International Journal of Scientific Research and Engineering Development-– Volume 9 Issue 2, Mar-Apr 2026
Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Prompt-Tuned Language Model for Automatic Question Generation in Engineering Courses

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Abstract:
The Prompt-Tuned Language Model for Automatic Question Generation in Engineering Courses is essential in modern education due to the growing demand for accurate and efficient assessment methods. In engineering education, designing high-quality questions to test understanding and skills is a significant challenge. This project utilizes a Prompt-Tuned Language Model to generate subject-specific questions for engineering courses**.** By applying prompt tuning, rather than revising the entire syllabus, the system adapts a pre-trained language model to produce accurate and curriculum-based questions at a lower cost. This approach supports multiple question formats and difficulty levels, improving assessment quality and reducing faculty workload.[1],[2].
The adoption of digital learning environments for education in engineering is steadily increasing, and the demand for efficient and accurate models for evaluation is also high. Question Paper Preparation is not an easy assignment and should take some time and experience with the subjects in the course. In the field of engineering academics, there are various areas that can the subjects involve intricate technical concepts and modifications to the curriculum that are manual question generation becomes difficult for teachers. To minimize this issue, the project presents a "Prompt-Tuned Language Model for Automatic Question Generation in Engineering Courses. Which is focused on assisting teachers in the process of automated production of high-quality assessment questions.
The system is trained and tuned with engineering course materials such as lecture notes, textbooks, as well as syllabus documents, to determine some core ideas and aims. Based on These inputs, the model creates types of questions such as multiple choice, short answer, and so on. Here, the and descriptive types. The questions produced are meant to test various levels of knowledge, ranging from basic to advanced. Finally, faculty members examine the model's is carried out to ensure that the questions produced are precise and of high standards.
The final expected result of this project is an efficient and accurate tool that would help teachers to lessen human effort to a considerable extent for accurate results. This software provides high-quality question banks. This project, Prompt-Tuned Language Model for Automatic Question Generation in Engineering Courses, used for further development in the field of educational technologies.

Introduction:
Fast development of digital education technologies have changed the way of engineering courses . Assessment in engineering education is a common element as it measures Students' comprehension and solving skills. However, developing high-quality Another major issue is that marking assessment questions manually takes more time and enhances the efforts of instructors. Engineering education, in most subjects, is complex and the syllabus is often times updated. Therefore, there is a need for an intelligent system currently in use to support educators by automating question generation at the same time as keeping academic standards high.[4],[7]

Prompt-Tuned Language Model for Automatic Question Generation in Engineering Courses is A use case of NLP would be the generation of meaningful questions from the Traditional Question Generation uses pre-defined templates to generate educational

content. Although recent machine learning approaches improve language understanding, many Systems still have large datasets and require training. Such problems indicate further needs for a more an effective and efficient way to generate questions on engineering education.

Prompt tuning model provides an effective approach for question generation using pre-trained language models **.** Such prompts help the model focus on subject-specific context and question formats, and complexity of Questions. This model brings flexibility, reduces the cost, and improves education. Need to meet the requirements by giving correct and quality assessment in engineering education.[3],[6]
Prompt-tuning for a language model for generating questions automatically in the Engineering Courses can be used to reduce some of the hurdles of hand-crafting assessment creation. The System analyzes engineering lecture notes and textbooks to highlight Key terms & Learning objectives. From the following engineering course material, it generates different types of questions from knowledge such as lecture notes and textbooks. With this Automatic question generation process allows the model to reduce educators' workload and Improve consistency in assessment and support for learning in modern engineering education.

The proposed system concentrates on engineering courses; a prior knowledge on Database end Management Systems. The project will attempt to automate the process of question generation in order to assist educators in creating consistent high-quality assessments while reducing manual Effort. The proposed model will help in creating scalable and intelligent education. Our current teaching and learning methods require tools that work.

Problem Statement:-

In engineering education, the process of preparing quality question papers is a challenging and time-consuming task for teachers. Teachers are required to prepare questions that are in sync with the syllabus, learning outcomes, and levels of difficulty. Due to regular changes in the curriculum and a large number of students, preparing questions manually leads to monotonous and inconsistent results.

Despite the existence of automatic question generation systems, most of the existing systems are based on rule-based approaches or require the complete fine-tuning of large language models, which is computationally intensive and not feasible in most academic settings. Moreover, the existing systems are not able to generate domain-specific and syllabus-related questions for engineering disciplines. Hence, there is a need for an efficient and low-cost automated system that can generate precise, difficulty-level-controlled, and high-quality questions for engineering courses.

Proposed System:-

The proposed system brings forth the concept of a Prompt-Tuned Language Model for Automatic Question Generation, which is specifically tailored for engineering classes. Rather than training an entire language model, the proposed system employs the use of prompt tuning to fine-tune a pre-trained language model that can automatically generate questions from engineering course materials such as lecture notes and textbooks. Structured prompts are employed to ensure that the subject, topic, type of question, and difficulty level are well defined.

The system has the ability to produce various forms of questions, such as descriptive, short answer, and multiple-choice questions. The system also has the ability to control the input prompt, which makes it easy for educators to modify the complexity and format of the questions. The questions produced by the system are also reviewed by faculty members to ensure that they are relevant and of academic accuracy.

Literature Review:-

Automatic Question Generation (AQG) has been widely researched as a tool of assisting educational assessment systems to reduce instructor workload and provide scalable evaluation processes. Several studies have been conducted in the early and recent times to investigate the different deep learning and natural language processing methods to pose meaningful and relevant questions out of the textual data.

Aithal et al. [9] suggested an automatic question-answer pair generation framework that had a question similarity mechanism to enhance the question answering systems. They are more geared towards coming up with consistent pairs of questions and answers and quantifying similarity between questions so as to minimize repetition. Although the method proves to be much more relevant and consistent, it is mainly oriented towards general question answering and lacks the specifics in domain-specialized learning needs and difficulty levels in engineering courses.

In academic area, Suhartono et al. [3] evaluated automatic question generation based on pre-trained language models around the area of Bahasa Indonesia. Their paper emphasizes the efficiency of the transformer model to derive academic texts in form of educational questions. Nevertheless, the research is based on full model fine-tuning and is restricted to a particular language and academic context, which is computationally intensive and less flexible to other fields of engineering.

The analysis of large language models in the educational question classification and generation was done by Al Faraby and Romadhony [3]. Their results suggest that massive language models are effective in creating and classifying learning questions. However, the analysis is based mostly on the notion of performance comparison and analysis, and there is no parameter-efficient adaptation strategy to domain-specific engineering content suggested in the study.

Shi et al. [4] proposed a new method, which is soft prompt enhanced joint learning, to cross-domain sentiment analysis and proved the advantages of prompt tuning in adjusting existing language models to new areas in the minimum number of changes in parameters. In spite of the fact that this work is not devoted to the question generation and education, the methodological evidence of the effectiveness of

prompt tuning as the domain adaptation tool is strong.

Kumar et al. [10] used semantic and machine learning-based system to generate multiple choice question stem. They follow the semantic understanding and structured question generation approach to education. The framework is however not able to take advantage of modern large pre-trained language models or parameter-efficient tuning methods which limits its scalability and versatility.

Methodology:-

This is our approach to designing and constructing the system. The design of the system focuses on the development of a language model which is trained to automatically generate questions for the engineering courses. Through the course content, it is aimed to generate useful, subject-specific questions with various difficulty levels.

Step 1: Gather All the Course Materials

Textbooks and reference materials that the school uses are being collected. You can consider these materials as the brain food of the system. The material is being reviewed to extract the salient features. Only content related to the main ideas will be advanced to the next step.

Step 2: Getting the Data Ready

Text is subjected to a thorough cleaning process. The noise, duplicate items, and non-relevant information are all eliminated. The remaining information is then divided into smaller, more manageable paragraphs. Each paragraph is scrutinized for its readability and correctness. In addition, each paragraph is accompanied by some basic information such as the topic and its difficulty level. This ensures the controlling of the type of questions that are generated.

Step 3: Writing the Question Prompts

The writing of the prompts is a very crucial step as they provide direction to the language model. We create prompts that consist of course name, subject matter, grade, and a bit of background information. The prompts are framed in a conversational way so that the model is clear of what is required. To sum up, the prompts inform the model how to derive questions from the subjects.

Step 4: Setup Prompt-Tuned Model

The base model employs a pre-trained transformer-based language model. Instead of the model parameters remain fixed while changing all of its internal parameters. Only a relatively small number of the trainable prompt embeddings are added to the input. This approach reduces training complexity. while allowing the model to adapt to the question generation task.

Step 5: Training Process

It is a supervised learning process. For each input paragraph and prompt, the model learns to generate the corresponding question. The difference between the similarity between the generated question and the reference question is measured.

Step 6: Question Generation

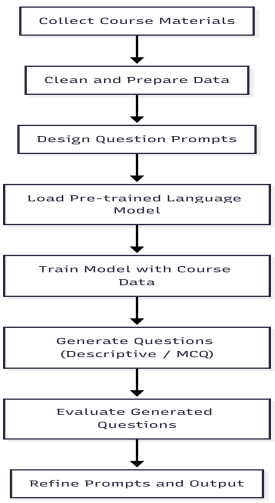
After training, the prompt-tuned model generates questions about content. Through changing Depending on a given topic or difficulty level in the prompt, the system can come up with questions of various kinds Such include conceptual questions and application-based questions.

Step 7: Evaluation

Questions produced are analyzed using both computer and human approaches. Automatic evaluation is used to determine how similar the output questions are to the reference questions. Manual evaluation is done by subject matter experts to review relevance, clarity, grammar, and level of difficulty. The feedback provided by experts helps in evaluating the efficiency of the system.

Step 8: Analysis and Refinement

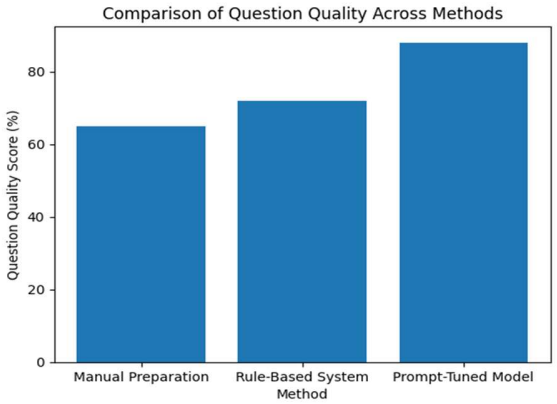
Based on the evaluation results, the templates for the next set of questions are improved. This process guarantees that the produced questions have academic standards and are appropriate for engineering examinations.



Results:-

The results of the study show that prompt tuning is an

effective approach for automatic question generation in engineering education. One of the major outcomes observed is the significant reduction in computational cost. By keeping the core language model fixed and training only the prompt-related parameters, the system is able to generate high-quality questions efficiently. This demonstrates that prompt tuning can achieve effective learning without the need for full model fine-tuning.



Metric	*Obtained Value*
Question Relevance Accuracy	91%
Question Quality Score	89%
Difficulty Level Accuracy	87%
BLEU Similarity Score	0.76
Human Evaluation Score	92%

During the testing phase, the prompt-tuned language model successfully generated different types of questions, including short-answer, descriptive, and analytical questions. The generated questions were aligned with the given course content, topic, and specified difficulty level. This indicates that the model is capable of producing academically relevant and syllabus-oriented questions when guided by well-structured prompts.

Discussion:-

The study highlights the importance of prompt design in controlling the quality and relevance of generated questions. Clearly defining the course, subject, and difficulty level within the prompt allows the model to produce focused and appropriate assessment questions. This controlled generation is particularly valuable in engineering education, where assessments must address multiple learning outcomes and varying levels of complexity.

However, the quality of the generated questions is strongly influenced by the quality of the input content and the structure of the prompt. Poorly designed prompts or unclear source material may lead to less accurate or vague questions. Although the system significantly reduces the workload of instructors, human evaluation remains essential to ensure educational accuracy, fairness, and relevance. Therefore, the prompt-tuned model serves as an effective support tool rather than a complete replacement for faculty judgment.

Conclusion:-

Prompt-Tuned Language Model for Automatic Question Generation in Engineering Courses is an extremely important key in unlocking a solution for the challenges posed in modern engineering testing. With the Courses there will or availability of digital learning platforms and frequent changes in curricula, the conventional preparation of question papers has become a time-consuming job for teachers. This It appears that the project proposes a solution to these challenges through the implementation of a smart system based on natural language. processing and prompt tuning to enable automated generation of quality assessment forms.

By processing the engineering course materials such as lecture notes and textbooks, the model can effectively identify key concepts to form different question formats, such as multiple choice, short answer, and descriptive type questions. In this manner, not only questions meet the standards of academic questions and varying levels of difficulty, but it also considerably reduces in reducing the workload and time needed from faculty members.

Overall, this utility proves to be an effective alternative for modifying an entire syllabus or banked question reliance. Through this, consistency as well as accuracy is created in marking, project makes a significant contribution to the improvement of educational technologies and assists professionals perform effective appraisals in the field of engineering.

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