



# PERFORMANCE COMPARISON OF RANDOM NUMBER GENERATION TECHNIQUES TO MINIMIZE THE REDUNDANCY FOR RETRIEVAL OF DATABASE RECORDS

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## ABSTRACT

The major process in the education methodology is organizing and conducting the examination. Administration of the question paper setting is an important task in the objective-type examination system. While setting the objective type question paper, the highlighted problems are the lack of expertise, the time, and the questions redundancy. Generally, during the retrieval of records from an objective type question bank redundancy may occur even for the large size databank as well as smaller size databank. To solve this problem, a methodology is required to retrieve records from a database without redundancy. This paper discusses the impact of mid-square, mid-product and constant multiplier techniques for random number generation, to retrieve records from the question bank with minimal redundancy as far as possible. To retrieve records from a database, a modified approach is identified and applied to generate random numbers. Also, this paper justifies the role of suggested approach, which performs reasonably better than the actual techniques reported in the literature for records retrieval process even for a smaller size database.

**Keywords:** *Minimizing Redundancy, Record Retrieval, Objective Type Question Bank, Mid-Square Technique, Mid-Product Technique, Constant Multiplier Technique*

## 1.INTRODUCTION

An important aspect of education process is examination. Teaching, Learning and Evaluation are the different components of education system. At various stages, evaluation is carried out in a number of ways. Generally, at the end of the day, or after the completion of a specific topic in the class by the teacher and also at the end of a period of study, the performances of the students are evaluated. The response of the students makes evaluation as a continuous process and it has to be preplanned systematically and scientifically [1]. The 1964-66 education commission report pointed out the examination has become more crucial in all respect and it has to go hand in hand with the improvements in teaching. Examination

reforms are the key objective of the university education, suggested in their study report by Radhakrishnan Commission. The 1986 New Education policy proposed two major goals of examination reform programmes. One of them is the reliability and validity of examinations and the other one is making them as powerful instruments of teaching and learning. Examination system helps the teacher to identify the students who are good at the subjects and to locate the weaker students. It can help the teacher in suggesting some remedial measures to the weaker students. Examination motivates the learner to be regular and attentive. Further, Examination helps the teacher to find out how much a student stands in a group, to find the components, topics, units and subjects in which a

student is strong and weak. Examination helps the teacher to improve his/her instruction method and take vital role as an effective feedback mechanism. It also directs the teacher to improve in the areas or topics where the students are lacking and to identify the relative strength of the students in the subject and in the group. Thus, examination is a tool in the self development of the individual.

The examination process helps in developing a better curriculum, the areas in which all learners score the maximum marks, a topic which is too trivial and such topics may be excluded from the curriculum in the future. Examination is the most frequently used method of evaluation. A standard question paper is to be set administered to all the students [2]. The advantages of this type of evaluation are, all the students are given the same set of questions, the best and worst scores can be easily determined. Question paper designed scientifically can be used as a powerful tool for examination not only in the education process but also for recruitments for jobs, to shortlist candidates from among a very large list of candidates. Hence, the effective tools of an examination system are setting question papers scientifically and properly evaluating them.

## **2. RELATED PREVIOUS RESEARCH WORK**

Nowadays, computer is a most significant tool, which must be a part of examination system. To carry out the different tasks involved in the examination system, number of models has been developed. This section describes the different models surveyed. The functions and characteristics of a computerized question banking system were explained by Newbould and Massey [9]. It related to the process and requirements of the multiple-choice test development. The authors justify the use of multiple-choice questions are appropriate, since the use of this type of test is increasing significantly and also recommend, choosing questions from a larger question bank. Pedro Lira *et al.*, [10] designed an approach for the generation, administration and correction of multiple choice tests. The performance monitoring using a computerized question banking system was described by Sandra Johnson and Brain Maher [11].

Using Mid-product method, Meenakshi sundaram *et al.*, [5] has tried out to minimize the redundancy in the retrieval of records from question bank. An attempt has been made to

minimize the redundancy in the retrieval of records from question bank by applying Constant Multiplier method [6]. Also, Santhanam *et al.*, [12] has tried out to minimize the redundancy in the retrieval of records from question bank using Mid-square method. Meenakshi sundaram *et al.*, [7] discuss the performance analysis of modified mid-square and mid-product techniques to minimize the redundancy for retrieval of database records. Also, an attempt has been made by them on the performance analysis of modified mid-product and constant multiplier techniques to minimize the redundancy for retrieval of database records [8]. Naturally, in the question bank, the positions of questions are randomized and then it starts the test construction procedure. Vishnu P S [13] developed a prototype knowledge based system for question paper setting using artificial intelligence concepts. A comprehensive algorithm for this task cannot be used for an expert system since the major portions of the problem domain of expert systems are invariably characterized by unstructured, not too formal knowledge. The algorithms used in the systems are generation of pseudo random number sequences and create randomly a large number of different tests.

Systems are developed for setting question paper without human intervention has not been attempted so far in the area of question paper setting. Before setting the question paper, framing syllabus should be attempted since the syllabus is not uniform. Because of varying nature of the syllabus, syllabus and the question paper for a subject should be made independent of each other. If the prescribed syllabus is separated by units of study, a separate question bank has to be maintained. While creating and updating a database, the principles like reduce the redundancy, avoid the inconsistency to some extent must be followed, suggested by Kannan *et al.*, [4]. Hence, developing a computer-aided objective type question paper system which permits the flexibility with minimizing redundancies in the questions is essential.

## **3. MATERIALS AND METHODS**

### **3.1. Mid-Square Technique**

This technique starts with an initial number or seed, and then squared, and the middle digits of this square become the random number after placement of the appropriate decimal. The middle digits are then squared to generate the second random number. The above process is repeated until the required number of random numbers is generated [3].

Example: Suppose that a sequence of four digit random numbers is needed. Let  $X_0 = 5497$

$$X_0^2 = (5497)^2 = 30217009 \Rightarrow X_1 = 2170 = R_1$$

$$X_1^2 = (2170)^2 = 04708900 \Rightarrow X_2 = 7089 = R_2$$

$$X_2^2 = (7089)^2 = 50253921 \Rightarrow X_3 = 2539 = R_3$$

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### 3.2. Mid-product Technique

The mid-product technique for generating random numbers [3], starts by selecting two seeds  $X_0$  and  $X_0'$  each containing the same number of digits  $D$ . Now, multiply  $X_0$  by  $X_0'$  to get a number  $U_1$ . Set  $X_1$  equal to the middle  $D$  digits of  $U_1$  with the placement of appropriate decimals to obtain  $R_1$ . Next multiply  $X_1$  by  $X_0$  to obtain  $U_2$ , set  $X_2$  equal to the middle  $D$  digits of  $U_2$ . Place the appropriate decimal to obtain the next random number  $R_2$ . Repeat the above process until the required number of random numbers is generated. The following example illustrates this technique.

Example: Generate a sequence of four digit random numbers with seeds,

$$X_0' = 2938 \text{ and } X_0 = 7229$$

$$U_1 = X_0' * X_0 = 2938 * 7229 = 21238802 \Rightarrow X_1 = 2388$$

$$U_2 = X_0 * X_1 = 7229 * 2388 = 17262852 \Rightarrow X_2 = 2628$$

$$U_3 = X_1 * X_2 = 2388 * 2628 = 06275664 \Rightarrow X_3 = 2756$$

.....  
.....

### 3.3. Constant Multiplier Technique

Jerry Banks et al., [3] use a constant multiplier  $K$  and the initial seed  $X$  to generate random numbers. Both the constant and the initial seed have the same digits say  $D$ . The constant multiplier and the initial seed are multiplied and the middle  $D$  digits of the multiplied value ( $V_1$ ) are considered as new random number say  $X_1$ . The new random number  $X_1$  is multiplied with the constant multiplier  $K$  and the middle  $D$  digits of the multiplied value ( $V_2$ ) is considered as next random number  $X_2$ . This technique continues in this fashion.

Example: Suppose that a sequence of 4 digit random numbers required. Begin with the constant  $K=3987$  and the initial seed  $X=7223$  to obtain the sequence of four digit random numbers.

$$V_1 = K * X = 3987 * 7223 = 28798101 \Rightarrow X_1 = 7981$$

$$V_2 = K * X_1 = 3987 * 7981 = 31820247 \Rightarrow X_2 = 8202$$

$$V_3 = K * X_2 = 3987 * 8202 = 32701374 \Rightarrow X_3 = 7013$$

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.....

### 3.4. Proposed Approach

The following algorithm describes the steps to be followed while selecting the objective type question records from a question bank

1. Set the required number of records (questions).
2. Generate the random number using mid-square or mid-product or constant multiplier technique.
3. Select the records based on the random number generated and group them into one collection.
4. Sometimes, the records appropriate to the random number generated may not be satisfying the given constraints.
5. To eliminate this problem, assign codes to the records serially that are satisfying the constraints, having a range.
6. Apply the following formula to get the converted sample so as to be within the range

$$R = m \text{ MOD } n$$

Where  $m$  be the random number generated by the mid-square/mid-product/ constant multiplier technique;  $n$  be the upper limit of the total number of records;  $R$  be the new converted sample.

7. Even after this, the system may have the repeated number of converted samples. For instance, let us consider that there are 20 records satisfying the given constraints. While generating a random number, the system generates 934 as a random number. It exceeds the upper limit 20. Hence, 14, the remainder of  $924/20$  is the new converted sample and the system selects the 14<sup>th</sup> record.
8. After few selections, if the system generates 534 as random number, the converted sample is the same 14<sup>th</sup> record, which is selected already.
9. To avoid this selection of repeated records, the actual number is also stored along with converted sample. The system checks the new random number with the previous one (here comparison between 934 and 534).
10. If it is same, the system gets new seed, since degeneracy occurs in random number generation.
11. If it is different, the system ignores the random number and generates next new random number based on the mid-square / mid-product / constant multiplier technique (here 14<sup>th</sup> record ignored).

12. This process eliminates the restriction on having a total number of records satisfying the given constraints as large.

9	1284	4	4
10	6486	86	86

## 4. RESULTS AND DISCUSSION

### 4.1. Mid-square Technique Application

**4.1.1. Case-A.1:** This case attempts to set a question paper database consisting of 10 records out of 200 records that are selected with the seed value 5837 using modified approach of mid-square technique for random number generation (Table.1).

**4.1.2. Case-A.2:** Here the system retrieves and constructs a question paper database consisting 10 records out of 160 records which are selected with the seed value 5837 using modified approach of mid-square technique for random number generation (Table.2). Note that, though the seed value and method of random number generation is same as the case-A.1, this case selects different records, since the total number of records satisfying the constraints are different.

**4.1.3. Case-A.3:** The system sets a question paper database consisting of 10 records out of 20 records with the seed value 5837 using modified approach of mid-square technique for random number generation. (Table.3)

*Table-1. Selection of 10 records from 200 records for the seed 5837*

Sl.N o	Random No	Converted sample	Sample considered
1	705	105	105
2	4970	170	170
3	7009	9	9
4	1260	60	60
5	5876	76	76
6	5273	73	73
7	8045	45	45
8	7220	20	20
9	1284	84	84
10	6486	86	86

*Table-2. Selection of 10 records from 160 records for the seed 5837*

Sl.N o	Random No	Converted Sample	Sample Considered
1	705	65	65
2	4970	10	10
3	7009	129	129
4	1260	140	140
5	5876	116	116
6	5273	154	154
7	8045	45	45
8	7220	20	20

### 4.1.4. Case-A.4:

Here, using modified approach of mid-square technique for random number generation, the system sets a question paper database consisting of 10 records out of 15 records with the seed value 5837. (Table.4)

### 4.2. Mid-product Technique Application

**4.2.1. Case-B1:** With the seeds 4958 and 2583, the system retrieves and constructs a database consisting of 10 records from 200 records using modified approach of mid-product technique for random number generation (Table.5).

*Table-3. Selection of 10 records from 20 records for the seed 5837*

Sl.N o	Random No	Converted sample	Sample considered
1	705	5	5
2	4970	10	10
3	7009	9	9
4	1260	0	0
5	5876	16	16
6	5273	13	13
7	8045	5	****
8	7220	0	****
9	1284	4	4
10	6486	6	6
11	681	1	1
12	4637	17	17

\*\*\*\* Repeated converted Sample

*Table-4. Selection of 10 records from 15 records for the seed 5837*

Sl.N o	Random No	Converted sample	Sample considered
1	705	0	0
2	4970	5	5
3	7009	4	4
4	1260	0	****
5	5876	11	11
6	5273	8	8
7	8045	5	****
8	7220	5	****
9	1284	9	9
10	6486	6	6
11	681	6	****
12	4637	2	2
13	5017	7	7
14	1702	7	****
15	8968	13	13

\*\*\*\* Repeated converted Sample

**4.2.2. Case-B2:** The system retrieves and constructs a database consisting of 10 records which are selected from 160 records with the seeds 4958 and 2583 using modified approach of mid-product technique for random number generation (Table.6).

Note that, though the seed value and the technique of random number generation is same as in the case-B1, this case selects a different collection of records, since the total number of records satisfying the given constraints are different

**4.2.3. Case-B3:** In this scenario, the system retrieves and constructs a database consisting of 10 records with the seeds 4958 and 2583 out of 20 records using modified approach of mid-product technique for random number generation (Table.7)

**4.2.4. Case-B4:** Using modified approach of mid-product technique for random number generation, the system retrieves and constructs a database consisting of 10 records with the seeds 4958, 2583 out of 15 records (Table.8).

*Table. 5. Selection of 10 records from 200 records for the seeds 4958,2583*

Sl. No	Random No	Converted sample	Sample considered
1	8065	65	65
2	8318	118	118
3	846	46	46
4	370	170	170
5	3130	130	130
6	1581	181	181
7	9485	85	85
8	9957	157	157
9	4421	21	21
10	198	198	198

*Table. 6. Selection of 10 records from 160 records for the seeds 4958,2583*

Sl. No	Random No	Converted sample	Sample considered
1	8065	65	65
2	8318	158	158
3	846	46	46
4	370	50	50
5	3130	90	90
6	1581	141	141
7	9485	45	45
8	9957	37	37
9	4421	101	101
10	198	38	38

### 4.3. Constant Multiplier Technique Application

**4.3.1. Case-C.1:** With the initial seed 3579 and the constant 9753 chosen at random, the system retrieves and constructs a database consisting of 10 records out of 200 records using modified approach of constant multiplier technique for random number generation (Table.9).

*Table. 7. Selection of 10 records from 20 records for the seeds 4958,2583*

Sl. No	Random No	Converted sample	Sample considered
1	8065	5	5
2	8318	18	18
3	846	6	6
4	370	10	10
5	3130	10	****
6	1581	1	1
7	9485	5	****
8	9957	17	17
9	4421	1	****
10	198	18	****
11	8753	13	13
12	7330	10	****
13	1594	14	14
14	6840	0	0
15	9029	9	9

\*\*\*\* Repeated converted Sample

*Table. 8. Selection of 10 records from 15 records for the seeds 4958,2583*

Sl. No	Random No	Converted sample	Sample considered
1	8065	10	10
2	8318	8	8
3	846	6	6
4	370	10	****
5	3130	10	****
6	1581	6	****
7	9485	5	5
8	9957	12	12
9	4421	11	11
10	198	3	3
11	8753	8	****
12	7330	10	****
13	1594	4	4
14	6840	0	0
15	9029	14	14

\*\*\*\* Repeated converted Sample

**4.3.2. Case- C.2:** The system retrieves and constructs a database using modified approach of constant multiplier technique for random number generation consisting of 10 records which are selected from 160 records with the initial seed value 3579 with the constant 9753 chosen at random (Table.10). Note that, though the seed

value and the technique of random number generation is same as in the case of C1, this case selects a different collection of records, since the total number of records satisfying the given constraints are different

**Table. 9. Selection of 10 records from 200 records for the initial seed 3579 with the constant 9753 chosen at random**

Sl. No	Random No	Converted sample	Sample considered
1	9059	59	59
2	3524	124	124
3	3695	95	95
4	373	173	173
5	6378	178	178
6	2046	46	46
7	9546	146	146
8	1021	21	21
9	9578	178	****
10	4142	142	142
11	3969	169	169

\*\*\*\* Repeated converted Sample

**Table. 10. Selection of 10 records from 160 records for the initial seed 3579 with the constant 9753 chosen at random**

Sl. No	Random No	Converted sample	Sample considered
1	9059	99	99
2	3524	4	4
3	3695	15	15
4	373	53	53
5	6378	138	138
6	2046	126	126
7	9546	106	106
8	1021	61	61
9	9578	138	****
10	4142	142	142
11	3969	129	129

\*\*\*\* Repeated converted Sample

**4.3.3. Case-C.3:** In this scenario, the system retrieves and constructs a database consisting of 10 records with the initial seed value 3579 with the constant 9753 chosen at random out of 20 records using modified approach of constant multiplier technique for random number generation (Table.11)

**4.3.4. Case-C.4:** Using modified approach of constant multiplier technique for random number generation the system retrieves and constructs a database consisting of 10 records with the initial seed value 3579 with the constant 9753 chosen at random, out of 15 records (Table.12).

Table.13 depicts the performance analysis summary of the techniques handled. The performance of the above three discussed techniques are shown in the Table.14, 15 and 16 and plotted in the graphs Figures 1, 2 and 3 respectively.

**Table. 11. Selection of 10 records from 20 records for the initial seed 3579 with the constant 9753 chosen at random**

Sl. No	Random No	Converted sample	Sample considered
1	9059	19	19
2	3524	4	4
3	3695	15	15
4	373	13	13
5	6378	18	18
6	2046	6	6
7	9546	6	****
8	1021	1	1
9	9578	18	****
10	4142	2	2
11	3969	9	9
12	7096	16	16

\*\*\*\* Repeated converted Sample

**Table. 12. Selection of 10 records from 15 records for the initial seed 3579 with the constant 9753 chosen at random**

Sl. No	Random No	Converted sample	Sample considered
1	9059	14	14
2	3524	14	****
3	3695	5	5
4	373	13	13
5	6378	3	3
6	2046	6	6
7	9546	6	****
8	1021	1	1
9	9578	8	8
10	4142	2	2
11	3969	9	9
12	7096	1	****
13	2072	2	****
14	2082	12	12

\*\*\*\* Repeated converted Sample

## 5. CONCLUSION

It is evident from the table-13 regarding 100% retrieval of records without redundancy is possible with the modified approaches than using the actual mid-square, mid-product and constant multiplier techniques. It justifies that the modified approaches performs better than the actual approaches with regard to redundancy for the retrieval of records. Also, the proposed approach is appropriately suitable to retrieve the

records even for small collection of database records which eliminates redundancy. The issues associated with the various tasks of objective type question paper setting in an automated fashion are discussed in this paper. Generally, while maintaining the question bank, the records are inserted and updated in a question bank with key values. Sometimes it is possible that the

question bank may contain some questions which appear to be in different forms but actually conveys the same meaning. The future work will concentrate on the other random number generation techniques to remove the redundancy and the possibility of using the dynamic hashing techniques can be explored in future.

**Table. 13: Performance Analysis Summary**

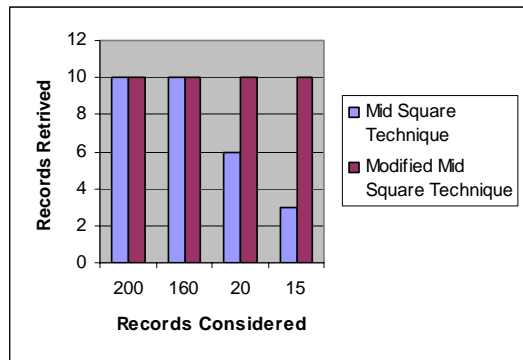
<b>Table. 14: Performance Analysis while retrieving 10 records using Mid-square Technique with seed values 5837</b>			
Case	Maximum Records	Record retrieved using	
		Mid-square Technique	Modified Mid-square Technique
I	200	10	10
II	160	10	10
III	20	6	10
IV	15	3	10

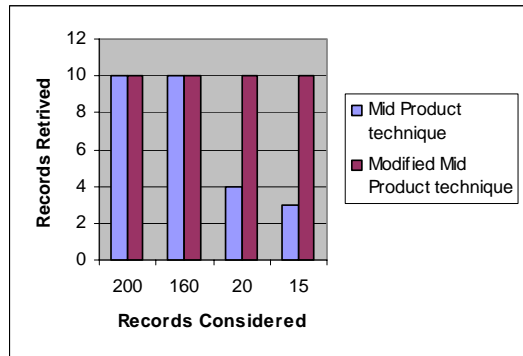
<b>Table. 15: Performance Analysis while retrieving 10 records using Mid-product Technique with seed values 4958 and 2583</b>			
Case	Maximum Records	Record retrieved using	
		Mid-Product Technique	Modified Mid-product Technique
I	200	10	10
II	160	10	10
III	20	4	10
IV	15	3	10

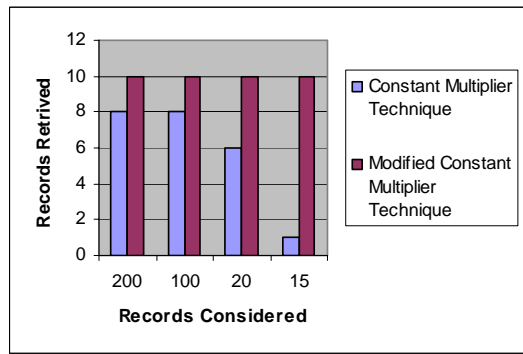
<b>Table. 16: Performance Analysis while retrieving 10 records using Constant Multiplier Technique with seed value 3579 and constant value 9753 chosen at random</b>			
Case	Maximum Records	Record retrieved using	
		Constant Multiplier Technique	Modified Constant Multiplier Technique
I	200	8	10
II	160	8	10
III	20	6	10
IV	15	1	10



**Fig. 1: Performance comparison of Mid-square Technique with modified Mid-square Technique**



**Fig. 2: Performance comparison of Mid-product Technique with modified Mid-product Technique**



**Fig. 3: Performance comparison of Constant Multiplier Technique with modified Constant Multiplier Technique**



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