

Strengths and Limitations of Quantitative Research Applied in the Educational Sciences

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Abstract

The aim of this study consists in identifying the most common advantages and limitations of quantitative research applied in the educational sciences. There are explored the main quantitative tools: factory analysis, clusters analysis, and multiple regression technique. The aim of factor analysis is to test a hypothesis or theory about the research structure. By cluster analyses the data can be summarized bringing together the variables and can be classified based on similar answers. The types and degree of relation between the dependent and the independent variables are given by regression models. Studying the educational results of these techniques we identify the advantages and limitations of quantitative analyses that we must take into account on the initial research design for improving the educational research. The strengths of quantitative research applied in the educational sciences consists in the fact that it can be interpreted big data with a lot of endogenous and exogenous variables. Also, the latent structure among the investigated variables can be identified. The limitations are related to abnormal distribution present on natural dependent variables and the long period that is required to apply the research instrument.

1. Introduction

The educational approach of integrating the new technologies led to some researchers' preoccupation to create innovative models based on correlating technological and educational components [1, 2]. Qualitative analysis was used to investigate the effects produced by the use of the new technologies on school results, student's motivation or perception [3], highlighting advantages and benefits [4]. However, in educational sciences the quantification of the identified effects or of the factor's influences cannot be done using only qualitative analysis methods.

For example, performing pre-university educational activities, in general, and in higher education, in particular, with the help of interactive whiteboards IWB [4] offers multiple advantages, from different perspectives. The need of this current study starts from noticing the fact that quantitative research have in the same time the strong points and weaknesses. In order to performed a good model to investigate an educational research subject we must identify from the start the proper tools and avoid unnecessary ones.

In present, different kinds of multivariate analyses are used to investigate variables behaviour that are easy to identify and results can be generalized to larger populations. In social sciences many researchers prefer quantitative methods because they provide clear objective based on data that can be evaluated. There have been done studies which approach the development of some valid research tools based on exploratory factor analysis [5, 6] or multiple regression models [7]. In the educational field, there can be identified studies which use the principal component analysis [8-10], clusters analysis [11, 12] and multiple regression [13-15] for different interpretations of the recorded experimental data. However, interesting research topics, but who have low results due to failed research design are still disseminated.

We present most relevant quantitative analyses methods based on multivariate analysis which, applied in the educational sciences, can complete qualitative analysis to reveal latent information based on results and can facilitate implementing an integrated policy for education in development.

Also, this study provides a new approach on the initial research design. From this perspective, this theoretical study presents the advantages and limitations of quantitative analyses that we will have to take into account for improving the research related to perception of new technologies used in education.

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2. Defining quantitative research

2.1. Factory analysis technique

Both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) are used to understand common variance of measured variables which are assigned to a latent factor. However, EFA and CFA are conceptually and statistically different.

EFA is a technique for identifying clusters of dependent variables in order to understand the relationship between the variables that we have measured. This type of multivariate analysis allows the identification of latent structure among the investigated variables. This thing is done by estimating the variance common at their level. Each factor can be presented in terms of the variables measured and the factor score regression coefficient. More than that, the analysis of the factors is based on Pearson linear correlation. That is why the variables must present a linear association, in order to be introduced in the analysis. In many cases, we notice an abnormal distribution (the negative asymmetry is predominant) for natural dependent variables. But taking into consideration the significant number of respondents, we will consider the normality condition as not compulsory.

The use of KMO index Kaiser-Meyer-Olkin represents a measure of sampling adequacy and Barlett's test of sphericity, offers us information about the existence of multicollinearity. There is a KMO index for each variable, and their sum indicates the KMO global index. Communality values are multiple correlation coefficients for each variable as dependent variable, using the factors as predictors. The higher value of KMO index as well as the significance level of Barlett's test of sphericity suggests the existence of one or more common factors which justifies the use of a factor reduction.

CFA allows testing the suitability of models established "a priori", for example, to verify the structure of the instrument scale. Primary statistical analysis of the data is used to test the factorial structure of the instrument.

2.2. Clusters analysis technique

Cluster analysis, based on the results of factor analysis, indicates that participants can be classified into several clusters with particular characteristics in their behavior. Thus, starting from the scores obtained from the instruments, the respondents can be classified. The dependent variables are built on the basis of the results of factor analysis. For each main factor, a global score will be calculated by adding scores for each included element and dividing it to the number of items which represent the factor. Thus, all factors will have the same scale and thus, standardization will not be necessary anymore. The construction of clusters can be made by the method of interactive updating of centers, either by partitioning techniques, thus the distance among the internal elements of groups should be smaller, and the distance among groups should be bigger.

After the number of clusters was established, k means clusters method is recommended, as being suitable for medium size samples. The database of respondents can be used as analyzed bodies and weighing factor analysis as dependent variable.

2.3. Multiple regression technique

Regression models are used to identify the types and degree of relation between the dependent and the independent variables of the study. A regression model can be established for each dependent variable separately, based on a single or a combination of independent variables (predictors). In order for the chosen model to explain the relationships between variables, the value of determination ratio (R^2) should be between 0 and 1 and the value of statistical significance index (Sig.) should be less than 0.05. When the relationship between the dependent variable and the independent variable is not linear, the estimation of the regression curve is recommended.

3. Strengths and limitations of quantitative research applied in the educational sciences

The most common *strengths* are:

- the data are shown as descriptive terms and can be used to create graphical models easier to interpret;
- can be applied to large numbers of people;
- allow the identification of latent structure among the investigated variables;
- contribution of each variable as dependent variable can be estimated;
- the respondents can be classified under certain categories (types) which present similar answer models;



- model the relationships between variables;
- can explain the education impacts on social and economic factors.

The most common *limitations* are:

- natural dependent variables usually presents an abnormal distribution;
- all variables with communality values lower than 0.5 are recommended to be eliminated thus results can be lost;
- separate and randomized cases are needed to validate and confirm the instrument scale, increasing the investigation period;
- quantitative research not explain why and how social and economic factors contribute to education.

4. Conclusions

To summarise, the main contributions of each quantitative research technique presented in this study are:

- The purpose of factor analysis is to test a hypothesis or theory about the structure obtained on the basis of interdependencies among variables. This type of analysis enables the identification of the main categories of factors, and groups the participants.
- Through the exploratory factor analysis, data can be summarized by bringing together the variables that were interrelated in the early stages of research. The validation of the measurement tool can be performed by analyzing the internal consistency with Cronbach alpha index.
- Based on particular characteristic of the participants, using cluster analysis they can be classified into similar answers' models, while regression analysis can be used to identify the types and degree of influence of the particular characteristics.

The strengths of quantitative research applied in the educational sciences are related to large numbers of people that can be taking into account, identification of the latent structure among the investigated variables, and the possibility to quantify the education impacts on various social and economic factors. The limitations are related to abnormal distribution present on natural dependent variables, the long period of time needed for investigation. Also, the social and economic factors cannot be explain why and how contribute to education only by quantitative research.

To conclude, quantitative analyses techniques can complete qualitative analysis providing a deeper understanding of the interdependencies and relationships, but only if the initial research design taking into account all limitations aspects.

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