Automatic Question Paper Generation System using Shuffling Algorithm

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Abstract

In any Educational Institutions, Examination is an important process to predict the talent and quality of students. The Automatic Question Paper Generation System employing a Shuffling Algorithm represents a technological innovation geared towards transforming the conventional method of creating exam question papers. In educational institutions, the manual creation of question papers is often time-consuming, and maintaining the integrity of assessments through fair question distribution poses a significant challenge. This system addresses these issues by automating the question paper generation process while incorporating a shuffling algorithm for enhanced randomness and security.

Keyword(s): Examination, Question paper, Shuffling Algorithm

1. Introduction

Education serves as the foundation of a nation, and knowledge significantly influences the operation of society. Within the realm of education, assessment functions as a test that validates the proficiency and aptitude of a candidate in a specific course or subject. Assessment [1] is crucial in enhancing the learning process and serves as a vital tool for evaluating the effectiveness of teaching and learning. With advancements in technology, assessment methods have evolved. The issue of standardizing question papers has long been a concern. According to Ashok Immanuel et al. assessments should evaluate students across multiple dimensions of learning. A manual approach to designing question papers may not meet this need adequately. An automated approach offers the potential for a more efficient and effective process in designing question papers

The examination system commonly adopted in many educational institutions is traditional [2]. Typically, the course instructor is responsible for creating one or more question papers for a given course. From these papers, one is selected either randomly or deliberately for assessment purposes, a method referred to as the Classical Method. However, this conventional approach has numerous limitations, such as incomplete coverage of the syllabus and insufficient length of the question paper. Consequently, the efficiency of the entire examination process is compromised.

Aishwarya Chavan et al.[3] addressed the complexities involved in crafting question papers, highlighting various crucial parameters such as difficulty level, balance between numerical and theoretical content, and the allocation of marks. Despite the significance of these factors in manual question paper construction, there are no universally applicable rules for each course; the approach varies for every subject. Hence, establishing standardized rules for every discipline is impractical and illogical. Humans excel in approximate reasoning, whereas machines are better suited for precise tasks.

Fenil Kiran Gangar et al. [6] discussed about several challenges and restrictions in prevailing conventional system which includes repetition of questions, partial coverage of syllabus, formatting issues in question papers, security of question papers developed and so on.

2. Related work

The Automated Question Paper Generator System integrates Fuzzy and Apriori algorithms. Fuzzy Logic, known for its ability to emulate human reasoning, is employed in paper [3] to logically select parameters for constructing question papers across various subjects, regardless of their disciplines. The system autonomously determines these parameters by soliciting inputs from users and categorizing them based on predefined logic, ensuring ease of understanding for the system. This fuzzy logic-based approach allows the system to effectively navigate the complexities of parameter selection, enabling it to adapt to diverse subject matters. By utilizing human-like reasoning, the system can make informed decisions in framing question papers, enhancing its overall effectiveness and efficiency in the generation process.

The Apriori algorithm serves as a fundamental tool in the Automated Question Paper Generator System for discovering frequent itemsets.

This algorithm utilizes existing knowledge about common itemset characteristics and employs a step-by-step process where sets of k items are used to investigate sets containing (k+1) items. Following the principle that any non-empty subset of a common itemset must also be common, Apriori detects frequently occurring individual items in the dataset and expands them to larger item sets if they occur frequently enough [2]. To efficiently count candidate item sets, Apriori employs a hash tree structure. In the system, once the paper generation process commences, the Apriori algorithm retrieves questions from the corresponding category. Initially, it retrieves basic course details and then proceeds to search for various parameters, generating the questions required for the question paper. This integration of the Apriori algorithm ensures an efficient and effective approach to question generation, based on the frequent itemset properties identified within the dataset.

Classifying data is a critical endeavor that entails organizing diverse attributes or criteria into categories or rules. Its primary objective is to precisely forecast the target class for every instance within a dataset. In the context of questions classification (QC), the objective is to determine the type of entity for a question, typically written in natural language, by assigning it to a category selected from a predetermined set of categories. The main objective of paper [4] is to establish rules for classifying exam questions based on their grammatical structure. These rules were derived from a training set comprising examination questions in programming subjects. There are two primary reasons for implementing these rules:

i) To distinguish suitable keywords for each question based on its category.

ii) To aid in selecting the correct category in cases where a keyword belongs to multiple categories.

By utilizing these regulations, the paper strives to improve the precision and effectiveness of question classification, guaranteeing that questions are correctly sorted according to their grammatical structure and substance.

3. Methodology

3.1. Shuffling algorithm

The Automatic Question Paper Generation System employs a shuffling algorithm, which is an efficient method for randomizing stored questions. This ensures the generation of diverse sets of question papers without repetition or with minimal repetition. The algorithm, as described in paper [5], is designed to prevent duplication and repetition of randomly selected questions. For a set of N elements (representing the total number of questions in the database), the algorithm executes the following steps to generate a random alteration of the numbers 1 to N:

```
1. Create an array of N locations
2. Generate random number
3. if(loc==0)
4.          store generated number
5.      else
6.          compare the generated number with previous
            number in array
7.      if matching value found
8.          go to line no. 2
9.      else
10.         store the no in next location
11. Repeat line no. 2 for N numbers
12. Select questions from DB, matching with values from
    array location one by one
```

Figure 1. Shuffling algorithm

By operating in this manner, the algorithm ensures that each number from 1 to N is rearranged randomly, effectively preventing duplication and repetition of questions in the generated question papers. This approach provides a reliable means of achieving variation and randomness in the question paper generation process

3.2. Identification of bloom's level

The processing phase described in paper [4] commences by pre-processing the questions stored in the database. These questions are transformed into a simplified form to serve as input for the rule-based system. The initial step of this processing phase involves:

3.2.1. POS tagging:

This module is tasked with annotating words in a provided question with their corresponding part-of-speech (POS) tags. Each word is tagged with its respective grammatical classification, such as verb, noun, or adjective.

3.2.2. Shallow parsing:

This module proceeds to analyze the sentence further by segmenting it into clusters of words according to their Part-of-Speech (POS) tags, with the objective of forming more coherent phrases. It recognizes various phrase types including noun phrases, verb phrases, and basic adjectival and adverbial phrases. Employing shallow parsers, this process entails retrieving limited syntactic details to identify such phrases within natural language sentences. Unlike full parsing, which aims for a comprehensive extraction of syntactic structures, partial parsing concentrates solely on extracting vital information, rendering it quicker, more resilient, and applicable across numerous natural language processing tasks.

To classify questions into various Bloom's categories, Bloom's verbs are identified as they exemplify the level of cognitive activity and represent intellectual engagement. Table 1 provides examples of keywords from each of Bloom's cognitive domains. Meanwhile, Table 2 displays samples of questions from a C Programming course along with Bloom's verbs corresponding to each cognitive level.

Table 1. Sample keywords from Bloom's Cognitive Domain

Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Define State Recall Identify Name	Explain Describe Interpret Paraphrase Summarize	Apply Solve Illustrate Calculate Demonstrate	Analyze Compare Contrast Categorize Distinguish	Evaluate Choose Predict Estimate Recommend	Create Design Plan Develop Construct

Table 2. Sample of questions with blooms verbs for each cognitive level

Blooms Level	**Blooms Verb**	**Sample Questions**
Remember	Define	Define a variable.
Understand	Explain	Explain about various branching statements with suitable examples.
Apply	Demonstrate	Demonstrate the swapping of two numbers using the concept of parameter passing.
Analyse	Compare	Compare and contrast the memory allocated for three members (int age, char gender, float salary) using structures and union.
Evaluate	Choose	Choose the suitable parameter passing mechanism for swapping the values of two variables.
Create	Develop	Develop a banking application to perform various transactions using C.

4. Question paper generation System

The Question Paper Generation System facilitates the automatic generation of question papers. This process involves selecting various parameters such as course outcomes, total marks, number of questions, and others. These parameters play a crucial role in shaping the content and structure of the generated question paper. Question bank or a material repository is maintained where QP is generated out of existing DB. Blooms level for each question is given and question paper is generated using shuffling algorithm. The generation of questions is customizable and can vary depending on the type and duration of the assessment. Figure 2 illustrates the overall block diagram of the Question Paper Generation System, outlining the various components and their interconnections in the system's architecture.

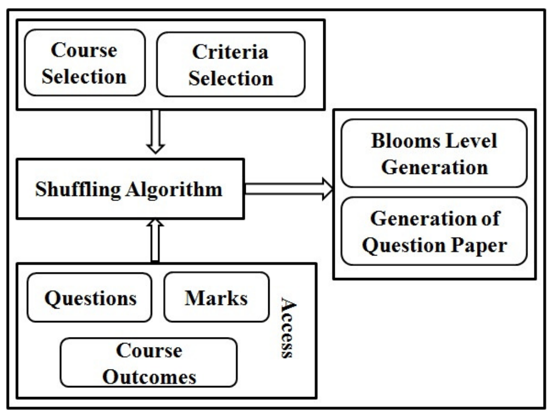

Figure 2. Block Diagram for Question Paper Generation System

5. Results and Discussion

This section aimed to test the proposed system and review the experimental results achieved. The proposed system enables to automate question paper generation process with less time, effort, and more accuracy. Instructor makes login and choose the required details for question paper generation. With the selection of these parameters, question paper is generated automatically using shuffling algorithm with minimal repetition of questions.The efficiency of the system is estimated using its accuracy. Analysis on identification of blooms level and repetition of questions were done.

Blooms level analysis was done by generating different question paper sets for two diverse types of assessments which indicated the blooms level of each question. Assessment 1 had 12 questions and Assessment 2 had 17 questions. Also, Assessmet1 question were generated form same course outcome. For generated question sets, blooms level was identified manually based on the bloom's verb in the question. System and manually generated blooms levels were compared. If both the level matches, score is 1 else score is 0. Bloom’s level Accuracy is computed using the given formula.

$$\text{Bloom's level Accuracy} = \frac{x}{n} \text{ X } 100 \qquad (1)$$

Where x is Total number of questions with bloom’s level matched

n is Total number of questions generated

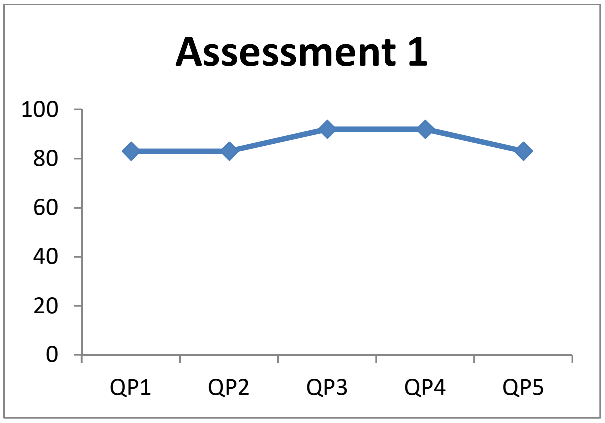

Figure 3. Accuracy Graph for Assessment 1

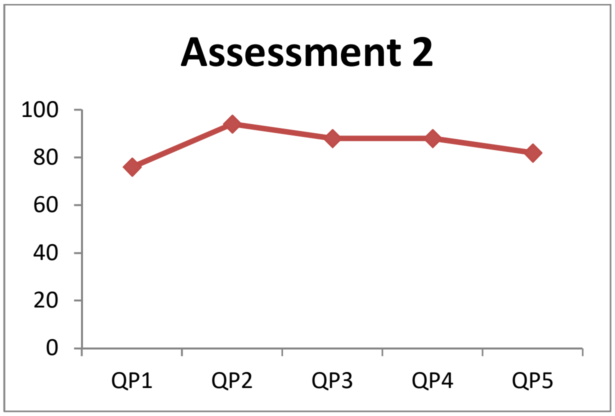

Figure 4. Accuracy Graph for Assessment 2

The graph shows the accuracy of question sets generated for both assessments. The average accuracy of QP set for assessment 1 is 87% and for assessment II is 86%

Analysis on repetition of questions was done by comparing the question sets generated. Repetition Percentage is calculated as,

$$\text{Repetition percentage} = \frac{y}{n} \times 100 \qquad (2)$$

where y represents the total number of questions that are repeated.
n represents the total number of questions generated.

Table 3. Repetition Percentage for assessment 1

	QP1	QP2	QP3	QP4	QP5
QP1	-	0	0	8%	8%
QP2	0	-	8%	0	0
QP3	0	8%	-	0	8%
QP4	8%	0	0	-	0%
QP5	8%	0	8%	0	-

Table 4. Repetition Percentage for assessment 2

	QP1	QP2	QP3	QP4	QP5
QP1	-	5%	0	5%	0
QP2	5%	-	0	0	0
QP3	0	0	-	5%	0
QP4	5%	0	5%	-	0
QP5	0	0	0	0	-

The table shows the repetition percentage among the question sets generated. Obtained results shows that there occurs 0 - 8 % of repetition of question in Assessment 1 question set and 0 - 5% repetition occurs in Assessment 2 question set.8 % of repetition in Assessment1 question set may be due to limitation that question set need to be generated from only one unit.

6. Conclusion

The creation of question papers utilizes a shuffling algorithm, where various criteria are selected to ensure diversity. The system determines the Bloom's level based on the verbs present in the questions. Question papers can be automatically generated according to specific requirements, with minimal repetition of questions. In the future, question paper generation can evolve to incorporate identified Bloom's levels based on the context of each question. Additionally, the replication of questions from the same topic can be avoided by mapping each question to its respective topic. These topics can then be considered during the generation of question papers, further enhancing the diversity and relevance of the questions included.

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