

Multivariate Analysis of Determinants of the Implementation of European Strategic Educational Objectives in Poland

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Abstract

One of main strategic objectives of the European Union is the development of the education and training required in the era of knowledge-based economy. The Lisbon Strategy, established in 2000 proposed a set of indicators to monitor the development process, including those concerning the area of education. The continuation and extension of guidelines in the field of education can be found in the strategic framework of cooperation entitled *Education and Training 2020*. Evaluations of the Lisbon Strategy indicate that there are some areas of low-fulfillment of strategic objectives in Poland. The aim of the paper is to identify and present the determinants of this disadvantageous situation in relation to a set of benchmarks suggested in the *Education and Training 2010 and 2020*. Socio-demographic factors play a key role in the analyses and therefore have a significant impact on the application of appropriate analytical methods.

Keywords: education and training; lifelong learning; multivariate analysis;

1. Introduction

In this paper some problems concerning the realization of chosen educational objectives in Poland are examined. The European programmes on education define a number of targets to be achieved and indicators characterizing this achievement. The overview of the situation in terms of meeting the defined benchmarks allowed to identify the area with the weakest performance and the weakest progress in Poland. Further analysis was limited to the identified problem area. The aim of the detailed analysis was to study the conditions of disadvantageous situation at the regional level (according to the territorial units NUTS 2) and the individual level. So defined scope of the analysis demanded data both at individual and aggregated level and therefore the study was carried out on the basis of various data sources, i.e. public statistics and surveys. As the changes in the studied phenomena in time are also of great importance, the paper presents the dynamic approach to selected issues. The educational processes are characterized by a high complexity so as research methods some multivariate analysis techniques were applied. The choice of the methods was conditioned by the nature of the data analyzed.

Education constitutes one of the key elements of the knowledge-based economy. The need to improve education systems is reflected in *Lisbon Strategy* and in *Europe 2020 Strategy*. Detailed guidance can be found in the *Education and Training 2010* programme as well as in the *Education and Training 2020* programme which contain a set of targets in various areas of education. These benchmarks were elaborated to monitor the situation in the Member States which have to decide how to achieve the objectives in accordance with the open coordination method. The benchmarks included in ET 2010 ET 2020 programmes are presented in Table 1.

Table 1. European education and training benchmarks

Benchmarks for 2010	Benchmarks for 2020
<ul style="list-style-type: none"> • The percentage of low achieving 15-year olds in reading literacy in the EU should decrease by at least 20% • The share of early school leavers of no more than 10% should be reached • At least 85% of 22 year-olds in the EU should have should have completed upper-secondary education • The total number of MST graduates in the EU should increase by at least 15%, gender imbalance should decrease • The EU average level of participation in lifelong learning should at least reach 12.5% of the working age population (25-64) 	<ul style="list-style-type: none"> • At least 95% of children between the age of four and the age for starting compulsory primary education should participate in early childhood education • The share of 15 year-olds with insufficient abilities in reading, mathematics and science should be less than 15% • The share of early leavers from education and training should be less than 10% • The share of 30-34 year-olds with tertiary educational attainment should be at least 40% • An average of at least 15 % of adults (age group 25-64) should participate in lifelong Learning • At least 20 % of higher education graduates and 6% of 18-34 year-olds with an initial VET qualification should have had a period of study or training abroad • The share of employed graduates (20-34 year-olds) having left education and training no more than three years before the reference year should be at least 82%

Sources: Five Education Benchmarks for Europe. Trends 2000-2008, http://ec.europa.eu/education/lifelong-learning-policy/doc/benchmarks_en.pdf, retrieved 2013/07/28; European Commission. (2012). Education and Training Monitor 2012, Luxembourg: Publications Office of the European Union, p.8

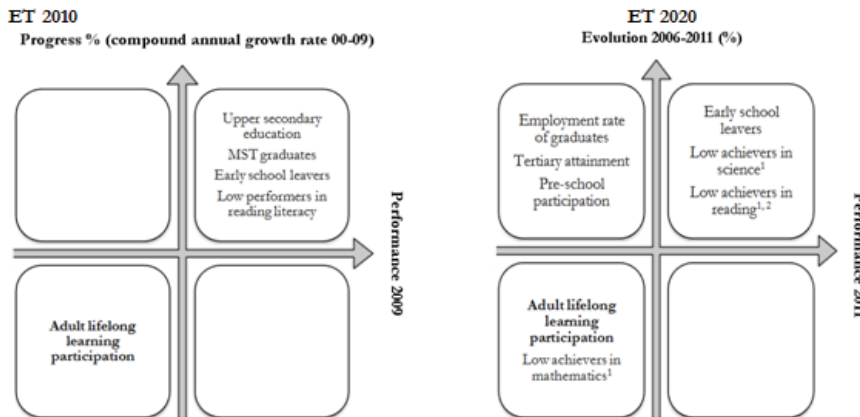
The assessment of the achievement of the educational objectives in the context of established benchmarks showed that (European Commission 2011):

examples of good performance and progress can be found throughout Europe that have the potential to inspire others for improvement. At the same time, educational systems in many Member States continue to show signs of struggling in the face of major challenges.(p.3)

Identification of problem areas is important from the point of view of educational policy of the country. Figure 1 shows the situation in Poland in meeting strategic educational benchmarks (as in the year 2009 for ET 2010 benchmarks and as in the 2011 for ET 2020 benchmarks). The graphs show two analytical dimensions: first, indicating whether the benchmark has been achieved (a positive value on the horizontal axis), and second, showing whether there has been progress in the implementation of the benchmark (a positive value on the vertical axis). Such an approach proposed in (European Commission, 2011) allows to trace the development of the indicators and provides an indication of the best and worst areas.

With regard to the benchmarks defined in ET 2010 the position of Poland in 2009 was relatively good - the desired level was achieved in case of four indicators, and moreover the situation in these four areas has improved in years 2000-2009 (elements presented in the upper right quadrant of the chart for ET 2010). At the opposite side there was the indicator reflecting adult lifelong learning participation (the element in lower left quadrant). The level of adult education engagement was very low and no progress was observed in this field.

Figure 1. Degree of meeting educational benchmarks (ET 2010, ET 2020) in Poland



¹ Evolution 2006-2009 (as PISA results available),

² Value equal to the benchmark

Source: own elaboration based on: European Commission (2011) Progress towards the common European objectives in education and training: Indicators and benchmarks 2010/2011. *Commission Staff Working Document SEC (2011) 526*; European Commission. (2012). *Education and Training Monitor 2012*, Luxembourg: Publications Office of the European Union; European Commission. (2012). *Education benchmarks for Europe*. Luxembourg: Publications Office of the European Union

Revision and broadening of benchmarks related to ET 2020 induced a necessity for a thorough insight into selected fields of the educational system in Poland. How far, the best results were achieved in reducing early school leavers and low achievers in science and reading (upper right quadrant of the chart for ET2020). Unsatisfactory, but improving indicators concerned the employment rate of graduates, tertiary attainment and pre-school participation (upper left quadrant). The lower left quadrant comprises the areas that require special attention due to unfavorable ratios and negative changes, i.e. low achievers in mathematics and adult participation in lifelong learning. It should be noted that the benchmark related to adult education and training is a continuation of the guidelines in the ET 2010 programme. Moreover, its value was increased from 12.5% to 15%. The evaluation of this domain is made on the basis of the Labour Force Survey, namely by the *percentage of persons aged 25 to 64 who received education or training in the four weeks preceding the survey*. In this area, Poland's performance was very poor as compared to other European Union countries and the participation rate was far below the suggested level.

Adult lifelong learning involvement seems to be the weakest part of the educational process in Poland in relation to the benchmarks set out in the Education and Training programmes. The unfavorable performance occurred in all analyzed years and no continuous improvement can be pointed out. On the contrary, a decrease in the participation rate was observed after the temporary increase in 2010.

Overview of the performance and progress in the domains defined in educational benchmarks gives rise to an in-depth analysis of the problem area which is the adult participation in longlife learning in Poland. For this reason, the further part of the work will be focused on this topic.

Hence the main objectives of the study are:

- analysis of factors associated with adult lifelong learning participation both at regional and individual level,
- assessment of the spatial diversity of adults participation in lifelong learning (by NUTS 2 regions - voivodships) in a long-time perspective (2001-2012),
- evaluation of the relationship between adults participation in lifelong learning and chosen indicators describing the socio-economic situation in the Polish regions in a long-time perspective (2001-2011),
- search for socio-demographic factors associated with gaining new professional qualifications or skills (at the individual level).

Some quantitative researchers were carried out concerning adult education engagement in Poland. Logistic regression was used to analyze possible factors influencing the participation (Czapiński and Panek 2009, Czapiński and Panek 2011). Grzeškowiak (2013) applied classification trees as data mining technique to identify determinants of educational involvement and considered regional differences in 2011. This paper contains further discussion on this topic

in a broader context - the analysis concerns a long period of time, multivariate techniques were applied to capture interactions, including higher-order relationships. In addition, some visualization techniques were used to give a concise presentation of information.

2. Data Sources and Methods

2.1 Data sources

The study is based on various data sources. Information on regions were derived from Eurostat databases, in particular the Labour Force Survey results and the regional database. Data on individuals were taken from a Polish panel social survey Diagnoza Społeczna (Social Diagnosis) which includes a question about the participation in activities allowing the improvement of qualifications and skills during the last two years. The Diagnoza Społeczna survey is carried out every two years but the question concerning lifelong learning formulated in such a way was asked in 2007 for the first time, so the presented analyzes at the individual level concern three years: 2007, 2009 and 2011. Only respondents aged 25-64 were considered.

2.2 Set of variables

Both metric and non-metric (categorical) variables were taken into consideration in the study. Table 2 shows the list and description of the variables used.

Table 2. List of variables used in the study

Variable	Character	Units	Level
Participation in education and training (LFS)	metric	%	regional
GDP	metric	PPS per inhabitant	regional
Employment rate (age 20-64)	metric	%	regional
Tertiary educational attainment (age 25-64)	metric	%	regional
People at risk of poverty or social exclusion	metric	% of total population	regional
Total intramural R&D expenditure	metric	% of GDP	regional
Gaining new professional qualifications/skills	categorical	0 - no, 1 - yes	individual
Age of respondent	categorical	1: 25-34, 2: 35-44, 3: 45-54, 4: 55-64	individual
Gender	categorical	0 - men, 1 - woman	individual
Place of residence	categorical	0 - urban, 1 - rural	individual
Educational status	categorical	1 - primary/no education	individual
		2 - vocational/grammar	
		3 - secondary	
		4 - post-secondary and higher	

Source: own elaboration

2.3 Methodology

The dataset containing both metric and non-metric variables determined the application of various analytical approaches. Elements of descriptive statistics were used to examine the level and the variability of the phenomena featured by metric variables. As the central region turn out to be an outlier some order statistics were used to describe the changes and shape of the distribution. Correlation analysis and parametric hypothesis testing were used as tools for checking the relationships between pairs of continuous variables. Correlation analysis was applied for description purposes, i.e to investigate the kind of relationship and its strength (Affi, Clark and May 2012, p. 82). The significance level for Pearson correlation coefficient was set at 0,05.

Regarded categorical data formed multiway contingency tables. Log-linear models were chosen as a technique for analyzing these cross-classified tables. The main task was to examine associations among non-metric variables. According to Ishii-Kuntz (1994) "With the log-linear approach, we model cell counts in a contingency table in terms of associations among the variables and marginal frequencies" (p.5). Christensen (1997) underlines that log-linear models

have indisputable advantages as flexibility, interpretability and give a possibility to consider all dimensions of a multiway table. In this study standard, hierarchical approach was used what means that higher-order associations include all the lower-order ones. A stepwise procedure was applied to determine the best models (parsimonious and well-fitted) and two criteria were used to evaluate the goodness of fit of the models, i.e. Pearson chi-square and likelihood ratio chi-square (Jobson, 1995, p.41). The analyses were performed using SPSS 21 and STATISTICA ver. 10.

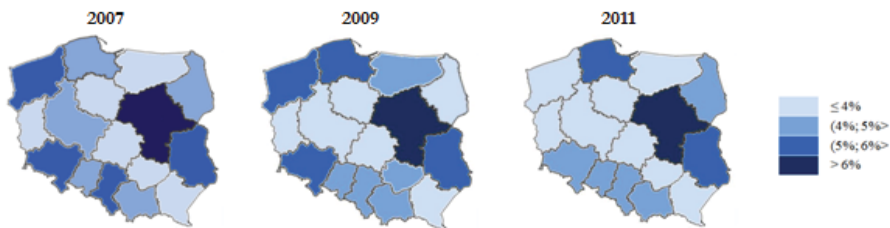
The analyzes were supported by selected visualization techniques, including panel plots allowing to represent multidimensional datasets, box-and-whisker plots and choropleth maps.

3. Results and discussion

3.1 Regional level

The administrative division of Poland at the NUTS 2 level includes 16 regions (provinces) called voivodeships. Choropleth maps (Figure 2) show the rates of adult lifelong participation by regions in chosen years according to LFS indicator.

Figure 2. Percentage of persons aged 25 - 64 who participated in education or training in Poland by NUTS 2 regions, selected years

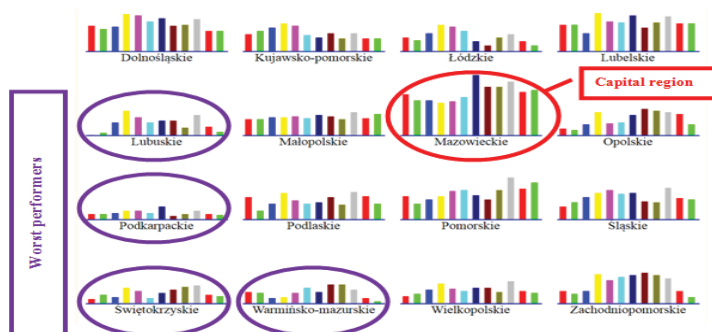


Source: own elaboration based on Eurostat LFS data

There were significant spatial differences in the field of lifelong learning in Poland. In the regions with the lowest results the participation rate did not exceed 4%, and in the others (with the exception of the mazowieckie region) was lower than 6%, which is very far from the benchmark. Adults involvement in education and training changed over time. There was a decline in the participation rate in many regions in 2011 as compared to previous years. In 2011 in half of the voivodeships the value did not exceed 4%. The highest level occurred in the mazowieckie voivodeship (capital region) in all analyzed years.

The maps illustrate the differences very well, but it would be inefficient and impractical to provide such a presentation for data describing long-term interval therefore the values covering the entire study period are visualized by means of a column panel chart (Figure 3).

Figure 3. Percentage of persons aged 25 - 64 who participated in education or training in Poland, by NUTS 2 regions in Poland, 2001-2012



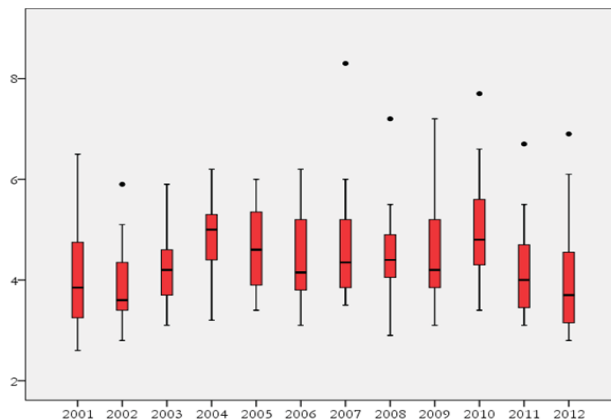
Source: own elaboration based on Eurostat LFS data

Long-term observations confirm the thesis of spatial diversity of adults engagement in the educational processes. It should be noted that the capital region (mazowieckie) was ahead of other regions in all years, although the results were still unsatisfactory (maximum level equal to 8.2% was achieved in 2007). Several regions were characterized by a relatively high participation rate (dolnośląskie, lubelskie, pomorskie, zachodniopomorskie). The most unfavorable situation occurred in podkarpackie, świętokrzyskie, warmińsko-mazurskie and lubuskie regions. The lifelong learning participation in case of the worst performing voivodeship (podkarpackie) did not exceed 3.8%. An essential worrisome decrease was observed in almost all regions in the last two years, as compared to 2010.

Regional diversity in the degree of adult educational involvement in subsequent years was assessed on the basis of order statistics (quartiles). The selection of these measures was conditioned by the presence of an outlier among voivodeships what would disturb measures used in classical approach. Box-and-whisker diagrams (Figure 4) display distributions of regional lifelong participation in years 2001-2012. First and third quartile are illustrated by shorter sides of the rectangles, the median by a line inside the boxes and the whiskers ends demonstrate the most extreme values but no lower than first quartile minus 1,5 interquartile range and no higher than third quartile plus 1,5 interquartile range.

The median representing the central tendency indicates the variation in the typical level of participation in the reporting period. The highest values were recorded in 2004 and 2010, and the lowest in 2002 and 2012. Outliers (represented by points) were identified six times as unusually high values. Each time it was mazowieckie voivodeship. The plots indicate that the dispersion measured by the interquartile range varied substantially over the examined time period. The highest dispersion occurred in 2001, 2005, 2006, 2012 and the lowest in 2003, 2004 and 2008. Distributions for all years were characterized by asymmetry, mostly right-sided type which was detected in ten cases. Such a shape of distribution indicates that the adult lifelong learning participation rates tended to concentrate at lower values. Opposite pattern i. e. negative skewness was found only in 2003 and 2004.

Figure 4. Spatial diversity of adult lifelong participation in Poland by NUTS 2 regions in years 2001-2013



Source: own calculations based on Eurostat LFS data

It seems important to research the factors associated with the regional diversity in the field of adult continuous education. We put forward a hypothesis that it may be related to the degree of socio-economic development of regions. In order to verify this hypothesis, correlation analysis was performed. The aim of this analysis was to determine whether there were any relationships between adult lifelong learning participation and chosen socio-economic indicators characterizing regions. The study was conducted for the years 2001-2011 due to the availability of statistical data. Table 3 shows the correlation coefficients between the participation rate and chosen indicators in years 2001-2011. Significant relationships are highlighted in red (significance level 0.05).

Table 3. Correlation coefficients between the education and training participation rate and chosen regional socio-economic indicators in Poland in years 2001-2011

Year	GDP per capita	Tertiary educational attainment (age 25-64)	Employment rate (age 20-64)	Total intramural R&D expenditure	People at risk of poverty or social exclusion
2001	0,59	0,80	0,45	0,79	:
2002	0,62	0,64	0,33	0,69	:
2003	0,78	0,61	0,26	0,69	:
2004	0,37	0,46	0,07	0,25	:
2005	0,58	0,58	-0,05	0,47	-0,15
2006	0,66	0,66	0,01	0,53	-0,36
2007	0,73	0,79	0,16	0,63	-0,14
2008	0,66	0,65	0,11	0,45	-0,50
2009	0,64	0,66	0,29	0,49	-0,31
2010	0,72	0,73	0,43	0,38	-0,25
2011	:	0,77	0,59	:	-0,25

: no data available

Source: own calculations based on Eurostat data

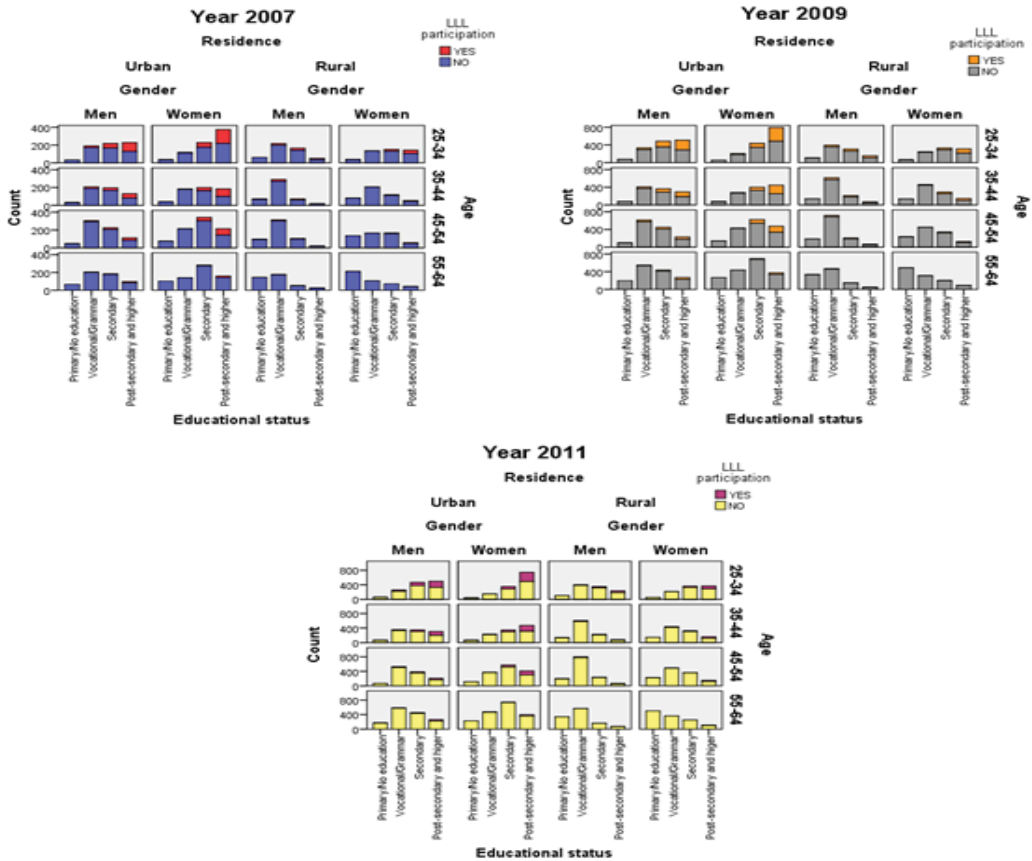
Significant positive correlations were recorded between lifelong learning engagement and such indicators as: GDP per capita, tertiary educational attainment, and in some years total intramural expenditures on research and development. Additionally, in 2011, a vital interaction concerning the employment rate was found. Negative but insignificant association occurred between adult educational involvement and poverty or social exclusion indicator. The wealth of the regions was related with the inclination of the inhabitants to gain new qualifications and skills. The higher rate of high-educated inhabitants, the bigger engagement in the education and training was observed. Regions involved in innovation processes tended to have a higher rate of participation in lifelong learning activities.

3.2 Individual level

At the individual level the aim of the analysis was to find the relationships between the declared participation in activities allowing to gain professional qualifications or other skills and some characteristics of individuals, i.e. respondents (aged 25-64) of Social Diagnosis in 2007, 2009 and 2009. As it was indicated in Table 2, all variables considered at the individual level were categorical what determined the use of relevant analytical methods.

Visualizations of datasets were made by means of panel plots (Figure 5) presenting the distributions of responses according to the categorical variables.

Figure 5. Adults participation in education and training with regard to socio-demographic characteristics



Source: own elaboration based on Social Diagnosis data

The graphical presentation suggests that there are some associations between the analyzed characteristics. Women tend to participate more frequently than men, younger people more than the older, urban areas residents more than rural areas inhabitants and well-educated people more than those of lower educational status. Such relationships would be evident when considering typical two-way cross-classified tables, but far more interesting and useful was to search for higher-order relationships. Log-linear hierarchical modeling was chosen to detect associations between five considered categorical variables simultaneously and accurately. The analyzed data formed five-way contingency tables making possible 32 types of interactions among variables (zero-order, first-order, second-order, third-order, fourth-order and fifth-order effects) so the task was to find more parsimonious models with a high goodness-of-fit by usage of stepwise procedure.

The saturated model comprises all possible effects among variables and is denoted [LAEGR] where L stands for lifelong learning participation, A for age, E for education, G for gender and R for place of residence. On the other hand the independence model consists of main effects only and is marked [L] [A] [E] [G] [R] indicating that all the variables do not depend on each other. As it was mentioned the hierarchical approach was applied meaning that the notation [LAEGR] for saturated model indicates that all lower-order interactions are included. The complexity of the saturated model led to the search for simpler solutions reflecting important associations in the contingency table. The application of stepwise procedure for model selection revealed that neither fourth-order nor fifth-order effects should be incorporated into the final equations. In each case (i.e. 2007, 2009 and 2011) a simpler model than the saturated one was found to describe essential interactions. Components of these models and the assessment of their goodness-of-fit are presented in table 4.

Table 4. Log-linear modeling results

Year	Effects included in the model	Pearson chi-square	p-value	Likelihood ratio chi-square	p-value
2007	[EGL][AEG][GLR][AER][EGR][AL]	56,995	0,6890	56,615	0,7017
2009	[EGL][AEG][AGL][LR][EGR][AER]	64,555	0,3546	64,099	0,3684
2011	[LR][AEG][AGL][AEL][EGR][AER][AGR]	58,128	0,2599	59,831	0,2127

L - lifelong learning participation, A - age, E - education, G - gender, R - place of residence

Source: own calculations based on Social Diagnosis data

Chi-square tests against saturated models show that the proposed models fit well the data. The interactions including lifelong learning participation are highlighted in red (Table 4). Two three-factor associations and one two-factor relationship concerning educational engagement were detected in each case, but the patterns were different. In 2007 there was an interaction between lifelong learning participation and age as well as higher-order interactions, i.e. educational involvement-educational status-gender and educational involvement-gender-place of residence. In 2009 the only second-order effect for lifelong learning participation referred to the place of residence and third-order interactions included educational involvement-educational status-gender and educational involvement-age-gender. Quite similar results were obtained from the latest survey (2011) with the exception of lack of association among lifelong learning engagement, educational status and gender. An interaction comprising lifelong learning participation, age and educational status was detected instead.

4. Conclusions

Low lifelong learning participation rate in Poland is very disadvantageous in the context of the educational benchmarks formulated in ET 2010 and ET 2020 programmes and therefore the in-depth analysis of this phenomena seems to be indispensable. There were substantial spatial differences at regional level in education and training engagement (namely if comparing capital region with others) what indicates the need for appropriate measures allowing to change this unfavorable situation. The analysis suggests the existence of significant interactions between lifelong learning participation by voivodeships and some socio-economic indicators such as GDP per capita, tertiary educational attainment and expenditures on research and development. However, it should be kept in mind that the findings from correlation analysis do not imply the causation between considered phenomena, but point out the occurrence of significant statistical relationships. Educational involvement is also associated with a number of socio-demographic factors (gender, age, educational status, place of residence). The research based on the categorical data revealed the existence of some problem areas in this regard. Log-linear analysis allowed to detect some higher order interactions not found out in previous studies based on logistic regression and classification trees. The results indicate that lifelong learning policy should take into account both regional differences and socio-demographic determinants.

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