The Socioeconomic Index in the Analysis of Large-Scale Assessments: Case Study in Baja California (Mexico)

Fernando Martínez-Abad
Universidad de Salamanca
Paseo Canalejas, 169
37008 Salamanca (España)
+34 615 15 45 59
fma@usal.es

Alicia Alelí Chaparro Caso López
Instituto de Investigación y Desarrollo Educativo.
Km. 103 Carr. Tijuana-Ensenada
22830 Baja California (México)
+52 646 175 07 07
achaparro@uabc.edu.mx

Luis Lizasoain Hernández
Universidad del País Vasco
Barrio Sarriena s/n
48940 Leioa, Bizkaia (España)
+34 943 01 80 00
luis.lizasoain@ehu.es

ABSTRACT

The generalization of assessment instruments for Elementary Education students, at the national and international level, involves the appearance of new techniques in the analysis of statistical results that allow the comparison between geographical areas, schools and students. In this way, the context surveys emerge as measures associated with the achievement tests to control the contextual factors with influence over the students. Although in the literature the socioeconomic level is imposed as a key contextual variable, there is not a particular standard to construct scales of this type at the international level. This study, from an initial sample of 6765 students and 78 educative centers located in Baja California (México), describes the process carried out for the construction of a scale for the socioeconomic level measurement and it validates the results obtained in relation with the "Tests ENLACE", applied to Elementary Education students at the national level.

Therefore, this proposal pretends to create a specific model for the construction of these contextual scales of socioeconomic level, taking into account its relation with the own Tests ENLACE.

Finally, it is shown the importance of contextual aspects as in the analysis of achievement tests as in the construction of contextual scales included as covariables in this type of analysis.

Categories and Subject Descriptors

K.3 [**Computers and Education**]: General.

General Terms

Measurement, Standardization.

Keywords

Large-scale assessment, context variables, socioeconomic level, evaluation, Secondary Education.

1. INTRODUCTION

The development of assessment tests of the achievement at the national and international level [1, 9, 17, 18, 20, 21, 28], among

these found the tests ENLACE, developed throughout Mexico, has been generalized to ensure the quality, the control, the standardization and the improvement of the students' educative results.

Specifically, the tests ENLACE emerged with the idea to generate information about the knowledge and abilities the students have, with the purpose of providing support to implement effective and relevant processes of educational planning and public policy [16].

At the same time, together with the importance assigned to the development and application of large-scale performance tests in the countries during the last decade of 20th century and the first one of this century, which originates a variety of comparative researches about the school performance of students and schools from different regions geographically, socially, economically, and culturally [8, 14, 31], appears the concern about the control of some differential variables which are not controlled by the school institutions and indicates the final performance of the students [11–13].

Fruit of the research generated in that area in the field of Education Sciences, linear hierarchical models are positioned (given their nested, multivariate and multilevel nature) as a strong and good alternative to exercise a control on the moderate effect of these contextual variables in the academic performance of the students and education centers, as well as to isolate it from the real effect in schools [4, 10, 30].

In particular, from the possibilities that the linear hierarchical models offer, emerge the model of added value, thoroughly studied in the 80's and 90's of the XX century [3, 5, 23, 24]. These models were generalized at the end of this century and at the beginning of XXI century to assess the differential performance of schools and students, controlling the effect of the contextual variables [15]. It is worth noting some examples, such as the researches of Sanders & Horn [26] with the implementation of the assessment system of value added of Tennessee (Tennessee Value-Added Assessment System o TVAAS), or the analysis carried out by Brit, Thum, Easton and Luppescu [2], who apply a longitudinal assessment of the students which are in Elementary Education in Chicago. These experiences, estimate the residual profit from the students' direct individual score, without considering the gross profits. Thereby, the statistical model applied for the study of students' growth and the educational centers, uses better the available information in paired test applications because it takes into consideration the matrix variance-covariance complete.

Within these linear hierarchical models, which could be considered of added value when they incorporate longitudinal

measures of the performance of students and schools [5, 24, 26], one of the contextual variables that has the best impact due to its influence over the academic performance is the socioeconomic level of the students and schools [27, 29].

Searching a definition for the socioeconomic level of students and schools, it starts from the proposal made in the report written by experts of the National Center for Education Statistics. [19]:

SES can be broadly defined as one's Access to financial, social, cultural and human capital resources. Traditionally a student's SES has included, as components, parental educational attainment, parental occupational status, and household or family income, with appropriate adjustment for household or family composition. An expanded SES measure could include measures of additional household, neighborhood, and school resources. [19].

Therefore, the socioeconomic level is considered as a measurable latent variable from several observables. For example, OECD, in the application tests of PISA, introduces a questionnaire of context to obtain a socioeconomic index, called "PISA index of economic, social and cultural status" (ESCS) [22], which integrates, through an analysis of the main components, the following variables:

- Possessions at home (possessions in the cultural field, not essential possessions that indicate richness, educational resources and number of books).

- Educational level of parents

- Parents' work status

This and other measures normally used in the socioeconomic index measurement are based generally on 3 fields that we could call like BIG 3 [19]: family income level (measured indirectly from existing resources and habits in the family home), parents' education and parents' work status. The socioeconomic level of the schools is considered equally important, and it is usually obtained through the socioeconomic index average of the students of the school [25]. Occasionally, in order to obtain these socioeconomic indexes of the school's level, the average of the student's level is complemented with another measure specifically linked to the school, as the quantity and the status of the available resources in the school [19].

Then, the aim of this research to design an index of the socioeconomic status of students and schools from context questionnaires applied in the State of Baja California (Mexico) from the Unit Educational Assessment of Institute of Educational Research and Development of the University of Baja California, as well as to evaluate its level in relation with the students' results in mathematics test ENLACE, developed which in Mexico in 2010.

2. METHOD
2.1 Participants

From the population of students in second and third year of Secondary Education in the State of Baja California (Mexico), a random initial representative sample of 6765 students and 78 schools is obtained. On the distribution of the sample by sex, it is obtained 48.6% men and 51.4% women; and by nationality, 89.8% are Mexican students and 10,2% are foreign students.

As regards to participating schools, it is obtained a tightly distributed sample of the reference population regarding modality (45,9% general modality centers, 18,8% particular modality center, 23,5% technical modality center and 11,8% e-secondary modality center). On the other hand, regarding the municipality of the state of Baja California (21,2% of Ensenada, 31,8% of Mexicali, 4,7% of Playas de Rosarito, 5,9% de Tecate y 36,5% de Tijuana).

2.2 Instruments

ENLACE 2010 is a standardized objective test which is applied to the whole population registered in the census of Mexico, and it offers an individual diagnosis about the students in some of curriculum subjects. It is focused on assessing the knowledge achieved by the students in their formal schooling. The ENLACE tests in the Elementary Education assess, mainly, the knowledge and abilities of the students in the subjects of Spanish and Mathematics, although since 2008 in each application another subject is included. This subject is focused on mathematics to avoid bias related to the nationality or the use of the language in different social groups.

To obtain the socioeconomic index, are used variables included in the context questionnaire which are applied as part of the Integral Assessment Strategy 2010 [6], that is performed from the Unit Educational Assessment of Institute of Educational Research and Development of the University of Baja California. The figure 1 shows the dimensions covered in that questionnaire.

The variables obtained for the design of the socio economic index are included in the dimension "learning opportunities which the student have". Specifically, the opportunities that the family give them include variables on physical resources, educational or not that they have, the number of people and rooms that have at home, the number of available books, number of computing available resources, etc. On the other hand, the opportunities that the health gives them include the eating habits and the diet.
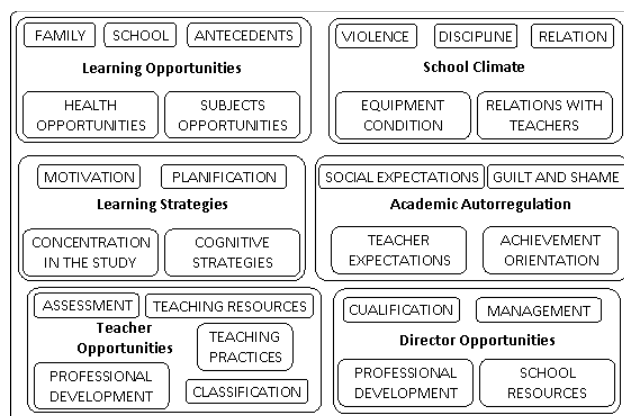

Figure 1. Variables applied in the comprehensive strategy 2010

2.3 Procedure

Firstly, it is constructed the socioeconomic index based on recommendations of institutions and the scientific literature consulted at the beginning of this research, and it is contrasted their level of correlation with the scores in the mathematics tests ENLACE 2010 for the selected sample. Then, this index is discretized based on the socioeconomic structure in the state of Baja California [7] and the correlation obtained is contrasted again. Finally, both obtained correlation indexes are compared to check if the discretization of the socioeconomic variable based on

the socioeconomic structure existing in the region improve with the behavior of them.

2.4 Data analysis

On the one hand, for the construction of socioeconomic index it is used the technique of data reduction of main components analysis, keeping as minimum criterion a 35% of variance explained by the component or components extracted.

On the other hand, it is applied the calculating the Pearson correlation coefficient to analyze the relation between the initial socioeconomic index and the final score in ENLACE tests, and the discretized socioeconomic index and the tests again.

3. RESULTS

Firstly, it is proceeded to a preprocessed of the variables that will be finally included in the socioeconomic index.

- Overcrowding index

It is calculated dividing the numbers of rooms that the home has between the numbers of people who live in that home. In this way, the highest values of this index will mean a minor level of overcrowding. Having calculated the variable, the histogram shown in figure 2 is obtained.
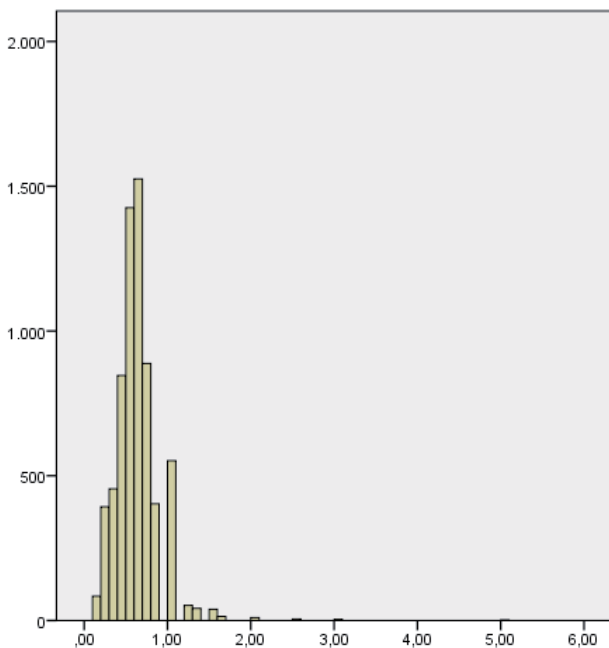

Figure 2. Overcrowding index. Histogram.

The average score achieved is 0.61, with a typical deviation of 0.26; so, the most of students live in a home with less than 1 room per person. In fact, the value 1 of the overcrowding index is in percentile 98. In the histogram it can be observed a clear tendency of the positive asymmetry (As.=2,96) and a high leptokurtic kurtosis (curt.=30,97).

- Basic resources at home

It is formed by a sum of dichotomous variables (if the home has light, water, piping system, type of floor, etc.). In that case, it is obtained a structure with a clear negative asymmetry. It can be observed in the figure 3.
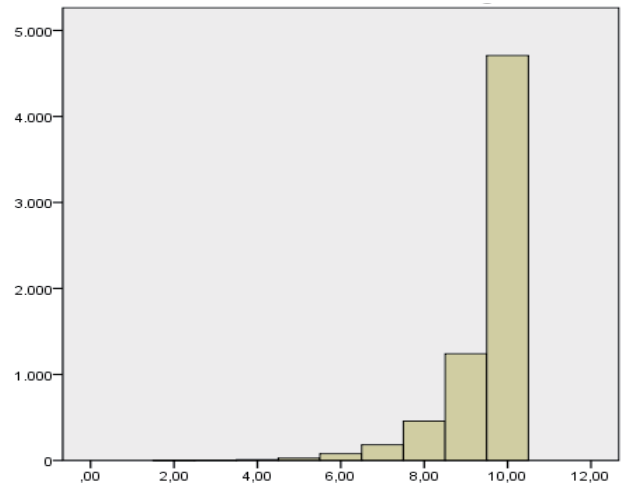

Figure 3. Basic resources at home

The 70,2% of the houses obtain the highest score in this variable (10 points), and the 94,5% of these cases obtain between 8 and 10 points.

- General resources at home

In this case, it is formed again a sum between dichotomous variables that question about the existence of general physical resources at home (car, personal computer, wash machine, internet, etc.). The figure 4 shows a negative asymmetry but it is less high than the previous case.
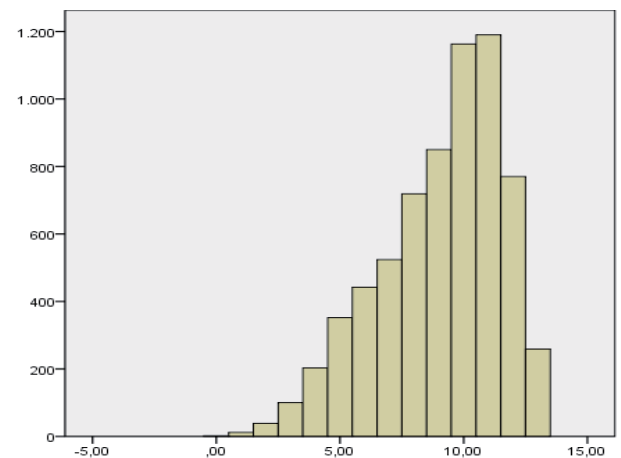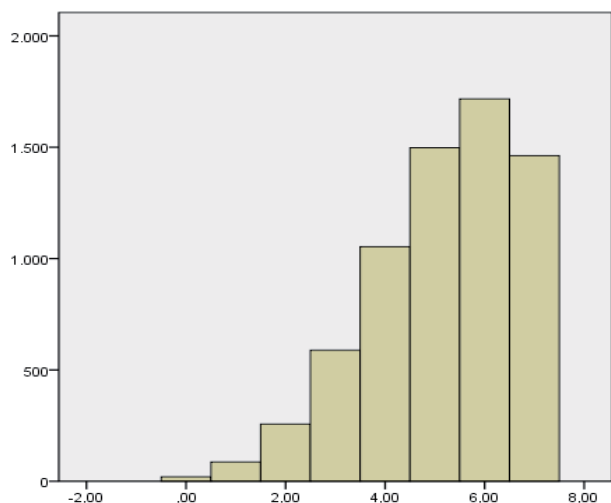

Figure 4. General resources at home. Histogram.

It is observed how only 10% of the sample is in very low scores less than or equal to 5 points.

- Educational resources at home

The variable formed remains a sum of dichotomous variables, of tenure or not tenure, of educational resources (desk for study, calculator, dictionary, textbooks, etc.). The figure 5 shows the tendency previously explained.

**Figure 5. Educational resources at home. Histogram.**

The 70% of the sample is in high scores, between 5 and 7 points.

- Mother and father's scholarly studies

These standards are obtained directly from the measured variables with a scale from 1 to 6 points, which go from the category "without scholarly studies" until "postgraduate studies". In both cases, it is obtained a positive asymmetry and a platykurtic kurtosis; so, the tendency is toward low scores and there is a flattened distribution. Only the 24% and 29% of the mothers and fathers, respectively, of the sample students have university studies.

- Attendance to cultural events

It is performed an analysis of the main components, from 4 variables which measure the frequency of attendance to the cinema, museum, theatre and concerts. It is extracted in the first factor a 51, 17% of the total variance and all the standards which have a positive weight about the factor .700. The figure 6, as in previous indexes (overcrowding index and parents' scholarly studies) shows a positive asymmetry, result of the high degree of social inequality existing in Mexico[1].
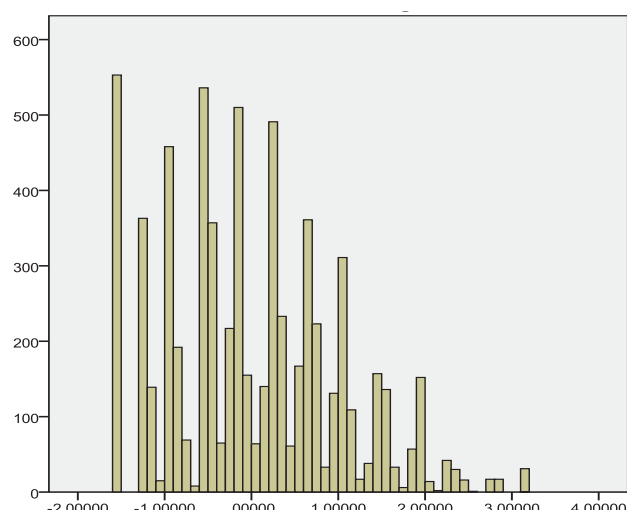
Figure 6. Attendance to cultural events. Histogram.

- Health and food

It is performed an analysis of the main components, from 4 variables which measure the frequency of consumption of fish and vegetables, meat and poultry, dairy products, cereals). The variable that questions about the frequency of consumption of fish is removed because Baja California is a fisher place, and it is considered that this variable is not going to reflect the economic possibilities of the families. It is extracted in the first factor a 45, 65% of the total variance and all the standards that have a positive weight about the factor and higher a .500 in all cases. The density distribution shows a negative asymmetry (As. = -0, 49) and a kurtosis lightly platykurtic (Curt. = -0, 25).

- Father and mother's work

Given the specific characteristics of Baja California, that mainly is a U.S. bordering state, and it has, consequently, a special socioeconomic structure according to the rest of Mexico, it is considered that the variables related to the parents' work will not be included. This occurs because the farmworkers, handmade activities and housework in U.S. have salaries higher than other workers who belong, a priori, to a higher working range in Mexico.

As added at these variables, for the construction of the definitive index of the variable, the number of books that the person has at home is included as an independent variable.

Therefore, it is applied a last analysis of mainly components with the addition of the 9 described variables, forcing 1 extraction factor. It is obtained a first factor with a 39% of the explicated variance and an autovalue of 3.451. "The elbow" of the sedimentation graph, shown in figure 7, confirms the pertinence to make the cut in the first factor.

---

[1] According to data provided by the World Bank (http://datos.bancomundial.org/indicador/SI.POV.GINI/countries/1W?display=default) this index in Mexico, in 2010, was 47,2, so it reaches a inequality social index very high, in the position 123 of 160 countries, according with Wikipedia (http://es.wikipedia.org/wiki/Anexo:Pa%C3%ADses_por_igualdad_de_ingreso).
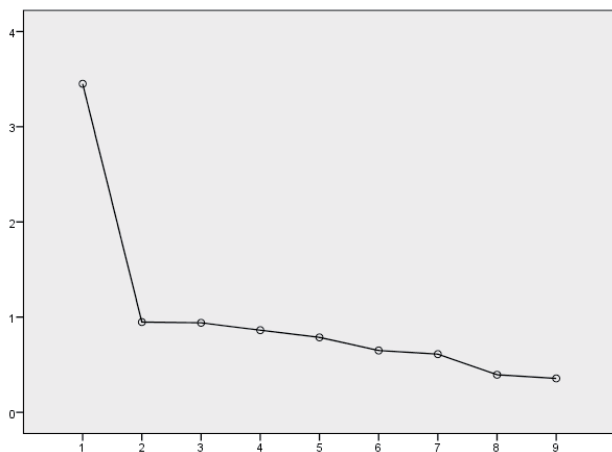
Figure 7. Socioeconomic Status. Scree Plot from principal component analysis.

The Pearson's correlation coefficient at students' level that the value of this index obtains in mathematics tests ENLACE is .272, so, it is highly significant (p<.001). By contrast, the correlation at a school center level is 0,597 (p<.001).

In fact, the figure 8 shows clear evidences that the socioeconomic index is determinant of the ENLACE scores, above all in the lower socioeconomic indexes.
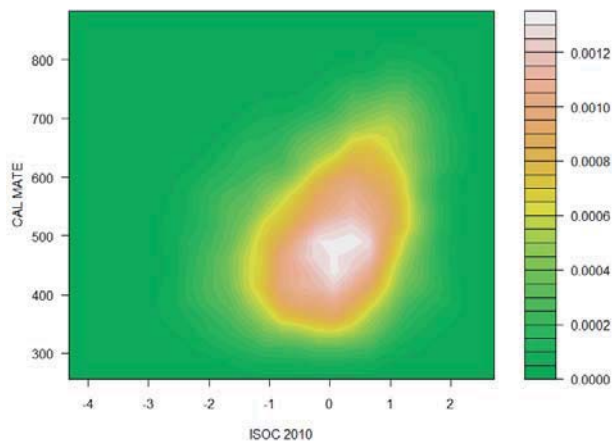
Figure 8. Socioeconomic Status. Density Plot with ENLACE 2010 mathematics punctuation.

So, since it is probable that within each social class is not established a clear relationship, it will seek to improve the coefficient, categorizing the calculated socioeconomic index from the classification that performed the Mexican Association of Marketing and Public Opinion Research Agencies (AMAI) in 2010. Such classification categorizes Baja California population in the following way: high class (5,7%); medium-high class (22,4%), medium class (27%), medium-low class (34,2%), low class (10,2%) and extremely poverty (0,5%). Due to the infrequency of the category of extreme poverty, it is decided add it to the low class.

The figure 9 shows the averages in mathematics within tests ENLACE of each categorized social class. It is observed a very clear gradual increase, above all in the intermediate social class.
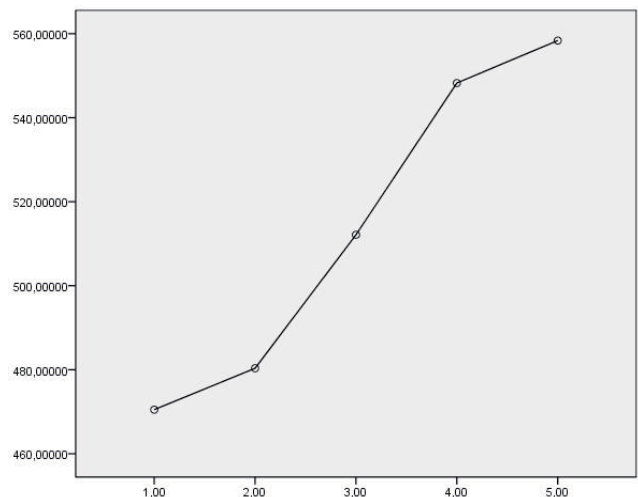
Figure 9. Socioeconomic Status. Means plot with ENLACE 2010 mathematics punctuation.

The correlation coefficient between this new variable and the score in mathematics in test ENLACE 2010 of each student grows until .276, and the schools sample grows until .635.
If it is performed a hypothesis contrast to check if the correlation difference is significant, it is obtained, at the case of students a not significant correlation difference (t=0,923; p=.187) and for the schools, it is obtained a significant correlation difference very high (t=2.843; p=.003).

So, it is concluded that the categorization of the socioeconomic index can improve the behaviors of this score in the search of a better explication about the student's academic performance.

4. DISCUSSION ANS CONCLUSIONS

In a time in which the Government and public institutions increase their concern about the quality control and expenses that are dedicated to an educational system in general, the large-scale assessments, at a national and international level, are increasing.

Although the institutions try to be cautious about this, these tests are often used in mass media as measures, which allow to compare the educational systems from countries and regions, while these are not comparable either at the level of its socioeconomic, cultural and political structure, neither, in many cases, at the level of its educational system.

That is why the importance of sure an assessment which controls the effect over some context variables that leave no trace about the academic performance of students and schools, and the consequent increasing impact that this type of research have had in the field of educational research and it is kept yet [8, 14, 31].

As regards to the boom that acquires calculating socioeconomic index in these studies of educational research, specifically, the adaptive assessment of the results of large-scale achievements tests [2, 5, 26], the performed efforts have had to do with the international standardization of criteria to construct these measures [19, 27, 29], disregarding the specific defining characteristics of each country or region.

Although, these measures of socioeconomic index of student and their families obtain results correlated significantly with the academic performance of students and that, as have evidenced in this and other researches, these measurements seem quite strong in their applications in all countries, not represent, exactly, social

structural differences of the countries. In fact, the empiric evidence which is obtained in this research, seems to confirm that the simplification of these socioeconomic indexes through a categorization based on the region structure, it is possible improve the explicative level of these indexes over the academic performance of the students, and above all, the average performance of the schools.

Therefore, the obtained results point to this tendency that allows updating and improving the calculation of the socioeconomic indexes from countries according to their internal structure, based on a division by social class in the ordinal direction instead of the direct application of a continuous index obtained in a standardized way for all countries and regions.

As weaknesses of this research, it is important to note that the socioeconomic index calculation only it is limited to the region of Baja California, in Mexico, so it could have an important slant relative to the location, due to the location is very definite. In this regard, because of characteristics of job and economics of this region, the variable of parents' work status, which are included in the index, it is not used, so it can have slants too.

It is obvious that, for future researches, the necessity of replicating the obtained results here in others regions with various socioeconomic structures, with the aim of checking the improvement of the explicative level of socioeconomic index about the academic performance. The obtaining of this of socioeconomic index improved can contribute to the increase of quality of estimation of hierarchical linear models for the calculation of value added in education and, thereby, to help to improve institutional assessment of the education system in the future.

5. REFERENCES

[1] Bogoya Maldonado, D., Unesco, Regional Office for Education in Latin America and the Caribbean and Instituto Colombiano para el Fomento de la Educación Superior 2005. *Segundo Estudio Regional Comparativo y Explicativo (SERCE): análisis curricular*. UNESCO : Instituto Colombiano para el Fomento de la Educación Superior.

[2] Bryk, A., Thum, Yeow Meng, Easton, John Q and Luppescu, S. 1997. Assessing School Academic Productivity: The Case of Chicago School Reform. *Social Psychology of Education*. 2, 1 (1997), 103–142.

[3] Bryk, A.S. and Raudenbush, S.W. 1987. Application of hierarchical linear models to assessing change. *Psychological Bulletin Psychological Bulletin*. 101, 1 (1987), 147–158.

[4] Bryk, A.S. and Raudenbush, S.W. 1992. *Hierarchical linear models: applications and data analysis methods*. Sage Publications.

[5] Bryk, A.S. and Weisberg, H.I. 1976. Value-Added Analysis: A Dynamic Approach to the Estimation of Treatment Effects. *Journal of Educational Statistics*. 1, 2 (1976), 127–155.

[6] Caso Niebla, J., Díaz López, K., Chaparro Caso López, A.A. and Urias Luzanilla, E. 2011. *Propiedades psicométricas de las escalas, cuestionarios e inventarios de la Estrategia Evaluativa Integral 2010: factores asociados al aprendizaje*. Unidad de Evaluación Educativa.

[7] Consulta Mitofsky 2010. *Niveles socioeconómicos por entidad federativa 2009-2010*. Tracking Poll.

[8] Drabowicz, T. 2014. Gender and digital usage inequality among adolescents: A comparative study of 39 countries. *Computers & Education*. 74, (May 2014), 98–111.

[9] Educational Resources Information Center (U.S.), N.C. for E.S. and National Science Foundation (U.S.) 1996. *Third International Mathematics and Science Study (TIMSS)*. U.S. Dept. of Education, Office of Educational Research and Improvement, Educational Resources Information Center : National Center for Education Statistics ; National Science Foundation.

[10] Goldstein, H. and Goldstein, H. 1995. *Multilevel statistical models*. E. Arnold ; Oxford University Press.

[11] González Barberá, C., Caso Niebla, J., Díaz López, K. and López Ortega, M. 2012. Rendimiento académico y factores asociados: aportaciones de algunas evaluaciones a gran escala. *Bordón. Revista de pedagogía*. 64, 2 (2012), 51–68.

[12] Joaristi Olariaga, L., Lizasoain Hernández, L. and Gamboa Ruiz de Eguilaz, E. 2012. Construcción y validación de un instrumento de medida del Nivel Socioeconómico y Cultural (NSE) de estudiantes de educación primaria y secundaria. *Bordón. Revista de pedagogía*. 64, 2 (2012), 151–172.

[13] Jornet Meliá, J.M., González Such, J. and Perales Montolío, M.J. 2012. Diseño de cuestionarios de contexto para la evaluación de sistemas educativos: optimización de la medida de constructos complejos. *Bordón. Revista de pedagogía*. 64, 2 (2012), 89–110.

[14] Kjaernsli, M. 2004. PISA and Scientific Literacy: Similarities and Differences between the Nordic Countries. *Scandinavian Journal of Educational Research*. 48, 3 (2004), 271–286.

[15] Lizasoain Hernández, L., Angulo, A., Azpillaga, B., Damborenea, I., Frago Del, R., Etxeberría, F., Intxausti, N., Joaristi, L., Méndez, Y., Nuñez, Y. and Valadez, C. 2012. *Caracterización y buenas prácticas de los centros escolares de alto valor añadido*. Universidad del País Vasco.

[16] Martínez Abad, F., Chaparro Caso López, A.A., Lizasoain Hernández, L., Caso Niebla, J. and Urias Luzanilla, E. 2014. *Identificación de escuelas de alto de alto y bajo residuo, con base en puntajes de enlace y variables de contexto*. Unidad de Evaluación Educativa.

[17] Meza, M.E., Regional Office for Education in Latin America and the Caribbean, Reunión. Laboratorio Latinoamericano de Evaluación de la Calidad de la Educación, Oficina Regional de Educación de la UNESCO para América Latina y el Caribe 2008. *Reflexiones en torno a la evaluación de la calidad educativa en América Latina y el Caribe: [el 11 y 12 de octubre de 2007, ... el Laboratorio Latinoamericano de Evaluación de la Calidad de la Educación (LLECE), coordinado por la Oficina Regional de Educación de la UNESCO para América Latina y el Caribe (OREALC/UNESCO Santiago), convocó a una reunión ... en Santiago de Chile]*. LLECE, OREALC/UNESCO.

[18] Mullis, I.V.., Martin, M.O., Kennedy, A.M., Trong, K.L. and Sainsbury, M., International Association for the Evaluation of Educational Achievement 2009. *PIRLS 2011 Assessment Framework*. International Association for the Evaluation of Educational Achievement. Herengracht 487, Amsterdam, 1017 BT, The Netherlands. Tel: +31-20-625-

3625; Fax: +31-20-420-7136; e-mail: department@iea.nl; Web site: http://www.iea.nl.

[19] National Center for Education Statistics (ED) 2012. *Improving the Measurement of Socioeconomic Status for the National Assessment of Educational Progress: A Theoretical Foundation--Recommendations to the National Center for Education Statistics*. National Center for Education Statistics.

[20] OCDE 2005. *Are students ready for a technology-rich world?: what PISA studies tell us (programme for international student assessment)*. OECD.

[21] OCDE 2012. *PISA 2009 technical report*. OECD Publishing.

[22] OECD and Organisation for Economic Co-operation and Development 2010. *PISA 2009 results: overcoming social background. Vol.II, Vol.II,*. OECD.

[23] Rogosa, D., Brandt, David, Zimowski, Michele 1982. A growth curve approach to the measurement of change. *Psychological Bulletin Psychological Bulletin*. 92, 3 (1982), 726–748.

[24] Rogosa, D.R. and Willett, J.B. 1985. Understanding correlates of change by modeling individual differences in growth. *Psychometrika Psychometrika*. 50, 2 (1985), 203–228.

[25] Rutter, M., Maughan, Barbara 2002. School Effectiveness Findings 1979–2002. *Journal of School Psychology Journal of School Psychology*. 40, 6 (2002), 451–475.

[26] Sanders, W.L. and Horn, S.P. 1994. The Tennessee Value-Added Assessment System (TVAAS): Mixed-Model Methodology in Educational Assessment. *JOURNAL OF PERSONNEL EVALUATION IN EDUCATION*. 8, 3 (1994), 299.

[27] Sirin, S.R. 2005. Socioeconomic Status and Academic Achievement: A Meta-Analytic Review of Research. *Review of Educational Research*. 75, 3 (2005), 417–453.

[28] Tatto, M.T., Schmidt, W., Michigan State University, Teacher Education and Development International Study Center and International Association for the Evaluation of Educational Achievement 2008. *Teacher education and development study in mathematics (TEDS-M): policy, practice, and readiness to teach primary and secondary mathematics : conceptual framework*. Teacher Education and Development International Study Center, College of Education, Michigan State University ; IEA.

[29] White, K.R. 1982. The relation between socioeconomic status and academic achievement. *Psychological Bulletin Psychological Bulletin*. 91, 3 (1982), 461–481.

[30] Willms, J.D., Raudenbush, Stephen W 1989. A Longitudinal Hierarchical Linear Model for Estimating School Effects and Their Stability. *JEDM Journal of Educational Measurement*. 26, 3 (1989), 209–232.

[31] 2012. *Policy, practice, and readiness to teach primary and secondary mathematics in 17 countries: findings from the IEA Teacher Education and Development Study in Mathematics (TEDS-M)*.