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Multidimensional Data Analysis towards Assessing the European Education Systems

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Abstract
By considering the fact that education in an important component within the context of Europe 2020 strategy, this paper aims at developing an aggregated indicator towards the assessment of European education systems, thereby being employed multidimensional data analysis techniques, namely principal component analysis. Withal, by using unsupervised classification techniques, specifically cluster analysis, the European countries will be grouped acording to the valuation of education systems. There was selected a sample consisting of 26 European countries, the data corresponding for the year 2012, being considered the following variables: school expectancy; the percentage of all 18-year-olds who are still in any kind of school; the total number of persons who are enrolled in the regular education system; the share of the population aged 4 to the age when the compulsory education starts who is participating in early education; mobility of students in Europe; pupil/teacher ratio in primary education; the average number of foreign languages learned per pupil in secondary education; the share of 15-year-old pupils who are at level 1 or below of the PISA combined reading literacy scale; early leavers from education and training; lifelong learning. The utility of current research is emphasized by the valuation instrument provided to the government authorities which could rank the European education systems.

Keywords: International standard classification of education (ISCED), Programme for international student assessment (PISA), principal component analysis (PCA), cluster analysis.

1. Introduction

Education emphasizes a major role towards future sustainable development. Education for sustainable development ensures the knowledge, skills, and values required to surpass the various ecological and social issues. In addition, education and training have a fundamental function towards fulfilling many challenges Europe and its citizens are facing, such as socio-economic, demographic, environmental, and technological (Notices from European Union Institutions and Bodies, 2009). Therefore, enhancing and recognizing the people' qualifications is essential towards their individual and occupational development, as well as for competitiveness, employment, and social cohesion in Europe (Recommendations European Parliament and Council, 2009).
However, by taking into consideration the existing discrepancies as regards the structure and the content of the educational programs, there is emphasized an obvious difficulty as regards the comparison of education systems. Therefore, in order to employ a fair step towards understanding and interpretation of the inputs, processes, and the results of education systems from a global perspective, we underline the fact that their consistency is fundamental. In fact, by employing the International Standard Classification of Education (ISCED) and the Programme for International Student Assessment (PISA)

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there is ensured an international comparability in order to reflect the development of education systems worldwide. Therewith, the Bologna process named after the Bologna Declaration of 19 June 1999 shows as primary aim the establishment and promotion of the European system of higher education through the adoption of a system of easily readable and comparable degrees, which will promote the employability of the European citizens, alongside the international competitiveness of the European higher education system; the adoption of a system essentially based on two main cycles (undergraduate and graduate), the first cycle being oriented to the European labour market, lasting a minimum of three years, whereas the access to the second cycle shall require the successful completion of the first cycle studies, leading to the master and/or doctorate degree as in many European countries; the establishment of a system of credits, respectively the European Credit Transfer and Accumulation System (ECTS) in order to promote the most widespread student mobility; the promotion of mobility for students, meaning the access to study and training opportunities, as well related services, also for teachers, researchers, and administrative staff, being acknowledged and valorized the periods spent within the European context of researching, teaching, and training, without prejudicing their statutory rights; the promotion of the European co-operation towards quality assurance for developing comparable criteria and methodologies; the promotion of the necessary European dimensions in higher education, especially as respects curricular development, interinstitutional co-operation, mobility schemes, and integrated programmes of study, training, and research.

ISCED was initially developed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in the 1970s, subsequently being first revised in 1997. It belongs to the United Nations International Family of Economic and Social Classifications which are applied in statistics worldwide in order to gather, compile, and examine the cross-nationally comparable data. According to ISCED, the education programmes are classified based on their content being used two main cross-classification variables, respectively the levels of education and the fields of education. PISA was launched in 1997 by the Organisation for Economic Co-operation and Development (OECD) with the aim of developing relevant, regular, and reliable policies towards 15-year-old students' results. PISA represents an international standardized assessment programme, being the most extensive world survey that aims to evaluate the education systems worldwide by testing the skills and knowledge of 15-year-old students in several key subjects needed in adult life such as reading, mathematics, and science. Thus, a higher score highlights a significant literacy, consequently that particular education system being more efficient. PISA was first performed in 2000, being repeated every three years. So far, there are five employed appraisals in 2000, 2003, 2006, 2009, and 2012. In PISA 2000 the main focus was on reading literacy, meaning general reading skills and literacy, essential within an information society. In PISA 2003, the emphasis was on mathematical literacy, being also introduced an additional domain on problem solving. In PISA 2006, the main subject was science. In PISA 2009, reading literacy was the major domain, whilst the main focus of PISA 2012 was mathematics and problem solving. For the first time, PISA 2012 also included an assessment of the financial literacy of young people.

In PISA 2012 participated all 34 OECD member countries and 31 partner countries and economies, representing more than 80% of the world economy (European Commission, 2013a). The PISA 2012 survey highlights the fact that the socio-economic status of students registered a significant influence on their performance in school. In fact, there was pointed out a higher likelihood of low students' performance at reading, mathematics, and science related to students coming from low-income households. Furthermore, there were emphasized the negative effects of immigrant background on performance, the significance of attending pre-primary education, likewise the difference existing between boys and girls towards reading. In PISA 2012, Shanghai-China and Singapore were the top performers at mathematics (OECD, 2013). Consequently, Shanghai-China recorded an equivalent of nearly three years of schooling, above the OECD average. In addition, Hong Kong-China, Chinese Taipei, Korea, Macao-China, Japan, Liechtenstein, Switzerland, and The Netherlands, in descending order of their scores, rounded out the top ten performers in mathematics. However, ten European Union (EU) Member States (Bulgaria, Czech Republic, Germany, Estonia, Ireland, Croatia, Latvia, Austria, Poland, and Romania) have achieved since 2009 meaningful progress in diminishing their share of low achievers across all three basic skills. Unfortunately, five EU Member States (Greece, Hungary, Slovakia, Finland, Sweden) registered an increase in the number of low achievers. Overall, the performance registered in the EU was slightly better than the United States, but both lag behind Japan. Besides, we ascertain the benchmark 2020 according to which by 2020, the share of 15-year-olds with a low achievement in reading, mathematics, and science should be less than 15%.

This paper aims at developing an aggregated indicator towards assesing the education systems from 26 European countries, respectively their classification based on ten specific selected indicators. The novelty of current research is underlined by the application of multidimensional data analysis techniques, as well as unsupervised classification techniques in order to appraise and rank the European education systems. The utility of this empirical study is depicted by the fact that it provides to the governmental authorities a comprehensive collection of information as regards the education systems within a single measure, based on which being established the ranking of a certain state from the education point of view.

2. Review of Previous Research

Adams (1993) stated that the terms efficiency, effectiveness, equity, and quality have often been used synonymously. According to the United Nations Children's Fund - UNICEF (2000), quality education includes the following constituents: learners who are healthy, well-nourished, and ready to participate and learn, being encouraged in learning by their families and communities; healthy, safe, protective, and gender-sensitive environments which provide adequate resources and facilities; the content that is considered based on relevant curricula and materials for gathering of basic skills, mainly in the areas of literacy, numeracy, and skills for life, and knowledge in such areas as gender, health, nutrition, HIV/AIDS prevention and peace; the processes through which trained teachers use child-centred teaching approaches in well-managed classrooms and schools, alongside ingenious valuation to ease learning and mitigate disparities; the outcomes that comprise knowledge, skills, and attitudes, being tied to national goals for education and positive participation in society.

The quality education could be reflected through the performance related to students or graduates. Moreover, the value added by school could be measured through labour market performance such as extra income or by employing qualified employees. However, Psacharopoulos and Woodhall (1985) noticed that labour market performance depends on external circumstances rather than school exclusively. Part of the studies (Boissiere et al., 1985; Bishop, 1989, 1992; Moll, 1998) identified the fact that the cognitive ability tests are a good predictor of future students' income. Thereby, Hanushek and Kimko (2000) identified a positive relationship between the test scores and real gross domestic product per capita. Lee and Barro (2001) found that family inputs and school resources are related to school outcomes, proxied by internationally comparable test scores, repetition rates, and dropout rates. Family characteristics, such as income and education of parents, have strong relations with student performance. Therewith, supplementary school resources, particularly smaller class sizes, but probably also higher teacher salaries and greater school length, enhance educational outcomes. Eide et. al (2002) ascertained differential effects of school resources on earnings, but without controlling for individual and family background characteristics. Subsequently, after controlling for a set of demographic variables, much of the impact of school resources on earnings declined.

There are studies (Card and Krueger, 1992; Betts, 1995; Grogger, 1996; Eide and Showalter, 2005) which researched if the improvement of the quality related to secondary education, measured through the growth of expenditures per pupil or through the reduction of the class size, cause the increase of subsequent earnings. Card and Krueger (1992) studied the effects of school quality, proxied by pupil-teacher ratio, average term length, and relative teacher pay, on the rate of return to education for men born between 1920 and 1949. There was found that men who were trained in states with higher-quality schools have a higher return to additional years of training. Likewise, the rates of return were also higher for the persons out of the states with better-educated teachers and with a higher fraction of female teachers. Contrariwise, by holding constant the measures of school quality, Card and Krueger (1992) ascertained no evidence that parental income or education affects average state-level rates of return. According to Betts (1995), the earnings of white male workers depend significantly on which high school they have attended. Furthermore, there was not identified any relationship between adult wages and class size, teachers' salaries, and teachers' level of education. Grogger (1996) revealed that a 10% increase in school spending would increase students' adult wages by only 0.68%. Eide and Showalter (2005) concluded that larger secondary schools and schools with lower pupil-teacher ratios tend to reduce the likelihood of being unemployed for noncollege-bound men in the period shortly after secondary school graduation. Besides, the results provided support for a lack of any effect related to secondary school quality on unemployment probabilities approximately a decade after secondary school completion.

Furthermore, we emphasize another research direction towards the efficiency of tertiary education within Europe: United Kingdom (Glass et al., 1995; Johnes and Johnes, 1995; Izadi, 2002; Flegg et al., 2004; Johnes, 2006 a, b), Italy (Ferrari and Laureti, 2005; Agasisti and Dal Bianco, 2006; Bonaccorsi et al., 2006; Agasisti and Salerno, 2007; Abramo et al., 2008; Agasisti and Johnes, 2009), Austria (Leitner et al., 2007), Germany (Warning, 2004; Fandel, 2007; Kempkes and Pohl, 2010), Poland (Wolszczak-Derlacz and Parteka, 2011), Finland (Räty, 2002). However, only a part of studies investigated the efficiency of higher education institutions out of more European states: Bonaccorsi et al. (2007a) included the universities from Italy, Spain, Portugal, Norway, Switzerland, and United Kingdom; Bonaccorsi et al. (2007b) compared the universities from Finland, Italy, Norway, and Switzerland according to the research field; Agasisti and Johnes (2009) compared the technical efficieny related to the universities from United Kingdom and Italy since 2002/2003 until 2004/2005.

We underline the report entitled The Learning Curve published by Pearson and written by The Economist Intelligence Unit, being part of a wide-ranging programme of quantitative and qualitative analysis, for the years 2012 and 2014. The Learning Curve (2014) provided evidence that East Asian nations continue to outperform others, while Scandinavia showed mixed results; the outcome of PISA indicate the value of engaging all of society in education; better adult retention of skills depends on how often, and the environment within which, they are used; lifelong learning supports slow age-related skill decrease especially for those who are highly skilled already; before focusing on 21st century skills, developing countries must teach basic skills in a more effective way. The Global Index of Cognitive Skills and Educational Attainment compares the performance of 39 countries and one region (Hong Kong, being used as a proxy for China due to the lack of test results at a national level). In the latest edition (2014) of the Global Index of Cognitive Skills and Educational Attainment, South Korea tops the rankings, followed by Japan, Singapore, Hong Kong, Finland, United Kingdom, Canada, The Netherlands, Ireland, and Poland. The index comprises two categories, respectively cognitive skill (the latest test results from the Progress in International Reading Literacy Study, PIRLS; the Trends in International Mathematics and Science Study, TIMSS; the Programme for International Student Assessment, PISA; the initial output from the Programme for the International Assessment of Adult Competencies, PIAAC) and educational attainment (the latest literacy rate and graduation rates at the upper secondary and tertiary level).

3. The Structure of the European Education Systems

ISCED 2011 comprises the formal and non-formal education programmes provided at any stage of a person's life. Formal education represents the education that is institutionalised, intentional, and planned through public organisations and recognised private bodies. The qualifications of formal education are recognised, being within the scope of ISCED. In the case of non-formal education is emphasized the alternative and/or complement to formal education within the process of lifelong learning of people. Informal learning does not fall within the scope of ISCED for measuring participation in education, being defined as forms of learning that are intentional or deliberate, but are not institutionalised. Likewise, ISCED excludes incidental or random learning, respectivley various forms of learning that are not organized or that entail communication not planned to cause learning.

The ISCED level describes the degree of complexity and specialisation as regards the content of an education programme, from fundamental to complex. ISCED level 0 refers to early childhood programmes having an intentional education component, following to enhance socio-emotional skills required for participation in school and society. The programmes at ISCED level 1 or primary education aims at providing students fundamental skills in reading, writing, and mathematics, respectively the formation of a solid ground for learning and understanding core areas of knowledge, personal, and social development, also training for lower secondary education. The programmes at ISCED level 2 or lower secondary education are designed to build on the learning outcomes from ISCED level 1, their purpose consisting in setting the foundation for lifelong learning and human development upon which education systems may then widen further educational opportunities. The programmes at ISCED level 3 or upper secondary education aims at completing secondary education in preparation for tertiary education or provide skills relevant to employment or both. The programmes at ISCED level 4 or post-secondary non-tertiary education are set to provide persons who finished ISCED level 3 with nontertiary qualifications required for admission to tertiary education or for employment when their ISCED level 3 qualification does not grant such access. The programmes at ISCED level 5 or short-cycle tertiary education are set to provide members with professional knowledge, skills, and competencies, being practically-based, occupationally-specific, and preparing students to enter the labour market. The programmes at ISCED level 6 or Bachelor's are designed to provide participants with intermediate academic and/or professional knowledge, skills, and competencies, guiding to a first degree or equivalent qualification. The programmes at ISCED level 7 or Master's are set to provide members with advanced academic and/or professional knowledge, skills, and competencies, conducting to a second degree or equivalent qualification. The programmes at ISCED level 8 or doctoral are set primarily to lead to an advanced research qualification.

Figure 1 shows the main models of primary and lower secondary education (ISCED 1-2) in Europe, 2013/14. Therefore, we acknowledge a single structure education, the education being provided uninterrupted from the beginning to the end of compulsory schooling, with no transition between primary and lower secondary education, the general education being provided in common for all pupils. Furthermore, we identify the common core curriculum provision within which after successful completion of primary education (ISCED 1), all students advance to the lower secondary level (ISCED 2) where they follow the same general common core curriculum. Not ultimately, we ascertain the differentiated lower secondary education characterized by the fact that after the primary education was successful completed, either at the beginning or during lower secondary education, the students are required to follow distinct educational paths or specific types of schooling.

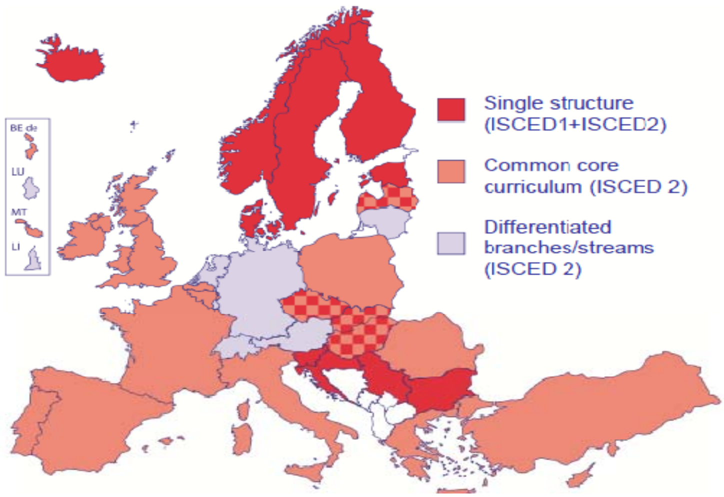

Figure 1. The main models of primary and lower secondary education (ISCED 1-2) in Europe, 2013/14. Source: European Commission. (2013b). The structure of the European education systems 2013/14: schematic diagrams. [Online] Available: http://eacea.ec.europa.eu/education/eurydice/documents/facts_and_figures/education_structures_EN.pdf (June 14, 2014).

Table 1 provides the structure of pre-higher education systems in Europe.

Table 1. The structure of pre-higher education systems in Europe.

BE FL	Pre-Primary 2 → 6	Elementary 6 → 12	General Secondary 12 → 18	Specialized Secondary 12 → 18	Technical 12 → 18	Vocational 12 → 19	Professional 15 → 18	Apprenticeship from: 16
BE FR	Primary 6 → 12	Secondary-Observation 12 → 14	Secondary-Orientation/guidance 14 → 16	Secondary-determination 16 → 18	Secondary-determination 16 → 19	Pre-university 18 → 19		
BG	Basic First Stage 7 → 10	Basic Second Stage 10 → 14	Secondary 14 → 19	Secondary 15 → 19	Vocational Secondary 15 → 19			
CZ	Basic 6 → 15	General Secondary 11 → 19	General Secondary 13 → 19	Academic Secondary 15 → 19	Technical Secondary 15 → 19 11 → 19 15 → 21	Vocational Secondary 15 → 19 15 → 18	Professional 19 → 21	
DE	Primary 6 → 10	Lower Secondary 10 → 15 10 → 16	General Secondary 10 → 19	Integrated Secondary 10 → 15	Higher Secondary 16 → 19	Vocational Secondary 15 → 18 16 → 18 18 → 20	Vocational	
EE	Basic 7 → 16	General Secondary 16 → 19	Vocational Secondary 16 → 19	Vocational 19 → 22				
IE	Primary 4 → 12	Junior Secondary 12 → 15	Senior Secondary 15 → 17	Vocational 16 → 18				
GR	Primary 6 → 11	Lower Secondary 12 → 14	Upper Secondary 15 → 17	Vocational Secondary 15 → 17				
ES	Primary 6 → 12	Secondary 12 → 16	Higher Secondary 16 → 18					
FR	Primary 6 → 11	Lower Secondary 11 → 15	Upper Secondary 15 → 18	Vocational 15 → 17	Professional 17 → 19			

HR	Primary 6 → 14	Secondary 14 → 18	Specialized Secondary 14 → 18	Vocational 14 → 18				
IT	Primary 6 → 11	Lower Secondary 11 → 14	Technical Secondary 14 → 19	Upper Secondary 14 → 19	Specialized Secondary 14 → 19 14 → 18	Vocational 14 → 17	Professional 14 → 19	
LV	Basic 7 → 15	Basic Vocational 16 → 18	General Secondary 16 → 19	Vocational Secondary 15 → 19	Vocational 15 → 18			
LT	Primary 6 → 11	Basic First Stage 10 → 17	Senior Secondary 16 → 19	Vocational 14 → 20 18 → 21				
LU	Pre-Elementary 4 → 5	Primary 6 → 12	Complete Secondary 12 → 15 15 → 19	Technical 12 → 19				
HU	Basic First Stage 6 → 10	Basic Second Stage 10 → 14	Academic Secondary 14 → 18 14 → 19 10 → 18 12 → 18	Vocational Secondary 14 → 18	Vocational 14 → 18			
NL	Primary 4 → 12	General Secondary 12 → 16	Senior Secondary 12 → 17	Prevocational 12 → 16	Vocational 16 → 20	Pre-university 12 → 18		
AT	Primary 6 → 9	Lower Secondary 10 → 13	Academic Secondary 10 → 17	Upper Secondary 14 → 17	Prevocational 14 → 15	Vocational 14 → 18		
PL	Pre-Primary 6 → 7	Primary 7 → 13	Basic Vocational 16 → 18	Lower Secondary 13 → 16	Technical Secondary 16 → 20	Upper Secondary 16 → 19	Vocational Secondary 16 → 19	
PT	Basic First Stage 6 → 10	Basic Second Stage 10 → 12	Basic Third Stage 12 → 15	Secondary 15 → 18	Professional 15 → 18	Specialized Tech./Voc. 15 → 18		
RO	Primary 6 → 10	Lower Secondary 10 → 16	Upper Secondary 16 → 19	Vocational 15 → 17 15 → 19	Specialized Tech./Voc. 19 → 22			
SI	Eight Year School 7 → 15	Nine Year School 6 → 15	General Secondary 15 → 19	Technical Secondary 15 → 19	Vocational Secondary 15 → 18 15 → 17			
SK	Basic First Stage 6 → 10	Basic Second Stage 10 → 15	General Secondary 15 → 19 10 → 18	Specialized Secondary 15 → 19	Vocational Secondary 15 → 19	Vocational 15 → 23 15 → 21	Apprenticeship 14 → 17	
FI	Basic 7 → 16	General Secondary 16 → 19	Vocational Secondary 16 → 19					
SE	Basic 7 → 16	Upper Secondary 16 → 19						
IS	Basic 6 → 16	Upper Secondary 16 → 20	Technical 16 → 20					
NO	Primary 6 → 13	Lower Secondary 13 → 16	Upper Secondary 16 → 19	Vocational 16 → 19	Apprenticeship 16 → 19			

Source: Authors' processing based on the data available at the following website: http://www.ceebd.co.uk/ceeed/prof.htm.

Notes: Belgium - Flemish (BE FL), Belgium - French (BE FR), Bulgaria (BG), Czech Republic (CZ), Germany (DE), Estonia (EE), Ireland (IE), Greece (GR), Spain (ES), France (FR), Croatia (HR), Italy (IT), Latvia (LV), Lithuania (LT), Luxemburg (LU), Hungary (HU), The Netherlands (NL), Austria (AT), Poland (PL), Portugal (PT), Romania (RO), Slovenia (SI), Slovak Republic (SK), Finland (FI), Sweden (SE), Iceland (IS), Norway (NO).

Table 2 reveals the duration of compulsory education in Europe.

Table 2. The duration of compulsory education in Europe.

Age of entry	Age of exit	Length of program in years	State
4	16	13	IE
4	15	12	LU
5	18	14	LV
5	16	12	NL
6	18	13	BE FL; BE FR
6	15	10	CZ; DE; HR; IT; PT; SI; SK
6	14	9	GR; AT
6	16	11	ES; FR; LT; RO; IS; NO
6	18	13	HU; PL
7	19	13	BG
7	16	10	EE; FI; SE

Source: Authors' processing based on the data available at the following website: http://www.ceebd.co.uk/ceeed/prof.htm.

Notes: Belgium - Flemish (BE FL), Belgium - French (BE FR), Bulgaria (BG), Czech Republic (CZ), Germany (DE), Estonia (EE), Ireland (IE), Greece (GR), Spain (ES), France (FR), Croatia (HR), Italy (IT), Latvia (LV), Lithuania (LT), Luxemburg (LU), Hungary (HU), The Netherlands (NL), Austria (AT), Poland (PL), Portugal (PT), Romania (RO), Slovenia (SI), Slovak Republic (SK), Finland (FI), Sweden (SE), Iceland (IS), Norway (NO).

According to data out of Table 1, we distinguish that Belgium - Flemish, Czech Republic, Germany, Italy, Poland, and Slovakia register the most components (seven or eight components) as regards the European pre-higher education system, whereas Sweden, Spain, Finland, and Iceland underscore a reduced number of components (two or three components). Thereby, the data from Table 2 supports the fact that Latvia register the highest length of compulsory education (14 years), whereas Greece and Austria record the lowest length of compulsory education (9 years). By considering the age of entry within compulsory education, we ascertain the age of six years within the majority of European states.

4. Empirical Research Methodology

4.1 Sample selection and variables' description

The empirical research will be employed for a sample which comprises 26 European states, the data corresponding for the last available year from Eurostat, namely 2012: Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Germany (DE), Estonia (EE), Ireland (IE), Greece (GR), Spain (ES), France (FR), Croatia (HR), Italy (IT), Latvia (LV), Lithuania (LT), Luxemburg (LU), Hungary (HU), The Netherlands (NL), Austria (AT), Poland (PL), Portugal (PT), Romania (RO), Slovenia (SI), Slovak Republic (SK), Finland (FI), Sweden (SE), Iceland (IS), and Norway (NO). Table 3 shows the description of each variable employed within empirical research.

Table 3. The description of all the variables employed within empirical research.

V	Variables' Description
v_1	School expectancy, which corresponds to the expected years of education over a lifetime, being calculated by adding the single-year enrolment rates for all ages. This type of estimate will be accurate if current patterns of enrolment continue in the future. Estimates are based on headcount data. [tps00052]

v_2	The percentage of all 18-year-olds who are still in any kind of school, being covered all ISCED levels. It gives an indication of the number of young people who have not abandoned their efforts to improve their skills through initial education and it includes both those who had a regular education career without any delays, as well as those who are continuing even if they had to repeat some steps in the past. [tps00060]
v_3	The total number of persons who are enrolled in the regular education system in each country. It covers all levels of education from primary education to postgraduate studies, excluding pre-primary education. It corresponds to the target population for education policy. [tps00051]
v_4	The share of the population aged 4 to the age when the compulsory education starts who is participating in early education. This indicator measures the Education and Training 2020 strategy's headline target to increase the share of children participating in pre-primary education, measured as those between 4 years old and the age for starting compulsory primary education to at least 95% in 2020. [tps00179]
v_5	The incoming students and outgoing students for each country, using the figures provided by the host country on foreign students enrolled in tertiary education by nationality. It includes only the EU/EEA/Candidate countries and the nationalities corresponding to these countries. For a given nationality, the number of students studying abroad is calculated by summing the numbers provided for this nationality by the receiving countries. [tps00064]
v_6	The pupil-teacher ratio, which is calculated by dividing the number of full-time equivalent pupils by the number of full-time equivalent teachers teaching at ISCED level 1. Only teachers in service, including special education teachers are taken into account. The pupil-teacher ratio should not be confused with average class size as it does not take into account special cases, like the small size of groups of special needs pupils or specialised/minority subject areas, or the difference between the number of hours of teaching provided by teachers and the number of hours of instruction prescribed for pupils for example in the case a teacher is working in a shift system. [tps00054]
v_7	The average number of foreign languages learned per pupil in secondary education, ISCED 2 and 3, being obtained by dividing the total number of pupils learning foreign languages by the number of pupils at that level. A foreign language is recognised as such in the curriculum or other official document relating to education in the country. Irish, Luxembourgish, and regional languages are excluded, although provision may be made for them in certain Member States. Allowing for exceptions, when one of the national languages is taught in schools where it is not the teaching language, it is not considered as a foreign language. [tps00056]
v_8	Reading literacy, which focuses on the ability of students to use written information in situations which they encounter in their life, the data coming from the Programme for International Student Assessment (PISA). We include the share of students which have serious difficulties in using reading literacy as an effective tool to advance and extend their knowledge and skills in other areas

	according to PISA. [tsdsc450]
v_9	Early leavers from education and training, which refers to persons aged 18 to 24 fulfilling the following two conditions: first, the highest level of education or training attained is ISCED 0, 1, 2 or 3C short, second, respondents declared not having received any education or training in the four weeks preceding the survey, at the numerator. The denominator consists of the total population of the same age group, excluding no answers to the questions 'highest level of education or training attained' and 'participation to education and training'. [tsdsc410]
v_{10}	Lifelong learning, which refers to persons aged 25 to 64 who stated that they received education or training in the four weeks preceding the survey, at the numerator. The denominator consists of the total population of the same age group, excluding those who did not answer to the question 'participation in education and training'. [tsdsc440]

Source: The definitions are provided by Eurostat.

4.2 Estimation framework

In order to develop an aggregated indicator for assessing the European education systems, there will be employed the principal component analysis (PCA). We decided to employ PCA as multidimensional data analysis technique since it ensures the decomposition expressed through a reduced number of components (Han and Kamber, 2006) and not redundant of the total variability out of the initial causal space (Jolliffe, 2002). The purpose of PCA consist in fixing new variables entitled principal components expressed through linear combinations of the original variables so as the newly formed variables are characterized by maximum variability. The initial causal space subject to current empirical investigation comprises ten explanatory variables, v_1, v_2, …, v_9 , v_{10}, thereby signifying the fact that each of the 26 selected European country is characterized by ten indicators.

The principal components which corresponds to the investigated causal space are described as a vector with ten dimmensions, labeled with w:

$$\mathbf{w} = \begin{pmatrix} \mathbf{w_1} \\ \mathbf{w_2} \\ \cdots \\ \mathbf{w_9} \\ \mathbf{w_{10}} \end{pmatrix} \qquad (1)$$

Thus, every coordinate w_i of the aforementioned vector represents a principal component described in relation with the original variables through the following linear combination:

$$\mathbf{w_i = \alpha_1^{(i)} * v_1 + \alpha_2^{(i)} * V_2 + \ldots + \alpha_9^{(i)} * v_9 + \alpha_{10}^{(i)} * v_{10}} \qquad i = 1, 2, \ldots, 9, 10 \qquad (2)$$

The coefficients $\alpha_j^{(i)}$ are the coordinates of the eigenvectors which correspond to the correlation matrix related to the original variables v_1, v_2, …, v_9 , v_{10}, whereas the variances of the principal components are the eigenvalues of the correlation matrix.

There is aimed to solve the following extreme problem, the optimum criterion being maximum or minimum, depending on the type of function Φ:

$$\begin{cases} \mathbf{opt}\ \boldsymbol{\phi}(\mathbf{v},\mathbf{w}) \\ \mathbf{w} = \mathbf{A^t} * \mathbf{v} \end{cases} \quad (3)$$

We will consider the fact that the vectors $\alpha^{(i)}$ are the colums of the matrix A of dimmension 10×10, having the following form:

$$\mathbf{A} = \begin{pmatrix} \alpha_1^{(1)} \alpha_1^{(2)} \cdots \alpha_1^{(9)} \alpha_1^{(10)} \\ \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \\ \alpha_{10}^{(1)} \alpha_{10}^{(2)} \cdots \alpha_{10}^{(9)} \alpha_{10}^{(10)} \end{pmatrix} \quad (4)$$

Withal, we will suppose the fact that v is the vector whose coordinates are the original variables $v_1, v_2, \ldots, v_9, v_{10}$, whilst w is the vector whose coordinates are the principal components $w_1, w_2, \ldots, w_9, w_{10}$.

Therefore, the linear combinations that define the principal components could be described as follows:

$$\begin{cases} \mathbf{w_1} = \propto_1^{(1)} * \mathbf{v_1} + \propto_2^{(1)} * \mathbf{v_2} + \cdots + \propto_9^{(1)} * \mathbf{v_9} + \propto_{10}^{(1)} * \mathbf{v_{10}} \\ \mathbf{w_2} = \propto_1^{(2)} * \mathbf{v_1} + \propto_2^{(2)} * \mathbf{v_2} + \cdots + \propto_9^{(2)} * \mathbf{v_9} + \propto_{10}^{(2)} * \mathbf{v_{10}} \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ \mathbf{w_9} = \propto_1^{(9)} * \mathbf{v_1} + \propto_2^{(9)} * \mathbf{v_2} + \cdots + \propto_9^{(9)} * \mathbf{v_9} + \propto_{10}^{(9)} * \mathbf{v_{10}} \\ \mathbf{w_{10}} = \propto_1^{(10)} * \mathbf{v_1} + \propto_2^{(10)} * \mathbf{v_2} + \cdots + \propto_9^{(10)} * \mathbf{v_9} + \propto_{10}^{(10)} * \mathbf{v_{10}} \end{cases} \quad (5)$$

Furthermore, in order to classify the European countries according to the developed indicator we will employ the cluster analysis. There will be employed the previously mentioned unsupervised classification technique since its purpose is to search and identify within the research data certain groups based on the similarities and dissimilarities between the objects which refer to the employed data. The cluster represents a distinct informational entity with clear significance, which comprises all the objects whose characteristics are identical or differs barely, but are significantly different towards the characteristics related to the objects from other classes or groups. Within current empirical research we will employ the Ward's method (Ward, 1963) as hierarchical aggregate classification method. According to Ward's method, in each stage of the classification there will be merged those two clusters for which the sum of the squared deviations for the cluster emerged upon aggregation is the lowest in comparison with other pairs of clusters. In fact, the Ward's method measures the distance between two clusters as the total sum of the squared deviations existing for the cluster configuration resulted upon merging those two clusters for which is assessed the distance (Zaki and Meira Jr., 2014).

The sum of squared deviations is defined as following, where y_{ij} depicts the object j from cluster i, whereas n_i signifies the number of objects from cluster i:

$$\mathbf{SSE} = \sum_{i=1}^{K} \sum_{i=1}^{n_i} (\mathbf{y_{ij}} - \overline{\mathbf{y_i}})^2 \quad (6)$$

Besides, there will be covered the following stages in order to render the tree diagram. Initially, there is considered a number of clusters equal with the number of countries, respectively 26 clusters. However, every cluster comprises a single object:

$$\boldsymbol{\omega}_1^{(1)} = \{\mathbf{S_1}\}, \boldsymbol{\omega}_2^{(1)} = \{S_2\}, \ldots, \boldsymbol{\omega}_{25}^{(1)} = \{\mathbf{S_{25}}\}, \boldsymbol{\omega}_{26}^{(1)} = \{\mathbf{S_{26}}\} \quad (7)$$

Subsequently, during several stages, the initial clusters are gradually aggregated in order to gather classes increasingly complex. Therefore, in each stage, labeled with t, there are aggregated only two clusters, respectively those clusters for which the aggregation distance is minimum in comparison with the distances between any two clusters existing in that stage. The aggregation distance could be defined as follows:

$$\mathbf{d}^{(\mathbf{t})}_{\mathbf{aggregation}} = \mathbf{min}_{i,j,i \neq j} \left\{ \mathbf{d}_{\boldsymbol{\omega}_{\mathbf{i}}^{(\mathbf{t})}, \boldsymbol{\omega}_{\mathbf{j}}^{(\mathbf{t})}} \right\} \quad (8)$$

Therefore, in the last stage of the aggregation, all the objects are covered within a single cluster:

$$\boldsymbol{\omega}^{(25)} = \{\mathbf{S_1}, \mathbf{S_2}, \dots, \mathbf{S_{25}}, \mathbf{S_{26}}\} \quad (9)$$

5. Empirical Research Results

5.1 Correlation investigation

Table 4 shows the correlation matrix related to the original variables. At baseline, the data was standardized. Thus, we notice the fact that there is a high correlation coefficient (0.8806) between the total number of persons who are enrolled in the regular education system in each country (v_3) and the incoming students and outgoing students for each country (v_5).

Table 4. The correlation matrix.

V	v_1	v_2	v_3	v_4	v_5	v_6	v_7	v_8	v_9	v_{10}
v_1	1.0000	0.5576	-0.1145	0.0506	-0.2126	-0.1793	0.1394	-0.3868	0.0945	0.6248
v_2	0.5576	1.0000	-0.1454	0.1536	-0.1359	0.0838	-0.0563	-0.4243	-0.2957	0.2845
v_3	-0.1145	-0.1454	1.0000	0.3088	**0.8806**	0.2702	-0.1329	-0.1522	0.2547	-0.2194
v_4	0.0506	0.1536	0.3088	1.0000	0.1334	0.0076	-0.1456	-0.1976	0.4097	0.2876
v_5	-0.2126	-0.1359	**0.8806**	0.1334	1.0000	0.2830	-0.1614	0.0061	0.1266	-0.3394
v_6	-0.1793	0.0838	0.2702	0.0076	0.2830	1.0000	-0.2208	0.1748	-0.1550	-0.1902
v_7	0.1394	-0.0563	-0.1329	-0.1456	-0.1614	-0.2208	1.0000	0.0039	0.0462	0.3932
v_8	-0.3868	-0.4243	-0.1522	-0.1976	0.0061	0.1748	0.0039	1.0000	0.1566	-0.3105
v_9	0.0945	-0.2957	0.2547	0.4097	0.1266	-0.1550	0.0462	0.1566	1.0000	0.0938
v_{10}	0.6248	0.2845	-0.2194	0.2876	-0.3394	-0.1902	0.3932	-0.3105	0.0938	1.0000

Source: Authors' computations.
Notes: Description of the variables is provided in *Table 3*.

5.2 Principal component analysis (PCA) results

Table 5 provides the eigenvalues of the correlation matrix, the principal components being descending sorted based on the information retained, as percentage out of the total variance. Likewise, there is disclosed the percentage from the initial information of each variable amongst the ten selected variables that is synthesized in the extracted principal components. Therefore, the first principal component explains 27.55% out of the total variance, the second principal component explains 20.60% out of the total variance, the third principal component explains 15.65% out of the total variance, whereas the fourth principal component explains 10.34% out of the total variance.

Table 5. The eigenvalues of the correlation matrix, and related statistics.

Value number	Eigenvalue	% Total variance	Cumulative Eigenvalue	Cumulative %
1	**2.7557**	**27.5566**	**2.7557**	**27.5566**
2	**2.0610**	**20.6098**	**4.8166**	**48.1664**
3	**1.5652**	**15.6519**	**6.3818**	**63.8183**
4	**1.0341**	**10.3408**	**7.4159**	**74.1591**
5	0.8964	8.9643	8.3123	83.1233
6	0.6658	6.6577	8.9781	89.7810
7	0.4498	4.4980	9.4279	94.2790
8	0.3665	3.6648	9.7944	97.9438
9	0.1369	1.3687	9.9313	99.3126
10	0.0687	0.6874	10.0000	100.0000

Source: Authors' computations.

Figure 2 shows graphically the eigenvalues of the correlation matrix as proposed by Cattell (1966). Thereby, there is shown that after the fourth point from the graph that signifies the fourth principal component, the slope is decreasing. According to Kaiser (1960) criterion, there are retained only those principal components that corresponds to the eigenvalues greater than unit. Based on the Cattell (1966) graph and Kaiser (1960) criterion, there will be withheld four principal components.

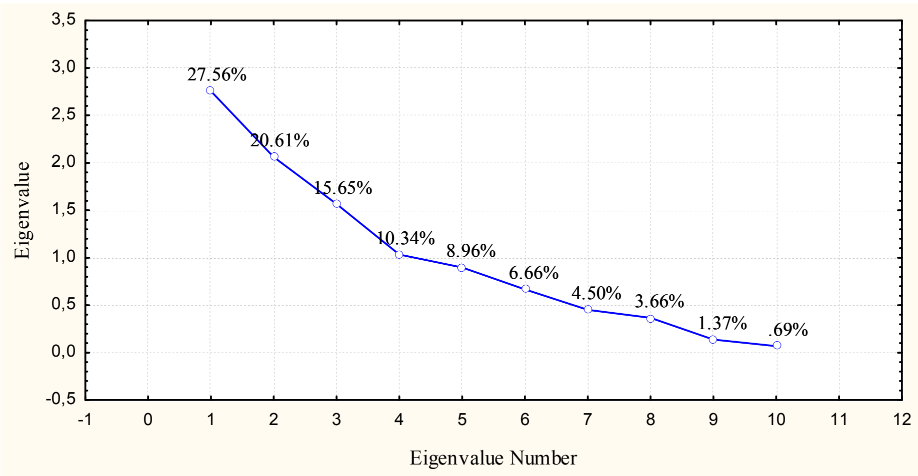

Figure 2. The eigenvalues of correlation matrix.
Source: Authors' computations.

Table 6 unveils the factor matrix, its elements being the correlation coefficients between the original variables and principal components. The strong relationship expressed by the first correlation coefficient (-0.7272) and by the last correlation coefficient (-0.7556) from the first column of Table 6 emphasizes that the first principal component expresses the informational content of the original variables v_1 and v_{10}. Likewise, the second principal component conveys the informational content of the original variables v_3 and v_4; the third principal component gives the informational content of the original variables v_2 and v_9, whilst the fourth principal component shows the informational content of the original variables v_4 and v_7.

Table 6. The factor coordinates of the variables, based on correlations.

V	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
v_1	**-0.7272**	0.3942	0.0601	-0.0775	-0.1166	-0.4924	-0.0711	0.0663	-0.1929	0.0586
v_2	-0.5553	0.3464	**0.5771**	0.1098	-0.1084	-0.0858	0.4205	-0.1146	0.1188	-0.0582
v_3	0.6038	**0.7054**	-0.0058	-0.3027	0.0458	-0.0358	-0.0250	0.0491	-0.0866	-0.1799
v_4	-0.0189	**0.6809**	-0.2797	**0.4760**	-0.0634	0.4174	0.1701	0.0697	-0.1267	0.0554
v_5	0.6896	0.5429	0.0955	-0.3575	0.0323	-0.1168	0.1181	0.1653	0.1221	0.1481
v_6	0.4101	0.1234	0.4717	0.0649	-0.7027	0.0882	-0.2311	-0.1845	-0.0141	0.0259
v_7	-0.3637	-0.1298	-0.4200	**-0.6891**	-0.2533	0.2392	0.2029	-0.1818	-0.0597	0.0212
v_8	0.4327	-0.5232	-0.3053	0.1600	-0.4688	-0.2212	0.2802	0.2657	-0.0306	-0.0392
v_9	0.1398	0.3617	**-0.7656**	0.2419	-0.0784	-0.3050	-0.0276	-0.3020	0.1174	-0.0055
v_{10}	**-0.7556**	0.3049	-0.2507	-0.0829	-0.2829	0.1410	-0.2248	0.2924	0.1691	-0.0433

Source: Authors' computations.
Notes: Description of the variables is provided in *Table 3*.

Table 7 provides the coefficients related to the linear combinations that define the principal components (the eigenvectors of the correlation matrix), based on these being computed the scores of the observations within the principal components space.

Table 7. The eigenvectors of the correlation matrix.

V	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
v_1	-0.4381	0.2746	0.0480	-0.0762	-0.1231	-0.6035	-0.1060	0.1095	-0.5215	0.2237
v_2	-0.3345	0.2413	0.4613	0.1080	-0.1145	-0.1051	0.6270	-0.1893	0.3210	-0.2218
v_3	0.3637	0.4913	-0.0046	-0.2977	0.0483	-0.0438	-0.0372	0.0810	-0.2341	-0.6860
v_4	-0.0114	0.4743	-0.2235	0.4681	-0.0669	0.5116	0.2537	0.1151	-0.3425	0.2114
v_5	0.4154	0.3782	0.0763	-0.3515	0.0341	-0.1432	0.1760	0.2730	0.3299	0.5647
v_6	0.2470	0.0859	0.3770	0.0638	-0.7422	0.1080	-0.3446	-0.3048	-0.0382	0.0988
v_7	-0.2191	-0.0904	-0.3357	-0.6776	-0.2676	0.2932	0.3026	-0.3003	-0.1615	0.0810
v_8	0.2607	-0.3644	-0.2441	0.1573	-0.4951	-0.2710	0.4177	0.4388	-0.0827	-0.1496
v_9	0.0842	0.2519	-0.6120	0.2379	-0.0828	-0.3738	-0.0412	-0.4989	0.3174	-0.0210
v_{10}	-0.4551	0.2124	-0.2004	-0.0816	-0.2988	0.1728	-0.3352	0.4830	0.4570	-0.1652

Source: Authors' computations.
Notes: Description of the variables is provided in *Table 3*.

Table 8 shows the matrix of scores. The objects' coordinates within the newly space, respectively the projections of the objects on its axes, are the assessments of the objects in relation with the new variables and are entitled the scores of the principal components.

By taking into account the informational content, there will be computed the importance coefficients (CI) for each of the four principal components. Therefore, by marking the importance coefficient for the first factor with CI_1, respectively the variance of the first principal component with var(w_1), then CI₁ = var(w_1)/$\sum_{j=1}^{4} var(w_j)$, thus resulting the following values for the importance coefficients: CI_1 = 0.0372; CI_2 = 0.0278; CI_3 = 0.0211; CI_4 = 0.0139. The aggregated indicator (AI) developed in order to assess the selected European education system will emerge as follows: AI = $\sum_{j=1}^{4} C_i(j)*F_j$.

Table 8. The factor coordinates of cases, based on correlations.

State	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
BE	-0.7694	0.7407	0.3577	1.2018	0.5833	-0.6292	0.1066	-0.1511	-0.8648	0.1729
BG	2.3675	-1.8795	0.0430	1.4357	-1.3857	-0.7289	0.5210	0.4521	0.2489	-0.0675
CZ	-0.2117	-0.3737	1.8828	0.3033	-0.8124	0.1433	-0.7512	-0.1874	0.0272	-0.0991
DE	2.7748	3.4787	1.0560	-1.2618	0.3596	-0.4722	0.0687	0.9791	0.3093	0.4650
EE	-1.7407	-0.0163	0.3696	-0.3364	0.3444	0.6790	0.0121	-1.0861	0.2756	0.0374
IE	-0.1134	1.0613	1.8951	1.7203	0.5178	0.5364	0.0249	-0.6072	0.5751	0.4129
GR	0.6476	-1.8575	-1.1001	-1.4182	1.1590	-1.1698	-0.5256	0.1223	-0.5013	0.4057
ES	1.1367	1.6830	-1.8550	0.8285	0.2070	-0.7150	-0.6415	-0.6901	0.2801	-0.5495
FR	2.9900	1.7862	0.1927	-0.2855	-0.5087	0.9374	-0.5341	0.0334	-0.4064	-0.4707
HR	1.0673	-2.7966	0.8624	-0.6695	0.8935	0.0866	-1.3848	-0.1290	-0.0057	-0.1381
IT	1.6765	1.5648	-1.5330	-0.8503	0.3641	0.3465	0.6980	-0.2794	-0.0351	-0.0620
LV	-1.0117	-0.3244	0.2633	0.5563	0.6856	0.1915	0.9596	-0.5309	0.0152	-0.0676
LT	-1.1888	-0.8454	0.8648	-0.3493	0.6096	-0.7286	1.3978	0.0243	-0.2667	-0.0543
LU	-0.0818	-1.7358	-2.1377	-0.8239	0.4563	2.7082	0.5256	0.3263	0.0294	0.0718
HU	0.2835	-0.3624	0.2825	1.7585	1.3393	-0.3786	0.2299	0.1057	-0.2357	-0.1806
NL	-0.9412	1.2847	0.7813	-0.4287	-1.9688	1.0337	-0.4650	-0.6651	-0.6707	0.3352
AT	0.2988	-0.6381	-0.1368	1.0809	0.8308	0.5797	-1.1268	1.2525	0.0254	0.0547
PL	0.0129	0.7398	1.3230	-1.5893	1.4204	-0.2199	0.6417	-0.1793	-0.1261	-0.3219
PT	0.0352	0.2516	-1.8378	0.5961	0.2912	-0.3130	-0.3429	-0.6462	0.1667	0.2946
RO	2.2444	-1.3805	-1.1445	-0.2254	-1.9614	-0.7217	0.6707	-0.6082	-0.0632	0.0352
SI	-1.0935	-0.4712	1.2621	0.7626	-0.7622	0.4185	0.0322	0.4845	-0.3560	-0.1366
SK	1.4417	-2.0149	1.2107	-0.6917	-0.7146	-0.1199	0.4067	0.1017	0.5613	0.1687
FI	-3.0880	-0.0163	0.5875	-1.9191	-0.5883	-0.9060	-0.8035	-0.2121	0.4395	-0.2393
SE	-2.5068	0.7240	-0.0681	-0.2179	-0.9506	-0.0358	0.5994	1.4335	0.0328	-0.2734
IS	-2.7188	0.7749	-2.4300	0.3034	-0.7587	-0.7969	-0.4079	0.4127	-0.0453	0.2090
NO	-1.5110	0.6229	-0.9913	0.5195	0.3496	0.2745	0.0884	0.2442	0.5904	-0.0025

Source: Authors' computations.

Notes: Belgium - Flemish (BE FL), Belgium - French (BE FR), Bulgaria (BG), Czech Republic (CZ), Germany (DE), Estonia (EE), Ireland (IE), Greece (GR), Spain (ES), France (FR), Croatia (HR), Italy (IT), Latvia (LV), Lithuania (LT), Luxemburg (LU), Hungary (HU), The Netherlands (NL), Austria (AT), Poland (PL), Portugal (PT), Romania (RO), Slovenia (SI), Slovak Republic (SK), Finland (FI), Sweden (SE), Iceland (IS), Norway (NO).

Through computing the aggregated indicator for each of the 26 selected European countries covered within the current empirical research, Table 9 conveys their classification. Thereby, we notice the fact that Germany (DE), France (FR), and Ireland (IE) are the top performers based on the values related to the aggregated indicator developed in order to rate the education systems. Unfortunately, Sweden (SE), Luxemburg (LU), and Iceland (IS) are placed on the last positions.

Table 9. The classification of the European education systems based on the aggregated indicator.

State	Aggregated indicator	Ranking	State	Aggregated indicator	Ranking
BE	0.0163	11	**LU**	-0.1079	25
BG	0.0567	6	**HU**	0.0309	7
CZ	0.0257	9	**NL**	0.0112	13
DE	0.2045	1	**AT**	0.0056	15
EE	-0.0620	22	**PL**	0.0268	8
IE	0.0893	3	**PT**	-0.0222	17
GR	-0.0706	23	**RO**	0.0177	10
ES	0.0614	5	**SI**	-0.0165	16
FR	0.1608	2	**SK**	0.0135	12
HR	-0.0292	18	**FI**	-0.1296	27
IT	0.0616	4	**SE**	-0.0775	24
LV	-0.0333	19	**IS**	-0.1265	26
LT	-0.0543	21	**NO**	-0.0525	20

Source: Authors' computations.

Notes: Belgium - Flemish (BE FL), Belgium - French (BE FR), Bulgaria (BG), Czech Republic (CZ), Germany (DE), Estonia (EE), Ireland (IE), Greece (GR), Spain (ES), France (FR), Croatia (HR), Italy (IT), Latvia (LV), Lithuania (LT), Luxemburg (LU), Hungary (HU), The Netherlands (NL), Austria (AT), Poland (PL), Portugal (PT), Romania (RO), Slovenia (SI), Slovak Republic (SK), Finland (FI), Sweden (SE), Iceland (IS), Norway (NO).

5.3 Cluster analysis results

Figure 3 shows the tree diagram for the 26 selected European countries in order to unfold the empirical investigation. Thus, by employing the Ward's method (Ward, 1963) we established two clusters.

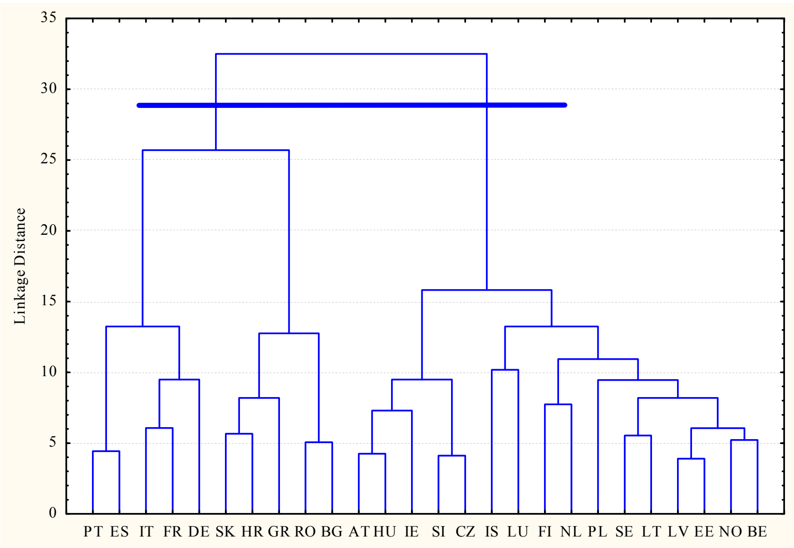

Figure 3. The tree diagram for 26 cases, Ward's method, City-block (Manhattan) distances.
Source: Authors' computations.

Notes: Belgium - Flemish (BE FL), Belgium - French (BE FR), Bulgaria (BG), Czech Republic (CZ), Germany (DE), Estonia (EE), Ireland (IE), Greece (GR), Spain (ES), France (FR), Croatia (HR), Italy (IT), Latvia (LV), Lithuania (LT), Luxemburg (LU), Hungary (HU), The Netherlands (NL), Austria (AT), Poland (PL), Portugal (PT), Romania (RO), Slovenia (SI), Slovak Republic (SK), Finland (FI), Sweden (SE), Iceland (IS), Norway (NO).

Therefore, the first cluster comprises the following European countries: Portugal (PT), Spain (ES), Italy (IT), France (FR), Germany (DE), Slovak Republic (SK), Croatia (HR), Greece (GR), Romania (RO), and Bulgaria (BG). Furthermore, the second cluster covers the following European countries: Austria (AT), Hungary (HU), Ireland (IE), Slovenia (SI), Czech Republic (CZ), Iceland (IS), Luxemburg (LU), Finland (FI), The Netherlands (NL), Poland (PL), Sweden (SE), Lithuania (LT), Latvia (LV), Estonia (EE), Norway (NO), Belgium (BE).

6. Concluding Remarks

The transition towards the knowledge-based economy, as stated within the Lisbon European Council (23-24th March 2000) requires the modernisation and uninterrupted improvement of vocational education and training (VET) systems, as an answer at quick transformations out of economy and society so as to support the growth of employment rates and social inclusion, respectively the betterment as regards the access of every person at lifelong learning, inclusively socioeconomically disadvantaged people. In fact, the evolution of people, their competencies, and skills are essential factors towards the long term competitiveness of Europe. The education is a fundamental human right, thus granting every people the chance to achieve the required knowledge in order to understand the natural environment and actively assist thereto. The European Quality Assurance Reference Framework for Vocational Education and Training aims at promoting a better vocational education and training (VET) system by providing joint instruments for Quality management to the relative authorities.
By selecting a sample comprising of 26 European countries, the data corresponding for the year 2012, respectively ten specific indicators, we developed an aggregated indicator in order to assess the related education systems, thereby being employed multidimensional data analysis techniques, namely principal component analysis (PCA). Therewith, by applying the cluster analysis the selected European countries were grouped within two clusters acording to the valuation of education systems. However, the limitations of current research emerge from the fact that the investigation was carried only for a single year. Furthermore, as future research avenues, our aim is to extend the research period, respectively to investigate the relationship between the aggregated indicator which will be developed and economic growth within European states.

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