IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388, p- ISSN: 2320-737x Volume 15, Issue 2 Ser. 2 (Mar. – Apr. 2025), 28-31
www.iosrjournals.org

Advancing Educational Research: Unveiling The Dynamics Of Multiple Matrices Sampling Technique

Kunuba, Agatha Chukwufumnanya
Department Of Science And Computer Education
Faculty Of Education, Godfrey Okoye University

Abstract
In educational research, sampling is one of the major aspects of fieldwork. Sampling techniques are used by researchers to select a subset of a population, study it, and draw inferences about the whole population. It means that the researcher does not have to study every member of the population before drawing conclusion. Having come across many studies, researchers rely solely on population sampling to measure performance or achievement, such as students, examinees, schools, etc., and neglect item sampling. In a situation where there are items and respondents, is it not possible to sample both? Depending only on the population can result in incomplete content coverage because using the same set of test items for all respondents may not cover the whole content area. This paper intends to address the problem of the sampling approach that depends only on a subset (like students or examinees) of a population. Hence, the paper presents an approach, multiple matrix sampling technique (MMS) which considers both items and respondents. It underscores item sampling whereby test items are divided into subsets and administered to groups of individuals that make up the entire population. It means that the population is divided into groups, and each of them is given a set of items. The paper among others recommended the use of multiple matrix sampling to researchers and schools for effective sampling and testing respectively.

Keywords: *Multiple Matrix Sampling, Item Sampling, Genuine Matrix Sampling, Partial Matrix sampling*

Date of Submission: 21-03-2025 Date of Acceptance: 31-03-2025

I. Introduction

In educational research, sampling is one of the most challenging part. It gives direction to the researcher on how to collect and collate data, and how to select the sample size. In sampling, according to Coulacogluo & Saklofske (2017), the researcher is faced with the challenge of having a large enough sample and representative of the population to be tested.

In measurement, techniques are instruments, tools or devices used in assessing individual's performance. The choice of sampling technique is essential. At the beginning of a research, the researcher should know the sampling technique to adopt and how to determine the sample size. This is in line with Singh (2006), who sees sampling as an indispensable technique of behavioural research, noting that research work cannot be undertaken without the use of sampling. The study of the total population is nearly not possible, and very complex. The concept of sampling has been introduced with a view to making the research findings economical and accurate. It is the process of selecting a representative group from a population under study, to study them (McLeod 2019). Sampling technique is, therefore, the method used in drawing a sample from the population. Multiple matrix sampling (MMS), though an approach, is one of the sampling techniques that focuses on sampling of both items and respondents. MMS is mostly adopted in quantitative research that is based on test items, large scale assessment of school achievement tests, and curriculum content coverage.

This paper attempts to present MMS as a technique that addresses the problem of sampling approach that depends only on a subset (like students or examinees) of a population, without sampling the test items. This is in line with Gonzalez & Rutkowski (2010), who noted that traditional approaches to sampling generally relied on sampling examinees from the population, but from a number of the initial investigations it was suggested that item sampling, in which a small subsets of the total available items are administered in groups to the entire population or multiple matrix sampling, could be an efficient and cost-effective way of assessing examinees and populations.

Multiple Matrix Sampling Technique

MMS is a technique whereby both the population of respondents and the universe of items are jointly sampled, that is, respondent sampling and item sampling. For instance, if there are 3,000 students in the population of study, 1,000 students can be randomly sampled in order to generalize their responses to the population. This

approach is called respondent sampling. On the other hand, randomly sampling of items from the total item pool (or universe) and administering them to all respondents of the population is called item sampling (Misanchuk 1977). MMS is, therefore, a combination of respondent sampling and item sampling.

MMS is a procedure that be used to achieve the content coverage of a subject and for reducing testing time. Shoemaker (2014) sustained that MMS is a psychometric procedure in which a set of test items is subdivided randomly into subtests of items with each subtest administered to different subgroups of examinees selected at random from the examinee population. MMS can, therefore, be called item-examinee sampling. When both items and examinees are sampled, it is an approach that Popham in Anigbo (2011) calls genuine matrix sampling.

The origin of MMS can be dated back to the early 50s when Turnbull, Ebel and Lord, researchers at the Educational Testing Service, adopted this technique for sampling items for and estimating the normative distribution of standardized tests. Though, it was Lord, Hooke and Tukey who developed the early statistical procedures for estimating population moments and other quantities from multiple matrix sampling designs. Thereafter, Shoemaker in 1973, wrote the first text which was entirely devoted to multiple matrix sampling, summarized the statistical methodology, including estimation and hypothesis testing, used in multiple matrix sampling designs and highlighted some of the procedural guidelines for implementing this technique (Gonzalez & Eltienge 2007).

Multiple matrix sampling of items is used for large scale assessments to accommodate a broad coverage of the content domain, so that items are administered to enough students without requiring so much testing time for any one individual student. Also, multiple matrix sampling of items also allows us to estimate proficiency distributions of the population, at the same time reducing individual examinee burden and testing time at the school and representing the assessment framework adequately (Gonzalez & Rutkowski 2010). This implies that large number of items do not affect the testing time with the application of MMS.

In MMS, subsets of items that are randomly sampled and are administered to randomly sampled examinees who respond to any of the subsets. Each examinee does not respond to all the subsets. That is, instead of all the examinees to take all test items, one approach to matrix sampling involves selecting a limited set of test questions in a way that allows evaluators to estimate results for the entire test. In other words, no individual examinee takes the entire exam (Jimenez and Boser, 2021). MMS is designed in such a way that every one of the examinees is administered only a portion of all the available items in the sample or assessment. Emaikwu and Nworgu (2015) found out from the studies they conducted, that tests designed to assess classroom achievement using multiple matrix sampling technique could provide nearly as accurate and valid information as could tests of the same length constructed in the traditionally manner.

There are three methods of matrix sampling: item sampling, partial matrix sampling and genuine matrix sampling. In the first method, subsets of the test package are administered to every examinee or group of examinees. In the second method, a subset of the package is selected to be common to all the examinees or groups, while the remaining subsets are then matrix sampled. In the third one, the examinees or groups of examinees are sampled so that only some of the students or groups take any test at all (Anigbo, 2011).

Steps in Multiple Matrix Sampling Technique

The first step is to construct a matrix containing all test items and all students. Step two is to choose between the models of matrix sampling to obtain overall test performance (Roeber 2015).

Illustration:

Let us demonstrate the three models of MMS, using the following data:

60 Christian Religious Studies multiple-choice items of Basic Education Certificate Examination, BECE (Enugu State Ministry of Education, 2024). Then, a sample of 126 Upper Basic III students, made up of three classes (41, 42, and 45) from one of the secondary schools in Enugu State, Nigeria, will be used.

Method One: Item Sampling

In item sampling, test items are divided into subsets, and group of examinees are randomly assigned to take only one of the subsets of the test package. This model, according to Anigbo (2011) saves time and ensures that all aspects of the curriculum are covered. However, comparing results across examinees or group of examinees poses a challenge which requires rigorous computations.

Table 1: *Item Sampling Table*

Students / Groups	Set 1 (Items 1-20)	Set 2 (Items 21-40)	Set 3 (Items 41-60)
Group A (41 students)	✅	❌	❌
Group B (42 students)	❌	✅	❌
Group C (45 students)	❌	❌	✅

✅ = Assigned Item Set

❌ = Not Assigned

Method Two: **Partial Matrix Sampling**

In this partial matrix sampling, a subset of the test package is selected to be common to all the groups of examinees. The remaining subsets are then matrix sampled. The common subset serves as an anchor and helps to improve comparability of students or group results, while the matrix-sampled items increase content coverage per testing time (Anigbo, 2011). This is illustrated below:

Table 2: *Partial Matrix Sampling*

Group	Common Items (All Groups Answer)	Matrixed Items (Unique to Each Group)	Total Items per Group
Group A	Items **1-20**	Items **21-33**	**33**
Group B	Items **1-20**	Items **34-46**	**33**
Group C	Items **1-20**	Items **47-60**	**34**
Total Items Administered	-	-	**100**

In the above table, items 1-20 are common across all groups. It means all the groups answered the items. Then the remaining 40 items (21-60) were matrixed into 13, 13, and 14. Each group answered a set of the common items and a subset of the matrixed items, which is unique to each group. Total items for group A, B, and C are 33, 33, and 34 respectively. Therefore, total items administered is 100.

Method Three: **Genuine Matrix Sampling**

In genuine matrix sampling, group of examinees are sampled in such a way that some of the examinees or groups take any test at all. Some groups are randomly selected to take the portion of the test items. In this type of sampling, both items and examinees are sampled. Below is the illustration:

Table 3: *Genuine Matrix Sampling*

Group	Assigned Item Package	Total Items per Group	Group Included?
Group A	Items 1-30	30	✅ Yes
Group B	Items 31-60	30	✅ Yes
Group C	Not Assigned	0	❌ No
Total Items Administered	-	60	-

In the table above, groups A and B will take the test while group C will not. Only a subset of items will be given to the sampled groups. Each of the sample groups receive a different subset of items, which means there are no common items. There are no matrixed sampled items, and no single examinee or group answered all the 60 items.

MMS like other test designs, have both advantages and disadvantages. Childs and Jaciw in Anigbo (2011) noted for instance, that testing time for an individual examinee is less than if each examinee received all the items, but the comparability of student scores may decrease. Also, curriculum coverage is maintained, but reporting of scores may be complex. According to Roeber (2015) Matrix sampling can be used when only an overall estimate of student performance is needed or desired because it may not be suitable in giving a detailed profile of the performance of a student or detailed item information from all students on multiple strands and content standards.

The most positive impact or beneficial effect of MMS is the reduction in the total amount of time needed for testing while still obtaining group-level estimates of students' performance. This can save assessment administration time and scoring time and reduce the costs of assessment without adding much to the data analysis and reporting tasks. If group-level data is all that is needed, then matrix sampling could be an attractive option for an assessment program (Roeber, 2015). In adopting the multiple matrixes sampling technique, there are two benefits that are usually borne in mind: content coverage and testing time (Anigbo, 2011). MMS technique is beneficial in sampling a large representation of content and reducing testing time which is exactly its purpose.

However, this paper has attempted to point out how MMS technique can help researchers, especially those who are involve in testing instruments, to sample items and respondents in measuring students' performance or achievement. *Genuine* MMS technique can be used for initial test administration and *partial* MMS technique for final test administration. MMS technique requires test items and respondents.

II. Conclusion

Multiple matrix sampling is a useful approach in educational research. It can be used to sample items and respondents, that is, the population. It is also an effective method for large scale assessment in schools, improves broad content coverage of curriculum and for reducing testing time given to examinees.

III. Recommendations

Based on the insights of this paper, the following recommendations are made:

1. Multiple matrix sampling will be beneficial to researchers for sampling items and respondents.
2. It will be useful to schools for sampling a large representation of content and reducing testing time.
3. Among the three types of multiple matrix sampling, partial and genuine matrices sampling will be more operative to the to researchers or schools.

References

[1] Anigbo, L.C. (2011) Demonstration Of The Multiple Matrices Sampling Technique In Establishing The Psychometric Characteristics Of Large Samples. Journal Of Education And Practice 2(3) 19-25.
[2] Coulacogluo C., & Saklofske, D.H. (2017). Recent Advances In Psychological Assessment And Test Construction. Psychometrics And Psychological Assessment, 3-25. Https://Doi.Org/10.1016/B978-0-12-802219-1.00001-8
[3] Emaikwu, S.O. & Nworgu, B.G. (2015). Relative Efficiency Of Four Multiple Matrix Sampling Models In Estimating Aggregate Performance From Partial Knowledge Of Examinee. The Siberian Academic Forum, 9(4) 1-13. Http//Www.Globalacademicgroup.Com/Journals
[4] Gonzalez J.M., & Eltinge J.L. (2007). Multiple Matrix Sampling: A Review. Https://Stats.Bls.Gov/Cex/Cesrvymethsgonzale3.Pdf
[5] Gonzalez, E. & Rutkowski, L. (Eds.) (2010). Principles Of Multiple Matrix Booklet Designs And Parameter Recovery In Largescale Assessments. Educational Testing Service. Https://Core.Ac.Uk/Download/Pdf/234633146.Pdf
[6] Jimenez, L., & Boser, U. (2021). Future Of Testing In Education: The Way Forward For State Standardized Test. Http://Learningportal.Iiep.Unesco.Org/En/Library/Future-Of-Testing-In-Education-Artificial-Intelligence
[7] Mcleod, P. (2019). Sampling Methods/Types And Techniques Explained. Https://Www.Simplypsychology.Org/Sampling.Html
[8] Misanchuk, E.R. (1977) Multiple Matrix Sampling Applied To Needs Analysis: An Introduction And Assessment Of Efficacy. Https://Www.Semanticscholar.Org
[9] Roeber, E. (2015). What Does It Mean To Use Matrix Sampling In Student Assessment? Http://Michiganassessmentconsortium.Org/Wpcontent/Uploads/Thinkpoint_Matrixsampling3.Pdf.Pdf
[10] Shoemaker, D.M. (2014). Multiple Matrix Sampling. Wiley Statsref: Statistics Reference Online. Https://Doi.Org/10.1002/9781118445112.Stat02622
[11] Singh, Y.K. (2006). Fundamentals Of Research Methodology And Statistics. New Age International Publishers.