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PAPER

Enhanced Agile Methodology for Ontology Development in E-Learning Environments

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ABSTRACT

This study explores the use of agile approaches to the creation of ontologies for e-learning, evaluating the benefits and drawbacks as well as the impact on information display. Traditional strategies conflict with the need to fulfill the ever-evolving expectations of users and adapt to the ever-changing features of e-learning environments. The challenge aims to encourage cooperation and versatility in the creation of ontologies for e-learning through the use of Agile standards. Because they make it simpler to organize relationships and statistics, ontologies are vital elements in e-mastering domain names due to the fact that they permit adaptive knowledge of structures and individualized learning experiences. Agile ontology engineering approaches are proposed as a choice for one's problems, emphasizing flexibility and response. This study highlights the need to work together with customers and incorporate their input into the advent of ontologies. It notably emphasizes using established feedback loops and cooperation with e-learning platform companies. The sensible usefulness and effectiveness of agile methodology for ontology development (AMOD) in e-learning settings are shown through validation efforts in real-global conditions.

KEYWORDS

ontology, e-learning, learning management system (LMS), ontology engineering, semantic web, agile methodology

1 INTRODUCTION

E-learning, which uses electronic media and information and communication technology to support learning patterns and techniques, has emerged as a significant technical development in contemporary education [1]. The fact that e-learning is often used synonymously with a variety of terminology, such as technology-assisted learning and computer-based training [1].

Indeed, the transformation of e-learning from a simple paradigm of information transmission to a dynamic and interactive platform with enhanced decision-making capabilities [2]. Nevertheless, in the midst of these progresses, there have emerged

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two notable obstacles: the smooth incorporation of e-learning systems into the growing semantic web ecosystem and the creation of adaptive personalization in response to the changing behaviors of learners [2].

To conquer these challenges, the real-time mastering styles of college students are tracked by using software agents, which then modify the e-learning experience to meet their individual needs. However, due to the inclusion of metadata and record reuse made viable by semantic web technology, new avenues for collaboration among educators and students have unfolded [3]. On the contrary, conventional e-learning management systems (ELMS) frequently fail to incorporate semantic web principles and ontologies, which requires the development of a framework to endow ELMS with semantic functionalities [4].

Under the learning process, ontology is a connection or network in which every learning item is semantically associated with a logical domain [1]. Ontology is the study of nature, or the kinds of objects that exist, in philosophy. AI and computer science describe ontology as the document or files that specify the relationship between their words. Each field defines its ontology terms in the context of their respective fields. The standard ontology for the web is taxonomy, which provides several notions about specialized relationships [5].

At the core of the semantic web, ontologies provide a systematic framework for organizing information across a wide range of domains [5], [6]. The goal of the development of Ontologies for Education (O4E) is to establish a system for the accumulation and classification of knowledge in institutions [7]. Through the utilization of ontologies, e-learning systems facilitate improved communication between computers and humans, thereby enhancing comprehension and accessibility [8].

Notwithstanding the progress made, obstacles continue to exist in obtaining individualized learning materials that are pertinent to one's requirements [9]. Recommendation systems are of paramount importance in the learning environment, as they facilitate the organization of data and offer personalized learning experiences [10].

Prominent e-learning knowledge of systems normally adheres to a three-tier structure, which consists of the subsequent three layers: presentation, utility, and records. Resource allocation and the mixing of emerging technology, including the semantic web, are facilitated via this design [6], [7], and [8].

The semantic web is a significant improvement in web technology that improves e-learning by providing software that assists educators and analyzes web-based learning frameworks. This technique necessitates a semantic depiction of instructional resources, enabling users to effortlessly handle and recycle information. The most important targets of the attempt are to mix semantic web technology with e-mastering structures and to spotlight the advantages of higher content material description and accessibility [11].

Integrating ontologies has come to be a key solution in the ever-converting world of e-learning, where the desire for flexible and effective mastering platforms is continually changing. An Agile-based total approach has been created to address the specific desires of e-getting to know, utilizing thinking of the want for a bendy and iterative technique in ontology development. This approach no longer fits the need for flexibility within the speedy-paced global of e-mastering. Still, it additionally solves the specific issues that arise due to the fact that ontological systems are so complicated [12], [13].

In light of this, the reason for this have-a-look is to observe how agile methods are used within the device to enhance ontologies for e-mastering know-how. It will observe this device's benefits and limitations and examine how it influences how information is provided in e-learning systems.

This strategy is divided into stages that are based on Agile ideas and practices that recognize the iterative and gradual nature required to keep up with how e-learning has changed. This model looks forward not only to creating ontologies but also to adaptive knowledge structures that suit the different needs of contemporary educational models as they define roles, take user feedback into account, and establish parallel activities.

This strategy aims at speeding up the development of ontologies and ushering in dynamic, user-centered, and successful online learning. This strategy aims at speeding up the development of ontologies and ushering in dynamic, user-centered, and successful online learning.

The following study questions will guide this study:

1. How can Agile methods be used in developing an ontology for e-learning?
2. What are the main challenges as well as the benefits associated with using an Agile technique when constructing an e-learning ontology?
3. How does the use of an Agile method change information display in e-learning systems?

The study has the following major objectives:

1. The proposed approach should encompass fast software engineering principles and techniques incorporated within the process of ontology creation.
2. To develop a specific Agile-oriented procedure for generating ontologies appropriate for e-learning environments.
3. Assess how effective this suggested Agile method is in terms of ease of update, its level of helping people work together, or what it changes about how information appears on e-learning systems.

2 SIGNIFICANCE OF THE STUDY

This study employs an agile technique to efficiently control the dynamic nature of e-studying content, evolving era necessities, and pedagogical techniques. The goal of this examination is to determine the speed and adaptability of ontologies in e-mastering environments by using iterative and bendy techniques for constructing ontologies. The project aims to provide precious insights into how to triumph over hurdles and optimize knowledge representation in e-studying. This may be achieved by examining precise instances and effects as a result of using agile approaches.

The study findings can decorate and direct the present strategies for creating e-studying ontologies, as well as impart valuable information to developers, instructional designers, and educators. This look complements the continuing discourse on effective knowledge management and illustration in e-studying situations, highlighting the practicality and benefits of agile strategies in ontology.

3 PROBLEM STATEMENT

In the context of e-learning, conventional ontology-constructing techniques face extreme obstacles, which calls for a paradigm shift in favor of more bendy techniques. To ensure accuracy in difficulty identification, the particular difficulties unique to e-learning environments must be described.

The development of e-learning ontologies offers several mainly significant problems:

1. Growing know-how domains, evolving pedagogical methods, and generational breakthroughs all contribute to the dynamic individual in e-learning environments. Because traditional ontology creation methods cannot keep up with these fast-paced changes, they lead to older ontologies that do not meet the needs of modern e-learning.
2. User-Centric requirements: E-learning systems supply a consumer-centric layout as a priority, hence, ontologies that may quickly adapt to the preferences and expectations of each scholar are essential. But traditional procedures can require drawn-out improvement cycles, which impedes the activation of customization required for a hit e-gaining knowledge of reviews.
3. Collaborative ontology representation: Integration of multiple human beings' points of view in actual time are vital for effective e-learning collaboration. Traditional strategies make it difficult to combine a couple of ideas and paintings easily at the same time as growing ontologies due to their linear and sequential shape.
4. Compatibility with new educational technologies: The basis of cutting-edge e-learning strategies is the mixing of the latest technologies, like synthetic intelligence and adaptive learning structures. The whole development of the e-learning experience might be restrained by the rigidity needed for seamless interaction with those technologies in conventional ontology-constructing strategies.

Methodologies that give edition and responsiveness top precedence are desperately needed given these unique e-learning problems. Agile tactics are frequently provided as a solution; however, their applicability in tackling the problems observed needs to be sufficiently shown.

4 BACKGROUND

The integration of semantic web technologies in the field of e-learning offers revolutionary breakthroughs. Rapid, tailored, and relevant mastering tales may be met by e-mastering systems by using merchants driven by the semantic web era. These improvements can be seen in many documents, such as the ability to use semantic querying to make customized publications, to let software agents work together interactively, and to use semantic navigation to make non-linear learning paths possible [14]. Fundamental to these improvements is the ontology, which acts as a link between user needs and understanding of fabric characteristics, ensuring common knowledge and terminology necessary for managing and retrieving green know-how within e-learning settings [9], [15].

The difficult circumstances involved in records and understanding retrieval within e-learning are addressed in large part by ontology. Regularly producing study materials using different terminologies, authors, and runners impedes effective retrieval and complicates aid aggregation. By creating common terminologies and understandings, ontologies ultimately become a fantastic tool for formal vocabularies and picture set descriptions. This strategy assures full coverage of learning fabric elements and spans many ontological degrees, including content material, context, and structure. The mounting of links among thoughts via content material ontology enables contextual perception and computational inference. While pedagogy ontology talks about how to present e-learning materials in different situations, shape ontology talks about how to use reading materials logically and stresses the need for well-connected, self-paced studies that are tailored to each person's needs [16].

4.1 Ontology

Ontology is a philosophical subject concerned with the underlying nature of life and reality [7]. Ontologies can be thought of as a means of describing knowledge. It entails portraying the aspects of a specific field and explaining the links between these elements by describing mental representations that include the issue. Ontologies are developed for specific domains of knowledge to reduce complexity and structure facts and concepts into useful information and knowledge [7], [17].

An ontology is a complete conceptual framework made up of related ideas that allow the exchange of information between people and software. This philosophical expression serves as a basis in various fields such as information systems modeling, computer science, and artificial intelligence. Ontologies are collections of statements written in languages like RDF and OWL that connect concepts, thus embodying logical principles for deriving conclusions about them. Participants within a community of interest include humans, computers, and robots working together to compile a common lexicon [18].

Ontology was defined by Gruber [18] as an extensive explicit representation of a conceptual framework, while Borst [19] described it as an exact formalism for representing universally accepted conceptual frameworks. The process of conceptualization involves creating a theoretical frame that explains core ideas and links between them within a particular situation in such a way that they could be understood by machines (see Figure 1).

Ontology engineering [20] is a field that encompasses the methodology used for building ontologies as well as their changes over time. As explained by [21], Figure 2 shows how the allocation of efforts made toward ontology engineering can be done through three phases, with each phase having further subtasks.

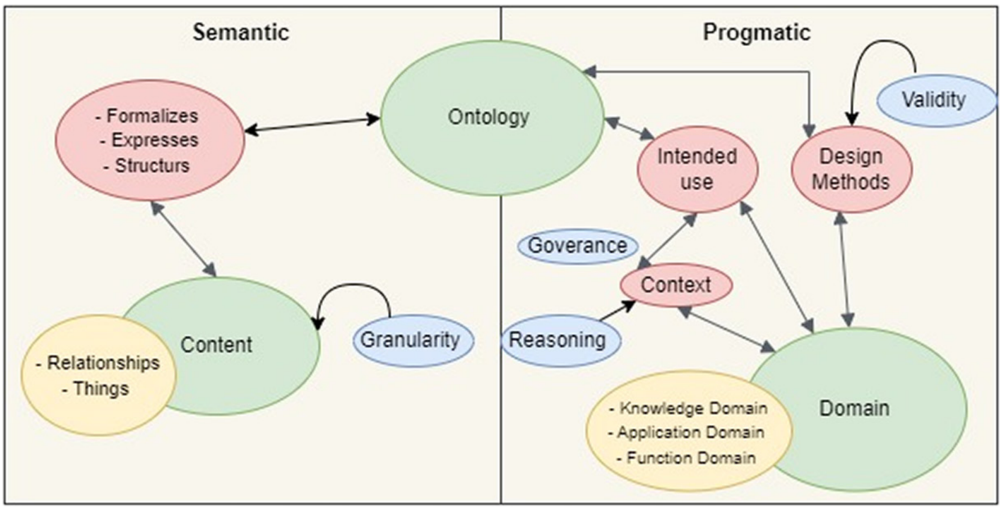

Fig. 1. Ontology overview

When it comes to early stages such as economic evaluations, preselection processes to find suitable ontology types for development, and feasibility studies, this is what ontology management involves. Primary responsibilities connected with building and maintaining an ontology are collectively referred to as "Ontology Development & Support." This includes developing, authoring, and documenting the ontology along with its engineering process, gathering knowledge, and then formalizing it too. Once developed, utilization of an ontology entails activities like continuous maintenance, revision, or usage.

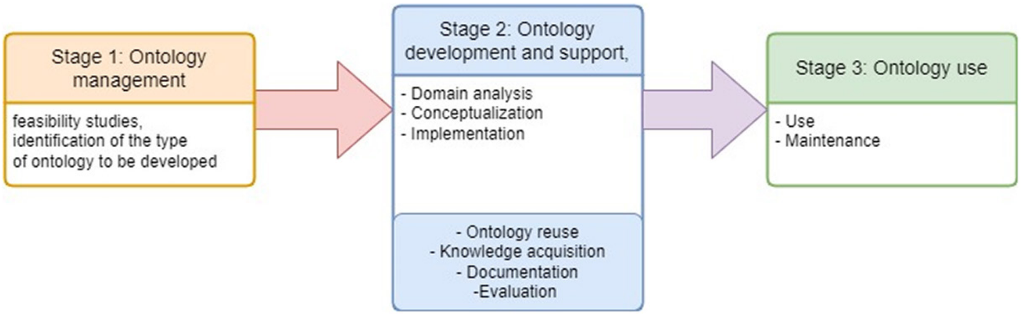

Fig. 2. Ontology engineering

The field of ontology has been widely acknowledged for its enormous impact on the progress of computing systems [22]. Ontology defines the fundamental ideas within a specific field of knowledge and clarifies the relationships that exist between them. The fundamental components of ontology design encompass concepts or classes, attributes that define distinct traits and qualities of the concept or class, and facet constraints. Ontology is a comprehensive presentation of concepts [22].

Ontology education, often known as OntoEdu, employs ontology to define essential ideas within an educational framework. The core module manages components by utilizing content and activity ontologies. OntoEdu utilizes ontologies to gather knowledge and automatically builds a service system according to user requirements [23]. In the field of computing, ontology is a method of representing knowledge by illustrating the elements of a specific area, arranging factual information, and simplifying intricacy. It is acknowledged for its role in promoting blended learning and improving the spread of knowledge in educational institutions. The W3C Standard-Ontology Web Language (OWL) has been developed to facilitate the generation and dissemination of domain ontologies [17], [24].

4.2 E-learning

E-learning is the use of technological devices to facilitate the transfer of knowledge. The available choices encompass the incorporation of supplemental components inside a traditional classroom environment as well as a total shift from in-person one-on-one meetings to remote learning [25], [26]. It includes teaching conducted in both conventional classroom settings and unconventional contexts, employing modern instruments such as computers and the Internet. E-learning, or electronic learning, is the process of imparting knowledge to students using electronic platforms, including the Internet, audio, and video.

It has transformed the traditional approach to educating students in person by offering a learning platform that enables the transfer of knowledge in a more straightforward, efficient, and fruitful way, available to all individuals, regardless of location or time. E-learning enables students to obtain knowledge conveniently and comfortably from their own homes, removing the need to search for learning opportunities elsewhere. Ontology simplifies the arrangement of educational materials by classifying them into small, semantically annotated units of learning. This enables the development of customized educational programs that may be provided to individuals according to their profile and specific company needs.

E-learning systems may provide complex educational alternatives thanks to semantic web technology. These technologies have the potential to enhance e-learning in many ways, including helping teachers plan and arrange their lessons and allowing self-organized, assigned training frameworks. The primary objective is to use semantic web capabilities to enhance concept clarity, knowledge of reusable items, and material descriptions, which are mostly based on green ontologies [27]. Flexible scheduling, ease of access, and consistently high-quality, personalized instruction are advantages of online learning. Future developments—likely involving device learning—should also improve these kinds of systems with capabilities like keyword extraction and intelligent search optimization [27].

5 RELATED WORK

Several studies have developed adaptive learning material using ontologies and semantic principles. [28] and [29] proposed ontology-based methods to implement personalized learning based on individual learning styles. The [30] studied tailored course material recommendations. They utilized course ontology to cater to consumers' specific knowledge needs. A method was introduced for ascertaining a learner's level of knowledge by analyzing behavior logs.

Ontologies have been used to model context information in order to facilitate the selection of learning resources for individualized e-learning. For instance, [31] conducted a study on e-learning service applications that utilize cloud computing and Owl ontologies.

Chen [32] established a competency ontology intending to consolidate terminology and concepts employed in the field of pharmacy. The objective of the cloud-based method is to implement personalized learning paths and facilitate collaboration between pharmacies and healthcare authorities.

[33] presented Gescur, a software program designed as an educational curriculum management system. Gescur is a tool that enables teachers to generate, retrieve, and evaluate educational courses. Gescur facilitates the identification of any deviation from the expected standards in curriculum implementation and assists teachers in formulating appropriate corrective measures and protocols. Al Fayez and Joy [14] consolidated medical educational content by including web publications grounded in biological ontologies into a unified linked data collection. The reconstruction of educational resources was accomplished using ontology-based methodologies in references [34] and [35]. They constructed a reference ontology for higher education using the NeOn technique. Reference ontologies facilitate the creation of specialized ontologies, enabling developers to circumvent the need to construct domain ontologies from the beginning. The authors of [36] introduced a semantic recommendation system designed for e-learning applications. The system consists of two subsystems: an ontology-based subsystem and an OWL rules subsystem. The process of constructing the ontology and the specific rule language employed are not elucidated in this study.

John and his colleagues introduced a methodology called incremental and iterative Agile methodology (IIAM) for developing ontologies in the field of education [37]. The steps of IIAM include the acquisition of domain vocabulary, the enumeration of concepts and properties, the identification of taxonomy, the establishment of ad hoc binary connections, the definition of concepts and relationships, the imposition of limitations, and the coupling of vocabulary with data. The stages are included in the RUP phases: genesis, elaboration, construction, and transition. Nevertheless, the phases for constructing ontology in IIAM are outlined broadly.

The study conducted by [38] introduces an enhanced version of the traditional three-tier design for a recommender system based on the semantic web. This is achieved by including a semantic layer that includes an ontology and semantic rules. The layer consists of a learning management system ontology that consists of two interconnected sub-ontologies: the learning content ontology and the learning context ontology.

As an example, [39] provides a thorough description of the stages of an ontology-based design approach. Often, problem parameters, model conceptualization, and model boundary definition are accomplished using elicitation techniques. Though this process might provide a domain model, it misses an important stage in the incorporation of explicit theory. Concepts and information use cannot be connected without one further step. The fact that the model incorporates the theoretical component and the practice involves common knowledge suggests that the learning design process does not indicate whether to depend on theory or practice when deciding on a specific user task. Determining the approach of a learning design tool to the application of theory may be challenging, which places possible pressure on the designer to make well-informed selections while building learning designs. To establish a connection between theory and practice, we have used many techniques to demonstrate the link in our design.

[11] the conversation revolved around the use of the semantic web to facilitate the creation of an e-learning platform that offers a unified interface for accessing educational resources. The participants also deliberated on the process of incorporating semantic web technologies into e-learning systems while considering adherence to standards and the use of reusable learning objects. The authors of the study introduced a revised e-learning model that utilizes the most recent semantic web architecture. The primary focus of their study is the layered architecture. The suggested approach stores the information, rules, and annotations externally in the ontology and knowledge base. Their concept has the benefits of minimizing storage requirements, facilitating easy retrieval of meta-descriptions stored in a database, and providing several options for descriptions.

The primary distinction between the proposed approach and other techniques is in its use of agile principles and practices in ontology building. Thus, software developers may readily comprehend and adhere to it when developing ontology-based software.

6 METHODOLOGY OVERVIEW

Agile methodology for ontology development (AMOD)

The study employed the existing method [40] with some modifications that made it more agile. The proposed method described in Figure 3 aims to incorporate agile principles and practices used in software engineering into ontology development. This methodology for ontology development is divided into three categories: pre-game, development, and post-game. Moreover, it highlights parallel support activities. The main roles of this methodology include the ontology owner, who represents customers' requirements; the ontology engineer, who implements the ontology; and the ontology user, whose interest is to apply the ontology for a certain purpose. The final framework of AMOD is shown in Figure 4.

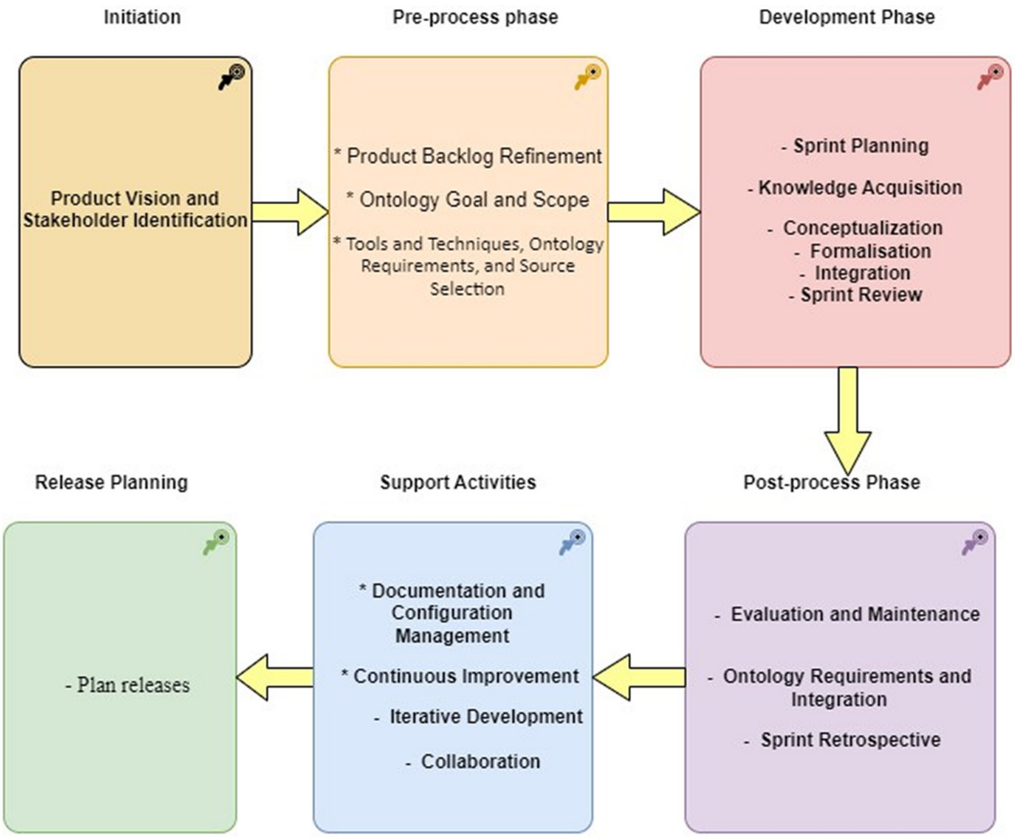

Fig. 3. The proposed method

I improved the AMOD so that its iterative and collaborative elements were incorporated into a new all-encompassing methodology for developing ontology. The suggested order technique consists of many steps, which are presented in Tables 1 to 6.

Table 1. Initiation

Activity	Description
Product Vision and Stakeholder Identification	– Clearly define the ontology's vision, aligning it with organizational goals. – Identify key stakeholders, including ontology owners, engineers, and users.

Table 2. Pre-process

Activity	Description
Product Backlog Refinement	– Refine the product backlog, emphasizing ontology goals, scope, and competency questions.
Ontology Goal and Scope	– Define ontology goals and scope, specifying intended uses and limiting concepts for analysis.
Tools and Techniques, Ontology Requirements, Source Selection	– Identify knowledge-capture techniques for collaborative research. – Select ontology implementation tools, considering collaboration (e.g., Google Docs, Protégé). – Gather requirements through engagement with researchers and domain experts. – Formulate competency questions and prioritize them in a product backlog. – Select sources, including domain experts, researchers, and existing collaborative platforms.

Table 3. Development phase

Activity	Description
Sprint Planning	– Collaborate on high-priority backlog items for each sprint. – Determine implementation approaches aligned with evolving collaborative research needs.
Knowledge Acquisition	Apply collaborative techniques (workshops, interviews) to capture relevant terms and concepts.
Conceptualization	– Organize knowledge into a semi-formal specification, creating an ontology conceptual model.
Formalization	– Transform the conceptual model into a formal representation using the chosen language and tool.
Integration	– Integrate the developed ontology with those from previous sprints.
Sprint Review	– Conduct sprint reviews with stakeholders. – Evaluate achievements, gather feedback, and adjust priorities for upcoming sprints.

Table 4. Post-process phase

Activity	Description
Evaluation and Maintenance	– Evaluate ontology through verification and validation processes. – Verify correctness, and validate relevance to collaborative research needs. – Perform consistency checks, verify competency questions, and assess ontology content. – Update and correct the ontology based on changes in collaborative research dynamics. – Continuously update and correct the ontology to reflect changes in the domain and ensure reliability.
Ontology Requirements and Integration	– Gather ontology requirements, and prioritize competency questions. – Integrate the newly developed ontology with those from previous sprints.
Sprint Retrospective	– Reflect on the sprint, and identify areas for improvement in the ontology development process.

Table 5. Support activities

Activity	Description
Documentation and Configuration Management	– Document ontology development results and the evaluation process. – Provide both human-readable and machine-readable representations. – Implement configuration management to record ontology versions, control changes, and perform audits.
Continuous Improvement	– Embrace an iterative approach, refining the ontology based on feedback and evolving requirements. – Foster collaboration among ontology owners, engineers, and users throughout the development process.

Table 6. Release planning

Activity	Description
Output	– Plan releases based on the completion of sprints and progress toward ontology development goals.

6.1 Development phase

Agile ideas require iterative improvement cycles, or sprints, to be brought into the improvement process to ensure incremental development and flexibility in reaction to converting necessities. Every sprint consists of cooperative practice and carrying out an evaluation, which encourages non-stop development inside the ontology development process.

Sprint planning: This is how stakeholders prioritize excessive-precedence backlog items at the start of each dash and determine sprint desires. This joint venture guarantees compliance with evolving stakeholder and study requirements.

Knowledge acquisition: The need for constant and open communication is fairly pressured in agile strategies. In sprints, stakeholders and challenge professionals are consulted collaboratively through workshops, interviews, and brainstorming periods to get relevant terminology and ideas.

Conceptualization: The foundation of ontologies is the system of organizing know-how into a semi-formal specification. Working collaboratively, stakeholders construct the ontology's conceptual version to ensure that key standards and linkages are understood by all people.

Formalization: The formalization system transforms the created conceptual model into a formal representation using some selected ontology languages and gear. Using this ongoing updating method primarily based on evolving requirements and stakeholder remarks, the ontology is assured to be accurate and thorough.

Integration: Agile ontology development depends heavily on integration, which ensures compatibility with advanced sprint ontologies and promotes information sharing and reuse. Stakeholders collaborate to combine the existing assets with the mounted ontology, consequently selling interoperability and collaboration across domain names.

Sprint review: In every dash, at the deliver-up, stakeholders examine achievements, solicit remarks, and recognize regions that want paintings. This comments-driven technique ensures non-prevent improvement and versatility to convert necessities in the course of the ontology development cycle.

Embracing iterative improvement cycles and giving collaboration and feedback pinnacle precedence, the development degree of the AMOD promotes slow progress and ensures the ontology's relevance and effectiveness in pleasing stakeholders' requests.

6.2 Benefits of AMOD

Iterative progress: Regular sprints allow for incremental and iterative improvement, making sure of non-stop improvement.

Flexibility: adapts to changing necessities and priorities through non-stop refinement of the product backlog.

Collaboration: Encourages collaboration amongst ontology stakeholders, selling shared understanding.

Feedback-driven: Regular evaluations and retrospectives provide opportunities for remarks and improvement.

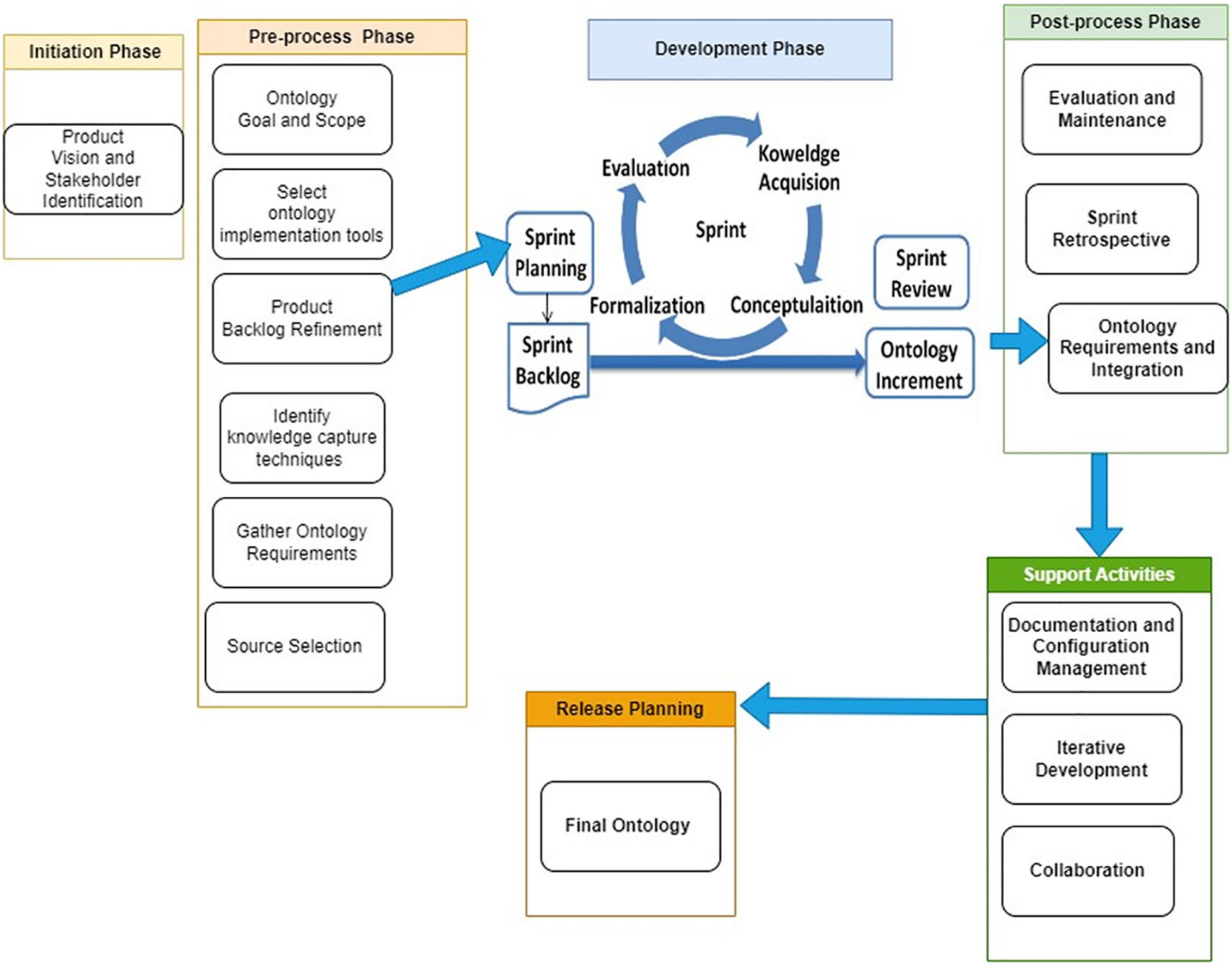

Fig. 4. The final framework of AMOD

7 SCENARIO: E-LEARNING WITH AMOD

In an educational organization searching to revolutionize its online studying, the implementation of the AMOD will become instrumental. The institution ambitions to create a contemporary learning management system (LMS) with superior functions, ensuring a seamless and personalized academic adventure.

Table 7 summarizes the scenario with the key capabilities and technologies for the development of an advanced LMS using the Agile methodology for ontology development.

Table 7. Summarizing the scenario for the development of an advanced LMS using AMOD

Step	Activities and Focus Areas
Initiation	– Define a vision for an advanced, interactive, and accessible LMS. – Identify stakeholders (teachers, managers, trainers, learners).
Pre-process	– Refine product backlog with priorities such as responsive design, user-friendly interface, analytics, and more. – Define ontology goals and scope aligned with advanced e-learning features. – Identify tools, techniques, requirements, and sources for knowledge capture. – Formulate and prioritize competency questions based on e-learning needs. – Select sources, including educators, IT professionals, and e-learning experts.
Development Phase	– Collaborate on high-priority backlog items focusing on responsive design, user-friendly interface, and analytics. – Apply collaborative techniques to capture terms and concepts for advanced e-learning. – Organize knowledge into a semi-formal specification, creating an ontology conceptual model. – Transform the conceptual model into a formal representation using chosen languages and tools. – Integrate the developed ontology with those from previous sprints. – Conduct sprint reviews to evaluate achievements and gather feedback.
Post-process Phase	– Evaluate ontology through verification and validation processes, ensuring correctness and relevance. – Update and correct the ontology based on changes in e-learning dynamics for continuous enhancement. – Gather requirements and integrate ontology with previous sprints for ongoing adaptability. – Reflect on sprints, identifying areas for improvement and refining ontology development.
Support Activities	– Document ontology development results and the evaluation process for transparency. – Implement configuration management to control ontology versions, ensuring stability and traceability. – Embrace an iterative approach, refining the LMS based on feedback and evolving requirements. – Foster collaboration among ontology owners, engineers, and users for ongoing feature enhancement.
Release Planning	– Plan releases based on completion of sprints and progress toward LMS development goals, introducing new features and improvements.

8 RESULTS

User involvement and feedback Integration: For this, surveys, interviews, and recognition corporations with educators and e-learning professionals were used to get comments from users. Their solutions were carefully sought over to find subject matters, tastes, and needs that were shared by them all. Then, these remarks were used to improve the ontology creation process again and again. This made certain that the ontologies met the real wants and demands of the e-learning network.

Structured feedback loops: Structured comment loops have been used inside the study to make it less difficult to preserve, refine, and improve the models. These comment loops were built into every step of the ontology advent system. This made it feasible to discover troubles and development possibilities early on. Feedback from stakeholders was cautiously gathered, looked over, and ranked.

These statistics guided later variations and made sure that the ontologies changed to satisfy new needs and consumer choices.

Cooperation and validation of interoperability: Workshops, online businesses, and shared improvement paintings with e-mastering platform businesses were used in this examination to inspire cooperation. Interoperability checking was finished to make certain that our models ought to work with extraordinary e-learning platforms without any issues. This made sure that each one of the systems was equal and would work with each other. These real-world evaluation initiatives have sponsored the claims made in the idea regarding teamwork and interoperability. They showed that the AMOD is beneficial and a hit in the e-learning context.

9 DISCUSSION

The study found that using Agile principles in building ontologies for e-learning can result in several advantages like adaptability, satisfaction of stakeholders, and conformity to evolving teaching approaches. As such, it becomes apparent that AMDO's iterative approach is more sensitive to the users' demands arising from novel techniques used in e-learning compared to what was employed in prior instances.

From these outcomes, AMDO is an appropriate framework for the agile development of educational ontologies that are specific to e-learning environments.

To evaluate the proposed framework, the methodology's conformance to the IEEE standard was described [41]. As shown in Table 8, the IEEE standard provides three kinds of processes:

Table 8. Compliance of the methodology with IEEE standard

	IEEE Standard Processes	Compliance with IEEE
Project management processes	Project initiation	C
	Monitoring and control	C
	Quality management	C
Ontology development-oriented processes	Environment study	P
	Feasibility study	C
	Requirements	C
	Design	C
	Implementation	C
	Installation	U
	Operation	C
	Support	C
	Maintenance	C
	Retirement	U
Integral processes	Knowledge acquisition	C
	Evaluation	C
	Configuration management	C
	Documentation	C
	Training	C

Project management entails creating a structure for the ontology's lifecycle.

Ontology development comprises three stages: pre-development, development, and post-development.

Integral processes are the procedures required to properly complete project operations.

Table 8 compares the methodology's conformity to the different phases stated in the IEEE standard. Each technique was assessed based on the following criteria: The table also shows if the technique complies with IEEE standards.

Requirements are:

Covered (C) denotes that the approach entirely covers the IEEE procedure.

Partially covered (P) indicates that the method thoroughly covers certain parts of the IEE process.

Uncovered (U) indicates that the technique does not cover the IEEE process.

Using an agile methodology. Agile concepts, such as rapid testing and consistent feedback channels, make it easy to implement more flexible improvement plans. Frequent iterative feedback with stakeholders that prioritize the customer promotes collaboration. As a consequence, creating E-learning corporate ontologies becomes easier, and minor changes may be made to meet changing business needs.

Table 9. Compatibility of each approach with the IEEE standard

IEEE Standard	AMOD	Enhanced-AMOD
Project initiation	C	C
Monitoring and control	C	C
Quality management	P	C
Environment study	P	P
Feasibility study	P	C
Requirements	C	C
Design	C	C
Implementation	C	C
Installation	U	U
Operation	U	C
Support	U	C
Maintenance	C	C
Retirement	U	U
Knowledge acquisition	C	C
Evaluation	C	C
Configuration management	C	C
Documentation	C	C
Training	U	C

The Table 9 shows which of the strategies—AMOD and enhanced-AMOD—is extra steady with positive IEEE popular components. For insurance, Enhanced AMOD on occasion outperforms everyday AMOD. Its thorough treatment of environmental studies, best management, and viability study—all of which AMOD simply skims the surface—sets it aside. Moreover, the enhanced-AMOD outperforms AMOD throughout the phases of installation, operation, maintenance, and retirement when AMOD shows no coverage. Conformance of enhanced-AMOD with the IEEE standard is evidence of its effectiveness in the project initiation, monitoring and control, requirements, design, implementation, maintenance, knowledge acquisition, evaluation, configuration management, documentation, and training phases. This comparison shows how Enhanced-AMOD works and verifies that it is the optimal method for adhering to the IEEE standard.

The conformity of the two techniques; AMOD and enhanced-AMOD, with the IEEE standard, is thoroughly evaluated in Table 10 and Figure 5. Being more comprehensive than AMOD, enhanced-AMOD is a superior option. More precisely, although AMOD only covers 10 areas, enhanced-AMOD completely covers 15. Moreover, AMOD does worse than Enhanced-AMOD with just three partially covered elements compared to enhanced-AMOD's. Moreover, with simply two exposed elements instead of five for AMOD, Enhanced-AMOD also performs better than AMOD in phrases of exposed regions. This complete evaluation indicates that Enhanced-AMOD now not only extra carefully complies with the IEEE fashionable but also offers an extra dependable and whole solution.

Table 10. Summary of compliance analysis results

	AMOD	Enhanced-AMOD
Covered	10	15
Partially Covered	3	1
Uncovered	5	2

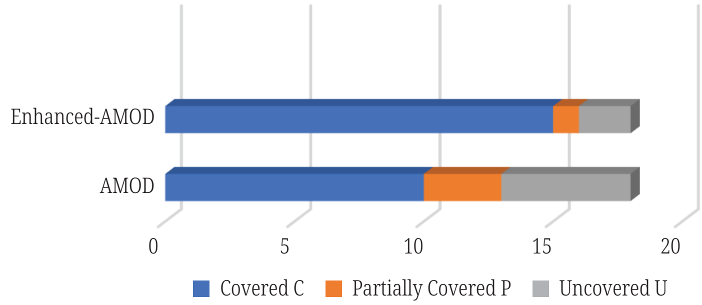

Fig. 5. A summary of the results of the compliance study

The three categories of covered (C), partially covered (P), and uncovered (U) for the two approaches, enhanced-AMOD and AMOD, that demonstrate their conformance with the IEEE standard are shown in Table 11 and Figure 6. Enhanced-AMOD does much better in terms of coverage percentage in every category than AMOD. The Covered group's coverage of Enhanced-AMOD is astoundingly 83.33%, while AMOD barely receives 55.55%. Where AMOD falls short, in the Partially Covered region, enhanced-AMOD has a much higher coverage rate (5.55% vs. 16.66%). Better further, enhanced-AMOD fills gaps more effectively than AMOD, leaving only 11.11% open; a significant improvement over AMOD's 27.77%. These findings demonstrate that enhanced-AMOD satisfies the IEEE standard and provides solid proof that it functions and is trustworthy.

Table 11. Percentage of coverage by technique

	AMOD	Enhanced -AMOD
Covered	55.55%	83.33%
Partially Covered	16.66%	5.55%
Uncovered	27.77%	11.11%

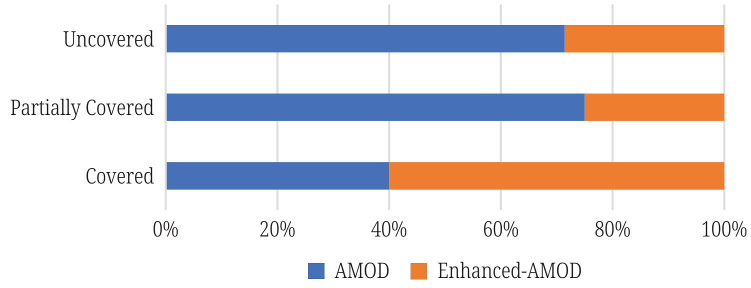

Fig. 6. Percentage of coverage by approach

10 CONCLUSION AND FUTURE WORK

This study described enhanced-AMOD, an ontology development process built on agile software engineering techniques. While the process of generating ontology differs from that of producing software, the underlying ideas and tasks are the same. As a result, while creating ontologies, software standards should be adhered to and customized to the unique features of ontologies. Based on the IEEE standard, a comparison analysis of current ontology engineering approaches was carried out. The results show that enhanced-AMOD complies with the IEEE standard better than the other approaches. Better stratification with an extra 27.78% coverage was obtained using the enhanced AMOD, which is essential for the growth.

The adaptability of enhanced-AMOD to many criteria, such as ontology complexity, domain of interest, and ontology size, is its strength. It also shows how ontology development activities can be implemented more easily when agile approaches are used. To gain more validation examples, it is advised that Enhanced-AMOD be included in new applications in future development.

The following points highlight the key issues brought out by the study:

- Efficiency and adaptability: Where education settings change quickly, ontologies created through enhanced-AMOD incremental iterative architecture are adaptable. Therefore, these ontologies should be more responsive to technology as well as educational trends since both are subject to dynamic changes.
- Stakeholders' participation: The continuous involvement of end users resulted in the generation of ontologies specifically designed so that they fulfill the needs of teachers, pupils, and other stakeholders who participate in the e-learning setting.
- Iterative feedback: Hence, continuous assessment procedures were put in place to allow for successive improvement by addressing any potential flaws early in the development process, leading to better ontological structures at large.

Although enhanced-AMOD has shown promise, there is still room for further study and development:

- Semantic web enhancements: Advanced semantic web technologies could be used to improve the interoperability and knowledge-sharing capabilities of ontologies created within the enhanced-AMOD system.
- Scalability: The examination of Enhanced-AMOD's scalability for large-scale e-learning ecosystems and diverse educational areas would make it possible to get insights into its wider utilization spectrum.
- Long-term impact assessment: A longitudinal study could be done to evaluate the long-term impact of ontologies developed by Enhanced-AMOD on educational practices, resource sharing, and future advancement adaptability.

This study represents a step forward at the intersection of agile principles and ontology development, and an ongoing refinement of approaches in this domain can change how educational content is represented or used.

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