Internet Use for Online Learning among Youth: Differences across European Countries and Educational Levels

M. Pejić Bach*, I. Miloloža**, J. Zoroja*

* University of Zagreb, Faculty of Economics & Business, Zagreb, Croatia
mpejic@efzg.hr, jzoroja@efzg.hr

** University of Osijek, Faculty of Economics, Osijek, Croatia
ivan.miloloza@fdmz.hr

Abstract - Abundant availability of online courses and materials has greatly expanded the opportunities for gaining new knowledge and skills, especially among younger population. Most of these courses and materials are freeware or could be purchased for a cost substantially lower than compared to those offered by HEIs or publishing companies. Although these new opportunities are available to everyone, researches indicate that their usage is not evenly spread across European countries and educational levels. Goal of the research is to investigate if the usage of online learning materials and courses over Internet is homogenous in Europe among youth (age 16-29) of low, medium, and high level education. Research has been conducted on the data from Eurostat Database on the following aspects of Internet use (i) Looking for information about education, training or course offers; (ii) Doing an online course (of any subject); (iii) Usage of online learning material; (iv) Communicating with instructors or students using educational websites/portals; (v) Usage of any aspect of online learning. Cluster analysis has been conducted in order to create a group of countries according to different level of internet usage for online learning. Relationship of GDP per capita has been compared across identified clusters.

I. INTRODUCTION

Online learning can be defined as innovative form of education which supports traditional teaching methods, and it has substantial positive impact to individuals and companies since it allows facilitated access to relevant knowledge during both university education and long-life learning. Since online learning is based on the usage of information and communication technologies, it could be expected that its usage is influenced by the digital divide, which indicates that there are barriers for the optimal utilization of information and communication technologies among people of different age, education and place of residence. Research goals of this paper are three-fold: (i) to investigate the level of online learning usage in European countries, as measured by Eurostat approach; (ii) to examine the applicability of K-means clustering methodology for the purpose of grouping European countries according to the level of online learning, and (iii) investigate the relationship of GDP per capita with online learning in European countries. We focus to the young residents of European countries (age 16-29) of different levels of education (low, medium, and high), and investigate the relationship between online learning and GDP per capita. Contributions of this paper are two-fold: (i) homogenous groups of European countries are identified that are similar according to the level of online learning usage among youth residents, thus indicating that digital divide is present in that area; (ii) positive relationship has been identified between the level of online learning and GDP per capita, thus indicating that the most likely cause of digital divide in that area is the different level of economic development.

Paper consists on the following parts. After introduction, in the second part of the paper we overview the relevance, advantages and barriers for online learning. Third part of the paper presents the methodology, while descriptive analysis of the data is presented in the fourth part. Cluster analysis is outlined in sixth part of the paper, while part seven investigates the relationship between the online learning and GDP per capita. Conclusion discusses the limitations and future research directions.

II. ON-LINE LEARNING

Ruiz (2006) describe online learning through usage of information and communication technologies. In addition, online learning refers to a virtual learning environment where information and communication technologies facilitate teaching activities (Wan 2008). In order to summarize all mentioned definitions, online learning can be described as internet platform where students can approach to course content, to all relevant information regarding studied program, to different documents and resources important for learning process, with no space or time limit (Raaij and Schepers, 2008).

Online learning presents critical factor in building a culture of lifelong learning. Knowledge economy implicit significant intellectual capital and investments in employees' potential and in job performance of each employee (Rosenberg, 2001). In order to provide more

effective educational process to their employees, companies use different online learning platforms (Rao, 2011). There are several advantages for companies when offer online learning: education with no space and time limit, motivating, cost effective, enhancing lifelong learning, higher productivity [1][2][3].

There are numerous advantages for online learning usage [4][5]. The most important is that users can learn where and when they want, which means that they can better organize their work, family, free time and learning [6]. In addition, online learning provides: many research opportunities, faster and better approach to information, individual instructions, standardize course content, interactivity, confidence, and convenience [7]. Moreover, online learning platforms enhance communication efficiency, provide automation of learners' activities, and permit professors to update the programme easily and enable users to have control over the learning activities [8][9]. Innovations in online learning refer to individual approach and cooperation among students and professors.

Beside many advantages, there are some barriers in online learning usage[10][11][12]. Online learning requires: advanced usage of information and communication technologies, higher investments in technology, user's willingness and motivation to accept online learning activities, more time and effort to organize the course, structured and technically designed course, well-educated and trained professors [13]. However, all these obstacles can be easily overwhelmed if learners and professors are ready to use and apply online learning possibilities.

III. METHODOLOGY

A. Data sources

In order to shed some light on the usage of online learning in European countries, we use Eurostat database, which tracks the following usage of online learning: i) Looking for information about education, training or course offers; (ii) Doing an online course (of any subject); (iii) Usage of online learning material; (iv) Communicating with instructors or students using educational websites/portals; (v) Usage of any aspect of online learning. We focus to youth (age 16 do 29) of different levels of education: low, medium, and high, according to Eurostat definition: 'Low formal education: At most lower secondary education [ISCED 0, 1, or 2]; Medium formal education: Upper secondary and post-secondary non-tertiary education [ISCED 3 or 4]; High formal education: Tertiary education [ISCED 5, 6, 7 or 8]', where ISCED refers to the International Standard Classification of Education.

We take into account the data for year 2015. Table 1 presents the research variables used in the analysis, which refer to the % of individuals using the particular form of online learning, aged 16-29 years. Following countries are included in the analysis: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, FYRM, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Turkey, and United Kingdom. Denmark was not included in analysis due to missing data.

Table 1. Research variables, European countries, 2015

Variable name	Statistical units
Looking for information about education, training or course offers	
SEARCH_16_29_ALL	Individ., 16 to 29 years old; %
SEARCH_16_29_HIGH	Individ., 16-29, high education; %
SEARCH_16_29_MEDIUM	Individ. 16-29 medium educ.; %
SEARCH_16_29_LOW	Individ. 16-29 low education; %
Doing an online course (of any subject)	
ONLINE_C_16_29_ALL	Individ., 16 to 29 years old; %
ONLINE_C_16_29_LOW	Individ., 16-29, high education; %
ONLINE_C_16_29_MEDIUM	Individ. 16-29 medium educ.; %
ONLINE_C_16_29_HIGH	Individ. 16-29 low education; %
Usage of online learning material	
ONLINE_M_16_29_ALL	Individ., 16 to 29 years old; %
ONLINE_M_16_29_LOW	Individ., 16-29, high education; %
ONLINE_M_16_29_MEDIUM	Individ. 16-29 medium educ.; %
ONLINE_M_16_29_HIGH	Individ. 16-29 low education; %
Communicating with instructors or students using educational websites/portals	
INSTRUCT_16_29_ALL	Individ., 16 to 29 years old; %
INSTRUCT_16_29_LOW	Individ., 16-29, high education; %
INSTRUCT_16_29_MEDIUM	Individ. 16-29 medium educ.; %
INSTRUCT_16_29_HIGH	Individ. 16-29 low education; %
Usage of any aspect of online learning	
ANY_16_29_ALL	Individ., 16 to 29 years old; %
ANY_16_29_LOW	Individ., 16-29, high education; %
ANY_16_29_MEDIUM	Individ. 16-29 medium educ.; %
ANY_16_29_HIGH	Individ. 16-29 low education; %

Source: Authors, Eurostat

B. Statistical analysis

Statistical analysis is conducted in three steps. First, we calculate descriptive statistics for all the variables at the total sample (including all investigated European countries). Second, we conduct k-means cluster analysis using Statistica software package, with the following parameters: Euclidean distances, Maximize initial distance, with the 10-fold Cross-validation. Finally, we compare GDP per capita across the clusters in order to investigate relationship between economic development and online learning.

However, proposed statistical analysis has some limitations that has to be taken into account. First, online learning is not necessarily related to national boundaries. Second, individual can take online course or use other online resources in different language and other country. Since English is predominant language in education, it is likely that low level of English (but also other languages) will impact the lower level of online learning. Therefore, online learning initiatives in local language would have a strong impact to online learning, besides GDP per capita and availability of high-speed internet. Third, there could be differences in understanding of the notion of e-learning, e.g. online learning can be understood as such only if it is provided by accredited HEI by one respondent, while other

respondent can consider any usage of online sources, e.g. over video search engines as online learning.

IV. Descriptive Analysis

Table 2 presents the results of the descriptive analysis of indicators of online learning in European countries. The highest level of usage is present for the variable "Looking for information about education. training or course offers", while the lowest level is present for the variable "Doing an online course (of any subject)". This result is in line with previous research, which found out that passive usage of online material is more present than active learning over the organized courses [7].

TABLE 2. DESCRIPTIVE STATISTICS OF ONLINE LEARNING, EUROPAN COUNTRIES, 2015

	Min	Max	Mean	Std. Dev.
Looking for information about education. training or course offers				
SEARCH_16_29_ALL	37	79	55.78	12.648
SEARCH_16_29_HIGH	43	86	62.55	12.551
SEARCH_16_29_MEDIUM	34	83	54.45	13.414
SEARCH_16_29_LOW	25	77	51.71	15.321
Doing an online course (of any subject)				
ONLINE_C_16_29_ALL	3	27	8.91	5.006
ONLINE_C_16_29_HIGH	4	34	13.81	6.959
ONLINE_C_16_29_MEDIUM	3	27	8.32	5.088
ONLINE_C_16_29_LOW	0	26	6.00	5.779
Usage of online learning material				
ONLINE_M_16_29_ALL	5	54	25.19	10.584
ONLINE_M_16_29_HIGH	8	57	30.94	12.236
ONLINE_M_16_29_MEDIUM	7	47	24.77	10.375
ONLINE_M_16_29_LOW	2	61	22.97	13.159
Communicating with instructors or students using educational websites/portals				
INSTRUCT_16_29_ALL	4	43	20.28	9.676
INSTRUCTOR_16_29_HIGH	7	35	20.65	8.155
INSTRUCT_16_29_MEDIUM	5	37	20.42	9.468
INSTRUCT_16_29_LOW	1	54	19.06	15.925
Usage of any aspect of online learning				
ANY_16_29_ALL	7	62	35.22	12.546
ANY_16_29_MEDIUM	10	55	34.35	12.637
ANY_16_29_HIGH	15	67	41.32	13.710
ANY_16_29_LOW	4	72	32.68	17.333

Source: Authors

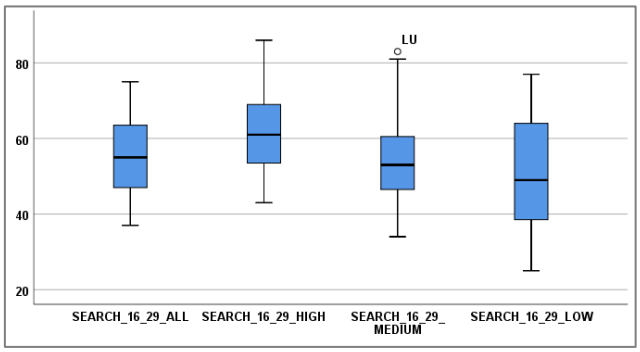

Figure 1. Box plot diagram of variables related to: Looking for information about education, training or course offers (Source: Authors)

Figure 2 presents the box plot diagram of the variable Doing an online course (of any subject). It can be noted that the average usage of online courses is substantially lower than searching for the information presented in Figure 1. Again, the individuals with high education use this type of online learning the most often. However, this indicator has substantially larger number of outliers, such as Finland, Estonia, FYRM, and Lithuania.

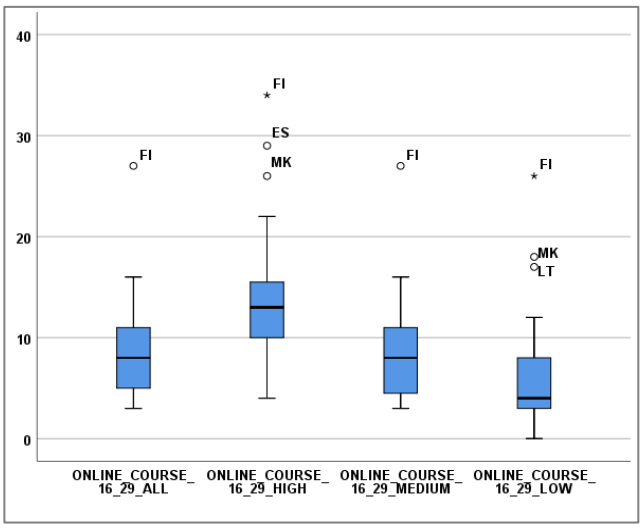

Figure 2. Box plot diagram of variables related to **Doing an online course (of any subject)** (Source: Authors)

Figure 3 presents box plot diagrams of the variable Usage of online learning material. Again, comparing to the Figure 1, the percentage of individuals using this type of online learning activity is lower. Only one country (Finland) is substantially different to others. It is particularly interesting that individuals with low education from Finland is substantially higher than in other countries. Similar trend is present at the Figure 4 presenting the Communicating with instructors or students using educational websites/portals, and Figure 5 presenting the Usage of any aspect of online learning.

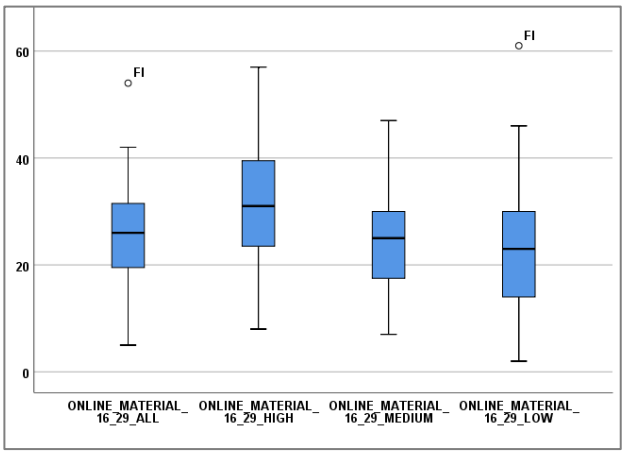

Figure 3. Box plot diagram of variables related to: **Usage of online learning material** (Source: Authors)

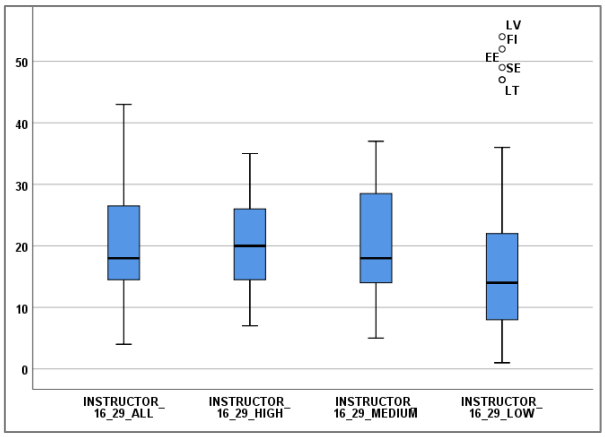

Figure 4. Box plot diagram: **Communicating with instructors or students using educational websites/portals** (Source: Authors)

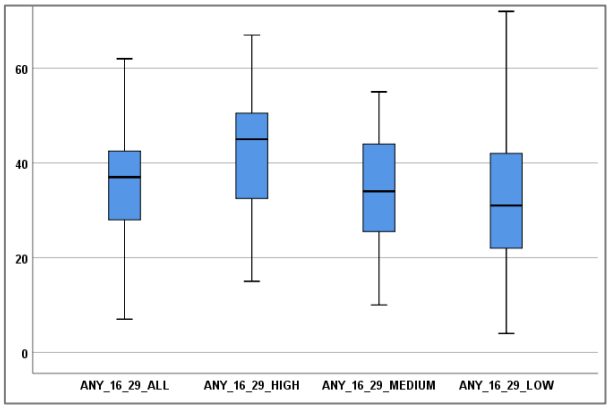

Figure 5. Box plot diagram of variables related to: **Usage of any aspect of online learning** (Source: Authors)

V. CLUSTER ANALYSIS

We apply K-means clustering algorithm to the observed online learning variables in European countries. Maximum average distance approach, using Euclidean distances was used in order to assign countries to clusters [14]. Statistica Data Miner was used for the cluster analysis, and all variables were normalized, using linear transformation. V-fold cross validation with the v=10 was used in order to estimate the optimal number of clusters [15]. In addition, graph of cost sequence presenting the error function for various number of clusters was used (Figure 6) in order to select optimal number of clusters, and it indicates that the optimal number of clusters is five. Cluster analysis was conducted on a sample of 31 European countries.

Table 3 presents the results of ANOVA analysis for the online learning variables of the variables used for developing cluster solution, which indicate that all the variables have statistically significant different values across clusters. In other words, the null hypothesis indicating that average values of variables across clusters are equal, cannot be rejected, which confirms that the decision to use five-cluster solution is justified.

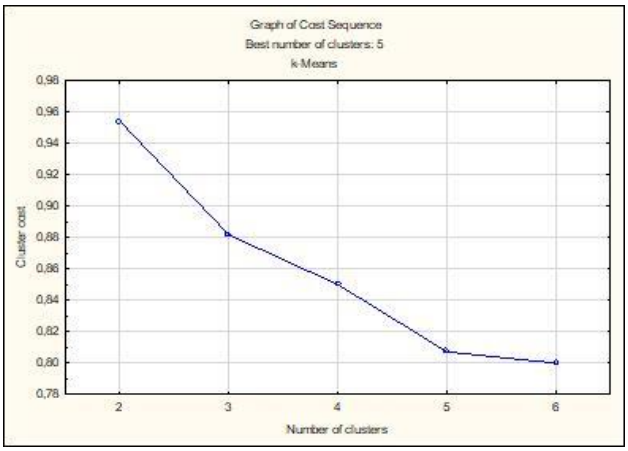

Figure 6. Cost sequence graph (Source: Authors)

TABLE 3. ANOVA ANALYSIS OF VARIABLES USED IN K-MEANS CLUSTER ANALYSIS

	df	F	p value
Looking for information about education. training or course offers			
SEARCH_16_29_ALL	26	7.58	0.00**
SEARCH_16_29_HIGH	26	7.03	0.00**
SEARCH_16_29_MEDIUM	26	9.07	0.00**
SEARCH_16_29_LOW	26	3.79	0.01**
Doing an online course (of any subject)			
ONLINE_C_16_29_ALL	26	13.55	0.00**
ONLINE_C_16_29_LOW	26	9.17	0.00**
ONLINE_C_16_29_MEDIUM	26	11.46	0.00**
ONLINE_C_16_29_HIGH	26	7.17	0.00**
Usage of online learning material			
ONLINE_M_16_29_ALL	26	25.89	0.00**
ONLINE_M_16_29_LOW	26	10.32	0.00**
ONLINE_M_16_29_MEDIUM	26	24.07	0.00**
ONLINE_M_16_29_HIGH	26	19.46	0.00**
Communicating with instructors or students using educational websites/portals			
INSTRUCT_16_29_ALL	26	25.39	0.00**
INSTRUCT_16_29_LOW	26	17.67	0.00**
INSTRUCT_16_29_MEDIUM	26	24.55	0.00**
INSTRUCT_16_29_HIGH	26	5.43	0.00**
Usage of any aspect of online learning			
ANY_16_29_ALL	26	31.48	0.00**
ANY_16_29_LOW	26	15.18	0.00**
ANY_16_29_MEDIUM	26	27.38	0.00**
ANY_16_29_HIGH	26	20.14	0.00**

Source: Authors
Note: Statistically significant at 5%

TABLE 4. COUNTRY MEMBERSHIP ACROSS CLUSTERS

Cluster	Countries
Cluster 1	Belgium, Latvia, Lithuania, Netherlands, Sweden
Cluster 2	Bulgaria, Germany, Croatia, Italy, Malta, Austria, Romania, Slovenia, Slovakia, United Kingdom, FYRM, Serbia
Cluster 3	Czech Republic, Ireland, Greece, France, Cyprus, Hungary, Poland, Turkey
Cluster 4	Estonia, Spain, Luxembourg, Portugal, Norway
Cluster 5	Finland

Source: Authors

Table 4 as well as figure 7 present the countries which are members of each cluster. It can be noted that first cluster contains countries which are geographically and

economically similar (Belgium, Latvia, Lithuania, Netherlands, Sweden). Second cluster is more heterogeneous according to the economic development and geographical position, including countries such as Germany and United Kingdom, but also FYRM and Bulgaria. Members of third and fourth clusters are also diverse according to the economic development and geographic position, while cluster 5 contains only one country (Finland), which was often the outlier according to the highest level of online learning usage.

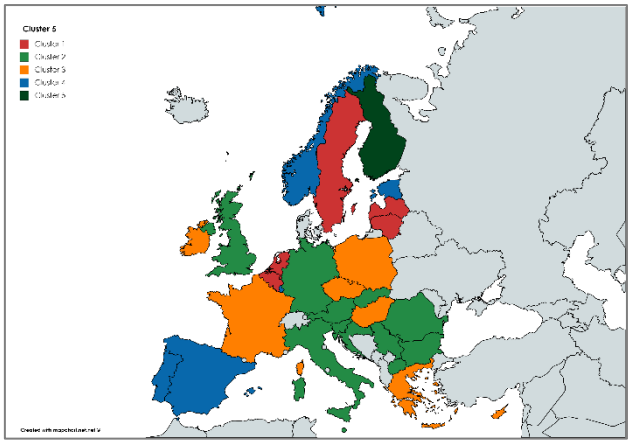

Figure 7. Countries membership across clusters (Source: Authors)

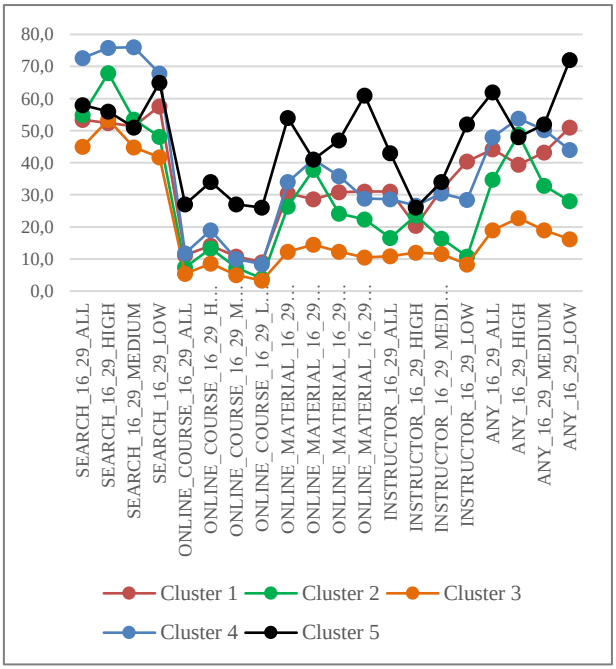

Figure 8. Mean values of research variables across clusters (Source: Authors)

Figure 8 and table 5 presents the mean values of research variables across clusters. It can be noted that countries which are members of cluster 4 (Estonia, Spain, Luxembourg, Portugal, Norway) are leading according to the variable "Looking for information about education. training or course offers", while Finland (as member of cluster 5) is the leading country according to all other indicators of online learning. Members of cluster 3 (Czech Republic, Ireland, Greece, France, Cyprus, Hungary, Poland, Turkey) are lagging behind the most according to all indicators of online learning.

Interesting results were observed according to the group of youth with the highest level of online learning activity. First variable "Looking for information about education. training or course offers" was the most often used online activity among youth with high education, with the exception of Finland in which it was used the most in the youth group with low education, while youth with high education was leading according to "Doing an online course" variable. In other variables, the youth with high education were leaders in clusters 2, 3 and 4, while youth with medium education was leading in cluster1 and youth with low education in cluster 5. It can be concluded that in countries which are leading according to online learning, youth with the low education is not left behind, but is included in lifelong education probably due to the abundant availabilities to reach high-speed internet with the strong computing devices.

Table 5. Mean values of research variables across clusters

Online learning indicator	Cluster value				
	1	2	3	4	5
Looking for information about education. training or course offers					
SEARCH_16_29_ALL	53.4	54.8	45.0	72.6	58.0
SEARCH_16_29_HIGH	**52.4**	**67.9**	**53.4**	**75.8**	56.0
SEARCH_16_29_MEDIUM	51.4	53.5	44.8	76.0	51.0
SEARCH_16_29_LOW	57.6	48.1	41.8	67.8	**65.0**
Doing an online course (of any subject)					
ONLINE_C_16_29_ALL	11.2	7.4	5.4	11.8	27.0
ONLINE_C_16_29_HIGH	**14.2**	**13.3**	**8.6**	**19.0**	**34.0**
ONLINE_C_16_29_MEDIUM	10.8	7.3	5.0	10.0	27.0
ONLINE_C_16_29_LOW	9.0	3.9	3.3	8.4	26.0
Usage of online learning material					
ONLINE_M_16_29_ALL	30.4	26.3	12.3	34.0	54.0
ONLINE_M_16_29_HIGH	28.6	**37.8**	**14.5**	**41.0**	41.0
ONLINE_M_16_29_MEDIUM	**30.8**	24.2	12.3	35.8	47.0
ONLINE_M_16_29_LOW	31.0	22.3	10.5	28.8	**61.0**
Communicating with instructors or students using educational websites/portals					
INSTRUCT_16_29_ALL	31.0	16.6	10.9	28.6	43.0
INSTRUCTOR_16_29_HIGH	20.4	**23.6**	**12.0**	26.6	26.0
INSTRUCT_16_29_MEDIUM	**31.6**	16.3	11.6	**30.4**	34.0
INSTRUCT_16_29_LOW	40.4	10.8	8.3	28.4	**52.0**
Usage of any aspect of online learning					
ANY_16_29_ALL	44.2	34.8	19.0	48.0	62.0
ANY_16_29_HIGH	39.4	**48.8**	**22.8**	**53.8**	48.0
ANY_16_29_MEDIUM	43.2	32.8	19.0	50.2	52.0
ANY_16_29_LOW	**51.0**	28.1	16.1	44.0	**72.0**

Source: Authors

VI. Relationship between GDP per capita and online learning

In order to further investigate if there is a positive relationship between economic development and online learning, we calculate mean values of GDP per capita across clusters. Figure 9 presents the average GDP per capita across clusters. Members of cluster 4 and 5 had the

highest level of online learning usage, and they have also the highest average GDP per capita, which indicates that there is a possible positive relationship between the level of economic development and level of usage of online learning. Other clusters, which were lagging behind according to online learning also lagged behind according to GPD per capita. However, the Kruskal-Wallis test (H=4.180, p-value=0.234) did not confirm that the found differences are statistically significant. Therefore, the hypothesis that there is a positive relationship between the usage of online learning and economic development was not confirmed.

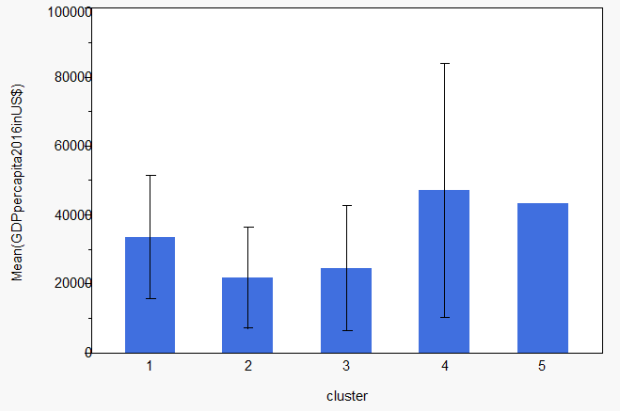

Figure 9. Average GDP per capita across clusters (Source: Authors)

VII. Conclusion

Online learning improves and enhances the quality of learning as well as lifelong educational activities. In this work we focus to the usage of online learning across European countries among youth, measured by the Eurostat indicators. The goal of the paper was to investigate if European countries could be grouped in homogenous groups using K-means analysis in order to investigate which countries are similar according to the usage of online learning. The results indicated that Finland is the most developed according to online learning, following by countries clustered in North Europe (Belgium, Latvia, Lithuania, Netherlands, Sweden). However, clusters that are lagging behind according to usage of online learning are not homogenous according to their economic development. Although cluster members with the highest online learning also have the highest GDP per capita, the relationship was not statistically significant. Preliminarily conclusion is some of the countries which are developing in economic sense, also catch up according to online learning among youth. This conclusion is justified taking into account that digital divide among youth is decreasing, since youth with low education is successful in gaining information literacy skills despite the barriers they face [16] [17].

Our research has several limitations which stem from the data and methodology used, but also indicate the future research directions. First, data sources limitations are described under section B. Statistical analysis. Second, we use only one-year data and we focus to European countries, and we use K-means cluster analysis. Future research should aim at researching wider sample in terms of time coverage, as well as different characteristics, such as gender. In addition, different clustering methods should be applied, such as hierarchical clustering and SOM analysis. This would provide broader conclusions, that could be used as a basis for long-term actions at the level of European Union.

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