robustness and reliability. Real-world data and scenarios are used to evaluate the ontology's performance, ensuring it can effectively assist in quality evaluation tasks.

Ultimately, this methodology is a strategic blend of research, expert consultation, technological innovation, and validation, all orchestrated to construct an ontology tailored to meet the demands of Higher Education quality evaluation. Through this comprehensive approach, we aim to provide a valuable resource that can navigate the ever-evolving landscape of Higher Education and contribute to the continuous enhancement of educational quality.

This work highlights the value of ontologies in improving educational quality and addressing complex academic and institutional challenges.

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