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FUNCTION AND SAMPLE SELECTION IN EDUCATIONAL RESEARCH

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Abstract. *Inferential statistics are based on part (sample) units selected from the entire set of statistics, with which through the application of appropriate statistical methods and techniques make statistical conclusions about the entire event. Patterns lead to the evaluation of the ability of the basic set, a statistical method used to determine the reliability and accuracy of these estimates. All these actions make a method that is called a representative sample method or methods. The authors of this paper are interested in the sampling method, because it is often used in educational research, and not enough is known to researchers and students. Therefore, it is necessary to first clarify the basic concepts of the method, as well as the basic generalization in a hypothetical population.*

Key words: *method of sample population, inferential statistics, educational research.*

INTRODUCTION

Inferential statistics are based on the use of numbers in numerical order to obtain information about a larger group than the one from which the original data are obtained. Inferential statistics include statistics that deal with drawing inferences about the appropriate values, characteristics, patterns and relationships as well as the statistical characteristics of the basic set, based on numerical data obtained by observing and measuring the characteristics of a representative sample of research units (Kundačina and Brkić, 2004: 14). The term *inferential statistics* derived from the notion of inference implies conclusion by induction or deduction. Inferential statistics belong to the set of inductive methods, which are deduced starting from the special to the general. The main stages of statistical research include: 1) statistical observation, 2) grouping (tabular and graphical representation of statistical data), and 3) statistical analysis and interpretation of the results of the analysis (Maksimović, 2010; Kožuh & Maksimovic, 2011).

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Statistical analyses based on complete observation imply access to information about each statistical unit of the observed phenomena. Complete information on the characteristics of the population that is just a list of statistics, which requires a lot of time and creates high cost, especially when dealing with large basic sets. We provide complete observation and analysis on the basis of such complete information about basic events, which allows us to give a number of their characteristics, indicate why such observations are performed only occasionally or try other methods as possible replacements.

THE MAIN POPULATION AND SAMPLES

Populations in the research are called statistical populations, or survey populations. In statistics, the statistical population includes all of the units that demonstrate the feature of the subject of research. Defining the population is achieved by enumerating the statistical units. During the research, there are often opportunities to include all of the statistical units, and if so, it is a costly and lengthy process. Units in the population are called statistical units or entities that differ according to their characteristics, known as attributes or variables. The population is the set of all the units (elements) with different characteristics (features).

In pedagogy, empirical research is not rare, and it examines dozens of variables, not rarely hundred or several hundreds of variables. Also, we are rarely interested in only one variable, so we always have data for several variables. For example, if the survey explored the attitudes of teachers (students, parents, and so on), it would never do a single poll question, and avoid studies that survey a hundred questions (and more). The same is true for other data collection procedures.

Very often, for various reasons we cannot collect data for all the units of the population. In such cases, we choose from just a small part of the population, but we are essentially interested in the entire population. All the research questions related to the population are more numerous than one can actually explore. In this case, the entire population will use the statistical term primary or basic set of populations. Thus we emphasize that we are interested in the population and that it is the subject of the research. A smaller part of the population, selected from the compiled data, we will call a short sample. The sample is a part of the basic set and based on its studies draws conclusions about the entire basic set, i.e. the part of the basic set used to estimate the parameters of the basic set. Based on the sample, we attempt to determine what the average population is. Our goal is to explore the basic population, and the sample is only a means of achieving that goal. If we have data for the whole population, the sample is not required, and we do not call this population an average population.

Some research is done on entire populations, but most are still carried out on the samples. Research on patterns includes the following:

1) defining the general population,

2) the selection of one or more samples from the general population and

3) the use of statistical methods, which allow generalizations from the sample to the population base.

REASONS FOR SAMPLING

Research populations in educational work are not always readily available. There are three main reasons why more pedagogical research is done on the samples rather than the whole population.

First of all, the general population can be very large. In Serbia, there are over 600.000 primary school students (in China over one hundred million). Of course, we rarely want to include students of all grades from the age of six to fifteen in the research. Only an eighth-grade student population is too large for empirical research. Also, we can say that the population of children's newspaper readers, all the graduates of one school year, and so on, is also too large. When the population is too large for basic research, we choose only a smaller part of it - a sample.

Secondly, general populations are often geographically dispersed. There are approximately 100 directors of high schools but they are dispersed all over Serbia. The number of the population is not too great an obstacle for empirical research, but geographical complexity is. In a survey by mail, the research could include all the directors. If we wanted to interview directors directly, then they would have to travel all over the country - to some places because of only one director. When the main population is geographically dispersed too, we choose to study only a smaller geographic area (for example, managers in the Belgrade region or in the Niš region, Bačka region, and so on). Thirdly, the overall population in educational research often occurs in successive generations. The population of students which covers several generations of graduates from a single department at the time could be of great importance for pedagogy research. If we want to include the entire study population, we need to repeat much of the research process each year of the program. Only after the last generation do we have a data base for the entire population and only then can we process the collected data and conclude the study. When the main population comprises several generations, we usually choose to explore a generation (or part of a generation).

For various reasons, educational research cannot cover the entire base set of studied cases, only part of the basic set (pattern), and a researcher on the basis of the findings obtained by examining the sample tends to draw a conclusion about the basic population. Based on the findings obtained in the research, the researcher attempts to predict cases not covered by the survey. We are essentially interested in the basic population and not the sample. The entire issue of the research, and all the research questions, relate to the population (Table 1). General questions are usually broken down into more detailed questions. This should reflect statistical terms.

Table 1. Research questions

General research questions	Detailed research questions
What is the main population?	What is the arithmetic mean of the general population? What is the percentage of a phenomenon in the primary population? What is the population variance in the primary? What is the coefficient of correlation between the two variables in the population base?
Does the general population differ?	Do you mean basic populations differ? Does the percentage of a phenomenon in the general population differ? Does the variance of basic populations differ? Do the correlation coefficients in the general population differ?

Most often we want to find out which is the value of a parameter in the primary population. If we have a data base for the population, then we simply need to calculate the parameter. Since we have no data to base the population on, we have based it on the parameters of the sample to estimate what the primary parameter in the population is. Such a procedure is called generalization parameter estimation. In addition, a question that often arises relates to whether the general populations vary. In the simplest form, these issues are related to both the general population (for example, if the average tuition fee is different at a faculty of philosophy and a faculty of economics). At the start of this process we hypothesize that the general population does not differ. In that case we will have two samples and on the basis of the difference between these two samples we will try to determine whether the general population differ. Such a procedure is called generalization hypothesis testing.

A REPRESENTATIVE SAMPLE

An suitable sample must fulfill the principles of impartiality, efficiency and representativeness. Impartiality implies the equal probability of each of the elements entering into the sample. It is achieved by way of the method of sample selection developed in statistical practices, which are based on probability theory and random settings, through combining elements. Cost effectiveness is the principle that imposes financial and time constraints. A large sample requires more financial and human resources, and time for the interview. The principle of economy is fundamentally at odds with the principle of representativeness. Representativeness means that the sample should include statistical units that will not have all the features of the basic set, i.e. those units whose characteristics, when counted or measured and calculated from their corresponding parameters (mean, standard deviation) are same or nearly the same as the real parameters of the basic set. The representativeness of the sample is achieved through adequate sample size and the objective method of sample unit selection. Determining the appropriate sample size is one of the most important tasks in the study, which can significantly influence making accurate conclusions.

The most important thing when choosing a sample is to ensure proper representation. The sample will be representative if its major characteristics are similar to the population from which it was elected, or if the sample is a thumbnail of the basic set. The representativeness of the sample is achieved by the proper selection of elements of the basic set. A representative sample accurately reflects the structure of the population it represents. Sampling units are a typical unit of population. Together they make up a small population, and conclusions can be generalized from the sample to the population. Data obtained by observations and measurements are processed to obtain the characteristics of the sample with which to assess the characteristics of the basic set. Patterns lead to the evaluation of the ability of the basic set, through a statistical method used to determine the reliability and accuracy of these estimates.

Given the fact that the only units in the sample are from the general population, the pattern still looks like a basic population and this similarity has to be as large. The more basic pattern resembles a population that is more representative. The goal of each study is that the findings of the primary population, obtained from the sample, are as regular and

reliable as possible. So it is good to have higher sample representativeness. Usually it is not enough that the sample resembles the basic population in only one characteristic (variable). We want to be related to the similarity between all the variables that we have studied, and the best of all the variables - and the ones that are not the subject of research. To facilitate the understanding of the situation in the following sections we will simplify the process.

The representativeness of the sample affects three main factors:

1. *The confidence level*

In practice, the most commonly used confidence levels are p = 0.95 (95%) and p = 0.99 (99%), which correspond to a standardized z-value of ± 1.96 and ± 2.58 (for the sake of simplicity often taken as values z 2 and 3). If we want a higher level of reliability, it is required that the sample is higher, and vice versa.

2. *Variability in the primary population*

The variability of the basic set is estimated from the SD of the sample from which to calculate the standard error of the basic set. The greater the variability of characteristics, the less homogeneous the set, and the corresponding accuracy and reliability estimates require a larger sample.

3. *The maximum permissible error*

The maximum permissible error is determined by the center point of the series and the largest deviations from it in one direction. That is, it is the maximum error that the researcher is willing to tolerate. A small permissible error requires a larger sample and vice versa.

If the primary units in the population differ, then the units included in the sample will vary. Thus the sample will differ from the general population. If the basic unit of population varies it is more distinct from the pattern of the general population. In this case, it is less representative. If, however, the differences between the units are small, then the sample is slightly different from the general population (and its representative). Imagine the extreme case that all units are in the same population base. Then make all the units in the sample identical and the pattern cannot be different from the general population (of course - just for that one variable). The representativeness of this sample would be complete. In this case, all the same units are included in the sample because all the samples were identical. Then the sample size would not affect the representativeness.

The greater the part of the general population selected for the sample, the more the sample will reflect the population base. A representative sample will be the smallest, as it has only one unit (one sample). The biggest will be the representative sample that includes all the basic units of the population (the sample and the general population are identical). In this case, the representation of the ideal (complete), and the sample were identical in the entire elementary population. Based on representation, this is the best solution, but in this case the sample does not bring any benefit. When planning the sample size, one should always take into account both traits - the representativeness and effectiveness. In educational research, samples often comprise only a few percent of the general population unit (and often less than one percent).

The problem of representativeness is at first glance very simple: the sample is necessary to select the units that will best represent the base population. But what are the units? Of the primary population, namely, we know almost nothing. If we have a basic command of the population, then we do not have the required pattern. What the main population is, we will find out only on the basis of the sample (not very accurately). So the weighing and

judging of the basic unit in the population to choose a pattern is not at all out of the question. How do we choose the units in the sample? In practice, there are many ways to use units.

THE SAMPLING METHOD

The choice of the study population (sampling) is very complex and responsible task of every researcher. Due to the sampling method, sampling from the population or a dial sample, we distinguish between probability samples, which are based on probability theory and improbabilistic samples, which are not based on probability theory (Kožuh, 2003; Kundačina and Brkić, 2004; Kundačina, 2010: 9-22).

The samples based on the theory of probability (probability samples) are: the simple random, stratified, systematic and aggregate sample (cluster sampling). The simple random sample is selected randomly, using a table of random numbers and, more recently, a computer. Samples were made in such a way that each member of the population has roughly the same probability of being a member of a sample. A prerequisite for the formation of a random sample is to have a list of all the members of the population. A systematic sample is obtained by taking every nth member of the population at equal intervals, starting from randomly selected starting point. Systematic sampling is a variant of simple random sampling, which is often used. For example, if we have a target population of 6000 members, and we want to make a sample of 2000, we selected every 30^{th} member (600 divided by 200). Stratified sampling occurs when the researcher knows the variables that are from different members of the population (as is the case with the demographic variables in the surveys). Categories of such variables are called strata, and the population is said to be stratified. Election of the members of the sample is done randomly, but specifically within each stratum. Based on the method for determining the number of members within each stratum, the difference between: 1) proportional selection (the same ratio as in the population), 2) disproportionate (opposite proportional), 3) parity selection (each stratum is given the same weight). The cluster or aggregate sample is used when the members of the population are grouped hierarchically into organized clusters.

Improbabilistic samples have been prepared on the basis of appreciation (at the discretion of) researchers concerning which members should be included in the analysis. These patterns are not based on probability theory and also called non-random samples. Most frequently used improbabilistic samples are the occasional specimens "at hand" - friends, passers-by, nearby school students, deliberate patterns when the researcher intentionally selected a sample, individuals, groups, variables, which in his judgment and opinion, best fit and contribute to the implementation of research and the quota samples formed in the stratified populations, usually via a proportional sample. The difference compared to the stratified random sampling is that the selection is done appropriately and not by chance, with the odds "meet".

LARGE AND SMALL SAMPLES

Numerous patterns in educational research are usually from fifty to several hundred. Samples with more than a thousand units are rare indeed. If we wanted to collect the reviews of students in the transition from lower grades to higher grades of elementary

school in a survey, it would not be a problem to collect data for a sample that had a few thousand units. Data could be obtained in the form of printed documents from the school, so it would be almost the same whether a school would take only a few students, or everyone. That would mean a little more work when printing and data entry into the computer. In such cases, we may opt for very large samples. Given that studies rarely include such simple empirical data, large samples are not very common. Frequently numerous samples do not exceed a few hundred units.

Without much evidence, it is clear that the basic population generalization is more reliable as larger samples (from this point of view it is best to take the whole sample as a base population). Economy, on the other hand, speaks in favor of the smaller samples. The final decision depends on the circumstances in each survey.

Small samples require greater vigilance and therefore greater consistency in the consideration of all the circumstances of the investigation. According to theory, large and small samples have to use the same statistical methods. However, practice has shown that procedures for the larger samples can be simplified. Where warranted and possible, we do so indeed. Therefore, in practice, different methods are used for large and small samples. But in fact there is no single sharp boundary. For some procedures that limit is thirty (samples with less than thirty units are treated as small, with more than thirty units as large) for some procedures that limit is fifty, and one hundred for some items (and even more).

For small and large samples we can use rigorous methods: which type of sample is mandatory is a big decision. Programs for processing data using unique methods, but without a computer for processing, usually involve large samples, but still prefer the simplified method. To put it simply: if a method is valid for small samples, then it is also valid for big ones - given that at least a few of them exist (that are at least that "good"). Vice versa does not hold, since what is allowed for large samples is not always allowed for small ones.

All the mass use of computers for statistical analysis of the issue of different methods for large and small samples has become almost completely irrelevant and is not a current issue. Just a few decades ago, the statistics textbooks included a detailed description of both methods. Simpler methods for large samples are described primarily for ease of understanding, as more complex methods, after all, are valid for both small and large samples.

DEPENDENT AND INDEPENDENT SAMPLES

When comparing the basic populations, we are also faced with the choice of the dependent and independent samples. When the selection of the sample from the second population does not take into account the procedures for sample selection from the first population then we get independent samples. Such samples usually have different numbers.

Dependent samples, when we get the choice of a second sample, take into account the election of the first sample. Frequently paired samples are obtained in two ways:

1) For the first general population we choose a unit for the first sample. After that, the second primary population looks like that unit. These two units are a very balanced couple. The second unit is in the second sample. So we take pairs and divide them into two samples until we get the desired sample size. These samples are dependent. The results of one sample are dependent on the results of the other one. The samples consist of the same

number of pairs. This process is called selection by pairs or by equating pairs. When the unit first sample is selected from the lot, the others can also be chosen. These are not random samples. They are used for special purposes, usually when we want to get two very equal groups. Equal groups at the beginning of an educational process provide a better comparison at the end of the process. Therefore, paired samples are rarely chosen in the manner described above. Usually the pairs are chosen from a population, and then after that they are split into two groups. These groups are subsequently treated as samples from two hypothetical populations. Because the samples are dependent, this is a special case of deliberate choice. In essence, the procedure is based on a tendency to equate the samples, and this process is called equalization in pairs.

2) The same participants can be measured twice (testing or interviewing skills) prior to any of the educational process and following them. Thus, each student is a pair with itself. The students at the first measurement are treated as the first sample and the second measurement as a second sample. These samples are dependent, especially because there is a greater degree of similarity and dependence than for the equalization of pairs. Dependent samples differ not only independently in terms of selection but also based on the results. The main difference is that the standard errors for the dependent samples were less than for the independent ones. That benefit is greater, as the pairs are more even. The pairs can be studied based on the amount of the correlation between the results from both samples (which is a better managed equation, the higher the correlation coefficient). Given that the equation of pairs is a demanding job, it is rarely done for large samples.

CONCLUSION

Research is carried out on samples from a population of entities. Entities are usually people involved in educational research, which is the term used for respondents. Samples in educational research can be various, activities, curriculums, teaching materials, resources, time, and more. The choice of the sample depends on the type of research being conducted. In experimental studies, a small number of participants is involved, due to the conditions under which the experiment is conducted. However, in non-experimental studies that include large samples, not all the members of the studied population are included. Educational research is based on the sampling method. For various reasons, in most cases, the research cannot be included in the entire base set, but only a part of the basic set, and a researcher on the basis of the findings obtained by examining the sample tries to infer the entire basic set. Based on the findings obtained by the research, the researcher is trying to predict cases not covered by the survey.

The selection of the sample should be done carefully because the characteristics depend on the ability to generalize the results of a population based on the principle of representativeness. The aim of using the study sample instead of the population is to obtain results that reflect the value of the entire population.

In most textbooks on educational research methodology and educational statistics, the sample size is discussed only in terms of a simple random sample. Sample selection has a significant impact on the quality of research. In the research conducted in schools, minimal attention is devote to the sampling method because the goal of the research is the improvement of educational practice, rather than the determination of the regulations and the science of education.

REFERENCES

1. Kožuh, B. (2003): *Statistične metode v pedagoškem raziskovanju*, Ljubljana: Filozofske fakultete Univerze v Ljubljani.
2. Kožuh. B. i J. Maksimović (2009): Obrada podataka u pedagoškim istraživanjima. Niš: Filozofski fakultet.
3. Kožuh. B. i J. Maksimović (2011): Deskriptivna statistika u pedagoškim istraživanjima. Niš: Filozofski fakultet.
4. Kundačina, M. (2010): Funkcija, izbor i formiranje uzorka istraživanja. *Zbornik radova Učiteljskog fakulteta, Užice*, (12), 9-22.
5. Kundačina, M. i M. Brkić (2004): Pedagoška statistika. Užice: Učiteljski fakultet.
6. Maksimović, J. (2011): Innovation in higher education using SPSS program, "Transnational Sustainable Methods for Quality Increase in Higher Education", International Scientific Conference, Timisoara, Romania, str. 38-46.
7. Maksimović, J. (2010): Statistička metoda u pedagoškim istraživanjima, Pedagoška stvarnost, 56(3-4), Novi Sad, str. 207-215.

FUNKCIJA I IZBOR UZORKA U PEDAGOŠKIM ISTRAŽIVANJIMA

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Inferencijalna statistika temelji se na delu (uzorku) jedinica izabranih iz čitavog statističkog skupa, pomoću kojeg se uz primenu odgovarajućih statističkih metoda i tehnika donose zaključci o čitavom statističkom skupu. Uzorkom se dolazi do procene karakteristika osnovnog skupa, a statističkom metodom određuje se pouzdanost i preciznost te procene. Svi ti postupci čine metodu koja se zove metoda uzorka ili reprezentativna metoda. Autore ovog rada interesuje metoda uzorka, zato što se često koristi u pedagoškim istraživanjima, a nedovoljno je poznata istraživačima i studentima. Zbog toga je potrebno na početku razjasniti osnovne pojmove ove metode, kao i generalizacije na hipotetsku osnovnu populaciju.

Ključne reči: *metoda uzorka, populacija, inferencijalna statistika, pedagoška istraživanja.*