Implementing Chat GPT in Moodle for Enhanced eLearning Systems

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Abstract

AI-based technologies have the potential to significantly enhance e-learning systems. ChatGPT, a sophisticated AI tool for natural language processing, enables users to engage with a chatbot in a manner that closely resembles human communication. This language model can assist users in various tasks, including composing emails, essays, and code, and it can provide responses to their inquiries. In this research paper, we will thoroughly examine the impact of ChatGPT on e-learning and education. Our paper not only offers practical examples of AI technology applications but also delineates the essential steps for integration. Furthermore, we focus on the evaluation of GPT-3.5 plugins tailored for Moodle, a popular e-learning platform, and provide sample PHP code to illustrate the seamless integration of ChatGPT into the Moodle environment. These examples and code snippets serve as valuable resources for educators and system administrators looking to incorporate artificial intelligence technology into their learning management systems. Towards the end of this paper, we will present our insights into the positive and negative influences of ChatGPT on learning and students.

Keywords

Chat GPT, Moodle LMS, Natural Language Processing, Conversational AI, Personalized Learning.

1. Introduction

The realm of eLearning has witnessed remarkable advancements with the emergence of Natural Language Processing (NLP) and Artificial Intelligence (AI) technologies. Among these innovations, the integration of Conversational AI, particularly Chatbots powered by GPT (Generative Pre-trained Transformer), has revolutionized the way learners interact with educational platforms [1-4].

This paper presents a novel approach to implementing Chat GPT within the Moodle Learning Management System (LMS) to enhance eLearning experiences, fostering interactive and personalized learning environments. Traditional eLearning systems have often struggled to provide engaging and personalized interactions with learners, leading to limited effectiveness and reduced motivation. Chat GPT, with its language comprehension and generation capabilities, offers a promising solution to this challenge. By enabling dynamic and contextually aware conversations, Chat GPT transforms the learning experience by providing learners with responsive, natural language interactions that cater to their individual needs. Generative AI pertains to a category of AI models capable of generating novel data patterns based on acquired knowledge from existing data. These models present the capacity to produce content across different domain, such as text, visuals, music, and more [5-6]. These generative

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AI models utilize advanced deep learning methods and neural networks to scrutinize, interpret, and produce content that bears a striking resemblance to human-generated outputs. Among these models, ChatGPT, an AI model crafted by OpenAI, has surfaced as a potent instrument with extensive applicability across multiple domains [7-8].

Comprehending the origins and evolution of ChatGPT is pivotal to grasping its role in propelling scientific exploration forward [9-10]. This segment furnishes an outline of the background, pivotal milestones, and advancements witnessed during the development of ChatGPT. This highlights the technological strides instrumental in its accomplishments within the scientific arena [11-12]. It's noteworthy to mention that ChatGPT is distinct from Generative Adversarial Network (GAN) models; instead, it operates as a language model founded on the Generative Pre-trained Transformer (GPT) architecture [13-14]. While GANs typically serve tasks like image generation, GPT models are specialized for tasks in natural language processing such as text generation and language comprehension [15-16].

Moodle, as a widely adopted open-source LMS, provides a conducive platform for integrating Chat GPT into eLearning systems. Leveraging Moodle's extensibility and flexibility, educators can seamlessly integrate Chat GPT and fine-tune the model to align with specific learning objectives, facilitating adaptive and personalized learning pathways. The primary objective of this paper is to present a systematic methodology for incorporating Chat GPT into Moodle, augmenting the platform's interactivity and learner engagement. By integrating advanced Conversational AI within the eLearning environment, this research aims to improve the effectiveness of knowledge delivery, learner satisfaction, and overall learning outcomes. ChatGPT can be valuable not only to students engaged in Moodle-based courses but also to educators who serve as authors and creators of learning materials and lectures within Moodle.

In the subsequent sections, we will delve into the significance of Chat GPT in the context of eLearning, review related literature, and outline the proposed methodology for customizing the Chat GPT model and seamlessly integrating it into Moodle. Also, we have described the integration of the existing plugin with the Moodle system. Due to certain limitations, we have also modified and enhanced the functionality of the "Source of Truth" component of the plugin. Additionally, we will explore the potential contributions of this research and address challenges encountered during the implementation process. So, the core of this paper's research is to provide a proposal for the use of ChatGPT in an eLearning system.

1.1. Limitation of eLearning platforms

E-learning platforms serve as digital arenas for the delivery of education, primarily conducted through online channels. These platforms come in various designs, functionalities, and features, carefully crafted to cater to a wide range of educational needs. They offer a versatile toolkit that includes multimedia resources, assessment tools, interactive forums, and numerous pedagogical resources. Notable examples of e-learning platforms include Moodle, Blackboard, Canvas, edX, and Coursera [17-18]. However, it's essential to acknowledge the inherent limitations that e-learning platforms encounter [19]:

- Lack of Personal Interaction: One of the most significant constraints is the limited opportunity for direct face-to-face interaction between educators and learners. This constraint can lead to feelings of isolation and hinder quick feedback and clarification.
- Limited Social Interaction: Several e-learning platforms offer only modest social interaction features, failing to recreate the collaborative atmosphere found in traditional classrooms. As a result, students might miss out on valuable peer-to-peer interactions that enrich learning through discussions and group activities.
- Static Content Delivery: Traditional e-learning often relies on one-way communication through static content, such as text-based modules and pre-recorded videos. This approach can result in passive learning experiences that may not fully engage students.
- Lack of Personalization: Providing the same content to all learners may not align with individual learning preferences and paces. Personalized learning pathways are often limited, potentially affecting knowledge retention.

- Inadequate Feedback Mechanisms: Timely feedback is critical for effective learning. However, many e-learning platforms offer limited opportunities for real-time assessment and feedback, which can impede the learning process.
- Technical Challenges: Accessing e-learning platforms requires specific technological resources, including devices, internet connectivity, and digital proficiency. These prerequisites can be obstacles for learners without easy access to such resources.
- Assessment Methods: Conventional assessment techniques, like multiple-choice quizzes, may not comprehensively evaluate learners' understanding and critical thinking abilities. Such assessments can inadvertently encourage rote memorization over deep comprehension.
- Motivation and Engagement: The absence of real-time interactions, gamification, and hands-on learning opportunities may lead to reduced motivation and engagement among learners.
- Self-Discipline Requirements: E-learning platforms demand a higher degree of self-discipline and self-motivation, which can be challenging for some learners to maintain consistently.
- Adaptation to New Technologies: To remain effective, e-learning platforms need to evolve continually by integrating emerging technologies, such as artificial intelligence (AI) and advanced interactivity.

Acknowledging these limitations is essential to drive innovation in e-learning systems. The integration of technologies like Chat GPT into platforms like Moodle shows promise in addressing specific challenges, enabling more personalized, interactive, and engaging learning experiences.

1.2. Introduction to Chatbots and Chat GPT in education

There have been several research studies focused on adapting Chat GPT models for educational contexts. These studies have highlighted the importance of fine-tuning GPT-based models to align with specific eLearning objectives [25]. Researchers have experimented with domain-specific training data and have demonstrated how customized Chat GPT can enhance the relevance and coherence of responses in educational interactions.

In [21] and [22], the authors propose the adoption of the concept of Cyber-Physical-Social Systems (CPSS), which encompasses human and social factors, to achieve efficient and effective chatbot systems. Several studies also have investigated the impact of Chat GPT on learner engagement [23][24].

Chatbots with advanced language generation capabilities, like those based on GPT, have been found to provide more natural and interactive conversations. Learners often respond positively to human-like interactions, leading to increased motivation and sustained engagement with the eLearning content.

The concept of personalized learning has been a focal point in Chat GPT integration research [25]. These technologies have been explored as tools for creating tailored learning experiences. Chat GPT can analyze learners' responses and preferences to deliver content that matches their individual learning styles, effectively addressing the challenge of one-size-fits-all content delivery.

Studies have also demonstrated the potential of Chat GPT in providing instant feedback and support to learners [26-27]. Through real-time interactions, learners can receive immediate clarification on queries, aiding in comprehension and reducing frustration. Additionally, the ability of Chat GPT to explain complex concepts in accessible language contributes to the overall effectiveness of eLearning.

In the realm of education, technological advancements have been instrumental in reshaping traditional learning methodologies. Among these advancements, the integration of Chatbots and the emergence of Chat GPT (Generative Pre-trained Transformer) hold immense potential to revolutionize the way learners and educators interact with educational content. This section provides an overview of Chatbots and Chat GPT in the context of education, highlighting their significance and applications.

By leveraging Natural Language Processing (NLP) techniques, Chatbots engage in real-time interactions with users, providing information, answering queries, and even facilitating learning experiences. In educational settings, Chatbots act as virtual assistants, enhancing the learning process through personalized assistance, immediate feedback, and dynamic engagement [28-30].

Chat GPT, built on the GPT (Generative Pre-trained Transformer) architecture, takes the concept of Chatbots to a higher level. It enables the generation of human-like text responses that are contextually relevant and coherent. This advanced capability makes Chat GPT an ideal candidate for creating more immersive and natural interactions within eLearning environments [31-33].

In education, Chat GPT can:

- Foster meaningful dialogue between learners and course materials, enhancing comprehension.
- Generate explanations for complex concepts in a manner that resonates with individual students.
- Facilitate interactive storytelling and scenario-based learning.
- Provide a human-like conversational experience, encouraging sustained engagement.
- The significance of integrating Chatbots and Chat GPT into education lies in their potential to address various challenges faced by traditional learning approaches. These technologies bridge the gap between one-size-fits-all content delivery and tailored, interactive experiences. They offer personalized learning pathways, immediate feedback, and increased accessibility to educational resources.

Applications of Chatbots and Chat GPT in education include [35]:

- Supporting students in remote learning environments by offering instant clarification.
- Enhancing engagement through gamified and interactive learning experiences.
- Assisting educators in managing administrative tasks, enabling them to focus on instruction.
- Catering to diverse learning styles and preferences through customized interactions.

As education continues to evolve in the digital age, the integration of Chatbots and Chat GPT holds promise for creating dynamic and engaging learning ecosystems. These technologies enrich interactions, foster personalized learning journeys, and redefine the way education is accessed and consumed. In the subsequent sections, we will delve deeper into the specific benefits and challenges associated with implementing Chat GPT within eLearning systems, particularly in platforms like Moodle.

1.3. Benefits and challenges of using Chat GPT in Moodle

The integration of Chat GPT (Generative Pre-trained Transformer) into Moodle, a widely used Learning Management System (LMS), presents a unique opportunity to enhance eLearning experiences. This section explores the potential benefits and challenges associated with incorporating Chat GPT within the Moodle platform.

Benefits and challenges from ChatGPT and Moodle are very good given in paper [25]. The benefits of integrating Chat GPT into Moodle are substantial. Firstly, it facilitates personalized learning experiences, where content delivery and responses are tailored to the unique preferences and needs of each learner. This customization ensures that students receive guidance that aligns with their individual learning journeys, ultimately enhancing comprehension and retention. Secondly, Chat GPT's real-time interaction capabilities provide immediate feedback and assistance within the Moodle environment. This means that learners can seek clarification, obtain explanations, and access supplementary resources instantly, supporting a more efficient and effective learning process. Moreover, the incorporation of Chat GPT adds an element of engagement and motivation to Moodle. The platform becomes more interactive, mimicking human-like conversations, which in turn boosts learners' motivation. The perceived relatability and engagement create a more enjoyable and effective learning atmosphere. Additionally, Chat GPT's advanced natural language understanding empowers Moodle to comprehend a wide range of user queries and prompts. This feature makes interactions more intuitive and user-friendly, as learners can communicate with the platform using everyday language, eliminating barriers to effective communication. Furthermore, Moodle with Chat GPT offers 24/7 accessibility and support. Learners can access assistance and resources at any time, which is particularly advantageous for remote or asynchronous learners who may have varying schedules. Lastly, the adaptive learning pathways enabled by Chat GPT enhance the learning experience. By analyzing learner interactions, Moodle can adapt content delivery and suggest learning paths that match each student's pace, preferences, and prior knowledge. This adaptability ensures a more personalized and effective learning journey. In summary, integrating Chat GPT into Moodle brings numerous benefits, including personalized learning, instant assistance, enhanced engagement, natural language understanding, accessibility, and adaptive pathways, all contributing to an enriched eLearning experience.

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adaptive pathways, all contributing to an enriched eLearning experience. However, this integration also poses notable challenges. Data privacy and security concerns arise as learner interactions are potentially stored, demanding robust measures to safeguard sensitive information. Ensuring ethical AI content creation and addressing potential biases in training data are vital ethical challenges. Maintaining accuracy and reliability, especially in complex subject matters, requires ongoing refinement. Customizing Chat GPT to align with educational contexts is a complex process, balancing human-like conversation with educational accuracy. User acceptance and comfort with AI-driven systems may be initial hurdles. Familiarizing users with the technology and addressing their concerns is essential. Continuous maintenance and updates are necessary to keep Chat GPT relevant and accurate amidst the evolving AI landscape.

2. The Moodle Learning Management System (LMS)

Moodle, one of the most popular Learning Management Systems (LMS), is widely used in educational institutions and organizations around the world. Its adoption rate has been consistently growing due to its open-source nature, flexibility, and comprehensive features.
Moodle is often used as an LMS in:
Given that the topic is novel, there is limited existing research focused on this subject. There are several studies that have outlined the utilization of ChatGPT within the Moodle Learning Management System (LMS). The integration of artificial intelligence (AI) technologies into learning management systems through tangible instances was illustrated in [25]. The study offers concrete illustrations of practical use cases along with comprehensive integration procedures. Additionally, it explores GPT-3 plugins tailored for Moodle and incorporates illustrative JavaScript code, showcasing the incorporation of Chat GPT within Moodle. By furnishing a valuable manual for embedding AI technology into learning management systems, this study contributes substantively to the existing scholarly discourse. In this paper is given potential negative ramifications of ChatGPT on learning, academic integrity, employment, and daily life, student opinions are divided. In summation, it is deduced that ChatGPT bears potential for educational application, though students must be cognizant of its limitations.

3. Chat GPT: An Intelligent Virtual Assistant

ChatGPT is a language model based on the transformer architecture, which has proven highly effective in handling sequential data such as language. This architecture employs attention mechanisms to process input data in a context-aware manner, enabling it to grasp intricate linguistic patterns and generate coherent responses.

ChatGPT also leverages self-attention mechanisms to assess the importance of different words within a sentence in relation to each other, facilitating contextually relevant responses. Beyond its initial training on a vast corpus of text data, ChatGPT's true capabilities emerge through fine-tuning, a process in which it is exposed to specific prompts and responses, shaping its behavior for various tasks [38-39].

The architecture of ChatGPT presents numerous opportunities for enhancing eLearning systems Moodle like [39]:

- Conversational Learning: ChatGPT's ability to engage in dynamic conversations opens ways for interactive learning experiences. Learners can engage in real-time discussions, seek clarification, and receive instant feedback, mirroring personalized tutoring.
- Question-Answering: With its language comprehension capabilities, ChatGPT can serve as an automated answering system. It can address learners' queries, provide explanations, and offer insights, supplementing traditional course materials.
- Adaptive Learning: By analyzing learner interactions, ChatGPT can adapt content delivery based on individual learning styles and preferences. This supports a personalized learning journey for each student.
- Feedback Generation: ChatGPT's coherent text generation can aid in providing comprehensive feedback on assignments and assessments. Its responses can include detailed explanations, suggestions, and corrections.

3.1. Understanding the capabilities of GPT-based models

GPT-based models, like Chat GPT, have introduced a transformative dimension to natural language processing and comprehension. They possess the ability to generate human-like text, comprehend language nuances, and work proficiently with multiple languages. These models can summarize content, perform sentiment analysis, offer translation services, provide text completion and suggestions, engage in conversations, and recommend content. They find applications in education as virtual tutors, in creative writing support, research assistance, accessibility enhancements, and the automation of repetitive tasks. Their role in improving human-machine interactions and facilitating technology's user-friendliness is significant. Overall, comprehending the extensive capabilities of GPT-based models is vital for leveraging their potential across diverse domains [37].

3.2. Applications of Chat GPT in various domains, including education

Applications of Chat GPT in various domains, including but not limited to education, span a wide spectrum of use cases. These applications harness the power of Chat GPT to provide solutions, support, and enhancements across different fields. Chat GPT can be employed as a virtual customer support agent, addressing inquiries and assisting customers with product or service-related questions. In content creation, it can assist in drafting articles, reports, or creative pieces, providing valuable content generation capabilities. In the healthcare sector [34], Chat GPT can aid in preliminary diagnosis by answering patient queries and providing information on common health issues. Its multilingual capabilities enable it to serve as a translation tool, facilitating communication across language barriers. Developers can utilize Chat GPT to generate code snippets, simplifying programming tasks and enhancing productivity. It can offer basic legal advice by providing information on legal terms, procedures, and regulations. Researchers and data scientists can use Chat GPT to assist in data analysis by answering queries related to data trends, statistics, and methodologies. In entertainment, it can engage users in interactive storytelling, creating personalized narratives and interactive fiction experiences. Beyond education, Chat GPT can aid in making digital content more accessible by providing text-to-speech services or generating alt text for images. For authors and writers, it can serve as a writing assistant, offering grammar suggestions, style recommendations, and creative ideas. Travelers can benefit from Chat GPT by receiving information on destinations, travel tips, and cultural insights. Businesses can leverage Chat GPT to gather market research data by posing questions to a wide audience and analyzing responses. Additionally, Chat GPT can assist in content curation by recommending articles, videos, or resources based on user preferences. These applications illustrate the versatile and transformative potential of Chat GPT across various domains, revolutionizing how we interact with technology and information.

4. Integration of Chat GPT into Moodle LMS and Case study

The integration of Chat GPT into the Moodle Learning Management System (LMS) signifies a significant advancement in augmenting the eLearning experience. This section presents a comprehensive outline of the step-by-step approach undertaken to seamlessly incorporate Chat GPT functionalities within the Moodle platform. For the purposes of this study, a course was created in Moodle titled "Introduction to Object-Oriented Programming." The course covers the fundamentals of programming in the Java programming language and spans over 12 weeks. Each week includes learning materials, PDF files, as well as homework assignments that students are required to complete.

The simplest approach to incorporate the ChatGPT interface into Moodle involves the installation of the "OpenAI Chat Block" plugin (available at https://moodle.org/plugins/block_openai_chat), which was created and is presently managed by Bryce Yoder as shown in Figure 1. The last version of “OpenAI Chat block” is 1.6.0 (2023031500) and can be integrated in Moodle 3.9, 3.10, 3.11, 4.0, 4.1 versions of Moodle. After successful installation within your Moodle system, this plugin empowers you

to introduce a novel block named "OpenAI Chat" into the block repository. To utilize the plugin, acquiring an OpenAI API key is essential.

Figure 1: Admin panel OpenAI Chat block

The ChatGPT API (https://platform.openai.com/) itself is not free and must be payed ChatGPT Plus subscription. When setting up the OpenAI Chat Block within your Moodle instance, it is imperative to input a series of questions and corresponding answers into the "Source of truth" field. This process resembles supervised training, aimed at imbuing the chatbot with knowledge specific to your LMS environment. In this part we put questions and answers (provided in the appendix) was utilized to train the chatbot for our elearning site. As a result, when users interact with the ChatGPT window on given questions, the responses they receive will be tailored to the platform's context, unless otherwise indicated. ChatGPT effortlessly fulfills the role of a translator, exhibiting a level of precision that often surpasses conventional tools like Google Translate. Its versatility extends to comprehending and providing responses in multiple languages, establishing it as a valuable asset for various language-related tasks. In Figure 2 is presented of OpenAI Plugin integration in Moodle course.

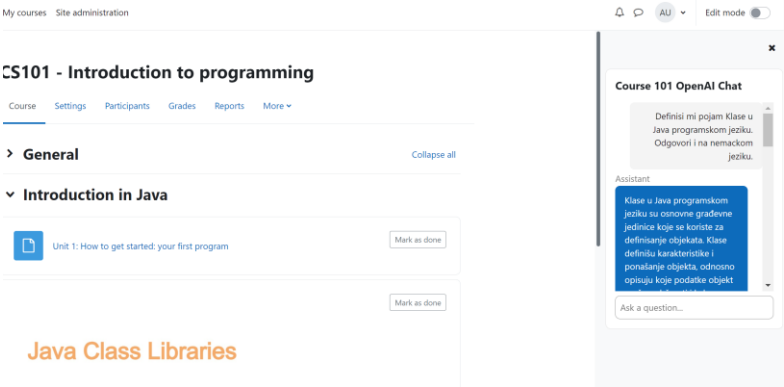


Figure 2: Representation of OpenAI Plugin Integration in Moodle

In advanced section is given selection of Model for choosing ChatGPT. Also is given one of most important thing - source of true.

4.1. Source of Truth in Open ChatGPT: A Valuable Tool for Educational Applications

Source of Truth (SoT) represents a significant and versatile component of Open ChatGPT, particularly valuable within educational contexts. While the AI possesses impressive default capabilities, there is a tendency for it to confidently provide incorrect information rather than declining

to answer if it doesn't know the response to a question. To mitigate this, the plugin offers a text area at both the block instance and plugin levels, enabling teachers or administrators to input a set of questions and answers that the AI will incorporate before generating a completion. This process enhances the AI's likelihood of furnishing accurate information when a query aligns with the questions it has been provided with direct answers to (Figure 3). However, if the source of truth box contains the following:
Q: What is code for packet restore?
A: packet\packet.restore.Targets
The AI will then provide the precise answer, " packet\packet.restore.Targets," when asked, " What is code for packet restore?“ It will also offer accurate responses if the question is phrased differently.

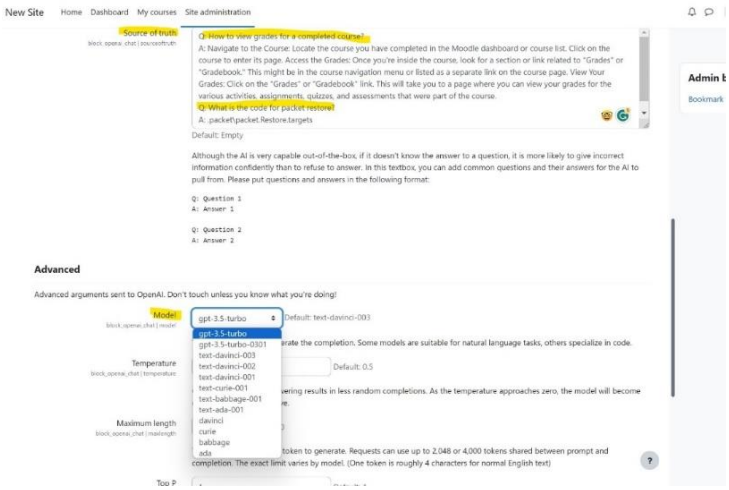


Figure 3: Advanced administration panel for OpenAI in Moodle

This tool finds utility in various applications, one of which is the establishment of usage limits for ChatGPT to prevent students from relying on it excessively when completing assignments. For instance, consider a scenario in an Object-Oriented Programming (OO Java) course where students are assigned weekly programming tasks. To discourage overreliance on ChatGPT for solving these assignments, the task descriptions for each week can be placed in the SoT. When students inquire about the assignment details, ChatGPT can be instructed to respond with a consistent message: *"Usage of ChatGPT for assignment problem-solving is not permitted. Please attempt to solve the tasks independently."*

4.2. Modifications to the Source of Truth Functionality

Given the limitations encountered in the "Source of Truth" (SoT) feature, particularly in the latest plugin version, it was imperative to make substantial adjustments to the plugin's code for research purposes. In fact, an entire section of the code that facilitated this functionality had to be rewritten. The implementation of the algorithm was initially executed in Python. However, due to the specific requirements of Moodle, it necessitated a transition to PHP scripting language. This transition ensured compatibility with Moodle's framework, allowing for a seamless integration of the modified SoT functionality.

4.3. Answering specific questions about lesson materials

Another intriguing use case for ChatGPT in eLearning involves providing answers to questions specific to lessons or courses. At times, students seek information about subjects covered within a course or wish to locate segments of a lesson containing answers to their precise queries. ChatGPT offers a mechanism to facilitate scenarios like these, termed "Prompt training." The ChatGPT language model can be furnished with a reference text, from which it can extract answers to a question. To employ this technique, we can leverage the chat completions OpenAI API. The reference text is included as

part of the chat, to be completed by the OpenAI language model. However, one challenge arises from this approach: all OpenAI models impose a limit on the number of tokens that can serve as reference text. For the chatgpt-3.5-turbo model, this limit stands at 4096 tokens. Therefore, if we intend to have the model address a question based on a single lesson or the entire course, we must initially devise a method to select pertinent text from the lesson or the entirety of the course for use as a reference.

This can be achieved by initially segmenting teaching materials into smaller units and subsequently selecting suitable segments based on semantic similarity with the question. Semantic similarity searches can be conducted using embeddings. Embeddings represent text as numerical vectors, with greater similarity between vectors of separate texts indicating a closer semantic relationship between the two. OpenAI offers distinct embedding models that can be employed to generate embeddings from provided text.

4.3.1. Implementation

We have implemented a plugin for helping find the answers related to materials in a course. This was achieved by firstly developing a method to automatically break down lesson text into smaller chunks, each sized appropriately for the embedding's engine (~1600 tokens). The ensuing embeddings are generated and stored, alongside their corresponding texts, within a vector database (Redis). Plugin adds a text block like already existing OpenAI chat block. This plugin receives user questions, generates embeddings from them, compares these embeddings with those from pertinent courses or lessons, chooses the top 5 most similar text chunks, and employs these chunks as reference text when utilizing the chat completions API.

4.3.2. Splitting a lesson file into chunks

For the first iteration of the plugin, we have split the text blindly, without taking care about logical units. This is something that can be improved upon, developing more precise ways to split files into logical units, like paragraphs (Figure 4).

```php
function createChunks($text) {
    $lst = encoding::encode($text);
    $chunks = [];
    $currentChunk = "";
    foreach ($lst as $i => $item) {
        $itemSizeInTokens = count(encoding::encode($item));
        if (count(encoding::encode($currentChunk)) + $itemSizeInTokens + 2 > $maxTokens) {
            $chunks[] = explode(', ', $currentChunk);
            $currentChunk = $item;
        } elseif ($i > 0) {
            $currentChunk .= ", {$item}";
        } else {
            $currentChunk .= $item;
        }
    }
    $chunks[] = explode(', ', $currentChunk);
    return $chunks;
}
```

Figure 4: Code Implementation: Splitting text in chunks for embedding generation

4.3.3. Storing chunks

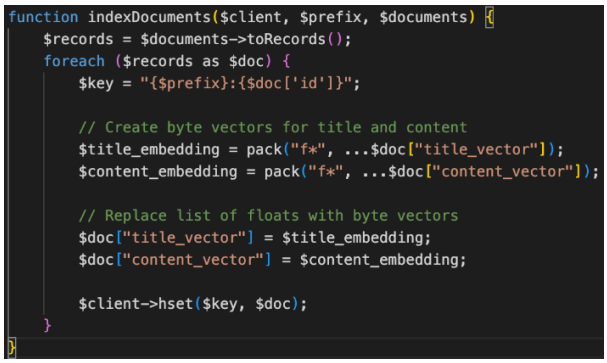
Chunks are stored in a Redis database, that runs on the same server as Moodle. Redis is useful as it already provides means to compare large vectors and therefore, embeddings can be queried according to vector similarity. We save text, title, text_embedding and title_embedding in redis for each chunk. Title here is lesson title.

To store our embedding data in Redis, we first need to create a search index (Figure 5).

```php
// Constants
$VECTOR_DIM = count($article_df['title_vector'][0]); // length of the vectors
$VECTOR_NUMBER = count($article_df);                 // initial number of vectors
$INDEX_NAME = "embeddings-index";                    // name of the search index
$PREFIX = "doc";                                     // prefix for the document keys
$DISTANCE_METRIC = "COSINE";                         // distance metric for the vectors (ex. COSINE, IP, L2)

// Define RediSearch fields for each of the columns in the dataset
$title = new TextField("title");
$text = new TextField("text");
$title_embedding = new VectorField("title_vector",
    "FLAT", array(
        "TYPE" => "FLOAT32",
        "DIM" => $VECTOR_DIM,
        "DISTANCE_METRIC" => $DISTANCE_METRIC,
        "INITIAL_CAP" => $VECTOR_NUMBER
    )
);
$text_embedding = new VectorField("content_vector",
    "FLAT", array(
        "TYPE" => "FLOAT32",
        "DIM" => $VECTOR_DIM,
        "DISTANCE_METRIC" => $DISTANCE_METRIC,
        "INITIAL_CAP" => $VECTOR_NUMBER
    )
);
$fields = array($title, $text, $title_embedding, $text_embedding);
```

Figure 5: Creating Redis search indexes

After that, we need to store chunks of text along with their embeddings in this index (Figure 6).



```php
function indexDocuments($client, $prefix, $documents) {
    $records = $documents->toRecords();
    foreach ($records as $doc) {
        $key = "{$prefix}:{$doc['id']}";

        // Create byte vectors for title and content
        $title_embedding = pack("f*", ...$doc["title_vector"]);
        $content_embedding = pack("f*", ...$doc["content_vector"]);

        // Replace list of floats with byte vectors
        $doc["title_vector"] = $title_embedding;
        $doc["content_vector"] = $content_embedding;

        $client->hset($key, $doc);
    }
}
```

Figure 6: Creating Redis search indexes

4.3.4 Searching chunks by embeddings

To answer questions, we first must search for text chunks related to our question. We do that by querying embeddings stored in Redis earlier (Figure 7).

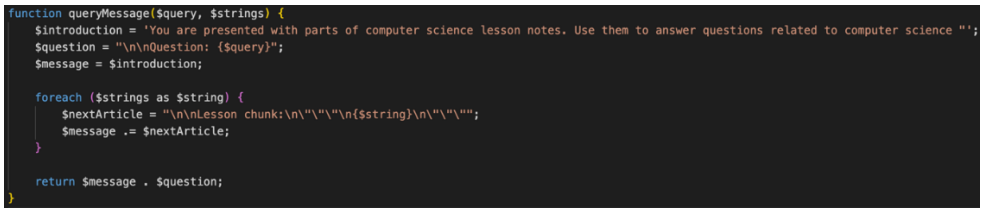
```php
function searchRedis(
    $redisClient,
    $userQuery,
    $indexName = "embeddings-index",
    $vectorField = "title_vector",
    $returnFields = ["title", "url", "text", "vector_score"],
    $hybridFields = "*",
    $k = 20
) {
    // Creates embedding vector from user query
    $embeddingData = \OpenAI\Embedding::create(array("input" => $userQuery, "model" => EMBEDDING_MODEL));
    $embeddedQuery = $embeddingData['data'][0]['embedding'];

    // Prepare the Query
    $baseQuery = "{$hybridFields}=>[KNN {$k} @{$vectorField} $vector AS vector_score]";
    $query = (new Query($baseQuery))
        ->returnFields(...$returnFields)
        ->sortBy("vector_score")
        ->paging(0, $k)
        ->dialect(2);

    $paramsDict = array("vector" => pack("f*", ...$embeddedQuery));

    // perform vector search
    $results = $redisClient->ft($indexName)->search($query, $paramsDict);
    foreach ($results->docs as $i => $article) {
        $score = 1 - floatval($article->vector_score);
        echo "{$i}. {$article->title} (Score: " . round($score, 3) . ")\n";
    }
    return $results->docs;
}
```

Figure 7: Code Implementation: Redis-Based Semantic Search

So, we pass a query parameter which would be our question, and there we first call OpenAI API to create embedding for that query. Then we search Redis for closest matching embedding vectors, and return texts and titles associated with them.

4.3.5 Asking questions with reference text

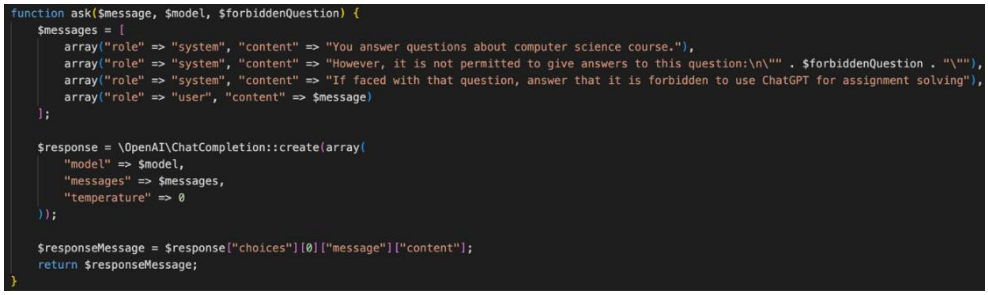
Now that we have relevant chunks ready, we can construct the question and provide reference texts. Here is query Message function that takes questions, and relevant chunks of reference text and creates question ready to be sent to chat completion API (Figure 8).



```
function queryMessage($query, $strings) {
    $introduction = 'You are presented with parts of computer science lesson notes. Use them to answer questions related to computer science "';
    $question = "\n\nQuestion: {$query}";
    $message = $introduction;

    foreach ($strings as $string) {
        $nextArticle = "\n\nLesson chunk:\n\"\"\"\n{$string}\n\"\"\"";
        $message .= $nextArticle;
    }

    return $message . $question;
}
```

Figure 8: Code Implementation: Message Generation for Computer Science Questions

In Figure 9 is given a method for constructing prompts for chat completion. Chat completion API does provide a means to give the full context to the engine by providing previous messages in a chat that should be completed. There we will also add a question that should not be answered by OpenAI. This will be useful to stop students from abusing this functionality to have ChatGPT solve their assignments.



```
function ask($message, $model, $forbiddenQuestion) {
    $messages = [
        array("role" => "system", "content" => "You answer questions about computer science course."),
        array("role" => "system", "content" => "However, it is not permitted to give answers to this question:\n\"" . $forbiddenQuestion . "\""),
        array("role" => "system", "content" => "If faced with that question, answer that it is forbidden to use ChatGPT for assignment solving"),
        array("role" => "user", "content" => $message)
    ];

    $response = \OpenAI\ChatCompletion::create(array(
        "model" => $model,
        "messages" => $messages,
        "temperature" => 0
    ));

    $responseMessage = $response["choices"][0]["message"]["content"];
    return $responseMessage;
}
```

Figure 9: Code Implementation: ChatGPT Question Handling with Forbidden Questions

After the implementation of the modified OpenAI ChatGPT Source of Truth (SoT), we defined homework assignments as "Questions." For example, a homework assignment was defined as follows: "Create a class named 'Rectangle.' Provide methods for calculating the perimeter and area. Implement a method to check if the rectangle is actually a square. Provide a getter method that returns the longer side of the rectangle. Implement a static method for comparing two rectangles based on their area. Implement a non-static method for comparing two rectangles based on their perimeter."As a response, it is indicated that inquiring about this question is not allowed“(Figure 10). Furthermore, Chat GPT can recognize the text of assignments even if it is slightly modified, potentially detecting that it pertains to homework.

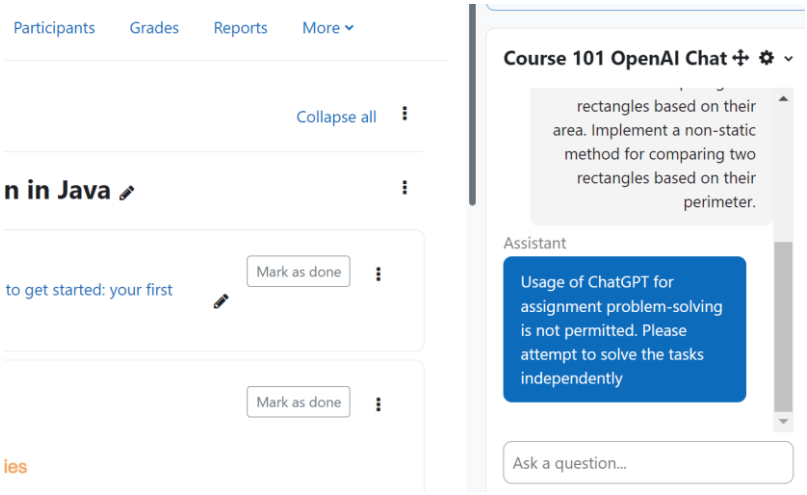


Figure 10: OpenAI's Response to the Question Defined in the SoT as Homework

5. Conclusion

The body of previous research demonstrates the growing interest in leveraging Chat GPT to transform eLearning experiences. As we delve into the specifics of integrating Chat GPT into Moodle, it is important to build upon these insights and contribute to the collective understanding of how AI-driven technologies can enhance education in the digital age. In conclusion, our development efforts have led to the creation of the "Source of Truth" (SoT) feature, which was absent in the previous version of the plugin. Our overarching plan is to continue advancing and refining the entire module, with the goal of providing valuable support to both students and educators within the Moodle platform. However, it's essential to acknowledge that further comprehensive testing, especially with student involvement, is imperative to assess the functionality's real-world viability thoroughly. Given the relatively novel nature of our topic, an extended testing period of several months will likely be required to identify potential challenges and areas for improvement. It is conceivable that students may attempt to misuse the module. Nevertheless, it's worth noting that such misuse is also possible on the ChatGPT website itself, where this version of the "Source of Truth" feature is not available. In essence, our work represents a significant step towards enhancing the educational experience within Moodle through the implementation of innovative features like SoT, although ongoing refinement and vigilant testing remain essential for its successful integration. In summary, the integration of Chat GPT into Moodle presents numerous advantages. Yet, to fully realize its potential within the Moodle LMS, we must actively address the associated challenges, including data privacy, ethical use, accuracy, customization, user acceptance, and ongoing maintenance. All in all, ChatGPT signifies the future, a future guided by AI. Its utility, including its role as a translator surpassing conventional tools like Google Translate, marks a substantial advancement. So, ChatGPT's potential reaches far beyond these capabilities. In conclusion, the strides we are witnessing represent a substantial leap forward for humanity.

6. Acknowledgements

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