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Linked Data in E-Learning Platforms: Enhancement and Impact on Students Learning and Thinking

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ABSTRACT

E-learning plays a pivotal role in higher education, particularly in remote settings, relying heavily on multimedia resources. However, it faces several challenges in effectively utilizing and connecting these resources. For instance, video materials often lack meaningful annotations and semantic links, hindering comprehensive understanding. Students also grapple with maintaining focus during video-based learning. Recent research indicates that annotation tools significantly enhance learning experiences. To address these issues, a study at Chadli Bendjedid El Tarf University (UCBET) developed an e-learning platform integrated with a customized ontology and a video annotation feature. This platform empowers students to semantically tag video content using Linked Data vocabularies, fostering deeper comprehension. It also enables educators to assess online teaching activities. An experiment was conducted to evaluate the platform, demonstrating that incorporating semantic video annotation enhances learning processes and outcomes in educational systems.

1. INTRODUCTION

In the digital era, e-learning has emerged as a cornerstone of modern education, offering unprecedented flexibility and accessibility to learners worldwide. However, as the demand for online education has been grown, so challenges have been associated with effectively delivering quality learning experiences. One promising avenue for addressing these challenges lies in the integration of Linked Data technology within e-learning platforms.

The concept of Linked Data, has rooted in the principles of the Semantic Web, offers a powerful framework for organizing, connecting, and leveraging vast amounts of educational resources in a meaningful and interoperable manner. By structuring data in a way that facilitates semantic understanding and knowledge inference, Linked Data holds immense potential to revolutionize the landscape of e-learning. The current state of e-learning through the Semantic Web technology has been presented [1], with the objective of achieving two main goals: firstly, to discern the emerging themes in e-learning facilitated by Semantic Web utilization. Secondly, to underscore the obstacles and potentials presented by Semantic Web technologies in remote learning. Integrating the Citations' Context and Reasons Ontology (CCRO) taxonomic hierarchy of reasons within a document has been proposed [2]. To streamline this process, they created a semantic annotation tool enabling authors to incorporate citation justifications while composing their papers. The package can be integrated into any authoring tool, and authors can tag a citation using appropriate CCRO properties. By doing so, a simple document can be transformed into a semantic document. The challenge of information security has been associated with the widespread implementation of online education during the COVID-19 pandemic, particularly within the framework of the Semantic Web [3]. Examination has delved into the necessity of steganography within this context, highlighting its significance despite the utilization of encryption methods. It has been revealed that they fall short of ensuring adequate safeguarding. Whereas Shahzad's research has delved into the ramifications of emerging e-learning technologies for university librarians and libraries. The study [4] has also addressed the obstacles that arise in the course of implementing these technologies.

Many applications of annotations are developed [5] in the literature for video annotation, such as multimedia annotation tools, video annotation systems, video annotation software, and video annotation learning systems [6]. The effectiveness of T-CoRe, a reflective tool, when used alongside annotated self-recorded videos and reflective writing, has been assessed [7]. The objective was to evaluate the application of digital technology in student teachers' teaching practices. The research results indicate a promising approach for teacher education, focusing on enhancing student teachers' proficiency with digital technology. The review [8] on digital video annotation tools, focusing on how video annotations were utilized in educational settings in various studies. It also highlights the professional competencies that were investigated and developed with the aid of video annotations, as well as the learning outcomes reported in the selected studies.

Video annotation is a technique for synchronizing commentary with video data. It is widely used in education and has received considerable research attention. However, they are diverse and dispersed. Ontologies for annotating educational resources can be utilized to improve information retrieval and search outcomes [9]. The study [10] on Social Annotation (SA) referred to a collaborative feature that allows users to highlight important text, make comments, and engage in discussions on the same online document. The purpose of the study was to explore how SA can be used to facilitate collaboration and knowledge sharing among users.

Research [11] aimed at automatically generating questions to facilitate learning about history using current linked open data (LOD) has been conducted. The purpose of this research is to elucidate LOD's potential as a learning tool. They established an open learning environment where students can access machine-understandable natural language content on a variety of subjects by connecting LOD to natural language texts.

Research [12] has concentrated on linked open data (LOD) in the educational area, creating RDF descriptions of video lectures taken from YouTube and Videolectures.net. An ontology derived from textbook data has been created to enhance the efficacy of learning materials [13]. In the realm of educational document retrieval, domain ontologies for the indexing of educational resources have been formulated. An IEEE LOM standard application profile has been suggested [14], with a focus on distant learning resources. It has been presented how this profile can be sufficiently general to be used with any kind of instructional resource and application. Additionally, an ontology model for this profile has been offered with the goal of enhancing the potential for educational resource retrieval and discovery in intelligent e-learning settings.

The study [14] offered a survey and examination of the literature on ontology-based recommenders for online education. Ontology-based e-learning recommenders employ many recommendation strategies, which they categorized. Along with classifying the categories of learning materials that e-learning recommenders suggest, they have also classified the knowledge representation method, ontology type, and ontology representation language employed by ontology-based recommender systems. The use of ontology for knowledge representation in e-learning recommender systems can enhance the quality of recommendations, as they demonstrated. They have also highlighted the future developments of this recommendation strategy in the context of e-learning. A subject or topic-based ontology was used to construct a portal for electronic learning. By focusing on the subject matter and searching the information semantically, one can retrieve content from the site [15]. The applications of semantic web technologies in e-learning have been categorized into five phases [16]: ontologies, instructional authoring ontologies, instructional assistance and adaptation, ontology-intelligent learning systems, and semantic web for social applications. Ontology and semantic annotation are included. The study [17] created an automatic test generation prototype that could produce multiple-choice questions based on domain ontologies. The first concern of the semantic web is the assertion of meaning. There are numerous free educational tools available on the web. Efficiently locating all relevant distributed educational resources is essential, students have difficulties maintaining their attention when watching videos and digesting the content.

Researches [18, 19] indicated that annotation tools can enhance student learning, with visual learning methods found to significantly boost student engagement. Education endeavors to cultivate scholarly engagement by prioritizing focused attention and concentration, particularly through video-based activities [20].

Various studies have demonstrated the effectiveness of video annotation as a tool for fostering reflection. This approach [21] prompts students to reflect on their academic endeavors. Students engaged in motivational and impactful self-reflection exercises that demanded deeper analysis [22]. Case study [23] highlighted the implementation of video-annotated projects aimed at enhancing advocacy communication skills among Juris Doctorate Students.

The crucial importance of video annotation for facilitating and motivating reflection among student instructors regarding their teaching methodologies was underscored [24, 25]. Additionally, peer feedback practices based on video are frequently used in classroom settings [26].

Another pivotal strategy involves course content recommendation, employing adaptive learning materials informed by ontologies and semantic guidelines. Numerous researches [27, 28] showcased ontology-driven approaches to personalize learning experiences according to individual learning styles. These studies have focused on tailoring course materials to suit learners' preferences and knowledge needs which is based on course ontology and user profiles [29].

Therefore, in this study, an e-learning platform was developed for El-Tarf University, along with a customized ontology. Video annotation was also integrated to enhance the learning experience. The platform provides online tools that allow students to semantically tag videos using linked data. The effectiveness of the online education process was evaluated through pre-tests, post-tests, and surveys administered to both students and teachers.

The following research questions are addressed to both teachers and students:

RQ1: How can multimedia content be annotated to improve the quality of video-based learning and ensure interoperability for both teachers and students?

RQ2: How can classes and teaching skills be enhanced by accommodating individual learning paces?

RQ3: How can students better comprehend concepts by using annotation tools while watching course videos?

RQ4: How can teachers effectively evaluate the outcomes of the proposed learning method?

The rest of the paper is organized as follows: Section 2 reviews existing literature relevant to our study. Section 3 details our contributions and the methodology employed in our research. Section 4 describes the platform that we developed and its associated semantic ontology. Section 5 evaluates the operation and impact of our e-learning system. Section 6 presents our findings and analysis. Finally, we conclude the paper with a summary of our results and their implications.

2. RELATED WORK

Online learning has transformed task completion by modernizing traditional educational methods with advanced technology, introducing flexibility in time, and diversifying educational programs, despite their inherent complexity. This topic has been extensively explored in various studies.

For instance, ATS-MOOCs, an innovative tutoring system for MOOCs, identifies students' affective states and adapts MOOC content to enhance learning performance [5]. A prototype was developed and tested through a case study to validate its feasibility.

Two collaborative filtering recommendation algorithms are proposed [6]: The first uses an improved k-means clustering technique, while the second combines it with Principal Component Analysis for dimensionality reduction. Experimental results show these algorithms outperform traditional collaborative filtering in recommendation accuracy.

The study [30] presented a framework for semantically annotating Arabic texts using Linked Data. This approach improves accessibility and interoperability of Arabic resources by linking text to knowledge bases, enhancing semantic understanding and searchability for natural language processing applications.

Evaluated the use of Linked Data in education, concluding it is an effective tool for enhancing learning [11]. Similarly, a comprehensive analysis of MOOC and e-learning research was conducted, offering valuable insights for educators and researchers navigating the complexities of digital education [27].

A review of deep learning techniques in e-learning has been conducted, focusing on neural network-based methods such as CNNs, RNNs, and hybrid approaches [28]. This review identifies the strengths and weaknesses of each method and provides a detailed analysis of their applications in open classrooms.

The potential of virtual study groups for mastering linked data is explored [31], demonstrating how collaborative learning improves comprehension and practical skills, highlighting the effectiveness of group-based approaches in complex data education.

Investigations into factors influencing MOOC engagement using LDA and QCA have identified key elements such as interaction quality, learning support, and course content as critical for student satisfaction [32]. These findings offer valuable insights for the improvement of MOOC design.

A novel approach to teaching programming integrated common errors into knowledge graphs to provide personalized tasks [33]. This method addresses misconceptions and enhances learning efficiency, showcasing the potential of linked data in computer science education.

Examining recommender systems for career and major selection in higher education reveals key factors such as algorithm performance and user satisfaction [34]. These factors emphasize the role of such systems in guiding educational and career decisions.

The surge in e-learning research during the pandemic is analyzed using bibliometric methods [35]. The study highlights trends, influential publications, and interdisciplinary collaboration, offering insights into the evolving e-learning landscape post-COVID-19.

Machine learning for identifying learning styles in e-learning [36] used interaction data to classify preferences, demonstrating improved engagement and outcomes through adaptive learning systems.

An investigation into medical staff's adaptation to e-learning during the pandemic identifies challenges such as technological barriers and lack of training [37]. However, it also notes a positive shift in attitudes toward digital tools and provides recommendations for improving e-learning in medical education.

The reviewed studies highlight various advancements in e-learning, including adaptive tutoring systems, collaborative filtering algorithms, semantic annotation frameworks, and personalized learning approaches using machine learning and linked data. These works emphasize the importance of enhancing accessibility, personalization, and engagement in online education.

In contrast, our approach focuses on developing an innovative e-learning platform that integrates a customized ontology with advanced video annotation capabilities. This platform enables students to semantically tag video content using Linked Data, creating dynamic, contextually rich learning materials. By annotating videos with structured metadata, learners can interact with content more meaningfully, fostering a deeper understanding of the subject matter.

Furthermore, the platform offers a personalized learning environment that adapts to individual student needs, delivering tailored content and insights based on their interactions with annotated videos. This integration of semantic technologies empowers students to explore educational resources more effectively, engage in collaborative learning, and track their progress through an interactive interface. Positioned at the intersection of semantic technologies and e-learning, our work advances personalized, interactive learning while addressing critical needs such as resource accessibility, platform interoperability, and enhanced learner engagement in the evolving online education landscape.

An overview and comparison are provided in Table 1.

Table 1. Overview and comparison of some studies

Ref.	Advantages	Disadvantages
[31]	-Encourages participation and offers group learning. -Gives ideas a useful, real-world application. -Increases students' skills through the frequent usage of tools.	-Participation may be inconsistent. -Measuring the impact can be difficult. -Requires motivated, self-directed learners.
[32]	-Focuses attention on new gaps and trends. -Gives the direction of future research	-Dependent on available literature databases. -Retrospective nature might miss latest developments
[33]	- Personalizes learning experiences. - Improves engagement and learning efficiency. - Uses data for ongoing improvement.	- Requires a lot of processing power and big datasets. - Accuracy depends on quality and variety of data.
[34]	-Provides actionable insights for platform improvement. -Supports evidence-based adoption decisions. -Enhances user experience and satisfaction	-Limited to one platform. -Survey-based, relies on self-reported data. -May not capture long-term usability trends.
[35]	-Provides practical insights into real-world challenges. -Informs policy and practice improvements. -Highlights factors influencing e-learning success	-Limited to medical staff. -Self-reported data may introduce bias. -Focuses on challenges, less on solutions.

3. METHODOLOGY

The aim of this study is to enhance e-learning by developing a platform for teachers and students, capable of generating a vast amount of question-and-answer content for online courses. Students engage with these courses, which leverage advanced multimedia technologies, enabling them to be evaluated and develop new skills and knowledge. The primary goal is to integrate semantic ontology technology into the newly created UCBET platform to improve learning processes and outcomes.

Our methodology involved analyzing foundational papers from relevant publications, defining research questions, and establishing research objectives. The first phase focused on platform development, incorporating custom ontologies and semantic annotation to enhance educational operations. A pre-test was conducted to assess students' prior knowledge, while a post-test evaluated the effectiveness of learning through semantically annotated videos. Additionally, an impact questionnaire was used to measure the influence of the platform on both teachers' and students' learning and thinking processes. The research methods and phases are detailed in Figure 1.

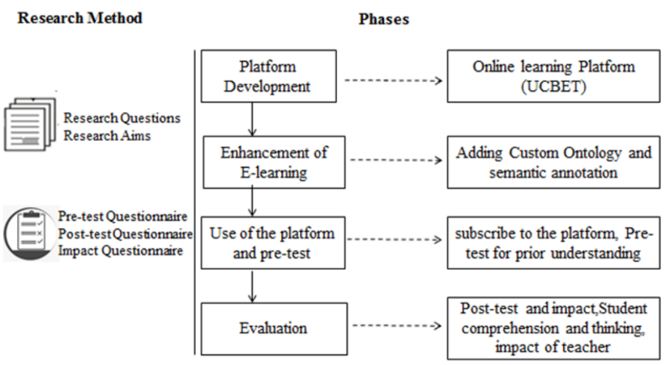

Figure 1. Research method and phases

All participants, in this study, provided informed consent before participating in the study. The consent process involved providing participants with detailed information about the study's objectives, procedures, and potential risks. Participation was entirely voluntary, and participants were informed of their right to withdraw from the study at any time without penalty.

To ensure the protection of participant privacy, all collected data were anonymized by assigning unique identification codes to each participant. No personally identifiable information was recorded or linked to the experimental data. Data were securely stored on password-protected systems with access limited to the research team.

By implementing these measures, we ensured that participant privacy and data security were rigorously protected throughout the study.

4. THE PLATFORM AND THE SEMANTIC ONTOLOGY

This study has adopted the development and utilization of an e-learning platform centered around an annotation system. By integrating semantic annotation capabilities, the platform enhances the learning experience, enabling students and educators to interact with content more effectively and fostering a deeper understanding of the material.

4.1 Development of the platform

The e-learning platform (UCBET) is designed to serve as a collaborative hub for the university community, facilitating remote interaction among various stakeholders including lecturers, tutors, administrators, designers, students, and learners. The university's distance learning unit aids pedagogical teams in developing online courses and educational materials. Our program features contain three user interfaces. The first interface, accessible to visitors without requiring login credentials, it offers open and explanatory courses hosted on the platform. The second interface is tailored for students, granting access to courses based on their proficiency level, featuring high-quality courses with video annotations and a semantic search engine integrated with the ontology.

The third component is designed for teachers, allowing them to create and publish courses, as well as design pre-tests and post-tests for each level and subject. Figure 2 displays the architecture of the platform. The platform functions within both hardware and software environments, utilizing a combination of various software tools for its development and implementation. This platform is built to support a large number of university stakeholders.

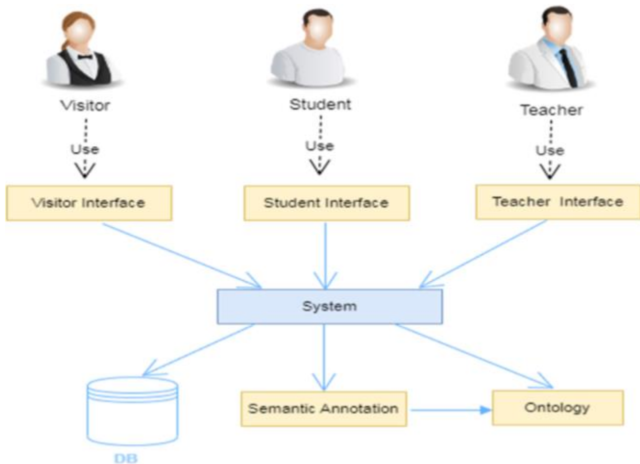

Figure 2. Platform architecture

Figure 3. Ontology classes

Proposed Approach (Ontology and Semantic Annotation)

(1) Custom ontology: A student can organize, communicate, and exchange knowledge with others about the source material through the transdisciplinary practice of

annotating. To answer research question one, the ontology is employed for its capability and ability to impart meaning to information that is indexed, searched, processed, and shared for the platform's e-learning courses. The ontology was created and being used to organize concepts and relationships in order to build and highlight the main learning content, which is the C programming language.

The semantic web ontology system is a promising breakthrough for improving the electronic learning environment. Also, customization is encouraged by the semantic web ontology, which allows users to search for learning content tailored to their unique needs. The ontology connects the user's needs to the features of the learning content. We created a custom ontology for the C programming language that will be added to the free DBpedia Spotlight. Our ontology will provide the correct responses and was created by Protégé 2000. Classes, subclasses, properties, and complex classes are all generated. Their hierarchy was also established, as presented in Figure 3.

(2) Examining the consistency of the ontology: The ability to check if the developed ontology does not contain contradictory concepts is a significant benefit of utilizing Protégé. Figure 4 displays the ontology consistency graph.

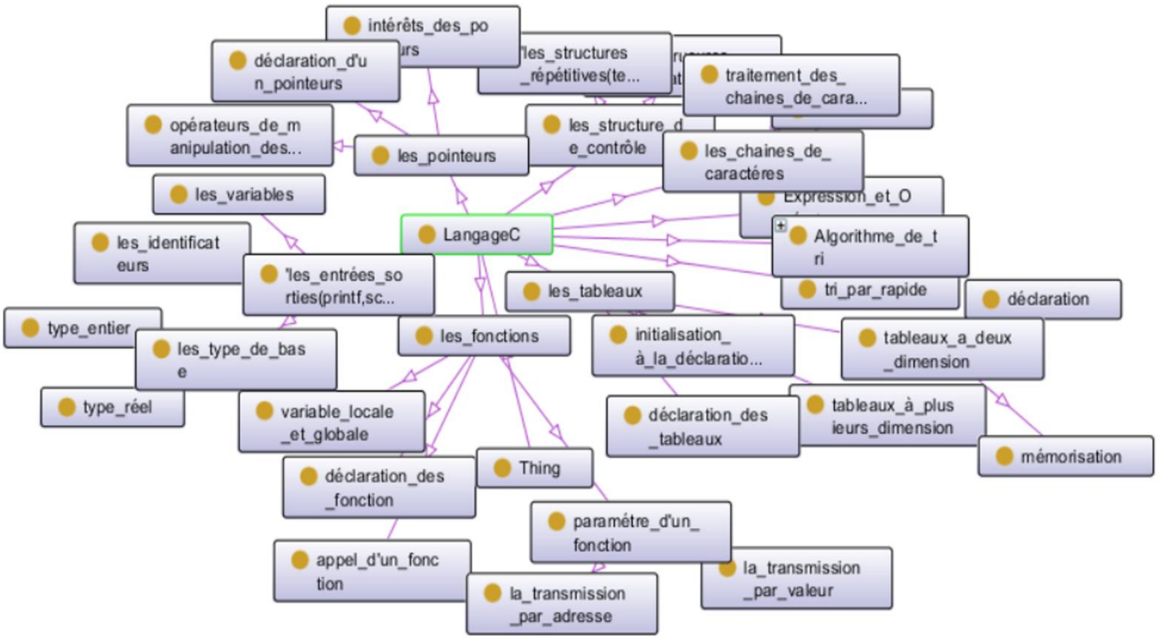

Figure 4. The ontology consistency graph

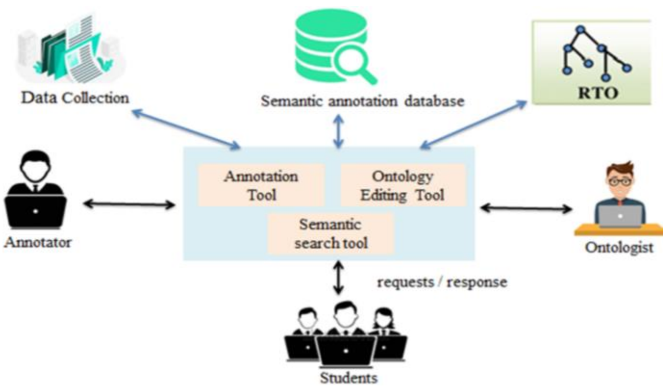

Figure 5. Semantic annotation architecture

(3) Semantic annotation: The process of associating the content of a text with entities in an ontology is known as semantic annotation. For example, the right annotation for the statement "Paris is the capital of France" would be Paris, not Paris Hilton. It's a more thorough but less precise version of the named entity method. Another example is if a learner from group A (video with semantic annotation) adds an annotation " What means {in the C program?" our system gives him a short, precise, and relevant answer. On the other hand, if the same question is asked by a learner from group B (video with web annotation), the system responds with an ambiguous, vague, inaccurate, and irrelevant answer. The task of semantic annotation is increasingly being considered one of the application parts of the Semantic Web, namely to locate metadata relevant to the semantic identity of the annotated material. In our study, semantic comments were used as a coordinator and request system in accordance with a SPARQL request and by connecting it to a natural language query. Semantic annotation architecture is presented in Figure 5.

A screenshot of the annotation student interface presented in Figure 6.

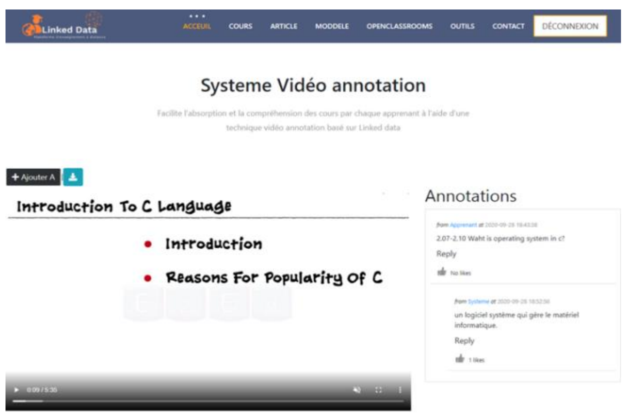

Figure 6. A screenshot of the annotation student interface

5. EVALUATION OF E-LEARNING OPERATION AND IMPACT

5.1 Group organization and data collection

The 80 participants were randomly assigned into two groups of 40 each (Group A and Group B) using a random number generator. This randomization process ensured that both groups were comparable in terms of demographic characteristics and baseline programming knowledge, thereby reducing the risk of selection bias. Participants were eager to learn the C programming language. Students in group A were instructed and directed to study using our semantic video annotation, while students in group B were informed and guided to learn using video with web annotation. The participants were selected based on their interest and willingness to learn the C programming language, ensuring motivation and engagement throughout the experiment. This selection criterion aligns with the study's objective of evaluating the effectiveness of the teaching methodologies for students genuinely invested in acquiring programming skills.

5.2 Use of the platform and pre-test

This phase consists of two key steps: First, students register for access to the platform. Second, they complete a pre-test designed to assess their existing knowledge. Administered before the course begins, the pre-test establishes a baseline understanding of the subject matter. In this context, the pre-test evaluates students' prior knowledge of the course content.

An experienced teacher developed the test based on the learning materials, specifically targeting students' understanding of the C programming language. The pre-test comprised ten multiple-choice questions, with a maximum score of ten. Participants received detailed instructions via email, ensuring they adhered to the learning schedule and respected the flexibility of the learning term. Table 2 outlines the pre-test questionnaire used to assess students' prior understanding of the C programming language.

Table 2. Pre-test questionnaire for students' prior understanding of the C programming language

N	Questions
Q1	When was the C programming language developed?
Q2	What is the keyword used to define a function in the C programming language?
Q3	How do you finish a C program instruction?
Q4	What is the proper syntax for declaring an integer variable in C?
Q5	In C, which function is used to read a string from user input?
Q6	In C, what is the value of the symbolic constant "NULL"?
Q7	In the C programming language, which function is used to convert a string to an integer?
Q8	What is the correct syntax to declare an array of 10 integers in C language?
Q9	In the C language, what type of data is used to hold individual characters?
Q10	What is the correct form of the conditional instruction?

Following the subscription, a statistical analysis was conducted to evaluate the differences between the two groups. The analysis used the covariance (ANCOVA) approach, with the pre-test scores serving as the covariate and the post-test scores as the dependent variables. This methodology was employed to establish the extent of disparity between the two groups and provide valuable insights to show the difference of the prior subject knowledge between group A and group B. The evidence has clearly indicated that both groups of students had an equal amount of prior knowledge. This is a crucial factor to keep in mind when evaluating the effectiveness of the activity as it ensures that any differences in performance between the groups can be attributed to the improvement itself and not to differences in pre-existing knowledge which are presented in Table 3.

Table 3. Descriptive data and ANCOVA of the pre-test results

Group	N	Mean	S.D	Adjusted Mean	Std. Error	F
A	40	16.15	3.71	16.34	0.58	4.43
B	40	16.00	3.69	15.98	0.58	
$P<0.01$						

5.3 Post-test to assess the student's intellectual progress

To truly put e-learning to the test. Students in group A were introduced to systems that focus on the connected data enrichment mechanism during the learning activity. Using commonly used vocabulary, this technique aims to connect annotations to external instructional datasets. They might look through the annotations in the documents using the semantic search paradigm. Group B has introduced learning with text annotation without using annotation-based linked data enrichment. When the learning activity has been completed, the post-test will be carried out on groups A and B. The post-test contains twenty questions expressed in pseudocode with four possible answers for each student who must select one answer. These post-test results for groups A and B are presented in Table 4.

The evaluation compares two types of learning: learning without semantic annotation and learning with semantic annotation, to establish the influence of linked data tools on learning and teacher motivation. The analysis revealed a significant difference in post-test scores between Group A and Group B ($F = 3.65$, $p < 0.01$). The experimental group, which used the semantic annotation approach, achieved significantly higher scores compared to the control group. This suggests that the semantic annotation approach was more effective in enhancing student learning outcomes than the approach without semantic annotation.

When discussing criteria such as “strongly agree,” “agree,” “disagree,” “strongly disagree,” and “undecided,” it is important to understand their role in gathering and interpreting opinions or feedback. These categories allow individuals to express varying levels of agreement or disagreement with a given statement, providing a nuanced view of collective sentiment. “Strongly agree” and “strongly disagree” capture the extremes of an opinion, indicating a high level of satisfaction. “Agree” and “Disagree” reflect more moderate positions, indicating a certain level of acceptance or disagreement without extreme intensity. “undecided” serves as a decisive option for those who feel neutral or lack sufficient information to form a final opinion. This spectrum helps analyze responses more accurately, allowing for more informed decisions to be made and it’s based on the feedback collected.

Table 4. ANCOVA results of the post-test of the two groups

Group	N	Mean	S.D	Adjusted Mean	Std. Error	F
A	40	2.78	1.09	2.75	0.06	3.65***
B	40	2.24	1.15	2.28	0.06	
***P<0.01						

In our study, we have observed that Group A had a very high concentration of individuals who strongly agreed. In contrast to, Group B's opinions were more diverse, with responses split between strongly agree, agree, disagree, strongly disagree, and undecided. This indicates that Group A had a strong consensus on the proposed approach, while Group B showed a wider range of opinions and less homogeneity in their responses are presented in Figure 7.

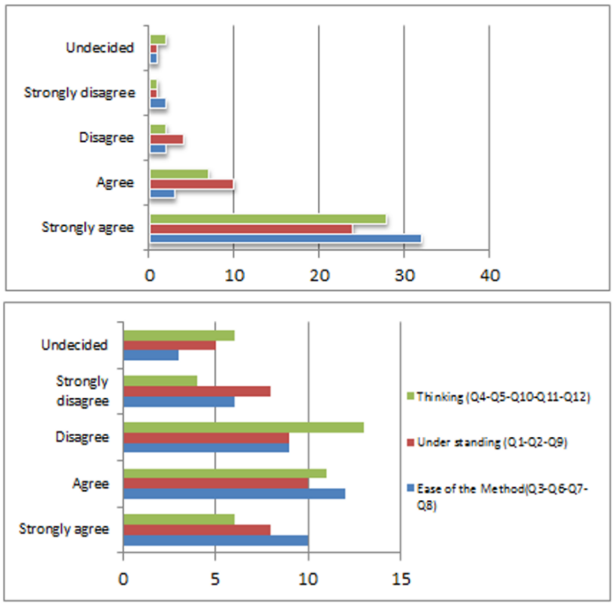

Figure 7. Evaluation results for students in groups A and B

After incorporating video annotations that contained semantic content to enhance student learning engagement, both groups of students were asked to complete a post-questionnaire. Table 4 presents the ANCOVA result of the post-questionnaire ratings given by the two groups. The mean ratings for group A were 2.78 with a standard deviation of 1.09, while for group B, they were 2.24 with a standard deviation of 1.15. It was found that the post-questionnaire ratings of the two groups were significantly different, with a p-value of less than 0.01. The adjusted mean of group A (2.75) was significantly higher than that of group B (2.28). Therefore, it can be concluded that video annotation had a significant impact on facilitating collaboration and knowledge sharing among students.

5.4 Impact on the comprehension and thinking of students

In addition to the post-test, students completed an impact questionnaire to assess the level of cognitive gain. The questionnaire is presented in Table 5.

5.5 Impact for teachers

Questionnaire for teachers: The questionnaire was completed by nine professors. They had provided distance lessons using the university platform approach, and they were allowed to evaluate the method's success and impact on students' learning and thinking. The result of the questionnaire showed that all teachers strongly agreed to use this method. A questionnaire for teachers is presented in Table 6.

Table 5. Questionnaire for impact, comprehension, and thinking for students.

Level of Agreement	The Choices
The learning approach (video with semantic annotation) enriched the learning activity	Strongly agree Agree Undecided Disagree Strongly disagree
The learning system was helpful for students	
The provided learning mechanisms smoothed the learning process	
The method is motivational and urges students to complete the educational course.	
The learning method is more effective than traditional computer-assisted learning methods	
Students are more interested in the data derived by annotated semantic video than in ordinary video	
The educational method leaves the student more positive and creates for him the goal of deepening and continuing learning	
The students' enthusiasm in this manner pushed the instructors to deliver more lectures and courses on this curriculum	

Table 6. Questionnaire for teachers.

The Method's Simplicity, Comprehension, and Thought	The Choices
Q1-The learning approach enriched the learning activity	Strongly agree Agree Undecided Disagree Strongly disagree
Q2-The learning system was helpful to me in acquiring new knowledge	
Q3-The provided learning mechanisms smoothed the learning process	
Q4-When I required information, the learning system assisted me in obtaining it.	
Q5-The learning method assisted me in learning more effectively	
Q6-The learning method is more effective than traditional learning methods.	
Q7-It is not difficult for me to learn to operate the learning system	
Q8-It only took me a short time to fully know how to use the learning system	
Q9- Did you fully understand the content of the lesson?	
Q10- The method encourages understanding by thinking and asking about what is not understood	
Q11-The educational method leaves the student more positive and creates for him the goal of deepening and continuing learning	
Q12- I can remain cool in the face of difficulty because I am confident in my ability to adjust and profit from the helpful coaching method	

6. RESULT AND DISCUSSION

According to the findings of this study, video annotations with semantic content and student learning engagement were positively associated. Only two students received less than 40% as a post-test score, while 22 received better than 70%. For the students who learned using conventional video annotation without semantics, 11 students received 70%, 19 students received 50%, and 10 students received less than 50%.

Based on post-test findings and student impact questionnaires, we determined that, in general, students had a positive attitude and learning satisfaction with the use of the platform and semantic video annotation learning material. According to the findings, 80% of the students in group "A" firmly believe that the method is the easiest. 60% of students strongly believe that the method helps them understand more, and 70% strongly agree that the method helps them to think more effectively.

Since it is a measure of total academic experience and success, student satisfaction is essential in this situation.

The visual learning approach was discovered to have the largest influence on student engagement.

Video with semantic annotation has been hailed as a remarkable pedagogical tool because of its ability to create a rich visual learning environment. In this study, we have discovered that students generally have a favorable attitude and learning satisfaction regarding the use of platform and video annotation learning material based on post-test results and impact questionnaires for students. Student satisfaction is crucial in this context, since it is an indicator of overall academic experiences and accomplishments.

The proposed impact questionnaire for students aims to show the usefulness of the approach for students and indicate the following highlights:

There is an improvement in the method of teaching and learning.

Easy to annotate; is the process simple for students?

There is a supply of information from the system if requested.

The method is recognized and used in a short time.

Simplicity of the interface

To pass this course, you must understand the content.

The strategy promotes comprehension by asking questions about what is not understood?

The instructional style makes the student feel more positive and inspires him to pursue deeper and ongoing study.

The visual learning approach was discovered to have the largest influence on student engagement.

According to the results of the group B questionnaire, 32% of respondents disagree with the traditional method that it increases thinking, whereas 22,5% disagree that using web annotation without semantic context improves understanding.

The instructors involved in the platform's development and its users, as well as those involved in the student evaluation procedure and the opinion questionnaire, all hold the belief that annotations on videos can help students learn. It was discovered to help students' reflection and feedback processes, improve their understanding of video content, encourage students' learning satisfaction and positive attitude, and was also viewed as a practical and simple-to-use learning platform.

The teachers brought up the following points:

The time spent on annotation and lecture notes for learning with sematic annotation is greater than the time spent on learning with a simple video method because our approach provides collaboration between the learner and the system via video annotation, which allows for interaction with the system. This takes time, as opposed to the method without interaction, because the student completes the lesson without interaction and without receiving a response from the system, and it is possible that he does not complete the lesson because he did not understand or because he did not find a way to motivate him to complete the lesson and try to absorb it.

The ease of use of the interface

The method enhances comprehension by inquiring from student about what is not understood.

Students are more interested in the data derived from annotated semantic video than in ordinary video.

The students' enthusiasm in this manner pushed the instructors to deliver more lectures and courses on this curriculum, as well as to try to strengthen the system with annotation via images and annotation via audio video.

Teachers also shed light on the fact that the semantic web ontology system is an exciting new development for improving the electronic learning environment since it fits basic educational objectives such as speed, efficiency, and relevance.

The following points serve as an overview of the platform's significance and the desired outcomes of using it:

•The platform intends to provide a large number of online courses as well as a comprehensive collection of tools to supplement the content of these courses.

•The platform offers 100% online training, and the content is enhanced with linked data tools.

•The teacher creates the content online, and the learner interacts solely through video annotation, which means without the teacher's presence.

•The pre-test and post-test are used to continually evaluate the student's level and what they have gained as a result of the training.

•The evaluation seeks to compare the two modes of learning, traditional learning and linked data learning, in order to determine the impact of semantic ontology on the degree of learning and teacher motivation.

While the study highlights the benefits of semantic annotation and linked data technologies in enhancing online learning, certain limitations must be acknowledged. These include the challenges in scaling the platform to handle large datasets and user bases, and reliance on consistent, high-quality ontologies to ensure accurate annotations. Additionally, the time investment for creating annotated content and the learning curve for educators unfamiliar with these technologies may hinder widespread adoption. Addressing these limitations through optimization, scalable solutions, and automated annotation tools will be crucial to expanding the applicability and effectiveness of this approach in diverse educational contexts.

7. CONCLUSION

This study has successfully developed an e-learning platform enhanced with a semantic web ontology, incorporating essential features of existing e-learning systems. The integration significantly improves the online learning experience by addressing learners' preferences for adaptable and personalized education, delivering search results tailored to academic inquiries. Customization of learning materials is achieved through a bespoke ontology, enabling the system to provide relevant resources to individual learners. The platform is highly scalable, supporting diverse courses and fostering productive interactions between learners and instructors.

Teachers have responded positively to the proposed approach, recognizing the semantic web ontology system as an innovative solution that aligns with core educational goals and enriches the e-learning environment. Machine learning and intelligent computing have emerged as crucial tools for tackling challenges in e-learning. Future work will focus on incorporating course content recommendation systems and integrating machine learning with semantic ontologies to further enhance the platform's capabilities

Building on this, future research will explore combining semantic annotation with personalized recommendation algorithms to create more tailored and adaptive learning experiences. By incorporating user preferences and learning behaviors, these approaches can enhance online learning, leading to more engaging and effective student experiences. Furthermore, integrating advanced natural language processing (NLP) techniques with semantic frameworks could improve understanding of user queries and content classification, refining the recommendation process. These developments will not only enhance personalization but also contribute to a more dynamic and student-centric e-learning ecosystem.

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