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### MANAGEMENT OF INNOVATIONS IN FINANCE EDUCATION: CLUSTER ANALYSIS FOR OECD COUNTRIES

**Abstract.** *Financial literacy and financial education is a concept that helps people in orientation in both the financial markets and the area of personal finances. Financial literacy can be acknowledged through financial education. Financial education should enable individuals to develop their decision-making competencies. It includes issues such as the understanding of money, how to deal with them within the risk of their investment. The issue of financial literacy for primary and secondary school students has been monitored over a long time through several evaluations. In this case, it is very well known the PISA rating, which was lastly performed in the first half of 2018. It represents the ability of how to use skills and knowledge in managing one's financial resources while achieving maximum prosperity. Financial education should enable individuals to develop their decision-making competencies related to money. The paper aims to perform a cluster analysis based on the data available from the PISA 2015 measurement in selected OECD countries. The analysis represents results in a cluster of countries. The study analysed of financial literacy 15-year-olds students. The study observed similar research results in both the area of financial literacy and mathematical literacy. From the selected PISA 2015 test results applied through cluster analysis, we decided that the Slovak students were placed in a cluster together with students from Spain, Chile and Lithuania. The study observed the quality of vocational education and training is criticized mainly by employers because the area of education is inadequately responsive to labour market needs. Employee stress that it is inadequately linked to practice. Vocational training is inadequate compared to general schools. The methodology we recommend should also be applied to the results of the PISA 2018 evaluation, which are not yet available to the public. We would like to address this issue in future. The cluster analysis helps to reveal competitiveness in the area of financial literacy. The results of our research within Slovak students were based on a similar level of financial literacy among Slovak pupils as in Spain, Chile and Lithuania.*

**Keywords:** cluster analysis, financial literacy, PISA, pupils, OECD countries, Slovakia.

**Introduction.** In the beginning, it is important to note that education systems and the higher education sector in Central and Eastern Europe, after a long period of oppression and ideology until recently lagged Western countries. Through modern strategies, the companies should focus on quality and organized organizational culture that combines tasks that adapt to the conditions of the knowledge economy (Pietruszka-Ortyl, 2019). They have gone through a rapid and intense transformation in recent decades. The latest trends prove that for a country to achieve economic and IT leadership, it is inevitable to exploit and intensify all types of resources (human, natural, financial, etc. (Bilan et al., 2019). Schools play an essential role in education for sustainable development, as they link regions and sprout bond between the local and global dimension of sustainable development. Their main task is to increase people's literacy.

For most people, the term literacy refers to the ability to read and write. That is only part of a whole set of skills of literacy. The term encompasses many areas and is called using a general term functional literacy. According to Kirsch and Jungeblut (1986), it is the ability to use printed and written material to fulfil one's different needs at home, to function in society, to achieve one's personal and professional goals, etc. It is also a tool to broaden knowledge and develop one's potential. The components of functional literacy include, e.g. health, institutional, cartographic, media, emotional, cultural, digital literacy and, naturally, financial literacy. The last one focusses our attention in this paper. Financial literacy can be characterized by the ability to use knowledge, skills and experience of an individual to make appropriate management decision of their

finances to provide life-long financial security for themselves and their families (Mihalcova et al., 2014). Therefore, it means having the ability to understand primary financial products people deal with in their everyday lives that considerably affect their economic situation and welfare.

**Literature Review.** Financial literacy and financial education can be considered as a new concept that is trying to find out how to help people in orientation at financial markets and in area of personal finances (Csikosova & Antosova, 2015). Financial literacy also includes the area of income security, future income and other similar aspects (Korcymaros et al., 2019). The US Financial Literacy and Education Commission of 2007 and the Organization for Economic Co-operation and Development (OECD) summarized the previous definitions as the ability and awareness to use knowledge and skills to manage financial resources to achieve maximum financial well-being (OECD 2013). Financial literacy is a significant predictor of resource acquisition (Ying et al., 2019). Financial literacy indicates how managers, the owner, even people generally understand the financial terms, financial management, financial practices, etc. In order to measure financial literacy, several studies used questions related to interest rate, inflation, etc. However, in the business context mainly within SMEs, studies preferred measures related to financial management, working capital, and financial reporting (e.g. Bongomin et al., 2017). Kadoya and Khan (2019) defined financial literacy as the ability to understand the implications of interest, inflation, risks, and diversification. This definition provides the benefit of measurability, which enables researchers to relate financial literacy with a country is a demographic and socio-economic environment.

Financial education should enable individuals to develop their decision-making competencies related to money, dealing with it as well as with the risks of its investment (Mihalcova et al., 2014). However, people are not generally interested in learning. Unfortunately, it also applies to organizations that have little interest in organizing additional training activities for their employees. For example, Richardson and Seligman (2018) stated, that using a sample of Indiana University graduate students, they found low receptivity to engaging in financial education opportunities. For those students who do accept, they found that receptivity to their offerings varies systematically across groups. Their results suggest that highly customized guidance and education programs may be needed to significantly increase participation in programs designed to improve the overall financial acumen of early-career workers. Several authors in different countries of the world have addressed the issue of financial literacy, and their views on this issue are similar. In the EU, countries, there were realized several types of research, orientated to the financial literacy or the individual areas of finances.

Most educational systems surveyed in Great Britain, Germany, Austria, Holland and France are modern and provide high-quality education. Despite that in certain areas, they have proved to be inefficient. Poland is by far the most active Member State in Eastern Europe in terms of financial education activities. Bulgaria, Latvia, Luxemburg, Slovenia, Slovakia and Romania seem to be active but only in the areas related to the EU multinational programs. An example of financial education in the Czech Republic is its integration into the school curriculum. The main target groups for financial education are now children and young adults. One of the most critical tools of financial education is both the Internet and private providers of financial services who operate every sixth system of financial education. According to them, there was realized training of financial education in individual countries (Mihalcova et al., 2014). It categorizes Financial Literacy as both the internal financial literacy and external financial literacy. Internal financial literacy assists top managers to optimize the use of scarce resources by a competent and efficient management system.

On the other hand, external financial literacy describes the necessary skills and knowledge of top management to set up external networking and to use communication and cognitive skills to achieve satisfactory outputs and desirable objectives (Wise, 2013). Krechovska (2015) described the link between financial literacy and security of personal income. She said that it is the ability to make decisions about spending, to understand the consequences of a personal decision on current and future income, and on the labour market. In the Czech Republic, financial literacy, according to the National Financial Education Strategy (2010), was divided into individual groups as:

1. Monetary literacy, which represents the necessary competencies for the management of cash and non-cash money and transactions with them, and the management of the tools for this purpose account, payment instruments).

2. Price literacy represents the competencies needed to understand price mechanisms and inflation.

3. Budget literacy, representing the competencies necessary for managing the personal / family budget, ability to lead the budget, set financial goals, and decide on the allocation of financial resources. It also includes the ability to manage different financial situations in financial terms. Budget literacy includes the general components also two components specialized: financial asset management, deposits, investments and insurance and management of financial liabilities, loans or leasing.

Several studies have focused on the impact of the environment on the level of financial literacy among children. Agnew and Cameron-Agnew (2015) noted that the timing of the first financial discussion of individuals in the home affects their future financial literacy. On the other hand, Sohn et al. (2012) said that family communications on financial matters are falling with age, but mutual communication increases with age. It means that the parental impact on children's financial literacy is slowly rising over time, while the impact of peers grows. When a child becomes older, it will be exposed to several socializing «agents». Children learn about money management by interacting with these «agents». Duflo and Saez (2003) found in their research that peers play an essential role in the decision-making of individuals on pension savings. Despite the attitudes and behaviour of parents, there is a strong influence of peers in youth behaviour in the area of gambling, betting and losing value in the value of money (Shim et al., 2010). Amagir et al. (2018) evaluated the impact of educational programs on increasing financial literacy. Research shows that financial education programs in schools can improve financial knowledge and attitudes to children's financial decisions. As an appropriate method to teach financial literacy of children and adolescents at elementary and secondary schools is an experience of learning. On the contrary, high school should focus on specific case studies from students' life events.

Zhu and Chou (2018) also measured the financial literacy of Chinese children in Hong Kong through the Financial Fitness for Life coefficient. The study results specify the critical role of parents, offer specific entry points for education policymakers and educators, providing parents with advice that has a positive impact on the development of financial literacy among teenagers. Hazudin et al. (2018) have again focused on his study of the link between mathematical and financial literacy. Knowledge of the use of logic and mathematics creates the basis for good analytical thinking and decision-making skills that can have a significant impact on the sustainability of an individual's individual life. The result of the study is to evaluate the significant impact of mathematical literacy on the financial by comparing the results of higher education students.

According to the findings of Al-Tamini and Bin Kalli (2009), there is a significant difference between the financial literacy level based on gender, work activity, and education level. Slovakia has one of the lowest levels of investment in education relative to GDP in the EU. A well-educated society and education reflecting the needs of the labour market are one of the main prerequisites for the innovative potential of the country, especially in terms of the long-term perspective of sustainable development of the Slovak Republic. Persons with insufficient competencies and insufficient qualifications required to be employed on the labour market are the most vulnerable group and the barrier to sustainable development in Slovakia. The quality of education has a significant impact on job sustainability and raising the standard of living. Specifically, education aims to improve the quality of primary and secondary education in order to prepare pupils best to work in the labour market, whether in terms of supply and demand in the labour market or even with a view to the transition to a higher, next level of education. The issue of financial literacy for primary and secondary school students has been monitored over the long term through several evaluations, with the best known being the PISA rating, which was last performed in the first half of 2018. Financial literacy as such is not only studied in elementary and secondary school students, across the demography of the population, it is they pensioners, young people up to 30 years or mentioned students. Financial literacy is a narrower concept that

emphasizes objective knowledge about specific topics related to money, the economy, or financial affairs (Policy Research Initiatives, 2004). According to PISA study 6, financial literacy can be understood as an understanding of risk factors, the ability, motivation and self-confidence of the individual to use the acquired knowledge to make effective decisions in various financial situations to improve the financial situation of individuals and societies into economic life (National administration of PISA, 2015).

**Methodology and research methods.** The contribution aims to analyse selected factors in PISA 2015 financial literacy within OECD countries (as actual 2018 results are not yet publicly available). Using agglomeration cluster analyses, we will be generating clusters of countries involved in financial literacy testing in 2015. Just PISA 2015 testing provides the latest known relevant financial literacy scores for pupils across the world. Country breaks will be based on selected results of 15-year-old pupils, more precisely 21 variables from the average number of points by gender, achieved levels of mathematical, natural and numerical literacy, youth savings, financial issues and research and educational activities in schools.

The cluster analysis itself is, according to Stankovicova and Vojtkova (2007), a set of statistical and mathematical techniques by which we can identify clusters. The cluster is a set of identifiable countries close to and similar, but the countries belonging to other clusters are different and remote. It means that, based on variables reflecting, the financial literacy of PISA 2015 pupils representing OECD countries, these countries will be aggregated at the end of the analysis, where countries in one cluster will achieve the same or similar results based on the selected variables. This part of the contribution will aim to characterize the results of Slovak students compared to other students involved in testing PISA 2015 according to selected variables using cluster analysis.

It is essential to stress that PISA 2015 results are the least relevant results of the OECD's financial literacy evaluation. Newer results are expected to release PISA 2018 in the coming months. The result of this analysis is to find groups of similar countries in the official PISA 2015 results. In the analysis, we will use a hierarchical approach, the essence of which is that the number of clusters of countries is unknown in the analysis but, the country that is once included in one cluster, it cannot be reassigned to another cluster. This approach makes it possible to analyse just for a smaller selection of survey objects – 18 countries involved in PISA 2015 testing. The procedure itself is described by Stankovicova and Vojtkova (2007) in the following steps: entering input data, choosing the type of variables, object names, choosing the clustering method, choosing the type of the clustering method – in our case the Ward method, selecting the similarity of objects we transfer based on the Euclidean distance, clusters and cluster interpretation.

Different groups of object measures can measure the similarity between country results. The choice of the degree of similarity also depends on the monitored characters whose values characterize the survey results for the given countries. The most well-known are distance measures, association coefficient, correlation coefficient and likelihood similarities. In our work, we will use the distance measure called the Euclidean distance. By using this distance, Vilamova et al. (2016) also deal with the research.

$$d_{ij} = \sqrt{\sum_{k=1}^n (X_{ik} - X_{jk})^2} \quad (1)$$

where:  $X_{ik}$  is the value of the  $k_{th}$  variable for the  $i_{th}$  enterprise,  $X_{jk}$  is the value of the  $k_{th}$  variable for the  $j_{th}$  enterprise.

In the clustering method, we will use Ward's method, which is the most used in practice. This method does not calculate the distance between the clusters, but the clusters are formulated on the maximization of the inside aggregate sum of squares. The homogeneity measure represents the subsonic sum of squares of deviations from the aggregate diameter we call ESS - error sums of squares, and we use the following formula for its calculation:

$$ESS = \sum_{i=1}^{n_h} \sum_{h=1}^q (X_{hi} - \bar{X}_{C_h})^2 \quad (2)$$

where:  $n_h$  is the number of objects in the cluster  $C_h$ ,  $X_{hi}$  is the vector of the average of the values of the character in the cluster  $C_h$ ,  $X_{hi}$  is the vector of the values of the character of  $i_{th}$  object in the cluster  $C_h$ .

The statistical analysis was performed by using the programming language R, which is suitable for both the creation of statistical models and data analysis and graphing and visual analysis of data. The data required for the analysis come from the OECD database, namely, from the PISA 2015 test results, the financial literacy sections and the variables used are in Table 1. These data are publicly accessible on the OECD website. The analysis itself is addressed to the following countries participating in the PISA 2015 financial literacy testing: Belgium, Canada, Chile, Italy, Holland, Poland, Slovakia, Spain, USA, Brazil, China, Lithuania, Peru, Russia, Belgium (Flemish Community – Basque Country).

**Table 1. Using variables**

Variables are expressed as the average for the tracking area in points	
1	Average financial literacy for the country
2	Average financial literacy girls for the country
3	Average financial literacy of boys for the country
4	Points for the part of the test «Managing Individual Cash Flows»
5	Points for the «Spending Money Student»
6	Discussion at elementary school «Financial problems» 1-2 times a year
7	Discussion at the elementary school «Financial problems» 3-4 times a year
8	Discussion at the elementary school «Financial Problems» once a month
9	Discussion at the elementary school «Financial problems» once a week
10	Discussion at the elementary school «Financial problems» several times a week
11	Research and educational activities supporting pupils' financial literacy by the school 1-2 times a year
12	Research and educational activities supporting pupils' financial literacy by the school 3-4 times a year
13	Research and educational activities supporting pupils' financial literacy by the school once a month
14	Research and educational activities supporting pupils' financial literacy implemented by the school once a week
15	Research and educational activities promoting pupils' financial literacy implemented by the school several times a week
16	Spent money for unnecessary purposes (not in the student's plan)
17	Renting money from family members
18	Renting money from friends and classmates
19	Average mathematical literacy for the landscape
20	Average reading literacy for the country
21	Average natural literacy for the country

Source: classification of PISA 2015 Ranking.

**Results.** A condition for the cluster analysis is to explore dependencies between variables. The starting point for us was a correlation matrix that contains Pearson correlation coefficients. For cluster analysis, however, it is necessary to exclude statistically significant, but weaker dependencies, as they could distort the result of cluster analysis. It is, therefore, necessary to test the statistical significance of the Pearson correlation coefficients. The statistical software R gives us statistically insignificant coefficients at the significance level of 0.05 crossing the crosses, as can be seen in Figure 1. The graph shows that, in the case of the Mathematical Literacy variable, several coefficients are statistically insignificant. However, for other variables, their correlations are statistically significant. It means that there may be a problem with cluster formation in cluster analysis. Therefore, it is necessary to use the analysis of the main components that work

with the original variables, but in their standardized form, i.e. it eliminates the correlations between the variables. We also refer to the original variables as PC1, PC2, ... PC18. Based on several assumptions to determine the required number of significant components, we select the two significant components that will use the aggregation method.

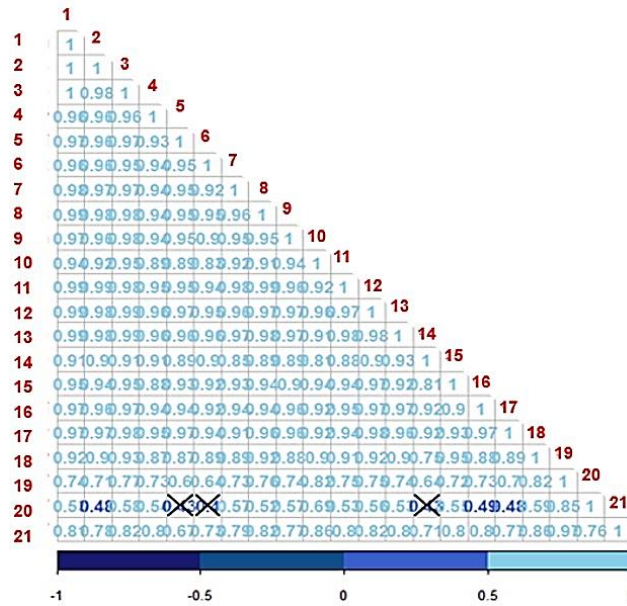


Figure 1. Correlation between variables

Source: own processing according to R-studio program

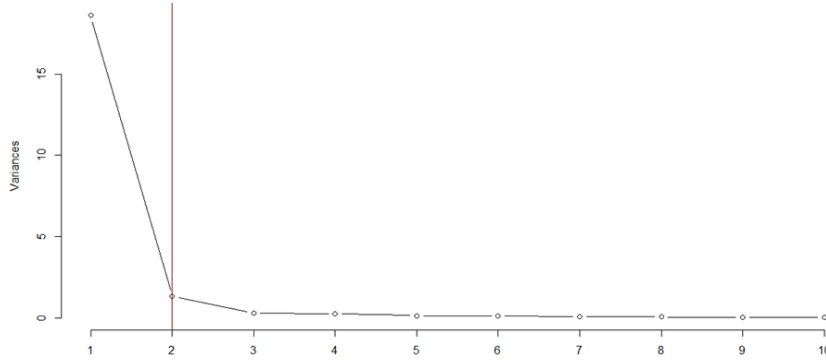
In Table 2, the first component explains the most and the last least variance - the proportion of the scatter. At the same time, we can see that in order to clarify 94.84% of the variability of the original file, we only need to use two components.

Table 2. Selected statistics for variables

Indicator	PC1	PC2	PC3	...	PC18
Standard derivation	4.311958	1.150787	0.5533554	...	2.168447e-17
The proportion of variance	0.885380	0.063060	0.0145800	...	0
<b>Cumulative of variance</b>	<b>0.397350</b>	<b>0.948440</b>	<b>0.9630200</b>	...	<b>1</b>

Source: own processing according to R-studio program.

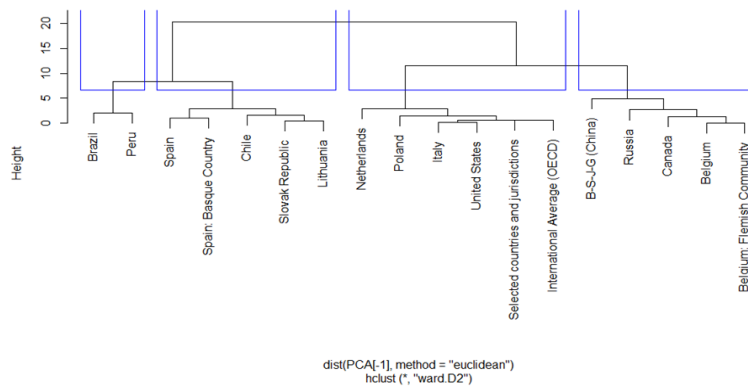
Therefore, we can say that we have met a rule that says the number of significant components explains at least 70% of the total scattering of the data. Subsequently, we explained the variability of the original file by the components also graphically in the following image using Screeplot, which explains the scatter of each significant component and where we found a break in the graph. Figure 2 showed the break with the second component, which explains the 94.84% variability of the total data dissipation. In the next process, the number of significant components will guide us. Next step was to select the number of clusters of countries in our analysis.



**Figure 2. Scree plot of principal components (PC)**

Source: own processing according to R-studio program.

Based on the heuristic approach, the study grouped the countries into four clusters. Consequently, we also plotted in a hierarchical tree where the clusters are marked (Figure 3).



**Figure 3. Dendrogram of selected OECD country**

Source: own processing according to R-studio program.

Four clusters have been created that are heterogeneously heterogeneous but homogeneous within their cluster. It means that countries in one cluster have similar characteristics in the field of financial literacy achievements and at the same time have different qualities of financial literacy results with countries in other agglomerations. From this dendrogram, we can state that a group of 18 countries has been divided into four clusters through cluster analysis. The largest aggregate is represented by six countries, followed by clusters with five countries and one cluster with South American countries. The representation of individual countries in individual clusters is shown in Table 3. From selected PISA 2015 test results, we can say that, based on the method of clustering, pupils from Slovakia were placed in a cluster together with pupils from Spain, Chile and Lithuania. The authors analyzed the results of the study. They noted how they could interpret the results in the context of another research. Besides, it is necessary all the time in the future to examine and compare the education systems of countries that are in stock but also different clusters. These systems will point to the links and different features of the systems that individual countries can incorporate into educational programs in the future.

**Table 3. Clusters of country**

Cluster no.	Country
1.	Netherlands, Poland, Italy, USA, OECD countries, selected regions not specified
2.	Spain, Spain (Basque Country), Chile, Slovakia, Lithuania
3.	China, Russia, Canada, Belgium, Belgium (Flemish Community)
4.	Brazil, Peru

Source: own processing according to R-studio program.

Finally, it is essential to examine the factors responsible for financial literacy to determine why financial literacy in Slovakia is at its low level. So far, we have had some research from this area. For example, analysis of financial literacy of universities students in Slovakia that was realized through questionnaire research in 2012. Majority of respondents were students from various universities in Slovakia, studying various disciplines. Researchers Antosova and Csikosova (2012) concluded that the financial literacy of universities' students in the area of investments and insurance was at level 61.31%. Hospido et al. (2015) uncover mixed effects in Spain, as students in private schools did not increase their knowledge much, possibly owing to a less intensive implementation of the program.

Moire (2016) researched of linking financial literacy and exit planning in Latin America (Chile). According to the results of the survey, the population of the country should understand the terms inflation (18%) and 47% of the population understand the compound interest. The positive relationship consists in verifying the assumption that an increased level of financial literacy can have an impact on retirement thinking. Students from different countries aimed at the research of Titko et al. (2015) at specifying the content and the structure of the instrument, as well as to reveal the differences in perception of financial matters. A set of 12 financial questions was developed to detect perceived importance and complexity of financial literacy components, as well as to get financial literacy self-assessment scores. The questions were disseminated among the Latvian, Lithuanian and Estonian students. The obtained results assisted in specifying the content and wording of questions to be included in the financial literacy measurement instrument. Besides, revealed differences between students' perception of financial questions allowed making conclusions about students' self-confidence that has a great impact on the financial literacy level. Koonce et al. (2008) have shown that groups such as friends, classmates, society, relatives affect the financial literacy of the population. Several authors describe financial literacy in the context of psychology. They argue that financial satisfaction, trust, focus on the future, woes and anxiety and other factors can affect the level of financial literacy of the population. (Kadoya & Khan, 2019; Arellano et al., 2014; Murphy, 2013). Kadoya and Khan (2019) examined the determinants of financial literacy in Japan and stated: The study of financial literacy in Japan is important for several reasons. Financial literacy is likely with the welfare of finances, not high in Japan. (Lusardi & Mitchell, 2011; Sekita, 2011; Hussein & Kalli, 2009). For this reason, it is possible to analyze the factors that work to reduce literacy in order to verify the low level of financial literacy in Japan. It has an impact on cultural and other administrative investment and savings activities. (Chui et al., 2010). Japan's people are prone to the danger and passivity of financial literacy. Based on the analysis, the financial level may be deducted from demography, social and economic character. The aim of further research will, therefore, examine the factors of financial literacy in Slovakia. We analyse several research teams to find out how management style and financial literacy affect work and employee performance (Gallo et al., 2019). Educational institutions can also play an important role in the level of financial literacy (Mura, 2019).

**Conclusions.** In the paper, we implemented the method by which we studied the position of Slovak 15-year-old pupils amongst other pupils who participated in the PISA 2015 financial literacy test. The results of the Slovak students were based on a similar level of financial literacy among Slovak pupils as in Spain, Chile and Lithuania. This methodology should also be applied to the results of the PISA 2018 evaluation, which are



not yet available to the public. This issue will be addressed in the future. The study theoretically defines the concept of financial literacy through the view of several authors and organizations active in the field. The Ministry of Education, Science, Research and Sport of the Slovak Republic focuses on its website essential documents, supporting materials and internet links to support the teaching of financial literacy covering the issue of financial literacy. Specifically, it is the National Standard of Financial Literacy or the Methodology of Financial Literacy. The National Standard of Financial Literacy is a financial education strategy and personal finance management. In this area, however, not only the ministry but also the school itself should give more space through discussions, workshops, case studies and other activities that deepen students' knowledge in the area of finance, insurance, financial and mortgage markets, capital and other similar topics.

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#### **Управління інноваціями у фінансовій освіті: кластерний аналіз для країн ОЕСР**

У статті проаналізовано особливості фінансової освіти учнів у країнах ОЕСР. Авторами зазначено, що фінансова грамотність є основою для розуміння функціонування фінансових ринків та управління особистими фінансовими ресурсами. У статті зазначено, що фінансова освіта формує та розвиває професійні компетенції учнів щодо прийняття фінансових рішень, а саме: розуміння сутності грошей та управління ними в умовах інвестиційного ризику. На основі результатів систематизації наукових напрацювань визначено, що система оцінювання рівня фінансової грамотності учнів початкової та середньої школи залежить від конкретної країни. При цьому одним із поширеніших універсальних підходів є міжнародне оцінювання знань учнів PISA. Авторами відмічено, що даний рейтинг ранжує учнів за рівнем знань щодо управління власними фінансовими ресурсами з метою досягнення максимальної користі. Метою статті є кластерний аналіз країн ОЕСР за рівнем фінансової грамотності з метою визначення країн лідерів та поширити їх інновації серед інших країн. Базу дослідження сформовано на основі даних рейтингу PISA 2015 для країн ОЕСР. Отримані результати дослідження представлено у вигляді кластерів у розрізі країн. Авторами встановлено, що рівні фінансової та математичної грамотності є однаковими для 15-ти річних учнів. Визначено, що учні Словачької республіки, Іспанії, Чилі та Литви розміщені в одному кластері за рівнем фінансової грамотності. При цьому авторами наголошено, що якість професійно-технічної освіти підлягає критиці роботодавців, рівень освіти учнів не відповідає потребам сучасного ринку праці через низький рівень їх практичної підготовки. Результати дослідження мають практичне значення і можуть бути використані для визначення рівня конкурентоспроможності країн у сфері фінансової грамотності. У свою чергу, запропонована методологія може бути застосована для оцінювання та аналізу результатів рейтингу PISA 2018.

Ключові слова: кластерний аналіз, фінансова грамотність, PISA, учні, країни ОЕСР, Словаччина.

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