Bloom Quest - Personalized Learning System Based on Knowledge Graphs and Bloom’s Taxonomy.

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Proposal Document

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Declaration

I declare that this is my own work, and this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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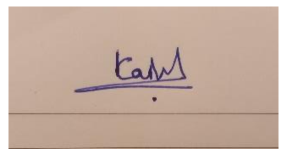
Colambage K.G	IT20126438	

Statement of the supervisor,

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

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Abstract

A self-learning system is a type of machine learning system that can automatically improve its performance by learning from its own experiences and feedback. Unlike traditional software programs that are programmed by human developers, self-learning systems can adapt to new data and changing environments without requiring explicit programming. Self-learning systems use algorithms that enable them to automatically learn from data, identify patterns, and make predictions or decisions based on that learning. They can also adjust their own algorithms and parameters based on feedback, allowing them to continuously improve their accuracy and performance over time. Examples of self-learning systems include self-driving cars, recommendation systems used by online retailers, and speech recognition systems used by virtual assistants like Siri and Alexa.

It is crucial to create balanced and high-quality exams to undergraduates that caters to various cognitive levels. As a result, lecturers rely on Bloom's Taxonomy cognitive domain, a popular framework developed to assess students' intellectual abilities and skills. Despite its widespread use, many students are not aware of Bloom's Taxonomy and how it affects their learning experience. This lack of understanding can lead to students missing important opportunities for growth and development in their academic pursuits. This project is based on a personalized self-learning system that helps students to understand and apply Bloom's Taxonomy in their own learning process. And by personalizing the system according to the student may help them learn from the type and level of the content they seem to fit in. The novelty of this project is this use the students personal learning material and provide several methods for students to do the self-learning according to the Bloom’s Taxonomy. The system takes a student’s study material then constructs a knowledge graph by extracting named entities and relations between the entities from material. The final output of the above project will be a fully-fledge Web application that provide personalized self-learning system based on Bloom’s Taxonomy for the users. In this proposal, the implementation of sub objective, “Generate set of set of questions and answers using knowledge graph and categorize them according to bloom’s taxonomy” is discussed. How the improve knowledge and learning QA system and given the answers in time duration ,study level discussed here in this document.

Keywords: Natural Language Processing (NLP) Question Generation, Answer Generation, Bloom's Taxonomy, Knowledge graph, Categorization

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List of Abbreviations

Abbreviation	**Description**
IEEE	**Institute of Electrical and Electronics Engineers**
CNN	**Convolutional Neural Network**
SVM	**Support Vector Machine**
DNN	**Deep Neural Network**
BLSTM	**Bidirectional Long, Short Term Memory**
ELM	**Extreme Learning Machine**
LLD	**Low-Level Descriptors**

1.Introduction

The research component "Generate a set of questions and answers using knowledge graph and categorize them according to bloom's taxonomy" aims to develop a system that generates questions and answers based on a given knowledge graph and categorizes them according to Bloom's taxonomy. Bloom's taxonomy is a classification system used to define and distinguish different levels of learning and understanding. The proposed system will be useful for educational purposes, such as generating assessment questions for students, and for other knowledge-based systems that require question generation. A knowledge graph is a type of database that represents information as a network of entities and their relationships.

The system will use natural language processing (NLP) techniques and machine learning algorithms to analyze the knowledge graph and generate questions and answers that match the taxonomy level selected by the user. The system will also provide feedback on the quality of the generated questions and answers, based on various metrics such as relevance, accuracy, and complexity. queries into structured queries that can be executed against the knowledge graph. These structured queries can then be used to extract relevant information from the knowledge graph and generate accurate and relevant answers to user queries.

The research component aims to contribute to the field of educational technology and natural language processing by providing a novel approach to question generation and categorization. By using a knowledge graph and Bloom's taxonomy, the system will provide a more targeted and efficient approach to question generation, allowing educators and other knowledge-based systems to generate high-quality assessment questions that match the level of understanding of their students or users.

For example, if a user asks a question such as "Who is the CEO of Microsoft?", an NLP algorithm could analyze the question and generate a structured query that extracts the CEO entity from the Microsoft entity in the knowledge graph. The answer to the question could then be generated by applying a response generation algorithm to the extracted information.

Generating a set of questions and answers using a knowledge graph can be useful in a variety of contexts, such as customer support, e-commerce, and education. It can help users quickly and accurately retrieve information and can save time and resources for organizations by automating the process of answering frequently asked questions.

Bloom's Taxonomy is a framework for categorizing different types of learning objectives, which was first proposed by educational psychologist Benjamin Bloom in 1956. The taxonomy is often used by educators to help plan and develop lesson plans, assessments, and curricula.

The original version of the taxonomy identified six levels of cognitive complexity, arranged in a hierarchical order from lower-order thinking skills to higher-order thinking skills. These six levels are:

Knowledge - This level involves the recall of information, such as facts, terms, and concepts.

Comprehension - This level involves the understanding of the meaning of the information, including the ability to summarize, explain, and restate it in one's own words.

Application - This level involves using the information in a new situation, such as solving a problem or applying a concept to a different context.

Analysis - This level involves breaking down the information into parts and understanding the relationships between those parts.

Synthesis - This level involves creating something new from the information, such as designing a solution or developing an original idea.

Evaluation - This level involves making judgments about the value or quality of the information, such as critiquing an argument or evaluating the effectiveness of a solution.

In recent years, a revised version of Bloom's Taxonomy has been developed, which includes different action verbs that better describe the different levels of cognitive complexity.

This chart(figure1.1) depicts the results of a survey that was conducted among 31 people and these are the results that were obtained, and it clearly shows that most of university exam papers are made based on the Bloom’s Taxonomy.

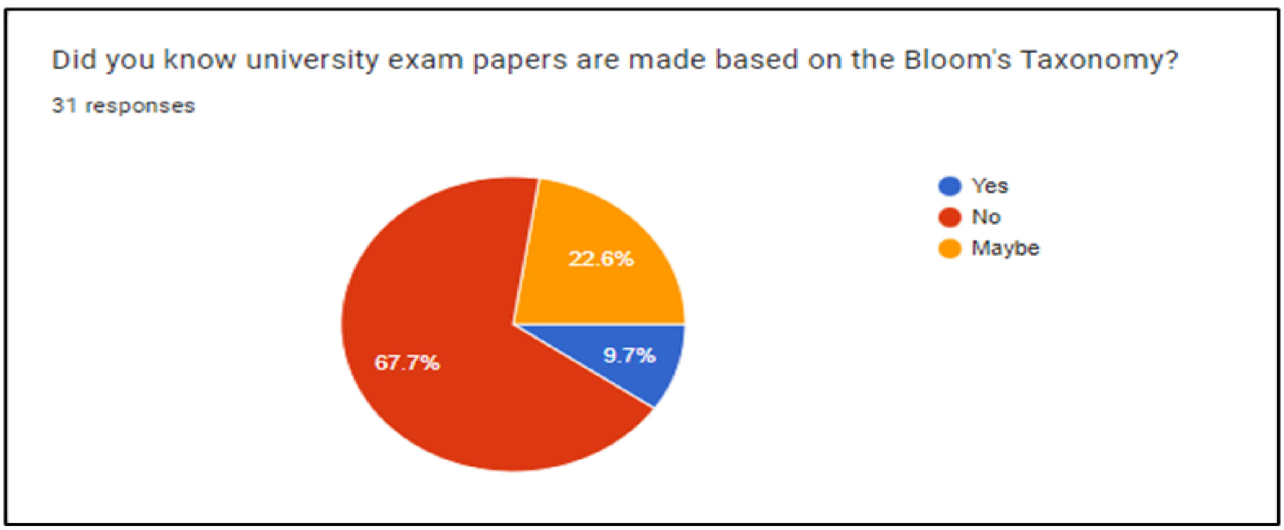

Figure 1.1 – User Preference Chart

And also, in the questioner the, the question of what university exam papers are made based on the Bloom’s Taxonomy below chart (Figure 1.2) illustrates the user needs in a music player.

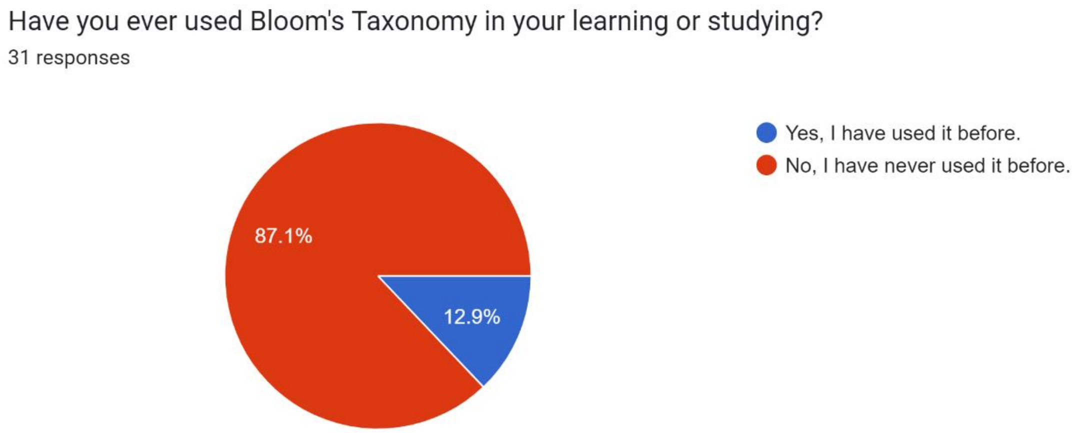

Figure 1.2 – User preferences on the features

Thus, we have taken these requirements in to consideration when designing the proposed solution with the sole intention of providing a new and modern user experience.

1.1 Background and Literature Review

In a research done by how question difficulty can be estimated in the context of community question ananswering services. There the Research in the DB and Semantic Web communities has investigated how structured queries formulated in SQL [3] or SPARQL [1] can be paraphrased in natural language processing use and generate questions and answers.

Another study was conducted by The knowledge graph database is queried by this system using Cypher, the query language of the Neo4j graphical database [2]. Initially, the Cypher statement is generated based on the entity name, entity category, and relationship name. After that, the knowledge graph database is queried using SQL syntax, and ultimately, the response to the inquiry and the associated knowledge network diagram are returned. They employed collaborative filtering in this study and got good outcomes.

Another study focused on this topic was quite successful. Starting with a collection of temporal reasoning templates, the QA dataset was generated. These were created using the five most frequent relationships from our Wiki Data subset, namely Temporal KGQA (QA over Temporal KGs), a field that has not been well studied. Another obstacle to success in this field has been the lack of datasets with extensive coverage. They offer a dataset that includes a Temporal KG with 125k things and 328k facts, as well as 410k queries in natural language that call need temporal reasoning. [3]

This research has propose an approach to generate natural language questions from knowledge graphs such as DBpedia and YAGO. We stage this in the setting of a quiz game. Our approach, though, is general enough to be applicable in other settings. Given a topic of interest (e.g., Soccer) and a difficulty (e.g., hard), our approach selects a query answer, generates a SPARQL query having the answer as its sole result,[4] before verbalizing the question.

A research which was done Frameworks and libraries often have APIs that provide similar functionalities, but have subtle differences. For example, java.lang.StringBuffer and java.lang.StringBuilder can be used for string construction, but StringBuffer is thread-safe while StringBuilder is not. Overlooking such subtle differences between similar APIs may result in program errors, e.g., using java.lang.StringBuilder in a multithread context. Therefore, developers are often concerned with the comparison of similar APIs. In fact, API comparison questions are common on SO (Stack Overflow). For example, as of March 3, 2019, 13,228 questions tagged with “java” have either the strings “difference between” or “vs” in their title. Among these questions, 38% (5,075 of 13,228) questions do not have an accepted answer. API documentation is an important source of knowledge for software developers, leading to a substantial body of work on API documentation. Shi et al. [5] conducted a quantitative study of API documentation evolution and found that it undergoes frequent evolution. Monperrus et al.

presented a study on directives in API documentation and a taxonomy of 23 kinds of API directives. Maalej and Robillard reported on a study of knowledge patterns in API documentation, such as functionality, concepts, and directives. They found that most API comparison questions could be answered with knowledge from the API reference documentation.

This research have done Machine learning (ML) is a branch of artificial intelligence focused on algorithms capable of learning relationships in the training data and use this experience to generalise and perform a specific task on unseen data. The performance of the algorithm at the given task improves with the increase of experience. Thus, more training data leads to better learned models and improved performance. ML is relevant to QA systems because it is used in most Natural Language Processing tasks and re-ranking. Natural Language Processing (NLP) is a multidisciplinary research area in the field of computer science, Machine Learning and linguistics. It concerns the process of automatically parsing text (syntactically and/or semantically) with the aim of extracting, analysing and understanding the information it contains and generating new information also in the text format. The analysis performed on the text has different stages of complexity, e.g. basic processes are: tokenisation, lemmatisation, morphological, syntactic and semantic analysis. Early work in NLP widely used rulebased methods, whereas nowadays Machine-Learning algorithms are applied for training linguistic models from data. The data typically contains examples of correct versus incorrect output of the NLP function that the Machine-Learning algorithms are supposed to replicate on unseen data. The NLP includes different tasks; some of them are Tokenisation, Sentence Boundary Disambiguation, Named Entity Recognition, Part-of-speech Tagging, Chunking, Parsing, Relation Extraction, Semantic Role Labelling and Co-reference Resolution. These tasks are carried out as preliminary steps in the design of applications dealing with a natural language, including QA systems. The rest of this subsection will give a brief introduction of the two main steps in realising a QA system, i.e. the NLP and the Ranking.[6]

This research done by Question answering is an indispensable link in high school teaching. Through question answering, on the one hand, it can solve students' learning doubts, on the other hand, it can provide teachers with teaching feedback. However, through the investigation and research, it is found that with the expansion of student size, the effect of question answering in high school is not satisfactory. This paper analyzes the current situation of question answering in high school, and designs an intelligent question answering system for high school teaching based on constructivism learning theory and cognitive structure learning theory.[7] The system, which is the first innovative application in the field of high school teaching, integrates knowledge graph technology and intelligent question answering technology, introduces big data technology. It can solve students' questions in time and accurately, link the knowledge points related to the questions to help students construct knowledge network graph, and the big data technology is used to analyze the students' questioning behavior and to predict students' learning behavior in order to feedback the teaching effect.

Question answering (QA) has been a long-standing research issue in machine learning and artificial intelligence, according to this study. Large-scale knowledge graphs have been developed, such as DBPedia (Auer et al. 2007) and Freebase (Bollacker et al. 2008), that have given QA systems access to well-organized knowledge on particular and open subjects. Many conventional methods for KG-powered QA are based on semantic parsers (Clarke et al. 2010; Liang, Jordan, and Klein 2011; Berant et al. 2013; Yih et al. 2015), which first translate a question to a KG query and map it to a formal meaning representation (for example, logical form). Executing the query will return the response to the query. These methods have some drawbacks, including the fact that the model.

1.2 Research Gap

Research gap in the context of generating a set of questions and answers using knowledge graph refers to the area where more research is needed or where the existing research has not fully explored. In other words, research gap is a knowledge gap or a gap in the understanding of a particular topic that can be identified through the analysis of the relationships between entities in a knowledge graph.

When generating questions and answers using knowledge graph, researchers may use the relationships between entities to identify areas where there are fewer connections or where connections are weaker. By doing so, they can identify the research gaps and generate questions related to these areas.

For instance, if the knowledge graph is related to the field of healthcare, and the researchers analyze the relationships between different entities such as medical conditions, symptoms, and treatments, they may identify areas where there are fewer relationships or where relationships are weak. This can indicate a research gap in that area, suggesting the need for further investigation to improve our understanding of that aspect of healthcare.

The research gap is essential in generating questions and answers using knowledge graph as it provides a clear direction for the research project. Researchers can use the identified research gap to focus their research and develop specific research questions that aim to address the knowledge gap. By filling the research gap, researchers can contribute to the advancement of the field of study and improve our understanding of the topic at hand.

In summary, research gap in generating questions and answers using knowledge graph refers to the gap in knowledge or understanding of a particular topic that can be identified through the analysis of relationships between entities in a knowledge graph. It is important as it helps guide the research project and directs researchers towards the areas that require further investigation.

One approach is to natural language processing (NLP) techniques to automatically generate questions based on the relationships between entities in the knowledge graph. Another approach is to use rule-based or machine learning algorithms to identify patterns in the data and generate questions based on those patterns.

A question answering system can be built by using the relationships between entities in the knowledge graph to generate candidate answers to a given question. The system can then use various techniques to rank the candidate answers and select the most likely answer based on the context of the question and other relevant information in the knowledge graph.

While there are tools and techniques available for generating questions and answers from text or structured data, and for categorizing them according to Bloom's taxonomy, there may be limited research or tools that combine these approaches with knowledge graphs..

Research Gap Cont'd

Feature	Paper [1]	Paper [2]	Paper [3]	Paper [4]	Proposed Research Project
Each question categorize bloom's taxonomy level	✘	✘	✘	✘	✓
Self-study help system.	✘	✘	✘	✓	✓
Question and Answer Generation	✘	✘	✘	✘	✓
Automated using knowledge graph and using (NLP)	✘	✘	✓	✘	✓
Using the Knowledge graph	✘	✘	✓	✘	✓

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Table 1.1 – Comparison of the Functions in proposed solution

Below table (Table 1.1) clearly specifies the Novelty of the proposed solution among the researches that were reviewed in the background and literature review.

1.3 Research Problem

Research problem in the context of generating a set of questions and answers using knowledge graph refers to the specific issue or challenge that researchers aim to address through their research project. It is a more focused and specific version of the research gap, and it provides a clear objective for the research project.

The research problem is typically informed by the research gap identified through the analysis of relationships between entities in the knowledge graph. Researchers may identify a research gap in a particular area and formulate a research problem that seeks to address that gap.

For example, if the knowledge graph is related to the field of finance, and the researchers identify a research gap in the area of credit risk assessment, they may formulate a research problem that seeks to develop a more accurate credit risk assessment model using the relationships between entities in the knowledge graph.

Difficulty in designing assessments that measure higher-order thinking skills: Traditional assessments often focus on testing students' knowledge of factual information, rather than their ability to apply, analyze, evaluate, or create new knowledge. By categorizing the questions and answers generated using Bloom's Taxonomy, this research component can help design assessments that measure higher-order thinking skills, which are essential for success in higher education and the workplace.

The research problem is an essential aspect of generating questions and answers using knowledge graph because it guides the formulation of research questions and the development of the research methodology. It also provides a clear objective for the research project, enabling researchers to focus their efforts and resources on a specific issue or challenge.

Limited availability of high-quality educational resources Students in many areas may not have access to high-quality educational resources due to limited funding, inadequate infrastructure, or other factors. By generating a set of questions and answers using a knowledge graph and categorizing them according to Bloom's Taxonomy, this research component can help provide students with access to a wider range of high-quality educational resources that can improve their learning outcomes.

In summary, research problem in generating questions and answers using knowledge graph refers to the specific issue or challenge that researchers aim to address through their research project. It is typically informed by the research gap identified through the analysis of relationships between entities in the knowledge graph, and it guides the formulation of research questions and the development of the research methodology.

The chart (Figure1.3) demonstrate the need of the feature of how familiar with bloom’s taxonomy

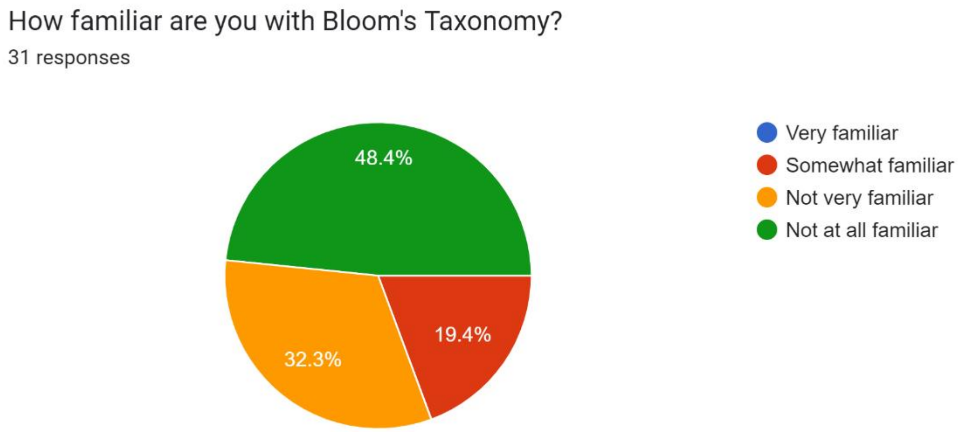

Figure 1.3 – User’s view on the feature of how familiar with bloom’s taxonomy

2. Objective

Main objective of this project is to develop a personalized self-learning system to help undergraduate students understand their current level in terms of Bloom's Taxonomy to work efficiently and effectively by utilizing student materials and building a knowledge graph that integrates information on the students' learning progress and performance.

- The main objective of a project is the overarching goal that the project aims to achieve. It represents the desired outcome or end result of the project. The main objective provides a clear direction and focus for the project team and stakeholders to work towards.

- When generating questions and answers using a knowledge graph and categorizing them according to Bloom's Taxonomy, here are some examples of how the main objective can be addressed

2.1 Specific Objectives

1. The main goal of this feature is to identify the user can have self learning and aim To develop a knowledge graph that includes relevant concepts and relationships for a given topic[1].

   - To use the knowledge graph to generate a set of self-study questions and answers.
   - Develop an algorithm to generate questions and answers from the knowledge graph
   - To categorize the self-study questions and answers according to Bloom's Taxonomy.
   - To generate a set of questions and answers that cover different levels of Bloom's Taxonomy.
   - Categorize the questions and answers according to the identified Bloom's Taxonomy levels.
   - To continuously improve the knowledge graph and the system based on user feedback.

2.2 Functional Requirements and Non-Functional Requirements

Functional Requirements:

Specific characteristics or functionalities that a software system must have in order to satisfy the needs of its users are known as functional requirements. These specifications outline what the software must achieve, and are concerned with the specific tasks that the software must perform. Functional requirements are typically documented in a requirements document or specification, and are validated through various testing methods.

Examples of functional requirements may include:

• Build knowledge graph: Your component must accept an Build knowledge graph that contains structured data that can be used to generate questions and answers.

• Question generation algorithm: Your component must have a question generation algorithm that can automatically generate questions based on the input knowledge graph.

• Answer generation algorithm: Your component must have an answer generation algorithm that can automatically generate answers based on the input knowledge graph.

• Bloom's taxonomy categorization: Your component must be able to categorize the generated questions according to the levels of Bloom's taxonomy.

• User interface: Your component should have a user interface to allow users to input the knowledge graph and interact with the generated questions and answers.

• Scalability: Your component should be able to handle large knowledge graphs and generate a large number of questions and answers in a reasonable amount of time.

Non-Functional Requirements:

For a software system to be regarded suitable for usage, it must meet certain non-functional requirements. These specifications detail the software's performance and expected behavior under various conditions. Non-functional requirements are focused on the software's quality characteristics, including its performance, dependability, and security.

Examples of non-functional requirements may include:

1. Performance and Scalability

- How quickly can the knowledge graph retrieve relevant information based on the query
- Can the system handle an increasing number of queries and users without sacrificing performance

2. Usability

- Are the answers generated by the system easy to read and understand
- Does the system provide helpful feedback to users if they make a mistake or if the system cannot provide an answer

3. Portability and Compatibility

- How easy is it to move the system from one platform or environment to another (e.g., from a local server to a cloud-based service)
- Is the system compatible with different types of data sources and formats

4. Availability and Maintainability

- How easy is it to maintain and update the system
- Are there any single points of failure that could impact the availability of the system

Both functional and non-functional requirements are critical to the success of a software development project. Functional requirements ensure that the software meets the needs of its users, while non-functional requirements ensure that the software is of high quality and performs well. It is important to identify, document, and validate both types of requirements throughout the software development process.

3. **Methodology**

3.1 System Design

To achieve the main objective some sub-objectives are introduced.

a. User interface: The user interface will allow users to input their domain-specific knowledge and generate questions and answers based on that knowledge. The interface may include features such as search bars, dropdown menus, and text boxes to allow users to input their knowledge in a structured way.

b. Building the knowledge graph: This involves creating a knowledge graph that represents the relationships between entities and concepts in the data. This can be done using various techniques such as semantic web technology, machine learning, and natural language processing.

c. Natural language processing engine: The natural language processing engine will be responsible for analyzing the knowledge graph and generating questions and answers based on that analysis. The engine may use techniques such as semantic analysis, syntactic analysis, and machine learning to generate questions and answers that are relevant and accurate.

d. Bloom's Taxonomy categorization module: Bloom's Taxonomy is a framework for categorizing educational goals and objectives based on the cognitive processes involved. To categorize the questions and answers generated using the knowledge graph, you will need to define the Bloom's Taxonomy categories that are relevant to the domain and map the questions and answers to those categories.

e. Generating questions and answers**:** Once you have built the knowledge graph and defined the Bloom's Taxonomy categories, you can use natural language processing techniques to generate questions and answers based on the relationships between the concepts in the knowledge graph. The questions and answers should be designed to test students' understanding of the key concepts and their ability to apply, analyze, evaluate, or create new knowledge.

f. Testing and validation: The generated questions and answers will be tested and validated to ensure that they are accurate, relevant, and appropriate for the intended audience and purpose. This may involve manual review by subject matter experts or automated testing using machine learning techniques.

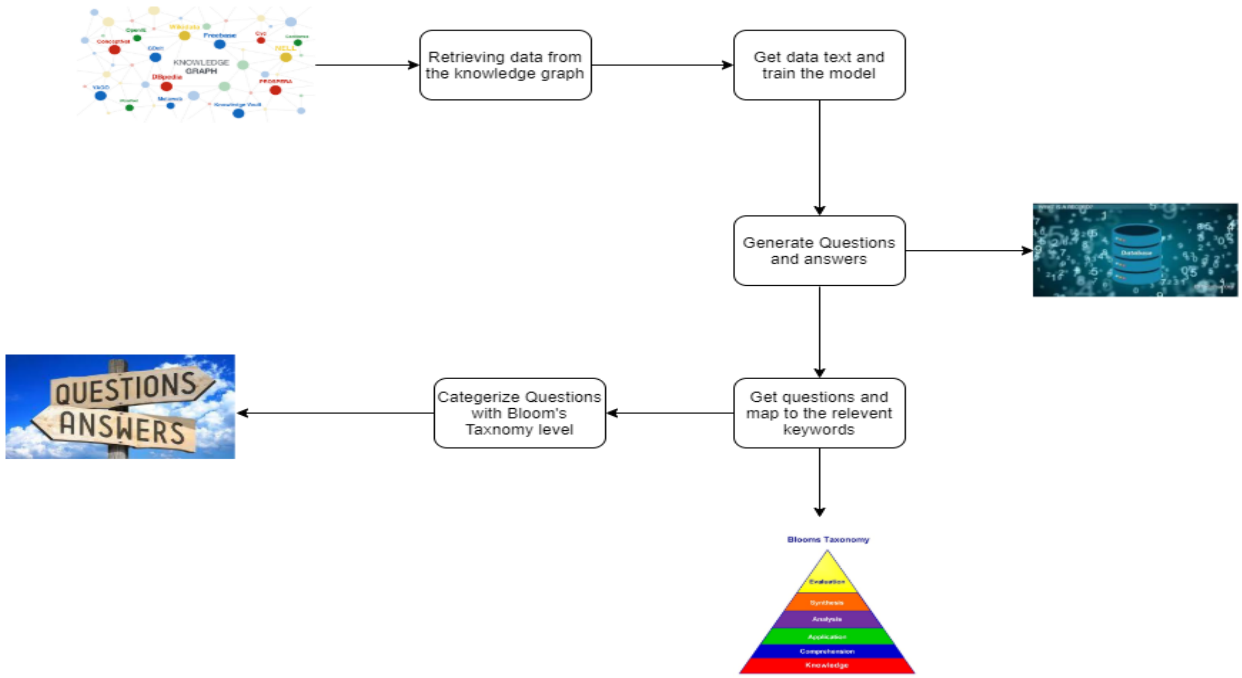

Figure 3.1 System Diagram

3.2. System Implementation

System implementation is the process of building, testing, and deploying the software system designed for my research component. The implementation phase typically involves the following steps:

- Building the software**:** During this step, the software system is built based on the system design. The developers will write code for each of the software components, including the user interface, knowledge graph database, natural language processing engine, Bloom's Taxonomy categorization module, and output module.
- Testing the software: After the software is built, it must be thoroughly tested to ensure that it is functioning correctly. This may involve unit testing, integration testing, system testing, and acceptance testing. Testing is an iterative process that involves identifying and fixing defects until the software meets the desired quality standards.
- Deploying the software: Once the software has been tested and approved, it can be deployed to the production environment. This may involve installing the software on servers, configuring the software for the target environment, and ensuring that the software is running smoothly.
- Maintenance and support: After the software is deployed, it must be maintained and supported to ensure that it continues to function correctly. This may involve performing updates, fixing bugs, and providing user support.

The system implementation phase is critical in ensuring that the software system works as intended and meets the requirements specified in the system design phase. It is important to follow best practices for software development and testing during this phase to ensure that the system is reliable, scalable, and maintainable.

3.3. Testing Plan

A testing plan is a report that describes the strategy, goals, scope, and resources needed to test a software system. The testing plan for this research component, which aims to generate a set of questions and answers using knowledge graph and categorize them according to Bloom's Taxonomy, should include the following:

- Testing objectives**:** This section should outline the goals of testing, such as ensuring that the system meets the requirements specified in the system design, verifying that the system generates accurate questions and answers, and verifying that the system correctly categorizes the questions according to Bloom's Taxonomy.
- Testing scope: This section should specify the areas of the system that will be tested, such as the user interface, knowledge graph database, natural language processing engine, Bloom's Taxonomy categorization module, and output module.
- Testing approach: This section should describe the testing approach that will be used, such as unit testing, integration testing, system testing, and acceptance testing. It should also specify the testing tools that will be used, such as automated testing frameworks or manual testing scripts.
- Test cases: This section should list the specific test cases that will be executed during testing, including inputs, expected outputs, and test data.
- Testing environment: This section should specify the hardware, software, and network configurations that will be used for testing, including any dependencies or constraints that may impact testing.
- Test data: This section should describe the test data that will be used for testing, including any sample questions and answers, knowledge graph data, and Bloom's Taxonomy categorization examples.
- Test schedule**:** This section should specify the testing timeline, including the start and end dates for each testing phase and any dependencies or constraints that may impact testing.

In the context of a knowledge graph-based question answering system, system testing could involve testing the system's ability to correctly identify and extract relevant entities and relationships, generate accurate and relevant answers to user queries, and handle different types of input scenarios and user traffic.

Test Case ID	Testing objective	Test case description	Example Input test data	Expected Outcome
1	Accuracy	Verify that the system generates accurate questions and answers	Topic: "The American Civil War" Question: "What was the main cause of the Civil War?"	System generates an accurate answer to the question based on the knowledge graph data
2	Categorization	Verify that the system correctly categorizes applying Bloom's Taxonomy, queries	Question: "Explain the significance of the Emancipation Proclamation"	System correctly categorizes the question as "analysis" or "evaluation" based on the level of cognitive complexity required
3	Usability	Verify that the system is user-friendly and easy to use	Topic: "World War II" User inputs a new question	System generates a response to the user's question and displays it in an easy-to-read format
4	Robustness	Verify that the system can handle unexpected inputs	Topic: "The French Revolution" Question: "What is the capital of France?	System generates an appropriate error message indicating that the question is not relevant to the topic
5	Performance	Verify that the system can handle large volumes of data	Topic: "The Human Body" Question: "List the bones in the human body"	System generates a response to the question in a reasonable amount of time, even with a large amount of data to process

3.4. Work Breakdown Structure

Figure 3.4 – Work Breakdown Structure

3.5. Overall System Diagram

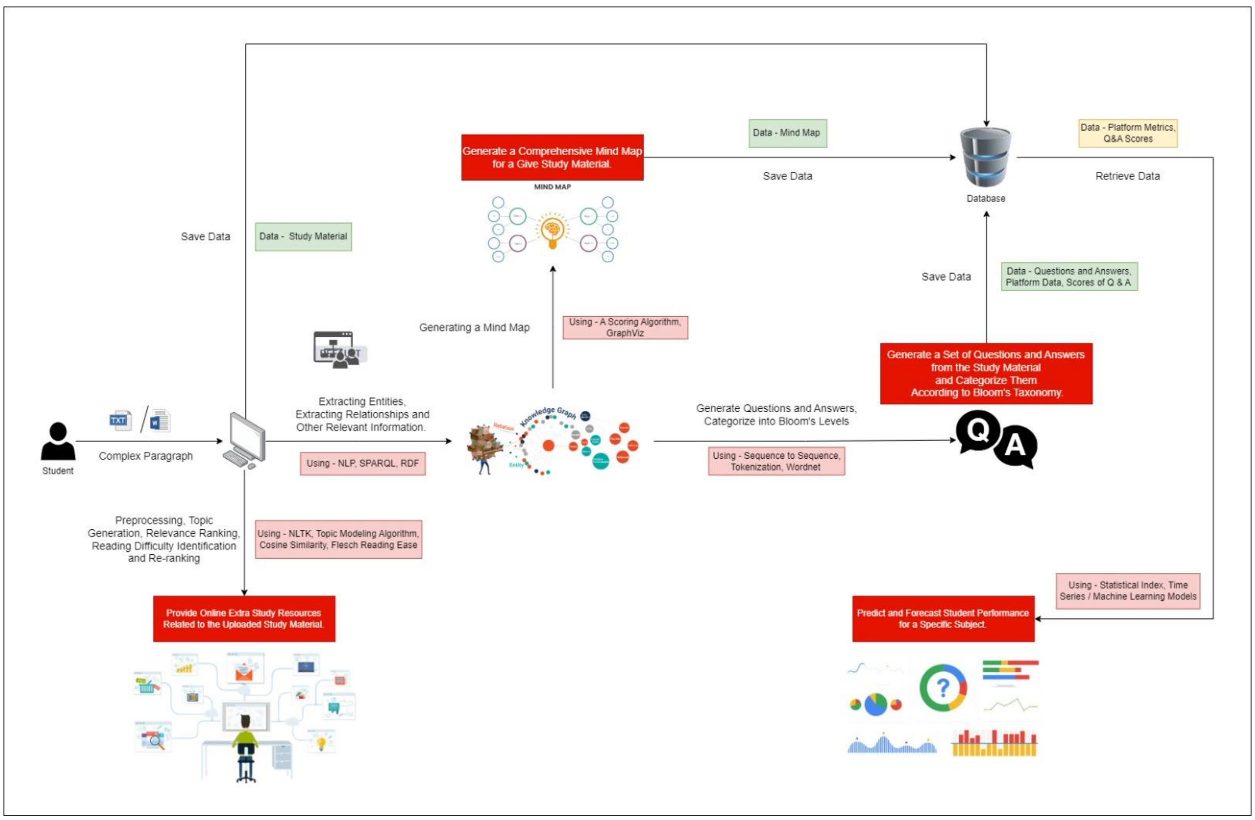

Figure 3.5 – Overall System Diagram

4.Description of Functionalities

- Knowledge Graph Creation: This functionality involves creating a knowledge graph that represents the relationships between different concepts related to the research topic. This knowledge graph can be based on existing literature, data sets or other sources of information.
- Question Generation: This functionality involves using the knowledge graph to generate a set of questions related to the research topic. The questions can be designed to target several Bloom's Taxonomy levels, include remembering, understanding, applying, analyzing, evaluating, or creating.
- Answer Generation: This functionality involves using the knowledge graph to create a set of possible answers for each question created in the preceding phase.. The answers can be based on existing knowledge or data, or they can be generated using machine learning or other techniques.
- Bloom's Taxonomy Categorization: This functionality involves categorizing the questions and answers generated in the previous steps according to Bloom's Taxonomy. This can help ensure that the questions target different levels of cognitive complexity and can be used to design assessments that measure different types of learning outcomes.
- User Interface: This functionality involves designing a user interface that allows users to interact with the knowledge graph, view the generated questions and answers, and categorize them according to Bloom's Taxonomy. The user interface can be designed to be intuitive and user-friendly, and can be customized to meet the specific needs of different users, such as teachers, students, or researchers.

5. Commercialization

Commercialization refers to the process of bringing a product or service to market and making it available to the public for purchase or use. In the context of research, commercialization involves taking a research project and turning it into a viable product or service that can be sold or licensed for commercial purposes.

The goal of commercialization is to create a sustainable business model around the research project and to generate revenue for the researchers or the organization behind the research. This can involve securing intellectual property rights, developing a marketing strategy, identifying potential customers, and establishing partnerships with other organizations or investors.

The proposed component has a lot of potential to be commercially successful. It can bring many benefits to its users, the individual learners and how to answering questions. With the help of this component, students can monitor their development and pinpoint their areas for growth

The Generate a set of questions and answers using knowledge graph and categorize them according to bloom's taxonomy system described above potential for Student can improve the knowledge for bloom's taxonomy level and face the bloom's taxonomy questions. By get the it once the knowledge graph has been constructed it can be querying to retrieve data relevant to the text. Create a set of questions to train the NLP model to identify and predicate questions Categorize questions with bloom's taxonomy level .

students can also help design and implement tests to evaluate the effectiveness of the system in generating questions and answers according to Bloom's Taxonomy. Students can help with collecting data from various sources, such as online databases, academic journals, and other relevant sources to help build a knowledge graph. Then can be provided access to resources such as books, research papers, and online courses related to knowledge graph, Bloom's taxonomy, and system design and implementation.

6. Gantt chart

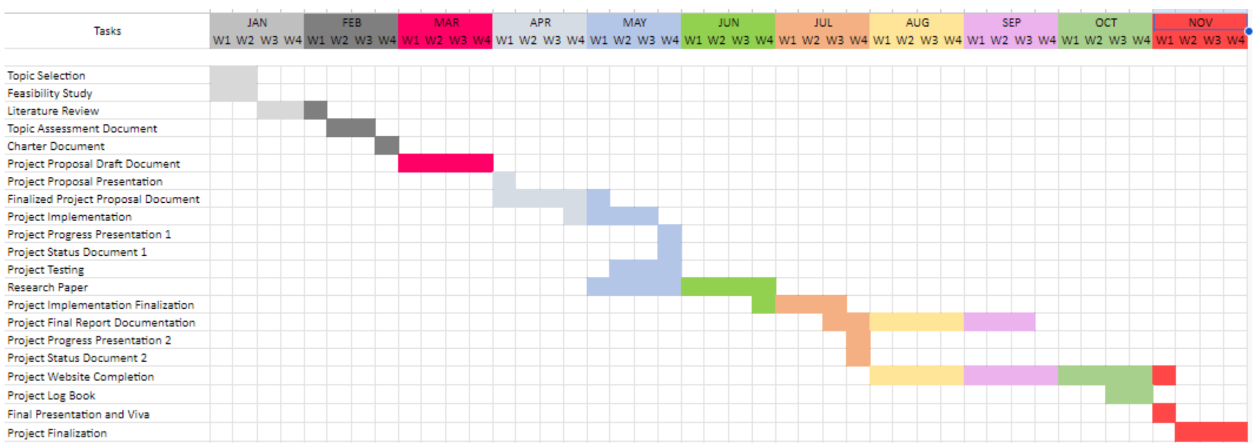

Figure 6.1 – Gantt Chart

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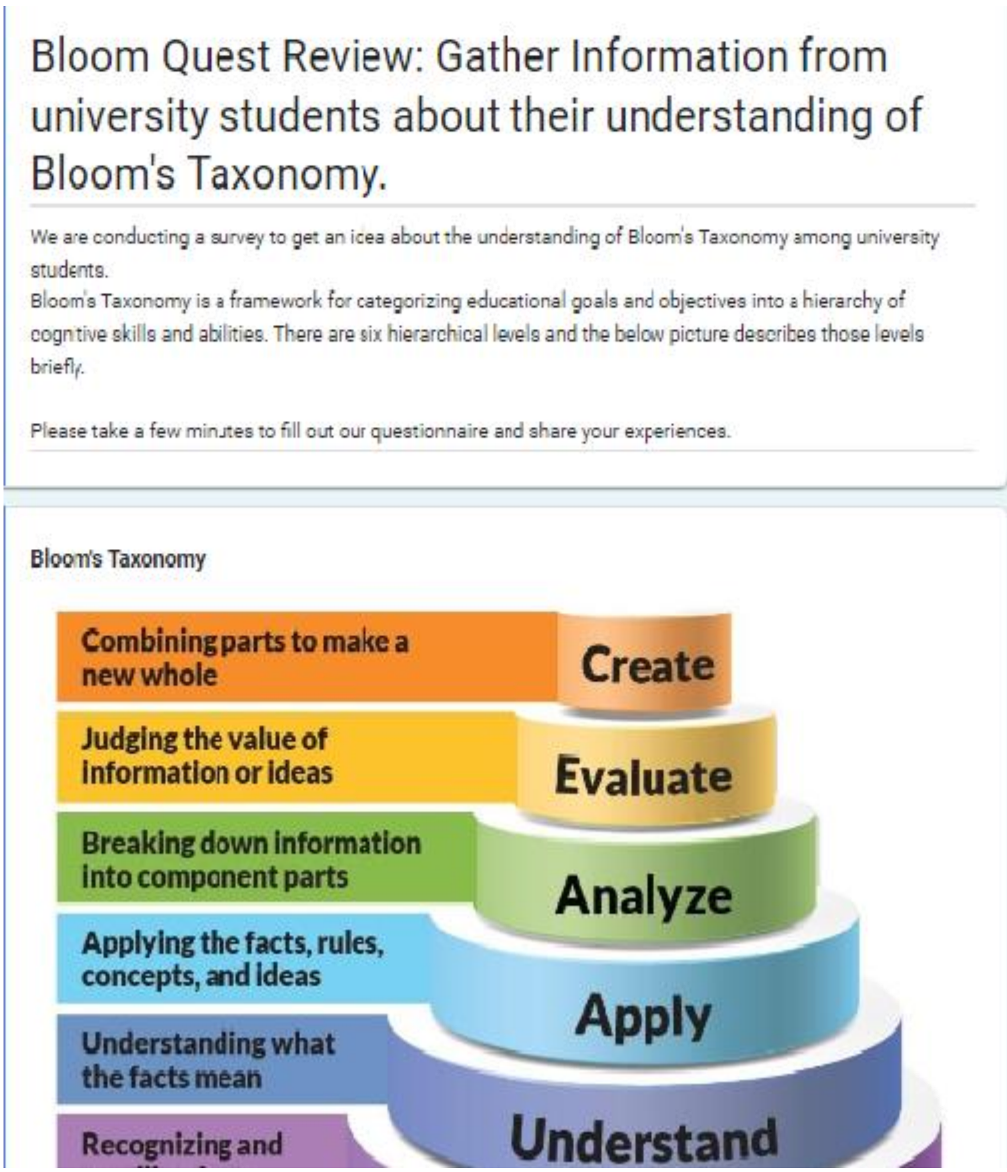
8.Appendix

8.1. Questionnaire

A survey was done by the research team to get an idea about the topic from the society, this survey was distributed among the university students and altogether 31 responses were captured. Figure 1.1, Figure 1.2, Figure 2.1, Figure 3.1, Figure 3.2, Figure 3.3 are the visualizations of the data collected from the survey.

Link - https://docs.google.com/forms/d/1uCgJ9DMHr5di2jCOG-aXPNKez1TMK42TeIS1PuK4gNs/edit?ts=644d463e#responses

Below are the screenshots of the questions asked,



Bloom Quest Review: Gather Information from university students about their understanding of Bloom's Taxonomy.

We are conducting a survey to get an idea about the understanding of Bloom's Taxonomy among university students.
Bloom's Taxonomy is a framework for categorizing educational goals and objectives into a hierarchy of cognitive skills and abilities. There are six hierarchical levels and the below picture describes those levels briefly.

Please take a few minutes to fill out our questionnaire and share your experiences.

Bloom's Taxonomy

How familiar are you with Bloom's Taxonomy? *

- ◯ Very familiar
- ◯ Somewhat familiar
- ◯ Not very familiar
- ◯ Not at all familiar

Did you know university exam papers are made based on the Bloom's Taxonomy? *

- ◯ Yes
- ◯ No
- ◯ Maybe

Have you ever used Bloom's Taxonomy in your learning or studying? *

- ◯ Yes, I have used it before.
- ◯ No, I have never used it before.

How often do your teachers use Bloom's Taxonomy in their lessons or assessments? *

- ◯ Very often
- ◯ Somewhat often

Do you engage in self-studying to learn university modules outside of the formal academic setting? *

- Yes, I frequently engage in self-studying.
- Yes, but only occasionally.
- No, I don't engage in self-studying.

How do you evaluate the effectiveness of your self-studying? *

- Taking practice tests.
- Self-assessment of understanding.
- Asking for feedback from others.
- Other...

Have you noticed any improvements in your work or personal life as a result of self-studying? *

- Yes, I have
- No, I have not
- Maybe

Are you able to create comprehensive mind map by your own? *

- Yes
- No
- Maybe

How frequently do you use mind maps while studying? *

- Often
- Sometimes
- Rarely
- Never

How satisfied are you with the mind map generation system you currently use, if applicable?

- Very satisfied
- Somewhat satisfied
- Neutral
- Somewhat dissatisfied
- Very dissatisfied

How often do you use online resource recommendation system when you are doing self studying? *

- Often
- Sometimes
- Rarely
- Never

Have you ever encountered any issues with the accuracy or relevance of the online resources recommended to you? *

- Yes
- No

Would you like to have a high-quality online resource recommendation system? *

- Yes, Very Much
- Maybe
- No, Not Much

Do you think it is very helpful if there is a self learning system that generate questions and answers, generate comprehensive mind maps, suggest online extra study materials and, track and forecast performance according to each level of Bloom's Taxonomy? *

- Yes, Very helpful.
- No, I am not interested about that.
- I am not sure.

Responeses,

31 responses

Link to Sheets

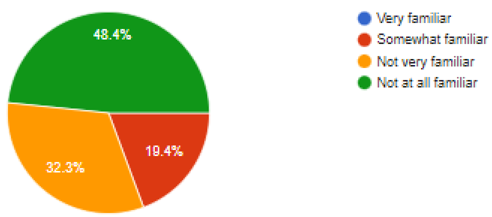
Accepting responses

Summary | Question | Individual

How familiar are you with Bloom's Taxonomy?

Copy

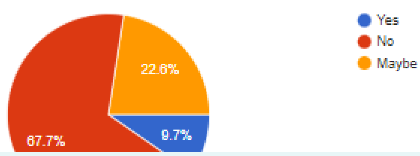
31 responses



Did you know university exam papers are made based on the Bloom's Taxonomy?

Copy

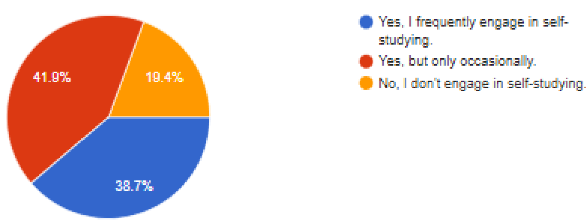
31 responses



Do you engage in self-studying to learn university modules outside of the formal academic setting?

Copy

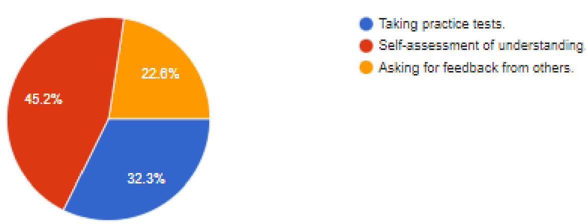
31 responses



How do you evaluate the effectiveness of your self-studying?

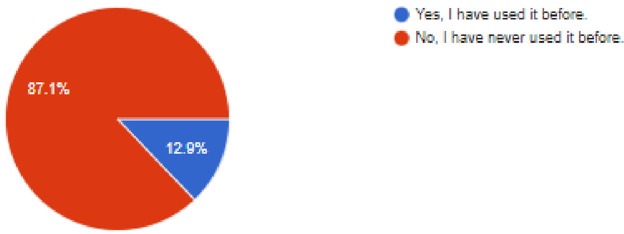
Copy

31 responses



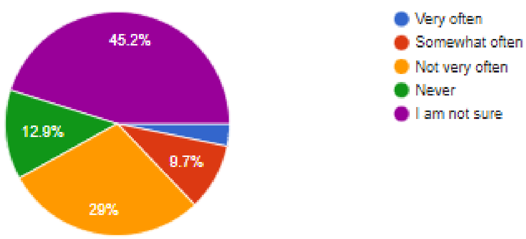
Have you ever used Bloom's Taxonomy in your learning or studying? Copy

31 responses



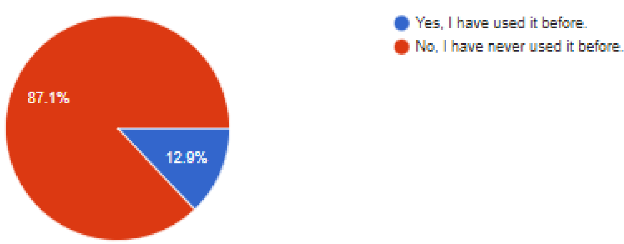
How often do your teachers use Bloom's Taxonomy in their lessons or assessments? Copy

31 responses



Have you ever used Bloom's Taxonomy in your learning or studying? Copy

31 responses



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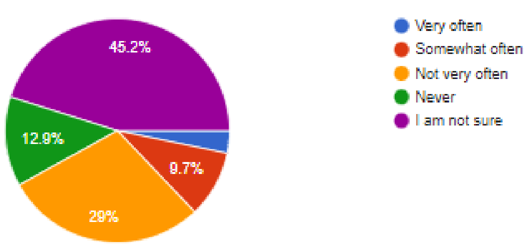
31 responses



Have you ever encountered any issues with the accuracy or relevance of the online resources recommended to you?

0 responses

No responses yet for this question.

Would you like to have a high-quality online resource recommendation system?

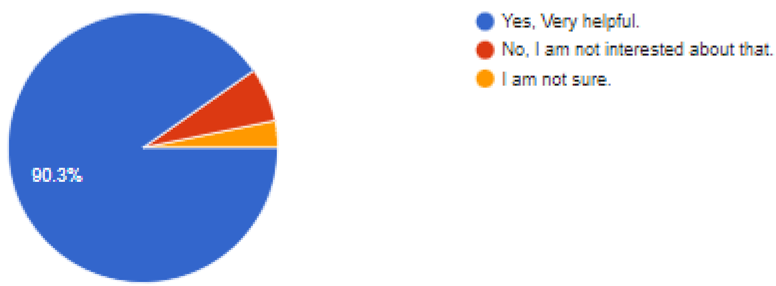
0 responses

No responses yet for this question.

Do you think it is very helpful if there is a self learning system that generate questions and answers, generate comprehensive mind maps, suggest online extra study materials and, track and forecast performance according to each level of Bloom's Taxonomy?

Copy

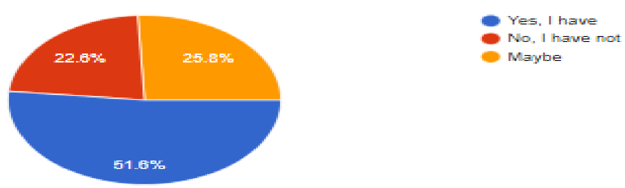
31 responses



Have you noticed any improvements in your work or personal life as a result of self-studying?

Copy

31 responses



Are you able to create comprehensive mind map by your own?

0 responses

No responses yet for this question.

How frequently do you use mind maps while studying?

0 responses

No responses yet for this question.

How satisfied are you with the mind map generation system you currently use, if applicable?

0 responses

8.2. Plagiarism Report

ORIGINALITY REPORT

10%	10%	7%	7%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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