FACTORS THAT INFLUENCE SAMPLE SIZE IN EDUCATIONAL RESEARCH

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Abstract
Many researchers agree that sample size has a two-fold role in research: sample size is inter-connected with statistical analysis of the data and generalisation. Therefore, sample size has attracted a lot of research efforts in all the research fields including educational research. However, little attention has been given to the analysis of factors that influence sample size in educational research. The research question is as follows: what factors influence sample size in educational research? The aim of the research is to analyze factors that influence sample size in educational research underpinning elaboration of a new research question for further studies in educational research. The present research involves a process of analysing the meaning of the key concepts statistical analysis, generalisation, population, sample, measurement procedures, probability sample, information-oriented sample, case and factors. Moreover, the study demonstrates how the key concepts are related to the idea of “sample size”. Explorative research was employed. Interpretive research paradigm was used. The empirical study involved four experts from different countries in February - April 2013. The findings of the research allow drawing the conclusions on factors that influence sample size. Directions of further research are proposed.

KEYWORDS: generalization, population, sample, sample size, measurement procedures, probability sample, information-oriented sample, case, factor.

Introduction
Sampling focuses on obtaining a group of subjects who will be representative of the larger population or will provide specific information needed (J. H. McMillan, 1996, p. 86). The goal is to select a sample that will adequately represent the population, so that what is described in the sample will also be true of the population (J. H. McMillan, 1996, p. 86). It should be noted that, in educational research, the best procedure for selecting such a sample is to use probability sampling as non-probability sampling does not ensure the construction of a parameter for a population. Moreover, the primary distinction between the two domains is that the probability sampling study findings can be generalized to the target population while the nonprobability sampling study findings can only be generalized to the institution where the sample was studied (S. Summers, 1991, p. 355). The key characteristic of a probability sample is that each element in the population has a known probability of being included in the sample (D. Sweeney, 2013). The probability sampling procedures include simple random, systematic, stratified, and cluster (J. H. McMillan, 1996, p. 87) as demonstrated in Figure 1.

Figure 1. Probability sampling procedures

The process of sample selection reveals such an issue as sample size. Therefore, sample size has attracted a lot of research efforts in all the research fields:
- In farmer surveys, sampling methods which range from the practical to the mathematical are focused on good practical points (R. Coe, 1996, p.1).
- In organizational research, the procedures for determining sample size for continuous and categorical variables have been described by use of Cochran’s (1977) formulas (J. E. Bartlett, J. W. Kottrlik, C. C. Higgins, 2001, p. 43).
In management and economics research, the emphasis is put on analysis of factors influencing sample size (Kamau, C. Guandaru, Kariuki, S. Nduati, 2012, p. 42).

In psychological research, analysis of selection of sample size has contributed to the outline of three criteria of sample size (A. Kroplijs, M. Raščevska, 2004, p. 76-77).

Psychological research and educational research are closely inter-connected as depicted in Figure 2.

**Figure 2. Inter-relationship between psychological and educational research**

Therein, psychological research provides the basis for pedagogical and, consequently, educational developments in terms of organization of educational environment, curriculum, institution activities, and etc., and, in its turn, educational research facilitates the promotion of psychologists’ professional knowledge, competences and behavior aimed at ensuring new discoveries, innovations, etc.

Thus, in psychological and, consequently, educational research, selection of sample size is identified by the application of three criteria of sample size (A. Kroplijs, M. Raščevska, 2004, p. 76-77) such as:
- first, effort quantity or intensity of interaction with sample components (participants in educational research) or elements (subjects in educational research), and
- second, a number of topics investigated within a particular educational research, and
- third, subject matter within a particular research.

Hence, sample size has a two-fold role in research as depicted in Figure 3: sample size is interconnected with:
- statistical analysis of the data and
- generalisation or theory formulation.

**Figure 3. Relationship between sample size and statistical analysis of the data and generalization in research**

In educational research, sample size has attracted a lot of research efforts, too. Traditionally, selection of sample size refers to empirical studies of educational research as illustrated in Figure 4.
However, little attention has been given to the analysis of factors that influence sample size in educational research.

**Methods and methodologies**

The research question is as follows: what factors influence sample size in educational research?

The aim of the research is to analyze factors that influence sample size in educational research underpinning elaboration of a new research question for further studies in educational research.

The present research involves a process of analyzing the meaning of the key concepts statistical analysis, generalisation, population, sample, measurement procedures, probability sample, information-oriented sample, case and factors. Moreover, the study demonstrates how the key concepts are related to the idea of “sample size”. The study presents how the steps of the process are related: sample size → factors that influence sample size in educational research → empirical study within a multicultural environment.

The methodological approach of the present research is determined as the development of the system of external and internal perspectives. Whereas the external perspective accentuates social interaction of development, the internal perspective focuses on cognitive activity (S. Surikova, 2007, p. 343). The methodological approach of the present research, namely, the development of the system of external and internal perspectives, is based on the System-Constructivist Theory. The System-Constructivist Theory is introduced as the New or Social Constructivism Pedagogical Theory. The System-Constructivist Theory is formed by
- Parsons’s System Theory (T. Parsons, 1976) on any activity as a system,
- Luhmann’s Theory (N. Luhmann, 1988) on communication as a system,
- the Theory of Symbolic Interactionalism (G. Mead, 1973),

The System-Constructivist Theory implies the dialectical principle of the unity of opposites that contributes to the understanding of the relationship between external (social, social interaction, teaching, etc) and internal (individual, cognitive activity, learning, etc) perspectives as the synthesis of external and internal perspectives (O. Bassus, J. Zaščerinska, 2012, p. 3). In comparison, the Constructivism Theory focuses on the internal perspective, the Social Constructivist Theory – on the external perspective as well as on the balance between the balance between the external and internal perspectives (O. Bassus, J. Zaščerinska, 2012, p. 3). The application of this approach to learning introduced by Reich (Reich, 2005) emphasizes that human being’s point of view depends on the subjective aspect (E. Maslo, 2007, p. 39):
- everyone has his/her own system of external and internal perspectives (A. Ahrens, J. Zaščerinska, 2010, p. 182) that is a complex open system (I. Rudzinska, 2008, p. 366) and
- experience plays the central role in the knowledge construction process (E. Maslo, 2007, p. 39).

Therein, the subjective aspect of human being’s point of view is applicable to the present research to analyse factors that influence sample size in educational research.
Results

Theoretical Framework

Factor is a reason of the research subject change (A. Lasmanis, 1997, p. 37). Factors are differentiated into external and internal as depicted in Figure 5.

![Figure 5. Types of factors](image)

External factors in educational research are surroundings (A. Lasmanis, 1997, p. 37) and resources. Internal factors in educational research are the aims of the researcher’s action, motivation, interest, skills and experience (A. Lasmanis, 1997, p. 37). As the researcher’s action requires a strategy, the internal factors are complemented by the researcher’s choice of the research methodology. It should be noted that the research methodology is differentiated into

- quantitative methodology that requires large, representative and precise sample, and
- qualitative methodology that is based on a small and non-representative sample.

Another internal factor that shapes educational research in general and sample size in particular is determined to be an educational research paradigm (P. C. Taylor, & M. N. D. Medina, 2013) chosen by the researcher. It should be noted that a paradigm is defined as a comprehensive belief system, world view, or framework that guides research and practice in a field (J. W. Willis, 2007, p.8). Such educational research paradigms are identified (P. C. Taylor, & M. N. D. Medina, 2013) as

- the positivist paradigm that is commonly used in research to test theories or hypotheses,
- the post-positivist paradigm that includes the analysis of interaction between the researcher and his/her research participants via use of such quantitative methods as survey research and qualitative methods as interviewing and participant-observation (J. Creswell, 2008),
- the interpretive paradigm which aims to understand other cultures, from the inside through the use of ethnographic methods such as informal interviewing, participant observation and establishment of ethically sound relationships,
- the critical paradigm which involves identifying and transforming socially unjust social structures, policies, beliefs and practices,
- the postmodern paradigm which holds that what goes on in our minds and hearts is not directly accessible to the world outside us,
- the multi-paradigmatic research by combining methods and quality standards drawn from two or more of the newer paradigms, and
- the new ‘integral paradigm’ that provides a rationale for drawing upon multiple paradigms to design new hybrid methodologies that involve multiple epistemologies and their accompanying quality standards.

Analysis of research results on selection of sample size reveals that external factors that influence sample size in educational research involve

- access to the sample which is a key issue that must be decided in research in order to determine the sample size (L. Cohen, L. Manion, K. Marrison, 2003, p. 109),
- resources such as time, personnel, technical support, competences, experiences, etc (U. Flick, 2004, p. 151).

It should be noted that research proposals are frequently based on an unrealistic relationship between the planned tasks and the personnel resources that can (realistically) be asked for (U. Flick, 2004, p. 151).

Table 1 demonstrates the factors that influence sample size in educational research outlined by the means of the analysis of research results on selection of sample size.
Table 1. Factors that influence sample size in educational research

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In order to reveal further factors that influence sample size, the present part of the contribution analyses the inter-relationships between
- sample size and statistical analysis of the data as well as
- sample size and generalization.

For the analysis of the relationship between sample size and statistical analysis of the data, statistical analysis is identified as the unity of the collection and processing of data and the results’ interpretation as demonstrated in Figure 6.

![Figure 6. Elements of statistical analysis](image)

Below the relationship between sample size and each element of statistical analysis is revealed. Data collection implies use of measurement procedures as depicted in Figure 7.

![Figure 7. Relationship between data collection and measurement procedures](image)

For the analysis of the relationship between sample size and measurement procedures, in the present research, by measurement procedures, measurement tools and scale are meant as shown in Figure 8.
Measurement tools such as questionnaires as well as measurement scales are fixed on one sample and tested in a new sample (G. Gigerenzer, 2004, p. 603) as measurement tools and/or scales have to be cross-validated in order not to provide non-precise data. Therein, a sample is to be of such a size as, in the measurement phase of the empirical study within educational research, the parameters of measurement tools and scales are kept fixed when used by sample’s further components or elements. Thus, Table 2 shows the external factors that influence sample size in educational research complemented with measurement procedures.

Table 2. Complemented factors that influence sample size in educational research

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Traditionally, data processing includes two methods (A. Geske, A. Grīnfelds, 2006, p. 58) as illustrated in Figure 9:
- method of descriptive statistics and
- method of inferential statistics.

Figure 9. Two methods of data processing

Figure 10 demonstrates methods of descriptive statistics (A. Geske, A. Grīnfelds, 2006, p. 58).
Figure 10. Methods of descriptive statistics

Figure 11 shows elements of central tendencies (A. Geske, A. Grifnelds, 2006, p. 58).

Figure 11. Elements of central tendencies

In its turn, Figure 12 demonstrates methods of inferential statistics (A. Geske, A. Grifnelds, 2006, p. 59) in educational research.

Figure 12. Methods of inferential statistics

In educational research such a method of inferential statistics as significance test is closely interconnected with sample size while null hypothesis testing relates to two measured phenomena, and variance analysis – to a variable's values.

For the analysis of the relationship between sample size and significance test, a sampling distribution is required. Sampling distribution is connected with probability distribution: the sampling distribution of the mean is a probability distribution of the possible values of the mean that would occur if we were to draw all possible samples of a fixed size from a given population (M. Plonksy, 1997). Knowledge of the sampling distribution is necessary for the construction of an interval estimate for a population parameter (D. Sweeney, 2013). This is why a probability sample is needed; without a probability sample, the sampling distribution cannot be determined and an interval estimate of a parameter cannot be constructed (D. Sweeney, 2013).

Sampling distribution is usually examined by the Kolmogorov-Smirnov test. Statistical Package for the Social Sciences Exact Tests also offers the asymptotic version of the Kolmogorov-Smirnov test to reach correct conclusions with small samples (Statistical Package for the Social Sciences (SPSS), 2009, p.
1. A sampling distribution is considered within the framework of deviation of the empirical distribution. Deviation of empirical distribution is significant if Significance \( p \) or Asymp. Sig. (2-tailed) is smaller than 0.05 (A. Lasmanis, 2003, p. 18). The Kolmogorov-Smirnov test identifies that
- if the deviation of empirical distribution is greater than 0.05, sampling distribution is normal, or
- if the deviation of empirical distribution is smaller than 0.05, sampling distribution is non-normal.

Further on, normal empirical distribution implies the use of parametric methods in the empirical study, and non-normal empirical distribution - the use of non-parametric methods.

However, the use of normality tests does not determine automatically whether or not to use a parametric or non-parametric test: they can help make the decision (GraphPad Software, Inc., 2007, p. 1). For example, non-parametric tests have little or no power to find a significant difference if there is a tiny sample (a few subjects in the group) (GraphPad Software, Inc., 2007, p. 1): a small sample involves smaller than 30 subjects in the group (I. Arhipova, S. Bāliņa, 2003 p. 99).

In comparison to theoretical sampling which relates not to the sample size determination, but to the analysis of the necessity in the increase of the sample size for the enrichment of theory developed from the data obtained in a previous sample (A. Kroplijs, M. Raščevska, 2004, p. 77) in psychological and, consequently, educational research, empirical sampling distributions are not true sampling distributions, since
- all possible samples are not chosen (M. Plonsky, 1997),
- some differences exist between any natural groups (G. Gigerenzer, 2004, p. 600).

Therein, a sample is to be of such a size as, in the data processing phase of the empirical study within educational research, the tests carried out on a given set of data allow extracting the required information in an appropriate form such as diagrams, reports, or tables. Thus, data processing refers to the internal factor, namely, research methodologies.

For the analysis of the relationship between sample size and results’ interpretation, interpretation (O. Krasnopjorovs, 2014) and judgment are part of the art of statistics (G. Gigerenzer, 2004, p. 604). Thus, a sample is to be of such a size as, in the statistical analysis phase of the empirical study within educational research, the information extracted from the obtained data processing ensures a possibility to make conclusions and generalisations.

For the analysis of the relationship between sample size and generalisation, generalisation is traditionally considered as a central aim of science, as a process of theory formulation for further applications (P. Mayring, 2007, p. 1). Types of generalisation are differentiated (P. Mayring, 2007, p. 3-4) into eight different types: universal laws, statistical laws, rules, context specific statements, similarities and differences, descriptive studies, explorative studies, and procedures to come to results as illustrated in Figure 13.

[Figure 13. Eight types of generalisation]

Generalisation can be arrived by different strategies which also include analysis of total population and samples (P. Mayring, 2007, p. 1). Therein, Figure 14 demonstrates that sample is part of population.
A population is a group of elements or cases, whether individuals, objects, or events, that conform to specific criteria and to which we intend to generalize the results of the research (J.H. McMillan, 1996, p. 85). This group is also referred to as the target population or universe (J.H. McMillan, 1996, p. 85). It is also important to distinguish the target population from a list of elements from which a group of subjects is selected (J.H. McMillan, 1996, p. 85). The list is termed the survey population or sampling frame (J.H. McMillan, 1996, p. 85).

The sample is the group of components, elements, or a single element, from which data are obtained (J.H. McMillan, 1996, p. 86).

By an individual who participates in a research study or is someone from whom data are collected subjects or cases are meant (J.H. McMillan, 1996, p. 86). The term subject may also identify individuals whose behavior, past or present, is used as data, without their involvement in some type of treatment or intervention (J. H. McMillan, 1996, p. 86). Further on, the focus in selecting the cases has changed to information-oriented sampling, as opposed to random sampling (B. Flyvbjerg, 2006, p. 229). This is because an average case is often not the richest in information. In addition, it is often more important to clarify the deeper causes behind a given problem and its consequences than to describe the symptoms of the problem and how frequently they occur (B. Flyvbjerg, 2006, p. 229). Random samples emphasizing representativeness will seldom be able to produce this kind of insight; it is more appropriate to select some few cases chosen for their validity.

In educational research, it is usually impractical and unnecessary to measure all the elements in the population of interest (J. H. McMillan, 1996, p. 86). Typically, a relatively small number of subjects or cases is selected from the larger population (J. H. McMillan, 1996, p. 86). In educational research, a sample should include more than 30 subjects due to the “central limit theorem” (P. Mayring, 2007, p. 5), a sample which involves less than 30 subjects is small (I. Arhipova, S. Bāliņa, 2003 p. 99), and a sample which consists of a few subjects is tiny (GraphPad Software, Inc., 2007, p. 1). It should be noted that generalization can be drawn from a single case study, too (P. Mayring, 2007, p. 6). However, for the result confirmation and drawing more general conclusions, the case basis has to be widened (P. Mayring, 2007, p. 6) up to three-ten single cases (R. Yin, 2005). Therein, a sample is to be of such a size as, in the analysis phase of the research, sample’s further components or elements do not change conclusions or generalisations drawn from the obtained data (A. Kroplijs, M. Raščevska, 2004, p. 77). Thus, Table 3 identifies factors that influence sample size in educational research complemented with aims of generalisation.

**Table 3. Factors that influence sample size in educational research**

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Analysis of the definitions of factor, external and internal factors as well as the inter-relationships between sample size and generalisation as well as sample size and statistical analysis of the data allow identifying that as shown in Table 3
- external factors in educational research include
  - access to the sample and
  - resources such as
    - time,
    - personnel and its competences and experiences,
    - technical support, and
    - measurement procedures, and
- internal factors comprise researcher’s
  - aims of research,
  - aims of generalisation (P. Mayring, 2007, p. 2) such as
    - comparison,
    - typology, etc,
  - research methodology,
  - motivation,
  - interest,
  - skills, and
  - experience.

Empirical Research

The present part of the paper demonstrates the design of the empirical research, survey results and findings of the empirical study.

Research design

The design of the present empirical research comprises the purpose and question, sample and methodology of the present empirical study.

The empirical study was aimed at analyzing factors that influence sample size in educational research.

The empirical research’s question was as follows: What is the expert evaluation of factors that influence sample size in educational research?

The present empirical study involved four experts from different countries in February - April 2013. All the respondents have been awarded PhD Degree in different fields of educational science. As the respondents with different cultural backgrounds and diverse educational approaches were chosen, the sample was multicultural. Thus, the group (age, field of study and work, mother tongue, etc.) is heterogeneous. The sample of four experts involved

- two researchers in the field of educational research, Educational Research Association, "Freie Universität" (Free University), Berlin, Germany,
- a researcher in the field of educational research, Latvia University of Agriculture, Jelgava, Latvia
- and a researcher in the field of applied research in education, CAH -Vilentum University of Applied Sciences, Dronten, the Netherlands.

In order to save the information of the present research confidential, the respondents’ names and surnames were coded as follows:

- two researchers from Germany were given the codes of E1 (Expert 1) and E2 (Expert 2).
- a researcher from Latvia was pointed as E3 (Expert 3),
- a researcher from the Netherlands was considered as E4 (Expert 4).

Interpretive research paradigm that corresponds to the nature of humanistic pedagogy (I. Luka, 2008, p. 4) was used in the present empirical study. The interpretive paradigm creates an environment for the development of any individual and helps them to develop their potential (I. Luka, 2008, p. 4). The core of this paradigm is human experience, people’s mutual everyday interaction that tends to understand the subjectivity of human experience (I. Luka, 2008, p. 4). The paradigm is aimed at understanding people’s activity, how a certain activity is exposed in a certain environment, time, conditions, i.e., how it is exposed in a certain socio-cultural context (I. Luka, 2008, p. 4). Thus, the interpretive paradigm is oriented towards one’s conscious activity, and it is future-oriented (I. Luka, 2008, p. 4). Interpretive paradigm is characterized by the researchers’ practical interest in the research question (L. Cohen, L. Manion, K. Mannion, 2003).

Exploratory research was employed in the empirical study (D. Phillips, 2006, p. 306). Exploratory
research is aimed at generating new questions and hypothesis (D. Phillips, 2006, p. 306). The exploratory methodology proceeds from exploration in Phase 1 through analysis in Phase 2 to hypothesis development in Phase 3 as demonstrated in Figure 15.

![Methodology of the exploratory research](image)

**Figure 15.** Methodology of the exploratory research

The qualitatively oriented empirical study allows the construction of only few cases (P. Mayring, 2004). Moreover, the cases themselves are not of interest, only the conclusions and transfers we can draw from these respondents (B. Flyvbjerg, 2006, p. 229). Selecting the cases for the case study comprises use of information-oriented sampling, as opposed to random sampling (B. Flyvbjerg, 2006, p. 229). This is because an average case is often not the richest in information. In addition, it is often more important to clarify the deeper causes behind a given problem and its consequences than to describe the symptoms of the problem and how frequently they occur (B. Flyvbjerg, 2006, p. 229). Random samples emphasizing representativeness will seldom be able to produce this kind of insight; it is more appropriate to select some few cases chosen for their validity.

Further on, the choice of experts was based on two criteria as depicted in Figure 16:
- recognized knowledge in the research topic and

![Criteria of choosing experts](image)

**Figure 16.** Criteria of choosing experts

The number of experts depends on the heterogeneity of the expert group; the greater the heterogeneity of the group, the fewer the number of experts (C. Okoli, S. Pawlovski, 2004, p. 20). Thus, four is a good number of experts for the study (C. Lopez, J. Salmeron, 2011, p. 202). Therein, the non-structured interviews comprised four experts who were researchers from different countries. It should be noted that all the researchers were professors in the fields connected with educational research. All the four researchers had decisively contributed to their fields of research. All the four researchers had received extensive research experience.

**Survey Results**

In order to analyse factors that influence sample size in educational research, non-structured interviews were carried out. Non-structured interviews with experts were conducted in order to search for the main categories of the research field (A. Kroplijs, M. Raščevka, 2004, p. 99).
Expert 1 thanked the authors for the interesting abstract submitted to the conference where Expert 1 were acting as a reviewer.

Expert 2 underlined that the authors had tried to summarize a study and identify the main characteristics of this study.

Expert 3 was interested in the continuation of the study.

Expert 4 assumed that the factors play a key role in forming the sample size in educational research.

**Findings of the Empirical Study**

Summarizing content analysis (P. Mayring, 2004, p. 269) of the data reveals that experts positively evaluated factors that influence sample size in educational research.

**Discussion**

The present part of the contribution highlights the issues outlined in the present contribution that require joint efforts for further analysis.

The role of sample size it plays in research is to be re-considered by the research community.

Application of methodological approaches different from the methodological approach of the present contribution, namely, the development of the system of external and internal perspectives, may outline other factors that influence sample size in educational research.

Another issue such as the relationship between sample size and statistical analysis of the data as well as generalization has to be re-considered. Particularly, further analysis is needed on such issues as

- the relationship between sample size and measurement procedures,
- the relationship between sample size and significance test,
- the relationship between sample size and results’ interpretation, and
- the relationship between sample size and generalisation.

**Conclusions**

The empirical findings of the research allow drawing the conclusions on experts’ positive evaluation of factors that influence sample size in educational research.

The following research question has been formulated: what are the principles of selection of sample size in educational research?

Validity and reliability of the research results have been provided by involving other researchers into several stages of the conducted research.

External validity has been revealed by international co-operation as following:

- the research preparation has included individual consultations given by other researchers,
- the present contribution has been worked out in co-operation with international colleagues and assessed by international colleagues, and
- the research has been presented at international conferences.

The present research has **limitations**. The inter-connections between the statistical analysis, generalisation, population, sample, measurement procedures, probability sample, information-oriented sample, case and factors have been set. Another limitation is the empirical study conducted by involving the experts only.

Further research tends to focus on empirical studies to be carried out in other institutions. And a comparative research of different countries could be carried out, too.

**References**

ФАКТОРЫ, ВЛИЯЮЩИЕ НА РАЗМЕР ВЫБОРКИ В ПЕДАГОГИЧЕСКОМ ИССЛЕДОВАНИИ

Андреас Аренс, Елена Защеринская

Аннотация

Многие исследователи сходятся во мнении, что размер выборки имеет двойную роль в исследованиях: размер выборки взаимосвязан со статистическим анализом данных и обобщением. Таким образом, размер выборки привлек много научно-исследовательских работ во всех исследовательских областях, включая исследование в области образования.
Тем не менее, мало внимания было уделено анализу факторов, влияющих на размер выборки в педагогических исследованиях. Вопрос исследования заключается в следующем: какие факторы влияют на размер выборки в педагогических исследованиях?

Целью исследования является анализ факторов, влияющих на размер выборки в педагогических исследованиях, лежащий в основе разработки нового исследовательского вопроса для дальнейших исследований в педагогической области.