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Ontology Design of a Modern Learning Environment and Modern Pedagogy Using Protégé Software

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Abstract

This article discusses ontology design for modern learning environments and modern pedagogy using Protégé software. Library research methodology is used to formulate an ontology that reflects the structure, relationships and properties of modern learning entities. This ontology serves as a formal representation that allows a better understanding of the essential elements in modern learning and the relationships between them. The ontology approach provides a clear framework for designing and developing adaptive and responsive learning environments, as well as for designing teaching strategies that suit individual needs. By using Protégé, researchers can systematically describe key concepts in modern learning, including collaborative learning methods, technology integration, and personalized learning. The results show that the resulting ontology can be a useful tool for curriculum developers and teachers to design learning experiences that are more effective and relevant to current demands.

Keywords: Ontology design; Modern learning environments; Protégé software; Pedagogy

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INTRODUCTION

The ontology design of modern learning environments (MLE) and modern pedagogies (MP) using Protégé software is an important requirement in developing learning systems and teaching methods that are able to provide a modern and effective learning environment (Musen, 2015). When the educational paradigm changes and moves towards a more innovative and adaptive approach, ontology plays a big role in structuring systematically organized knowledge. By using Protégé, MLE and MP ontologies can be built in a structured and integrated manner, allowing educators and policymakers to access relevant information more easily and efficiently (Gennari et al., 2003).

One of the main problems often encountered in the development of MLE and MP is a lack of understanding of the relationships between concepts and entities in the modern learning domain (Riyanto, 2020). Without a proper ontology, it will be difficult for the education system to integrate the various resources and information required (Haq & Lhaksmana, 2018). In this case, Protégé can help in creating a clear and easy-to-understand ontology, making it easier to model knowledge and form a solid foundation for further development.

With a relevant and structured ontology design, MLE and MP can overcome various challenges and obstacles in modern learning practices (Scherp et al., 2011). Ontologies built using Protégé enable system developers and users to perform deeper semantic analysis, identify relationships between information, and better improve teaching and learning processes (Musen, 2015). Thus, ontology can be used as an effective solution for facilitating collaboration between various stakeholders in the education sector and increasing the efficiency of knowledge management in the learning environment.

The use of Protégé in designing ontologies for MLE and MP also provides great benefits in dealing with the complexity and dynamics that exist in modern education systems (Schekotihin et al., 2018). With the increasing development of information technology and the use of big data, ontologies can be an effective means for integrating information, designing curricula that suit needs, and creating adaptive and innovative learning strategies. With a structured and up-to-date ontology, more contextual and personalized teaching practices can be better realized.

Overall, the ontology design of the Modern Learning Environment and Modern Pedagogy using Protégé software not only provides concrete solutions to complex problems in modern learning environments but also opens up new opportunities for optimizing the use of technology and data to increase learning effectiveness (Sudiantini et al., 2023). By utilizing an integrated and standardized ontology, educators can design relevant, sustainable, and results-oriented learning experiences that benefit student development.

METHOD

The literature research methodology regarding the ontology design of the modern learning environment and modern pedagogy using Protégé software can be divided into several main steps. The first step is to identify relevant sources of information (Pattah, 2014; Surur, 2020), such as scientific journals, articles, and books related to ontology design, modern learning environments, and modern pedagogy. This step helps researchers understand basic concepts and recent developments in the field.

The second step is to analyze the information that has been collected to extract key concepts that need to be modeled in the ontology (Hadiprakoso et al., 2021). The researcher examined the information carefully and compiled a list of key concepts needed to build a comprehensive ontology (Pratiwi et al., 2023). This step helps ensure that the ontology being built covers all important aspects of the modern learning environment and modern pedagogy.

The third step is to design the ontology structure using Protégé software (Putra et al., 2021). In this step, researchers utilize Protégé features to create the classes, properties, and relationships between classes needed in the ontology. Researchers can also add annotations and documentation to explain the concepts modeled in the ontology.

The fourth step is testing and validating the ontology that has been built (Hafiz, 2023). Researchers use Protégé to test the consistency and correctness of information in the ontology. Apart from that, researchers can also carry out evaluations (Nuriyah et al., 2023) with domain experts to ensure that the ontology meets the needs and standards that have been set.

Finally, the fifth step is to prepare a research report (Faizal, 2016), which includes the ontology development process using Protégé. The report includes the research background, methods used, findings, and conclusions from the research (Surur, 2022). This report is important to provide a comprehensive understanding of the ontology design of the Modern Learning Environment and Modern Pedagogy, which has been developed using Protégé software.

FINDINGS AND DISCUSSION

1. Protégé Software

Figure 1. Logo of Protege Software

Protege Software is an open-source platform used to build and maintain knowledge ontologies in RDF (Resource Description Framework) format (Park & Musen, 1998). This software helps in building and maintaining ontologies, as well as providing tools for managing ontologies and running inferences on them. Protege can be used in various applications such as semantic web, data integration, knowledge management, and others (Rubin et al., 2007). Protege is used by researchers, ontologists, and software developers in a variety of knowledge development applications (Sivakumar & Arivoli, 2011). With Protege, users can define classes, properties, relations, rules, and constraints to build ontologies that describe specific knowledge domains. Protege is equipped with an intuitive graphical user interface, making it easy for users to create and manage their ontologies (Yadav et al., 2016).

Protege supports many ontology languages, such as OWL (Web Ontology Language), RDF, and RDFS, so users can create ontologies that comply with the latest standards in the semantic web (Tudorache et al., 2008). Additionally, Protege provides various plugins that can be used to customize and extend the platform's functionality according to user needs (Fahrurrozi & Azhari, 2017).

With its flexible capabilities, Protege has become one of the software choices for developing knowledge-based systems, semantic webs, and other applications that require structured and semantic data models (Susilo et al., 2015).

2. Steps for setting up a network with Protégé software

1) Install software.

Protégé software can be obtained by visiting the page https://protege.stanford.edu/, then clicking Download Now ➔ Download for Windows

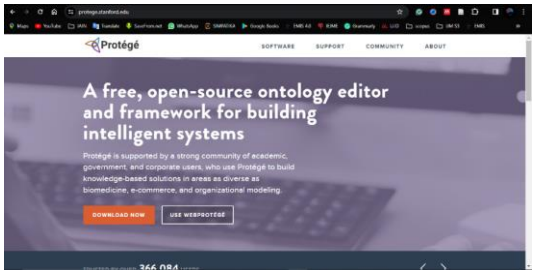

Figure 2. Home page of the Protege website

Then, to extract the download results, double-click the Protégé.exe software.

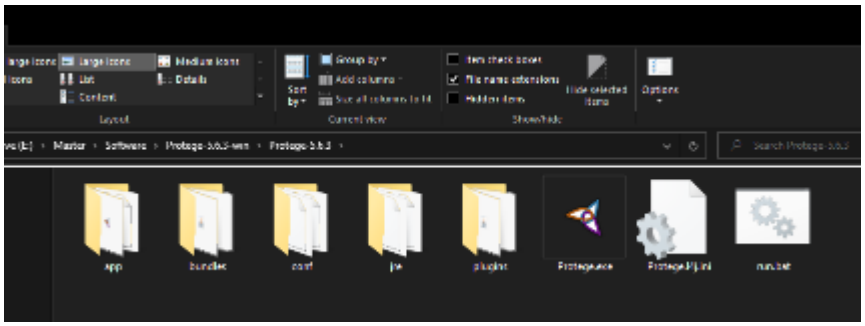

Figure 3. Protege Files that Need to be Installed

2) Open the software. The following is the initial display of the software.

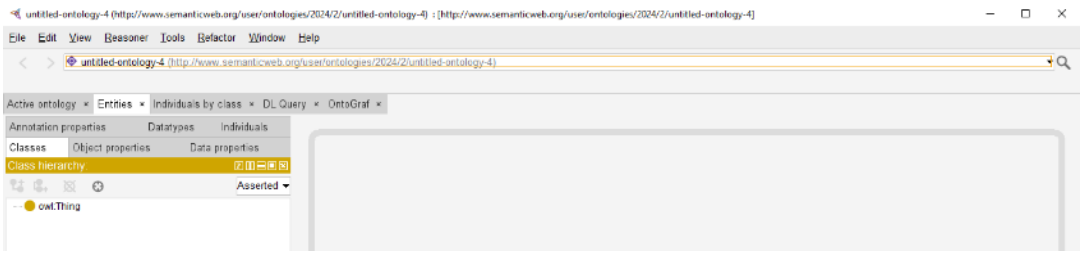

Figure 4. Protege Home Page

3) Prepare content.

The content used is lecture material with the theme "**Modern Learning Environment**," which is shared by the lecturer.

4) Content entry into the protégé software

Right-click on "owl:thing" and change the IRI (rename) to "Modern Learning Environment."

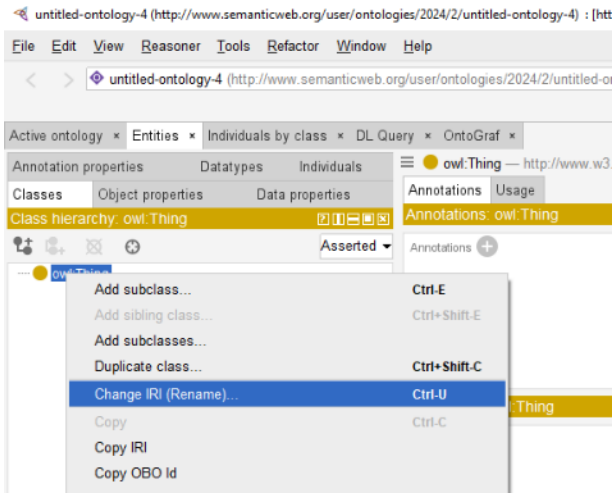

Figure 5. How to Change Name

5) Subclass entry

Click the following symbol, then type a title.

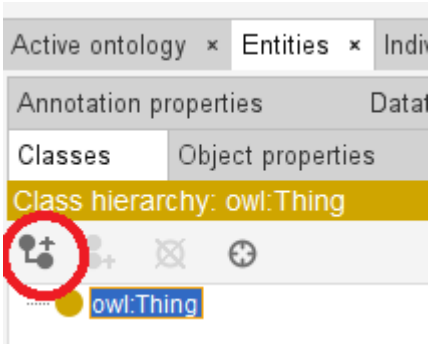

Figure 6. How to Add Classes

Enter until everyone enters the class,

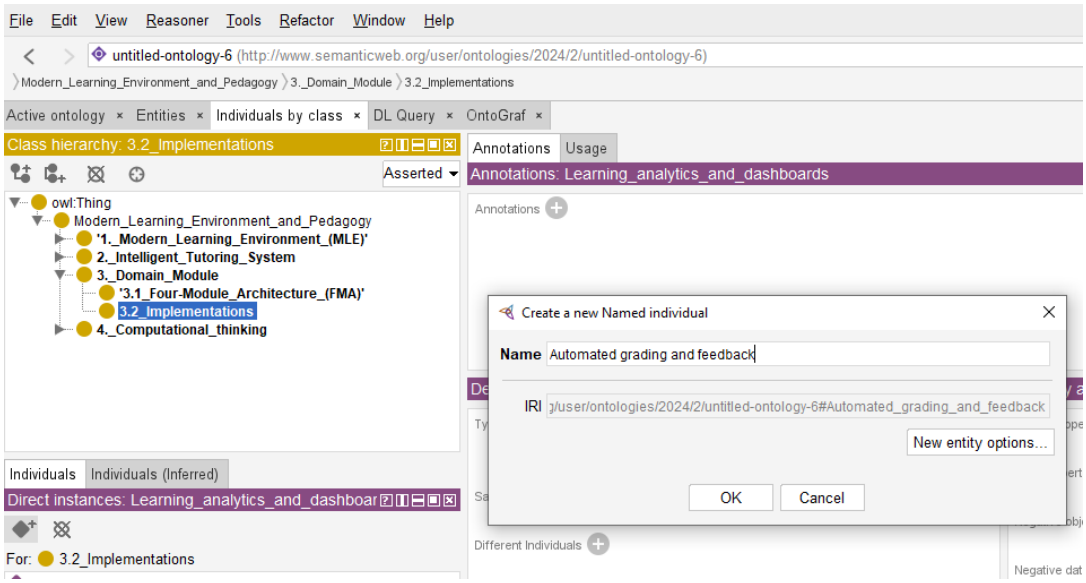

Figure 7. How to Add Sub Classes

and it looks as follows:

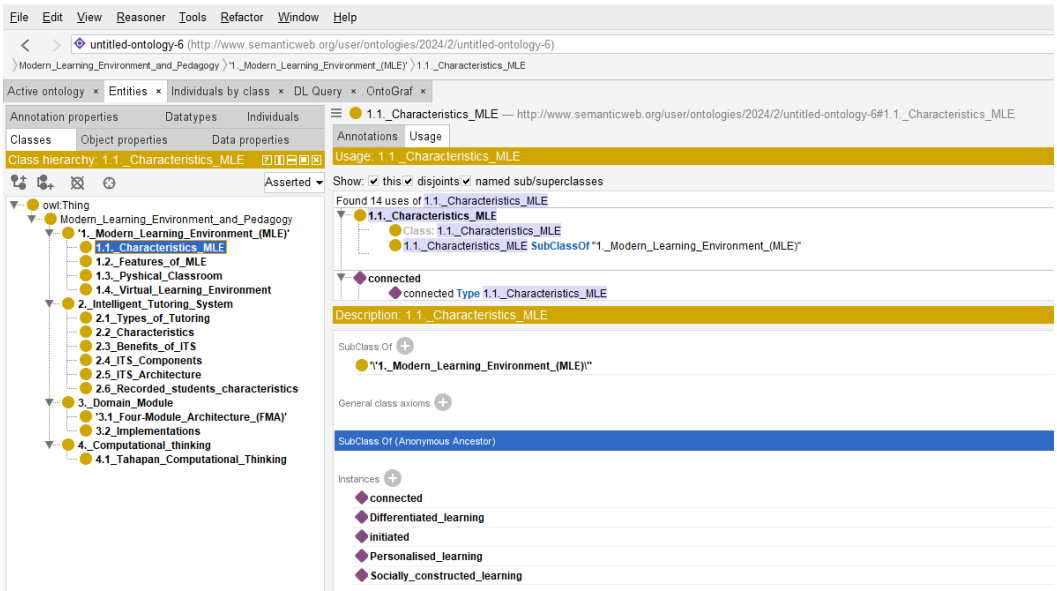

Figure 8. Complete Results of Modern Learning Environments and Pedagogy

6) Display per subclass

a. Class

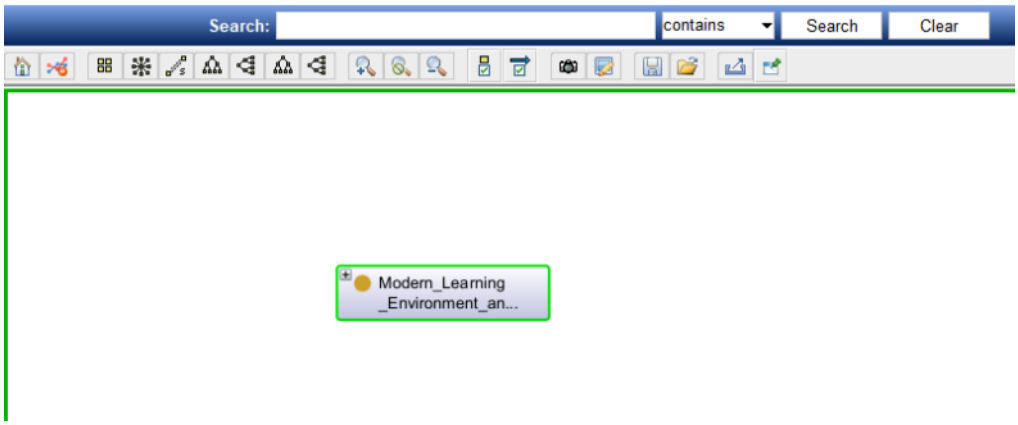

Figure 9. Initial Network View

3. Modern Learning Environments and Pedagogy

The modern learning environment is an educational concept that integrates technology and innovation into the learning process (Spivakovsky et al., 2019). This learning environment emphasizes the use of digital tools and platforms as a means to support learning, both inside and outside the classroom (Pratiwi et al., 2023). With an approach that emphasizes collaboration, interactivity, and student engagement, modern learning environments enable educators to create more engaging, effective, and relevant learning experiences for today's generation of students growing up in the digital era (Surur et al., 2023).

Pedagogy is a science that studies the theory and practice of education (Nurhidayati, 2017). In the context of a modern learning environment, pedagogical approaches must be in accordance with technological developments and the needs of today's generation of students. Pedagogy in a modern learning environment not only emphasizes the transfer of knowledge from educators to students but also prioritizes the development of critical thinking skills, creativity, innovation, and the ability to adapt to technological developments. Thus, pedagogy in the modern learning environment has an important role in creating a learning atmosphere that allows students to develop holistically and be ready to face future challenges.

1). Modern Learning Environment (MLE)

1.1) Characteristics of MLE

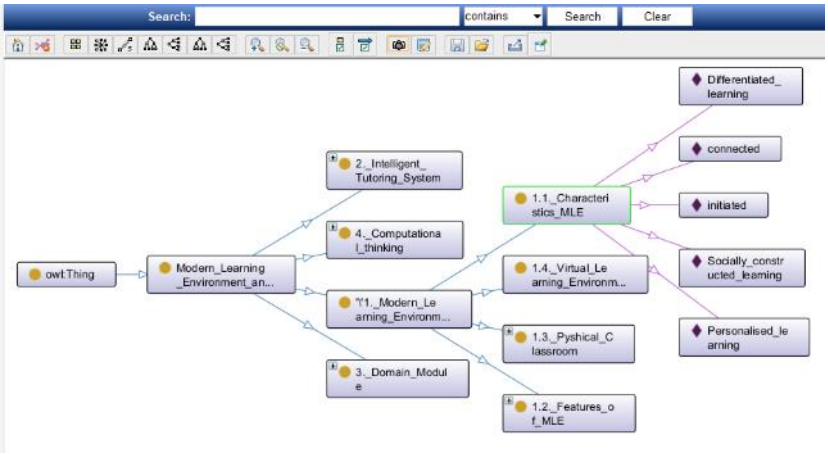

Figure 10. Network Display Characteristics of MLE

Characteristics of modern learning environments include technology integration, collaboration, flexibility, and active student engagement (Kovtoniuk et al., 2022). In this environment, technology is used as a tool to facilitate interactive learning and support a variety of learning styles.

- Personalized learning. Personalized learning encourages each individual to access learning materials and experiences according to their individual needs and learning pace. With the use of technology and data analysis, students can receive guidance tailored to their abilities, interests, and learning styles.

- Socially constructed learning. Socially constructed learning encourages collaboration, discussion, and joint problem-solving between students and teachers. Interaction between students allows the exchange of ideas and views that enrich the learning process.

- Differentiated learning. Differentiated learning accommodates individual differences in abilities, interests, and learning styles. Teachers design diverse learning experiences to meet the needs of each student individually.

- Initiated by the students themselves. Learning initiatives initiated by students themselves give students the freedom to explore their own interests and aspirations. By having control over their learning process, students become more motivated and enthusiastic about achieving their learning goals.

- Connected to the physical world and authentic context. Learning that is connected to the physical world and authentic contexts brings learning from the school environment to the real world. Students are given the opportunity to apply the knowledge and skills they learn in real-world situations, increasing their understanding of the relevance of the subject matter to everyday life (Sulistyawati, 2021).

1.2) Characteristics of MLE

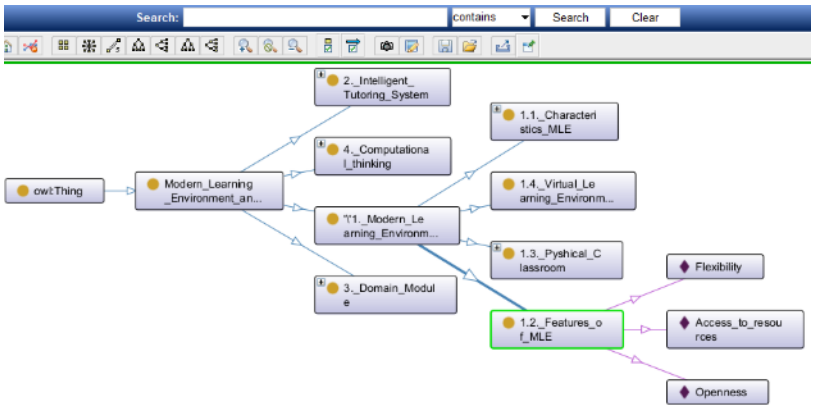

Figure 11. Network Display Characteristics of MLE 2

- Flexibility. Flexibility, openness, and access to resources are key elements that enable a person to thrive and survive in an ever-changing environment. Flexibility allows a person to adapt to a variety of situations and challenges, allowing for quick and effective adjustments.

- Openness. Openness is a mental attitude that accepts various ideas, views, and opinions from various sources to achieve a better understanding.

- Access to resources. Access to resources is key to expanding one's knowledge, skills, and experience, opening up more opportunities for personal growth and development (Berry, 1989).

1.3) Physical Class

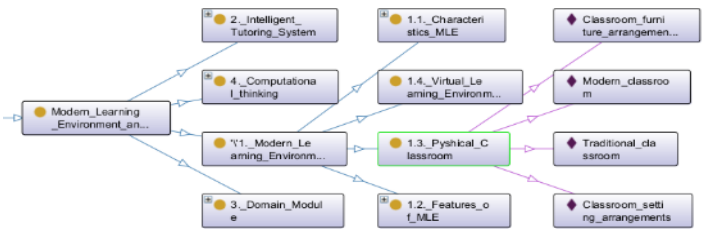

Figure 12. Network Display Physical Class

- Traditional classroom. Traditional classrooms are often dominated by tables and chairs arranged neatly in rows facing a blackboard, with a rigid and formal layout.
- Modern classrooms. Modern classrooms tend to be more dynamic with the use of modular and flexible furniture, allowing teachers and students to collaborate more comfortably.
- Arranging classroom settings. Traditional classroom settings usually tend to be hierarchical with a very dominant teacher role, while modern classrooms create a more inclusive atmosphere that encourages active participation from all parties.
- Arrangement of classroom furniture. The arrangement of furniture in traditional classrooms is more organized and ordered, while modern classrooms tend to pay more attention to flexibility and comfort in interactions between individuals (Kaya & Burgess, 2007).

1.4) Virtual Learning Environment

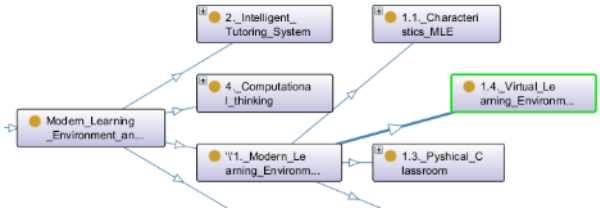

Figure 13. Network Display Virtual Learning Environment

2). Smart Tutoring System

2.1) Types of Tutoring

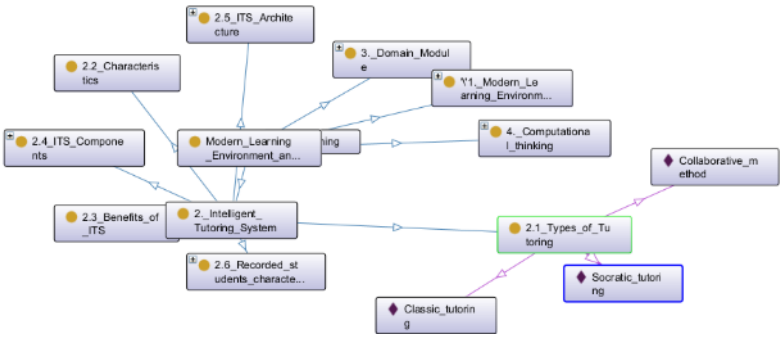

Figure 14. Network Display Types of Tutoring

- Classical tutoring (group tutoring). Classic tutoring, or group tutoring, is a learning method in which a group of students study together with the guidance of a teacher.
- Collaborative methods. Collaborative methods are learning approaches that encourage collaboration between students to achieve common goals.
- Socratic tutoring (private lessons). Meanwhile, Socratic guidance, or private tutoring, is an individual learning method where a teacher gives special attention to one student to facilitate a more intensive understanding and improvement of abilities (Ramli, 2022).

2.2) Characteristics

2.3) Benefits of ITS

2.4) The components

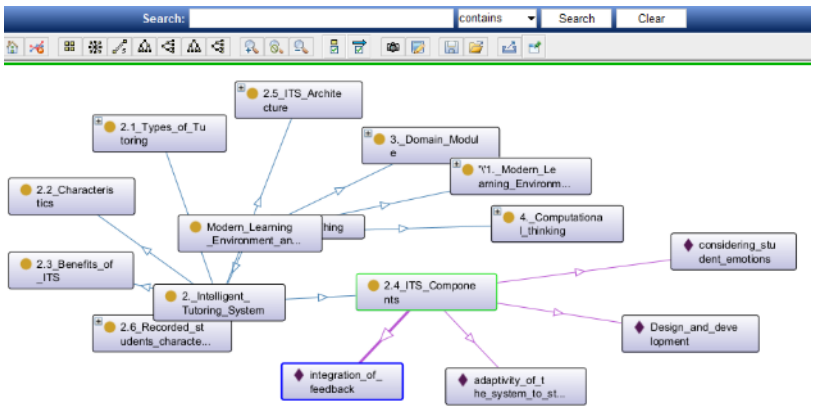

Figure 15. Network Display Components

- Design and development. In educational design and development, the integration of feedback and adapting the system to student needs are very important.
- feedback integration. With feedback, educators can continue to evaluate and improve the existing education system so that it can provide a better learning experience for students.
- Adapting the system to student needs. Adapting the system to student needs can also increase students' learning motivation and help them be more successful in achieving their learning goals.

- Consider students' emotions. By considering students' emotions, you can create a more effective and inclusive learning environment (Valiente et al., 2012).

2.5) ITS Architecture

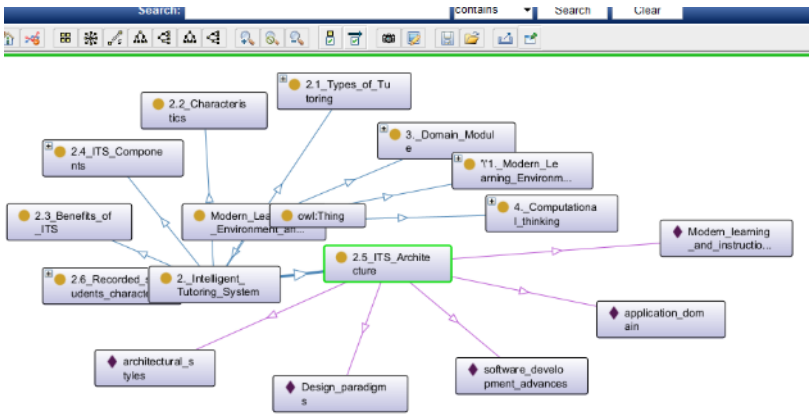

Figure 16. Network Display ITS Architecture

- Application domain. Application domain refers to the area in which a software application will be used, which includes various industries such as finance, health, transportation, and others.

- Design paradigm. A design paradigm is a general approach to developing software that involves certain patterns and principles.

- Architectural style. Architectural style in software development refers to the overall structure as well as the relationship between software components.

- Software development progress. Advances in software development include new methods, advanced tools, and ever-evolving collaborative approaches.

- Modern learning and teaching theories. Modern learning and teaching theories play an important role in training software developers to be able to face ongoing challenges and build relevant, innovative solutions (Fathurrohman, 2017).

2.6) Student characteristics are recorded.

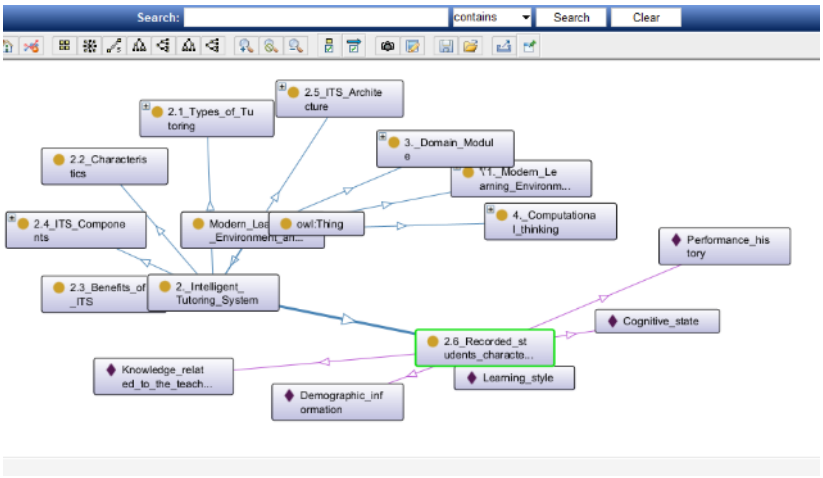

Figure 17. Network Display Student Characteristics Are Recorded

- Demographic information. Demographic information about a student can provide an in-depth understanding of that individual's background, such as age, gender, and educational background.
- Performance history. A student's performance history includes notes regarding academic performance and participation in previous lessons that can assist teachers in planning appropriate learning.
- Learning styles. Student learning style refers to individual preferences in understanding information, such as visual, auditory, or kinesthetic, which have an impact on learning effectiveness.
- Cognitive state. Students' cognitive states, such as problem-solving abilities, memory, and comprehension, can also influence success in learning.
- Knowledge related to the teaching subject. Knowledge related to a student's teaching subject will influence the student's level of understanding and ability to follow the lesson (Maryati, 2018).

3). Domain Module

3.1) Four-Module Architecture (FMA)

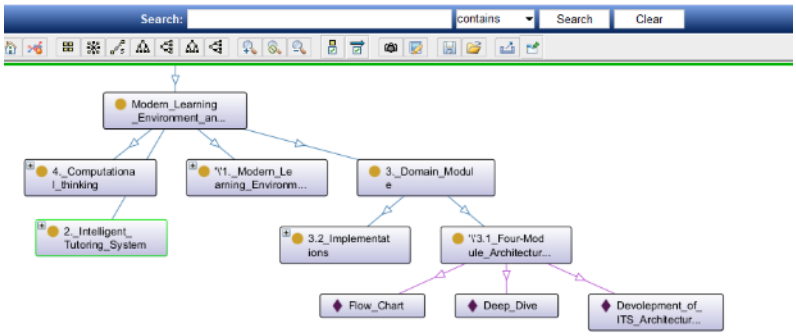

Figure 18. Network Display Four-Module Architecture (FMA)

- Deep Dive into the Model. In developing an ITS architecture, it is important to dive deeply into the model and understand every detail.
- Development of ITS Architecture. In developing an ITS architecture, it is important to dive deeply into the model and understand every detail.
- Flow diagram. Flow diagrams are one of the keys to this process, making it possible to explain the relationships between existing components clearly.
- Dive Deeper. By diving deeper into the models and flow diagrams, it will provide a deeper understanding and make it possible to identify potential improvements and innovations that can be applied in the development of the ITS architecture (Spriani et al., 2019).

3.2) Implementation

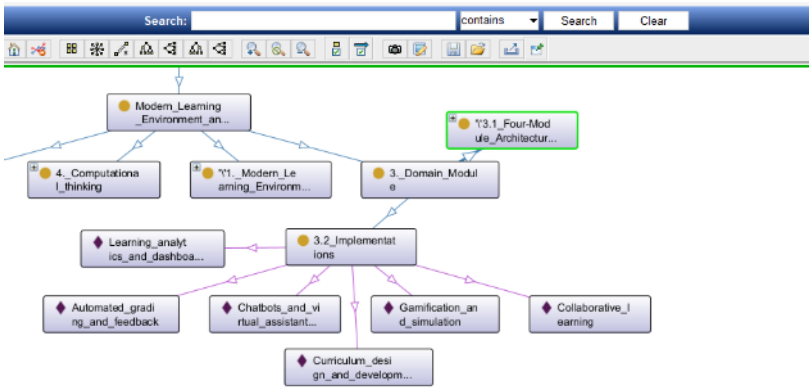

Figure 19. Network Display Implementation

- Automatic assessment and feedback. Automated grading and feedback play an important role in improving efficiency in the learning process by providing quick responses to students.
- Study analytics and dashboards. Studying analytics and dashboards provides deep insight into student learning progress and helps teachers make more informed decisions.
- Curriculum design and development. Innovative curriculum design and development are key to providing relevant and engaging learning experiences for students.
- Gamification and simulation. By utilizing gamification and simulation, learning can become more interactive and fun.
- Chatbots and virtual assistants. Chatbots and virtual assistants help provide help and support to students in real-time.
- Collaborative learning. Meanwhile, collaborative learning promotes cooperation between students to achieve learning goals together. By integrating these various technologies, the learning experience can be enhanced to support more effective educational development (Apriono, 2013).

4). Computational thinking

4.1) Stages of Computational Thinking

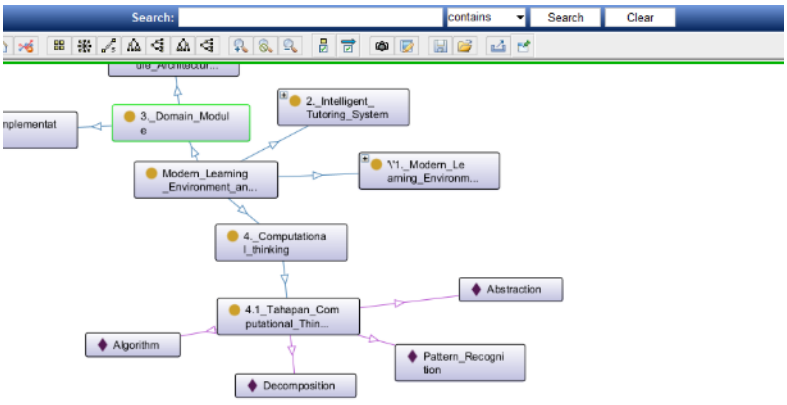

Figure 20. Network Display Stages of Computational Thinking

- Decomposition. Decomposition is the process of breaking down a task or problem into smaller parts to make it easier to understand and solve.
- Pattern recognition. Pattern recognition involves identifying hidden patterns or structures in data, making it possible to make predictions or generalizations.
- Abstraction. Abstraction is the process of simplifying information by extracting the main features and ignoring unimportant details.
- Algorithms. Algorithms are structured steps used to solve a problem or achieve a specific goal efficiently (Maulana, 2017).

Overall, the appearance of the "Modern Learning Environment" using Protégé software is as follows:

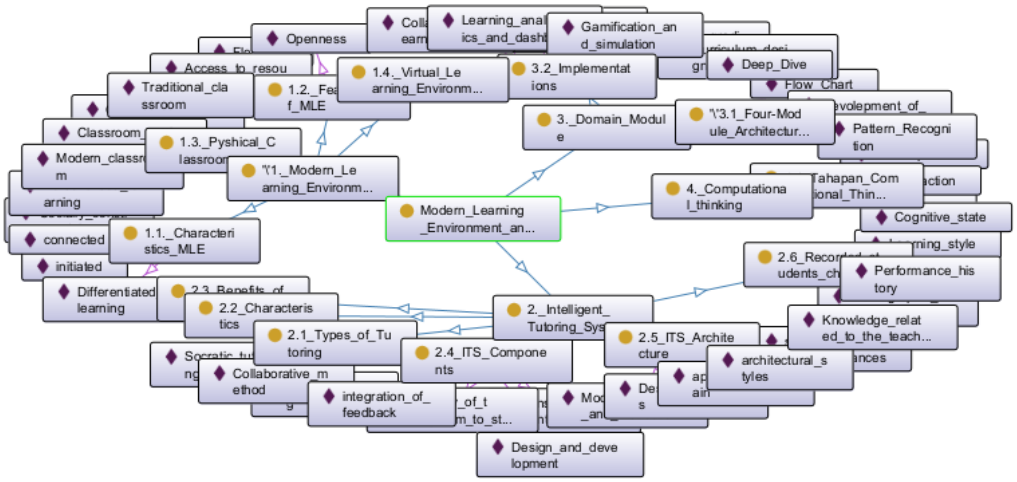

Figure 21. Network Display Modern Learning Environment

There are many networks presented, which show the complexity of the components related to the "modern learning environment.".

CONCLUSION

In the context of ontology design for modern learning environments and modern pedagogy using Protege software, it can be concluded that this approach provides a strong foundation for organizing knowledge, concepts, and relationships between entities involved in the learning process. With a well-structured ontology, interactions between students, teachers, and learning

materials can be managed effectively and efficiently. Apart from that, ontology design also strengthens the integration of information technology in learning, helps in designing adaptive and personalized curricula, and facilitates automatic management and assessment of learning performance. Thus, the application of ontology design using Protege in the context of a modern learning environment and modern pedagogy can improve the overall quality and effectiveness of learning.

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REFERENCES

Apriono, D. (2013). *Pembelajaran kolaboratif: Suatu landasan untuk membangun kebersamaan dan keterampilan. Diklus, 17(1).*

Berry, S. (1989). *Social institutions and access to resources. Africa, 59(1), 41-55.*

Fahrurrozi, M., & Azhari, S. N. (2017). *Rancang Bangun Plugin Protégé Menggunakan Ekspresi SPARQL-DL Dengan Masukan Bahasa Alami. IJCCS (Indonesian Journal of Computing and Cybernetics Systems), 11(2), 155-164.*

Faizal, M. (2016). *Trik Praktis Ms Word untuk Menyusun Laporan Penelitian. Mochappucinno Studio.*

Fathurrohman, M. (2017). *Belajar dan pembelajaran modern: konsep dasar, inovasi dan teori pembelajaran. Garudhawaca.*

Gennari, J. H., Musen, M. A., Fergerson, R. W., Grosso, W. E., Crubézy, M., Eriksson, H., & Tu, S. W. (2003). *The evolution of Protégé: an environment for knowledge-based systems development. International Journal of Human-computer studies, 58(1), 89-123.*

Hadiprakoso, R. B., Qomariasih, N., & Yasa, R. N. (2021). *Identifikasi Malware Android Menggunakan Pendekatan Analisis Hibrid Dengan Deep Learning. Jurnal Teknologi Informasi Universitas Lambung Mangkurat (JTIULM), 6(2), 77-84.*

Hafiz, M. A. (2023). *Penerapan Logika Fuzzy Sugeno Untuk Optimasi Stok Biji Kopi Pada Kafe Rooster. Jurnal Fasilkom, 13(02), 165-172.*

Haq, N. S., & Lhaksmana, K. M. (2018). *Penerapan Sparql Dan Ontology Pada Pencarian Data Buku Dan Perbandingannya Dengan Pendekatan Relasional. eProceedings of Engineering, 5(2).*

Kaya, N., & Burgess, B. (2007). *Territoriality: Seat preferences in different types of*

classroom arrangements. Environment and Behavior, 39(6), 859-876.

Kovtoniuk, M., Kosovets, O., Soia, O., & Tyutyun, L. (2022). *Virtual learning environments: major trends in the use of modern digital technologies in higher education institutions. Educational Technology Quarterly, 2022(3), 183-202.*

Maryati, I. (2018). *Penerapan model pembelajaran berbasis masalah pada materi pola bilangan di kelas vii sekolah menengah pertama. Mosharafa: Jurnal Pendidikan Matematika, 7(1), 63-74.*

Maulana, G. G. (2017). *Pembelajaran Dasar Algoritma Dan Pemrograman Menggunakan El-Goritma Berbasis Web. J. Tek. mesin, 6(2), 8.*

Musen, M. A. (2015). *The protégé project: a look back and a look forward. AI matters, 1(4), 4-12.*

Nurhidayati, E. (2017). *Pedagogi konstruktivisme dalam praksis pendidikan Indonesia. Indonesian Journal of Educational Counseling, 1(1), 1-14.*

Nuriyah, Z. C., Anggraini, A., Yusal, Y., Sa'id, I. B., Maiyanti, A. A., & Wulandari, R. W. (2023). *Digital Technology Development in the Form of YouTube Videos as Science Learning Media in Ecosystem Material on Learning Motivation. Indonesian Journal of Multidisciplinary Educational Research, 1(1), 14-28.*

Park, J. Y., & Musen, M. A. (1998). *VM-in-Protege: a study of software reuse. In MEDINFO'98 (pp. 644-648). IOS Press.*

Pattah, S. H. (2014). *Literasi informasi: peningkatan kompetensi informasi dalam proses pembelajaran. Khizanah Al-Hikmah: Jurnal Ilmu Perpustakaan, Informasi, Dan Kearsipan, 2(2), 108-119.*

Pratiwi, S. S., Nafi'an, M. I., & Rofiah, T. D. (2023). *Developing Pop up Book Media on Solar System Material to Improve the Understanding of Grade VI Students at SD Muhammadiyah 1 Padas. Indonesian Journal of Multidisciplinary Educational Research, 1(2), 123-136.*

Putra, M. A., Ferdiansyah, F., Atika, L., & Wardani, K. R. N. (2021). *Penerapan Ontology Berbasis Protégé Untuk Mengestimasi Nilai Ekonomi Cryptocurrency. Journal of Information Technology Ampera, 2(2), 77-89.*

Ramli, M. (2022). *Konsep Pendidikan Akhlak Ibnu Miskawaih. Sustainable Jurnal Kajian Mutu Pendidikan, 5(2), 208-220.*

Riyanto, P. (2020). *Kontribusi aktifitas fisik, kebugaran jasmani terhadap hasil belajar pendidikan jasmani. Journal of Physical and Outdoor Education, 2(1), 117-126.*

Rubin, D. L., Noy, N. F., & Musen, M. A. (2007). *Protege: a tool for managing and using terminology in radiology applications. Journal of digital imaging, 20, 34-46.*

Schekotihin, K., Rodler, P., Schmid, W., Horridge, M., & Tudorache, T. (2018). *Test-Driven Ontology Development in Protégé. In ICBO.*

Scherp, A., Saathoff, C., Franz, T., & Staab, S. (2011). *Designing core ontologies. Applied Ontology, 6(3), 177-221.*

Sivakumar, R., & Arivoli, P. V. (2011). *Ontology visualization PROTÉGÉ tools–a review. International Journal of Advanced Information Technology (IJAIT) Vol, 1.*

Spivakovsky, A., Petukhova, L., Kotkova, V., & Yurchuk, Y. (2019). *Historical Approach to Modern Learning Environment. In ICTERI Workshops (pp. 1011-1024).*

Spriani, H. G., Ain, N., & Pratiwi, H. Y. (2019). *Pengaruh Model Pembelajaran Problem Based Learning Melalui Metode Scaffolding Dan Motivasi Belajar Terhadap Pemahaman Konsep Fisika. RAINSTEK: Jurnal Terapan Sains & Teknologi, 1(2), 29-40.*

Sudiantini, D., Naiwasha, A., Izzati, A., & Rindiani, C. (2023). *Penggunaan Teknologi*

Pada Manajemen Sumber Daya Manusia Di Dalam Era Digital Sekarang. Digital Bisnis: Jurnal Publikasi Ilmu Manajemen dan E-Commerce, 2(2), 262-269.

Sulistyawati, E. (2021). *Penilaian eksperimen autentik (PEA) berorientasi pada literasi informasi dan teknologi sebagai inovasi asesmen bermakna. In Prosiding Seminar Nasional Tadris Matematika (SANTIKA) 2021: Computational Thinking Dan Literasi Matematika Dalam Tantangan Asesmen*.

Surur, A. M. (2020). Thorndike's Learning Theory Application for Improving Creative Thinking Abilities And Publications. *The Atlantis Press Proceedings*. https://doi.org/10.2991/assehr.k.210421.119

Surur, A. M. (2022). Application of monopoly media to improve readiness for class VI students in facing the national examination of mathematics learning. *International Journal of Pedagogical Development and Lifelong Learning*, *4*(1).

Surur, A. M., Fanani, M. Z., Septiana, N. Z., Purnomo, N. H., Ridwanulloh, M. U., & Soimah, Z. (2023). Management of Developing Mathematics Learning Modules to Reduce Students' Academic Stress. *AIP Conference Proceedings*. https://doi.org/10.1063/5.0123808

Susilo, A., Handayani, P. W., & Wilarso, I. (2015). *Perancangan Model Representasi Pengetahuan Berbasis Ontologi Pada Aplikasi Sipelantik: Studi Kasus Pusintek Kementerian Keuangan. Jurnal Sistem Informasi, 11(2), 93-103.*

Tudorache, T., Noy, N. F., Tu, S., & Musen, M. A. (2008). *Supporting collaborative ontology development in Protégé. In The Semantic Web-ISWC 2008: 7th International Semantic Web Conference, ISWC 2008, Karlsruhe, Germany, October 26-30, 2008. Proceedings 7 (pp. 17-32). Springer Berlin Heidelberg.*

Valiente, C., Swanson, J., & Eisenberg, N. (2012). *Linking students' emotions and academic achievement: When and why emotions matter. Child development perspectives, 6(2), 129-135.*

Yadav, U., Narula, G. S., Duhan, N., Jain, V., & Murthy, B. K. (2016). *Development and visualization of domain specific ontology using protege. Indian Journal of Science and Technology.*