AI BASED AUTOMATIC GENERATION OF QUESTION PAPER

DHENUSHA M, [2]DHISHA M, [3]SARANYA R

[1]TIRUTTANI, [2]SHOLINGAR, [3]PALLIPET
[1]ECE,
[1]GRT IET INSTITUTE OF ENGINEERING AND TECHNOLOGY, TIRUTTANI, INDIA
dhenushamagendran@gmail.com, [2]dhisha06@gmail.com, [3]rajeshsaranya37@gmail.com

***Abstract*—The generation of question papers through a question bank is an important activity in learning management systems and educational institutions. The quality of question paper is based on various design constraints such as whether a question paper assesses different problem solving skills, whether it covers all units from the syllabus of a course and whether it covers various difficulty levels. Preparing the exam questions is very challenging, tedious and time consuming for the instructors. Thus with the help of this paper we present the solution in form of Automatic Question Paper Generator System (QGS). The design process performs and composes the examination paper using an efficient algorithm with a high rate of success. From the entered input files, the examination paper will be generated automatically. The final paper may be stored as 'PDF' files. The system shows characteristics like simple operation, a great interface, good usability, immense security, and high stability along with reliability**

Index Terms— AI-Based Automated Generation of Question Paper uses AI for automated question generation with NLP, creating MCQs, Fill-in-the-blanks, and WH Questions. It adapts question difficulty based on student performance, offers cloud-based management for easy access, and includes automated grading for instant feedback, streamlining the exam process.

---

1. INTRODUCTION

In the realm of educational institutions, the demand for a proficient and adaptable automated system for question paper generation and data management has never been more pressing. Our project introduces a comprehensive solution to this challenge, offering a streamlined process for creating and managing question papers while catering to various educational needs.
By harnessing this system, educators can store and organize a vast repository of questions aligned with specific courses, providing a valuable resource for designing assessments that closely adhere to syllabi and curricula. The project goes beyond mere question storage; it implements a role-based hierarchy to ensure controlled access for different users, safeguarding sensitive data and ensuring that only authorized personnel can manipulate or retrieve questions. In a landscape where academic integrity is paramount, the system's robust security mechanisms prevent the illicit duplication of question papers, preserving the integrity of examinations. One of the project's most compelling features is its adaptability.Educational organizations have the freedom to input and modify crucial data, including course details, semesters, syllabi, and question patterns. This flexibility makes the system an indispensable tool, particularly for institutions with limited staffing and resources, as it streamlines operations, optimizes data storage, and upholds the highest standards of security in all its functionalities. In a rapidly evolving educational landscape, where efficiency, data integrity, and resource optimization are paramount, our project seeks to bridge the gap between traditional question paper generation methods and modern, technology-driven solutions. It offers educators a powerful tool to enhance the quality and security of assessments, ultimately improving the learning experience for students and simplifying the workload for instructors and administrators.Wherever Times is specified, Times Roman or Times New Roman may be used. If neither is available on your word processor, please use the font closest in appearance to Times. Avoid using bit-mapped fonts. True Type 1 or Open Type fonts are required. Please embed all fonts, in particular symbol fonts, as well, for math, etc.

2.LITERATURE REVIEW

A.RELATED WORK

AI-Based Automated Question Paper Generation System: This system leverages AI technologies such as Natural Language Processing (NLP) and machine learning algorithms to automatically generate question papers based on predefined guidelines. The system analyzes a given syllabus and textbook content, categorizing topics, difficulty levels, and question types. Using this data, the system generates diverse question papers with varying formats (multiple-choice, short answer, long answer, etc.). A major benefit of this system is its ability to create personalized question papers that meet specific academic requirements. However, it lacks the feature of real-time customization, such as adapting to student performance data, and does not provide any detailed analysis on question quality or topic coverage.

Machine Learning for Automatic Question Generation: In this study, machine learning algorithms are applied to generate questions from educational texts. The system extracts key concepts, generates relevant questions, and categorizes them based on difficulty. It enhances the efficiency of creating assessments and ensures the accuracy of the question paper's coverage of key learning objectives. However, the system requires large volumes of data and pre-trained models for accurate generation, making it difficult to scale across different subjects or curricula. Moreover, it does not support context-aware question adjustments, such as varying difficulty based on the class average or specific student needs.

Automated Question Paper Generation for Competitive Exams: This research presents an AI-driven solution designed to generate questions for competitive exams by analyzing past exam patterns, difficulty levels, and subject weightages. The AI system ensures that the generated question papers align with exam standards and regulatory guidelines. The advantage of this approach is that it helps streamline exam preparation and minimizes human error in paper setting. However, the system fails to offer flexibility in real-time topic adjustments based on student feedback or performance analysis, limiting its adaptability in dynamic testing environments.

AI-Based Adaptive Assessment System: This study focuses on AI systems that adapt question paper generation based on individual student performance. By analyzing previous answers, the system predicts the student's strengths and weaknesses and generates customized assessments tailored to their learning needs. The system supports a wide variety of question formats, including MCQs, essays, and practical problems. However, its challenge lies in maintaining a balance between ensuring fairness for all students and providing personalized learning experiences, as it could unintentionally create bias in the question generation process.

AI in Education for Exam Paper Generation: This research examines how AI can be employed in educational institutions to automate exam paper creation. The system uses NLP techniques to generate questions from textbooks, lectures, and online resources. It categorizes questions according to cognitive levels, such as recall, application, and analysis, to ensure diverse types of questions are included in the paper. While the system automates question creation effectively, it lacks deep understanding of context, making it difficult to generate more nuanced questions that require critical thinking or real-world application.

B. Problem Statement

- Current manual and traditional methods of generating question papers for assessments have numerous challenges
- and inefficiencies. These challenges include:
- **Inconsistent Question Quality**: Manual paper setting often leads to inconsistencies in question difficulty and topic coverage, resulting in assessments that may not accurately reflect student performance.
- **Time-Consuming Process**: The traditional method of manually preparing question papers is time-consuming and prone to human error. Teachers spend hours crafting and reviewing questions, which takes time away from other important academic activities.
- **Limited Customization**: Existing systems are not capable of dynamically adapting to changes in curricula, student performance, or specific educational needs. The lack of real-time customization hinders the ability to address individual student learning gaps.
- **Lack of Standardization**: Traditional question paper preparation methods do not always align with standard grading criteria, leading to subjective evaluations. Moreover, paper setters may unintentionally overlook certain topics or fail to provide a balanced representation of subjects.
- **Inefficient Feedback and Evaluation**: Feedback on question papers is often delayed, and the evaluation process can be inconsistent. Teachers may struggle to assess question difficulty levels and coverage areas after the exam is taken.

3. EXISTING SYSTEM

Traditional methods for generating question papers in educational settings primarily rely on manual processes or basic automated systems. In most cases, teachers or examiners manually create question papers by reviewing textbooks, syllabus guidelines, and previous exam papers. While this process has been widely used, it is time-consuming, prone to human error, and lacks efficiency, often resulting in inconsistencies in question quality, imbalance in topic coverage, and difficulty in meeting the specific needs of students. Additionally, manual systems are not able to easily adapt to real-time data or changes in student performance, further limiting the ability to create dynamic and personalized assessments.

Manual Question Paper Generation

In the traditional approach, question paper setters are tasked with manually creating and reviewing each question in the exam paper. This process can be labor-intensive and prone to bias, as human setters may unintentionally over-emphasize or neglect certain topics. Furthermore, manual systems do not provide any automated way to track question difficulty, ensuring that question papers adhere to standardized levels of complexity. This also poses a challenge for institutions that aim to create personalized question papers based on student learning outcomes or varying difficulty levels.

Basic Automated Systems

Some educational institutions have implemented basic automated systems for generating question papers. These systems may use keyword-based algorithms to extract questions from a repository of previous exams or a predefined set of questions. However, these systems often lack the ability to create diverse, contextually relevant questions based on syllabus updates, real-time data, or varying academic goals. They also do not support advanced question categorization based on cognitive levels (e.g., recall, analysis, application). As a result, they are not entirely effective in generating balanced question papers that meet all assessment requirements.

3.1 Limitations of Traditional Question Paper Generation Systems

A.Time-Consuming and Labor-Intensive Process

- Manual effort: Teachers often spend considerable time crafting question papers, which can reduce the time available for other educational duties, such as teaching or providing individualized student support.

- Delays in finalization: The review process can also cause delays, making it difficult to finalize exams in a timely manner and potentially leading to last-minute preparation.

B. Lack of Personalization and Adaptability

- Customization limitations: Traditional systems do not allow for easy adjustments based on individual student performance, making it hard to create personalized question papers.
- Alignment with syllabus: There is also a lack of flexibility in ensuring that question papers are updated with the latest syllabus changes or reflect specific learning objectives, which may compromise their relevance and effectiveness.

C.Inconsistent Quality and Fairness

- Variation in question quality: Manual generation of questions often results in inconsistencies, such as some papers being either too easy or too difficult, which can be unfair to students.
- Limited question variety: The process may also overlook the importance of including a diverse range of question types, which can affect the comprehensiveness and fairness of the assessment.

D. Lack of Real-Time Data Integration

- Static systems: Traditional methods do not adapt to real-time data, such as students' ongoing performance or trends in exam results.
- Absence of dynamic updates: Without the ability to adjust question difficulty or focus areas based on real-time information, the assessment system becomes less responsive to student needs.

E.Limited Cognitive Skill Assessment

- Lack of cognitive diversity: Traditional systems often do not take into account various cognitive levels, such as recall, application, analysis, and synthesis. This means question papers may fail to adequately assess higher-order thinking skills.

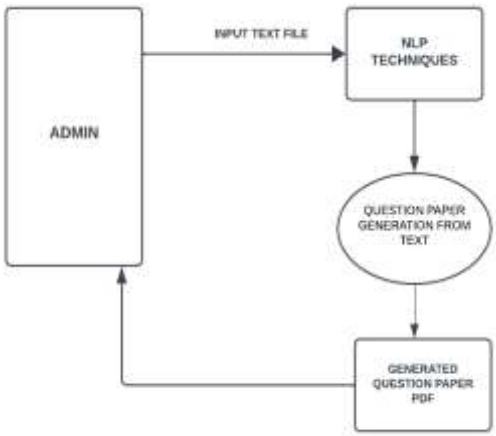
3.2 Summary of Existing System Challenges

The shortcomings of existing traditional and semi-automated question paper generation systems highlight the need for a more efficient, adaptable, and data-driven solution. Key challenges include:

- Time-consuming and labor-intensive processes that distract educators from other essential tasks.
- Lack of real-time adaptability and personalization, preventing the system from adjusting to individual student performance or new syllabus updates.
- Inconsistent quality and fairness of questions, leading to uneven assessment results.
- Limited ability to evaluate a wide range of cognitive skills, which results in a less comprehensive assessment process.

These limitations clearly indicate the need for an AI-based Automatic Generation of Question Paper system that can overcome these challenges and improve the efficiency, fairness, and adaptability of educational assessments.

4.PROPOSED SYSTEM



.

Fig.1. Block Diagram for Proposed System

To overcome the limitations of traditional question paper generation methods, the AI-Based Automated Generation of Question Paper System is designed to integrate machine learning, natural language processing (NLP), and real-time adaptability for creating dynamic, balanced, and personalized question papers. The proposed system uses advanced AI algorithms, large language models, and cloud computing to enhance the efficiency, accuracy, and fairness of question paper creation, thereby improving the overall assessment process.

The system employs an NLP module to process the syllabus, course material, and previous question papers, extracting essential topics, key concepts, and learning outcomes. It then uses an AI-driven algorithm to generate questions based on predefined cognitive levels (e.g., recall, application, analysis) and difficulty levels, ensuring a well-rounded assessment. The AI model continuously learns from student performance data, improving the question generation process to meet individual and group learning needs.

To facilitate ease of use, the system integrates a user-friendly interface, where teachers or administrators can input the course syllabus, exam format preferences, and specific instructions. Once the input is provided, the AI system processes the data and automatically generates a question paper that meets the specified criteria. The system also provides real-time feedback and evaluation, enabling administrators to adjust the question paper dynamically.

4.1 Key Features and Functionalities

The proposed system includes the following key features:

A. Intelligent Question Generation

- **Natural Language Processing (NLP)**: The system processes the course syllabus and other reference materials (e.g., textbooks, previous exam papers) to identify key topics and concepts.
- **AI-Driven Question Formulation**: Based on the extracted topics, the AI algorithm generates diverse questions across different difficulty levels and cognitive skills (e.g., recall, analysis, application).
- **Balanced Coverage**: The system ensures that all relevant topics from the syllabus are covered, creating a well-balanced question paper.

B. Customizable Difficulty and Cognitive Levels

- **Difficulty Adjustment**: The AI system adjusts question difficulty based on historical student performance data, ensuring a balanced assessment that caters to different student proficiency levels.
- **Cognitive Skills Categorization**: The system classifies questions into categories such as recall, application, analysis, and synthesis, ensuring a comprehensive evaluation of different levels of learning.

C. Real-Time Monitoring and Feedback

- **Dynamic Adjustments**: The AI system offers real-time feedback, allowing teachers to make quick adjustments to the generated question paper based on their preferences or specific requirements.
- **Evaluation Reports**: Teachers can access evaluation reports to assess the effectiveness of the generated questions in terms of topic coverage, difficulty, and fairness.

D. Cloud-Based Storage and Access

- **Cloud Integration**: The system stores generated question papers in the cloud, allowing easy access and retrieval by teachers and administrators from any device, anytime.
- **Data Security and Privacy**: The system ensures data security and confidentiality, protecting sensitive student and course information.

E. Instant Question Paper Generation and Distribution

- **Automatic Paper Generation**: Once the syllabus, preferences, and required inputs are provided, the system instantly generates the question paper in the desired format (e.g., PDF, DOCX).
- **Distribution Mechanism**: The generated paper is sent to the teacher for review and approval, or directly to students for online assessments.

F. Performance-Based Adaptive Questioning

- **Adaptive Question Difficulty**: Based on students' performance data (from previous assessments), the AI system adjusts the difficulty of questions to ensure an adaptive approach, offering more challenging questions to high-performing students and easier questions to those needing additional support.
- **Continuous Learning**: The AI system learns from past assessments and continuously improves the question generation process, adapting to changes in course content or exam patterns.

4.2 Advantages of the Proposed System

The proposed system offers numerous advantages over traditional and semi-automated question paper generation systems:

- Automated and Efficient Question Generation – The system eliminates the need for manual creation of question papers, reducing time and effort for teachers and administrators.
- Balanced and Fair Assessments – By ensuring balanced topic coverage, difficulty, and cognitive categorization, the system guarantees that the question papers are fair and comprehensive.
- Real-Time Adaptability – The AI system allows teachers to dynamically adjust the question paper based on evolving student needs, syllabus changes, and performance feedback.
- Personalized Learning and Assessment – By leveraging performance data, the system tailors question difficulty and cognitive levels to individual students' learning needs, promoting a more personalized and effective assessment process.

- Increased Accuracy and Reliability – The AI-driven question generation process ensures that questions are accurate, diverse, and aligned with the syllabus, reducing human error and inconsistencies.

- Scalability – The system is scalable to handle multiple courses, institutions, and exam formats, making it a versatile tool for modern educational systems.

4.3 Summary of the Proposed System

The AI-Based Automated Generation of Question Paper system integrates machine learning, NLP, and cloud computing to create a dynamic, adaptive, and intelligent solution for generating question papers.

By leveraging real-time student data, cognitive level categorization, and customizable preferences, the system ensures balanced, fair, and personalized assessments that are aligned with the syllabus. It offers automated question generation, real-time feedback, and instant distribution, making it an efficient and scalable solution for educational institutions.

This paper further discusses the architecture, implementation, and performance evaluation of the proposed system, showcasing its effectiveness in improving the quality, fairness, and efficiency of assessments in educational settings.

The proposed system is adaptable to various types of assessments (e.g., quizzes, midterms, finals) and can be extended to handle diverse educational contexts, ensuring that it contributes to enhancing the overall learning and teaching experience.

5. IMPLEMENTATION METHODOLOGY

The implementation of the AI-Based Automated Generation of Question Paper system involves integrating advanced AI models, natural language processing (NLP), machine learning, and cloud computing technologies to automate the creation of balanced, personalized, and adaptive question papers. The system comprises various hardware and software components that collaborate to ensure a seamless workflow from inputting the syllabus to generating the final question paper. Below is a breakdown of the methodology used for implementing the system:

5.1 System Architecture

The AI-Based Automated Generation of Question Paper system follows a modular architecture composed of the following key components:

- **Data Collection and Input Module**: This module collects the course syllabus, textbooks, previous question papers, and any other relevant resources as input data. The system allows teachers and administrators to input these resources in a structured format (e.g., text, PDFs, Word documents) through a user-friendly interface.
- **Natural Language Processing (NLP) Engine**: The NLP engine processes and analyzes the input data, extracting key topics, concepts, and learning outcomes from the provided materials. It uses techniques such as tokenization, named entity recognition, and dependency parsing to understand the structure of the syllabus and course content.
- **AI Question Generation Module**: Based on the extracted topics and concepts, the AI model generates questions that vary in difficulty and cognitive levels (e.g., recall, application, analysis). The AI model leverages pre-trained language models like GPT-4 or BERT to generate diverse and relevant questions. The difficulty of questions is adjusted according to student performance data and learning objectives.
- **Question Categorization and Validation:** This module ensures that the generated questions are categorized according to their type (e.g., multiple-choice, short answer, essay) and cognitive skill (e.g., recall, analysis). It also validates the generated questions for quality and relevance by comparing them to existing question banks.
- **Real-Time Feedback and Performance Evaluation**: This module allows teachers to provide real-time feedback on the generated question papers. It evaluates the quality of questions based on factors such as clarity, difficulty, and coverage of the syllabus. Additionally, it can track student performance on previous exams and use this data to adjust the complexity of future question papers.
- **Question Paper Generator and Distribution Module**: After the final validation and review process, the system automatically generates the question paper in the required format (e.g., PDF, DOCX). It can then distribute the finalized paper to students or teachers, either by email, online platforms, or printed formats.
-

5.2 Implementation Steps

Step 1: Data Collection and Preprocessing

- Syllabus and Course Material Input: Teachers or administrators upload the course syllabus, textbooks, and other relevant study materials into the system. This information is used as the basis for generating questions.
- Text Preprocessing: The input text is preprocessed using NLP techniques to clean the data. This includes removing irrelevant information, segmenting the text into manageable parts (e.g., chapters, sections), and identifying important terms and phrases

Step 2: NLP-Based Topic Extraction and Analysis

- Topic Identification: The system uses NLP techniques like keyword extraction, topic modeling, and sentence parsing to identify the core topics and concepts within the course material.

- Learning Outcome Extraction: The system identifies the learning objectives associated with each topic and maps them to cognitive levels, ensuring that the generated questions align with these outcomes.

Step 3: Question Generation Using AI Models

- Question Formulation: The AI-based question generation engine uses pre-trained models like GPT-4 or BERT to generate questions for each topic. The system generates questions at various difficulty levels (e.g., basic, intermediate, advanced) and in different formats (e.g., MCQs, short answers, essay-type questions).
- Dynamic Difficulty Adjustment: Based on historical student performance data (if available), the system dynamically adjusts the difficulty level of questions, ensuring that students of different proficiency levels are assessed appropriately.

Step 4: Question Categorization and Validation

- Categorization: The system categorizes each question by its type (e.g., MCQ, short answer) and cognitive level (e.g., recall, application). This ensures that the generated question paper has a balanced mix of question types and difficulty levels.
- Validation: The questions are then validated by the system to ensure that they are relevant to the course material and the learning objectives. If any question is deemed inappropriate or unclear, it is flagged for revision.

Step 5: Real-Time Feedback and Review

- Teacher Review: The generated question paper is reviewed by the teacher or administrator through a web-based dashboard. They can provide feedback and make necessary adjustments to the paper, such as modifying question wording, adjusting difficulty, or replacing questions.
- Automatic Adjustments: Based on feedback, the system makes automatic adjustments to the generated question paper, ensuring that it meets the desired specifications.

Step 6: Question Paper Generation and Distribution

- Final Question Paper Generation: After validation and adjustments, the system generates the final question paper in the required format (PDF, DOCX, or custom format).
- Distribution: The question paper is then distributed to the intended recipients via email or uploaded to a learning management system (LMS) for students to access.
- The **AI-Based Automatic Generation of Question Paper** system integrates advanced artificial intelligence and natural language processing techniques to automate the creation of question papers. This system offers several significant advantages over traditional methods of generating exam papers. Below are the key benefits of this innovative solution:

.

5.3 Advantages of the Proposed Implementation

- **1. Time Efficiency Instant Question Generation**: AI can generate a complete question paper in a matter of minutes, which significantly reduces the time spent by teachers and educators on preparing exam papers manually. This saves valuable time for teachers, allowing them to focus more on teaching and other important tasks.

2. Enhanced Quality and Consistency

- **Balanced Question Distribution**: The AI system ensures that the generated question paper is well-balanced, covering a variety of topics and types of questions (e.g., multiple choice, short answer, long answer). It helps to test different cognitive levels such as recall, analysis, application, and problem-solving.

1. Customization and Flexibility

- **Personalized Question Papers**: The system allows teachers to specify parameters such as difficulty levels, number of questions, or types of questions to be included in the exam paper. The AI then generates a paper that meets these specifications, providing a personalized and tailored exam experience for different student groups.

4. Fair and Bias-Free Question Generation

- **Eliminates Human Bias**: Traditional question paper creation may be subject to unintentional biases by educators. AI removes this human bias, ensuring that questions are neutral and fair for all students, regardless of background.

5.4 Summary

The AI-Based Automated Generation of Question Paper system employs an intelligent integration of NLP, machine learning, and cloud technologies to automate the process of question paper generation.

By utilizing advanced AI models, the system ensures that the generated question papers are well-structured, balanced, and aligned with the learning outcomes. This methodology provides teachers with a powerful tool to streamline the assessment process, improve question quality, and deliver personalized assessments that adapt to student needs.

6.CONCLUSION

In conclusion, the Automatic Question Paper Generator System (QGS) represents a transformative leap in the realm of educational assessment. By seamlessly integrating deep learning and natural language processing (NLP) technologies, this system has not only automated the arduous task of question paper creation but also elevated the quality and relevance of assessments. Its adaptability and user-friendly interface empower educational institutions to efficiently generate question papers aligned with syllabi and curricula, while its robust security mechanisms safeguard the integrity of examinations. QGS is a testament to the potential of cutting-edge technology in enhancing educational processes, promising streamlined operations, data security, and a more enriching learning experience for students and educators alike.

AI-based automatic generation of question papers is transforming the way educational assessments are created, offering a range of benefits that improve efficiency, fairness, and customization. One of the most significant advantages is the time-saving aspect. Traditionally, educators spend a considerable amount of time designing question papers, often manually selecting and organizing questions from textbooks or previous exams. With AI, this process can be automated, allowing teachers to generate a wide variety of questions in a fraction of the time. AI systems can be programmed to select questions based on predefined criteria such as topic coverage, difficulty level, and question format. This not only saves time but also frees up educators to focus on other critical aspects of teaching and student support.

The use of AI also enhances the objectivity and consistency of assessments. Human biases in question creation, whether intentional or unintentional, can lead to inconsistencies in how students are evaluated. AI, by contrast, follows a set of predefined rules and parameters to generate questions, eliminating these biases and ensuring a fairer assessment process. Moreover, AI can ensure that all topics within the syllabus are adequately represented in the question paper, maintaining balance and comprehensive coverage.

In conclusion, while AI-based automatic question paper generation has the potential to revolutionize education by improving efficiency, fairness, and customization, its full benefits can only be realized when integrated with careful oversight and continuous refinement. The technology should be viewed as a powerful tool that can assist educators, but not replace them entirely. By combining AI's capabilities with human expertise, we can create a more effective, equitable, and scalable approach to educational assessments.

7.ACKNOWLEDGMENT

We express our sincere gratitude to Mr. D.sarathy, M.E., Assistant Professor at GRT Institute of Engineering and Technology, for their invaluable guidance, technical expertise, and constant support throughout this project. Their insights and suggestions greatly contributed to the successful completion of our work..

8. REFERENCES

[1] F. Alasmary and S. Al-Ahmadi, "SBVQA 2.0: Robust End-to-End Speech-Based Visual Question Answering for Open-Ended Questions," in *IEEE Access*, vol. 11, pp. 140967-140980, 2023, doi: 10.1109/ACCESS.2023.3339537.

[2] P. Schwarzenberg and A. Figueroa, "Textual Pre-Trained Models for Gender Identification Across Community Question-Answering Members," in *IEEE Access*, vol. 11, pp. 3983-3995, 2023, doi: 10.1109/ACCESS.2023.3235735.

[3] W. Wu, Y. Deng, Y. Liang and K. Lei, "Answer Category-Aware Answer Selection for Question Answering," in *IEEE Access*, vol. 9, pp. 126357-126365, 2021, doi: 10.1109/ACCESS.2020.3034920.

[4] Y. -H. Chen, E. J. -L. Lu and Y. -Y. Lin, "Efficient SPARQL Queries Generator for Question Answering Systems," in *IEEE Access*, vol. 10, pp. 99850-99860, 2022, doi: 10.1109/ACCESS.2022.3206794.

[5] R. C. Muñoz, B. B. Blanco, J. d. Campo-Ávila and J. L. T. Rodriguez, "Teaching Compilers: Automatic Question Generation and Intelligent Assessment of Grammars' Parsing," in *IEEE Transactions on Learning Technologies*, vol. 17, pp. 1734-1744, 2024, doi: 10.1109/TLT.2024.3405565.

[6] S. Bano, S. Khalid, N. M. Tairan, H. Shah, and H. A. Khattak, ''Summarization of scholarly articles using BERT and BiGRU: Deep learning-based extractive approach,'' J. King Saud Univ. Comput. Inf. Sci., vol. 35, no. 9, Oct. 2023, Art. no. 101739

[7] S. Bano and S. Khalid, ''BERT-based extractive text summarization of scholarly articles: A novel architecture,'' in Proc. Int. Conf. Artif. Intell. Things (ICAIoT), Dec. 2022, pp. 1–5.

8] L. Qian, J. Wang, H. Lin, and L. Yang, ''Multi-perspective respondent representations for answer ranking in community question answering,'' Inf. Sci., vol. 624, pp. 37–48, May 2023 .

[9] Z. Fallahnejad and H. Beigy, ''Attention-based skill translation models for expert finding,'' Expert Syst. Appl., vol. 193, May 2022, Art. no. 116433.

[10] C. Suneera and J. Prakash, ''A BERT-based question representation for improved question retrieval in community question answering systems,'' in Proc. ICMLCI Adv. Mach. Learn. Comput. Intell. Singapore: Springer, 2021, pp. 341–348.