

DOES THE COMPOUND VESSELS LAW APPLY TO SECONDARY AND TERTIARY EDUCATION WORLDWIDE

Ali Baykal
Faculty of Educational Sciences, Bahcesehir University, Istanbul, Turkey
ali.baykal@es.bau.edu.tr

ABSTRACT

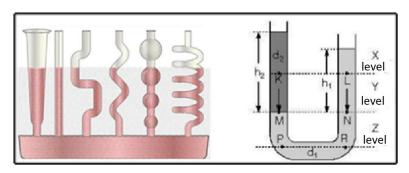
Although the higher education is not compulsory even in the highly developed countries almost every citizen has a chance to get access to universities or colleges. In developing countries however tertiary education is a privilege for the citizens at the upper level social strata. It is an investment to be made for social mobility upward. Is there a significant correlation between the quality of higher education and the quality of secondary education of the countries all over the world. The simplest and most repetitive measures of the quality in higher education and secondary education are world university rankings and country rankings in PISA respectively. In this paper the world university rankings of Times Higher Education (THE) and QS University rankings for the year 2018 are brought together. The final rank of any country is assumed to be the rank of the university at the highest rank from that country. The reason why for this choice is the fact that there are some small countries represented by a small number of universities in the list but on the other hand there are some countries represented with relatively large number of universities at relatively lower ranks. The final country rankings for higher education are matched with their rankings in PISA 2015. The rank order correlation has been found to be highly significant but far from being perfect unity.

Keywords: World university rankings, PISA, Higher education, secondary education,

INTRODUCTION

To begin with it deems to be appropriate to remind some brief but essential preliminary information about the "compound vessels" that appears within the title of this study.

compound vessels constitutes a whole system of vessels with different volumes and different cross section areas but interconnected with another horizontal vessel underneath them. When the system is filled up with some sufficient amount of liquid the top level of liquid will be observed at the same level. If the amount of liquid increases within the system the height of the liquid increases to the same level in all vessels. On the other way around when the liquid drains the height of the liquid levels along all of the combined vessels drops down to the same level. This is the simplest description of compound vessels. If there are different liquids which cannot mix the difference between the heights is inversely proportional with their density. For example if mercury and water are the liquids the height of the water is 13,6 times higher than that of the mercury. Because the mass of one unit volume of water is 1 gram but the mass of one unit of mercury is 13,6 gram. Let the height of the 1st liquid be h1, the height of the 2nd liquid be h2, the density of the 1st liquid be d1, and the density of the 2nd liquid be d2. In terms of these specifications h1/h2=d2/d1, or h1Xd1=h2Xd2. The visual and symbolic representation of these quantifications are demonstrated in Figure 1.



Şekil 1: The illustration of compound vessels law in symbolic terms



For so many practical reasons, especially in order not to lose the focus of attention this discussion will not be extended too far and there and the numerical exercises will be left up to the reader. However it can be beneficial to remind some applications: The water towers and in city plumbing function as compound vessels to distribute water to higher floors of buildings. Hydraulic press mechanism is also a system of compound vessels used in industrial practices (http05; http06).

Compound Vessels as a Metaphor in Social Context

'Compound vessels' analogies are also made for some characteristics of society. It is even a stereotypical shortcut used sometimes. Moreover, it is common not only in our country but also in the world.

If a recognition can be valid in the context in which it is applied, and is able to provide an explanation of the situation, it is often used and thus eventually becomes a cliché. Compound vessels' analogies are also made for some characteristics of society. It is even a stereotypical shortcut used sometimes. Moreover, it is common not only in our country but also in the world. So is the compound vessels premise (Belge, 2006).

This analogy is primarily based on a connection "phenomenon". Then it emphasizes the "dependency" result. It is said that the quality level of some institutions in a society also determines the quality of other institutions. For example, it is argued that the level in the economic field will determine the quality level of all other areas. Those who argue that this law of physics is also a law of society claim that public knowledge, culture, perception level, value judgments, policy, bureaucracy, education, formal and nonformal institutions, civil society organizations, business life, media and even the level of art life, even the quality of football (Erimhan, 2002).

Why do universities keep silent? Why is the level of education low and gradually decreasing? Why doesn't the rule of law reign supreme? Why cannot the bureaucracy achieve competency? Why is the media so low? Why do they ignore ethical rules in business? Why don't they develop assignments based on objective criteria? One cannot answer these questions independently. They are all interrelated, interdependent. One cannot expect different quality levels from the various institutions of society. Those who try to make a difference by raising the water level in a container are eliminated in some way. Inverse separation, the process of negative selection, excludes employees from being different, creating a difference (Akgüç, 2012).

In some cases, there are those who renounce themselves that the law of compound containers is valid in society. Because then it would be inconsistent to criticize one of the social components while praising the other. For example, it may be unusual for advocates of compound vessels to uphold the intellectuals as they sink politicians. Moreover, the behavior of the compound vessels can always be demonstrated in physics; in social sciences however, it is only in the draft phase. In this study, the ranks of secondary education and higher education will be tested with respect to the law of compound vessels not only in terms of purpose, method and content, but also in terms of components of time, physical setting, social setting, method and media. If it is a law, it must be universally validated. This, of course, does not mean that all the other conditions in all countries are equal, from the beginning to the end. But in every country secondary and higher education are articulated structures, purpose, environment, scope, tools and components of social setting are continuous. Countries have their own identity formation, but they share money, goods, energy and information with each other through global communication and interactions. In other words, even if the education assumes national identity it cannot be expected to ignore international connections. Moreover, the statistical methods used to determine whether secondary education and higher education are compound vessels are based on the independence of the subjects (Deng,1999).

World University Rankings

In this study, the quality levels of tertiary education will be determined from the global rankings of universities. Universities are the most esteemed source of manpower in almost every country. Therefore, they are the most important institutions of knowledge production, sharing and circulation. Even though the benefits are highly controversial, the world universities are ranked and compared by various organizations.

There is a worldwide demand for higher education and scientific development that is rising and



strengthening. In addition, people seek political security and economic opportunities, travel to improve their knowledge and experience, look for work and so on. There may be different reasons between countries.

But higher education and scientific sharing is one of the main causes of international mobility. The number of international students increased from 66.9 million in 1990 to 152.5 million (128%) in 2007 (UNESCO, 2009). By 2020, it is estimated that 4-7 million students will study in another country (Calderon, 2010).

The global mobility of people affects the social institutions and their behavior, and even their perceptions of corporate identity. This mobility has a mutual interaction with higher education (Rizvi and Lingard, 2010). The demand of qualified students, instructors and researchers in universities also rises until people demand qualified higher education. As a result, it should be welcomed that countries need to make their universities known and universities need to make themselves known. Research on assessment by benchmarking in education roots back 75 years in the US (Hood, 2008; 410-426). University rankings can be considered as a kind of educational research according to the definition of AERA:

Education research is the scientific field of study that examines education and learning processes and the human attributes, interactions, organizations, and institutions that shape educational outcomes. Scholarship in the field seeks to describe, understand, and explain how learning takes place throughout a person's life and how formal and informal contexts of education affect all forms of learning. Education research embraces the full spectrum of rigorous methods appropriate to the questions being asked and also drives the development of new tools and methods (AERA, 2011).

Even if the experience of educational assessment can be extended to a very old history in Turkey "assessment and evaluation in education and psychology" of the first congress was conducted in 2008 (Koç, Gülleroğlu and Coşkuner, 2008). Evaluation is essential to ensure the well-functioning of each system design (Boudett, City, Murnane, 2008).

In order to design better schools, evaluation is of importance and priority (Schlechty, 1997). However, as in all areas, the evaluation is multivariate and multipurpose in education (Gaynor, 1998; Anderson, 2001). Evaluation can be made by looking at the level of access to a predetermined criterion, or by looking at the hierarchies of the person or institutions to be evaluated according to the pre-determined criteria.

Organizations like UNDP, OECD, UNESCO etc. assume responsibilities in economy, health, communication, education etc. They conduct cross-country comparisons on many topics. The Human Development Report published annually is one of the most widely referenced examples of such assessments (http://hdr.undp.org/en/). The findings based on the results of exams such as PISA and TIMMS are also published with the ranking scale despite the known disadvantages of competing children of adolescent age (http: //www.pisa ...; http://timss.bc.edu/). Higher education programs and secondary education institutions in our country have been ranked according to their results in the selection examinations for many years (Baykal, 1978). University ranking studies, which are widely known in the world, are limited in Turkey (Erkut, 2010; http07; Baykal, 2018).

THE, <u>www.timeshighereducation.co.uk</u>). THE rankings are categorized by observers to the research activities of universities. There may be inconsistencies in the relationship between this subjective criterion and the number of citations given to the researchers of the university.



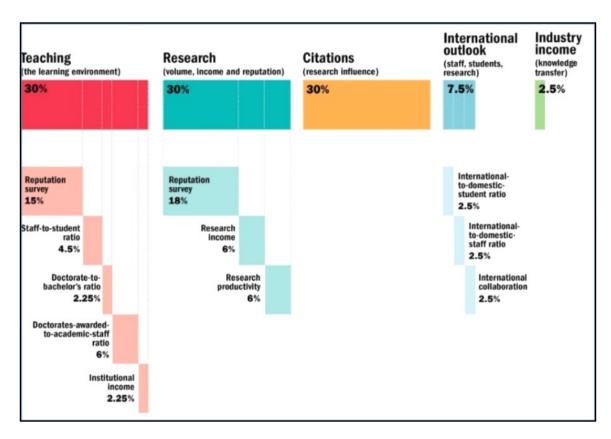


Figure 1: Criteria for THE World Universities Ranking (Source: http02)

QS World University Ranking: It is an academic achievement ranking of world universities conducted by British Quacquarelli Symonds, which is held every year. It was listed for the first time in 2004 covering 3000 universities and the "Top 400" list of these universities was created. Today this list is expanded and a list of top 700 universities is published in the list.

QS World University Rankings applies four criteria: research, teaching methods, employment prospects and international perspective. The weight assigned to these criteria in the evaluation in terms of percentages are as follows:

- Academic reputation (40%)
- Employability of graduates (10%)
- Faculty / student ratio (20%)
- Citation rate per faculty (20%)
- International Student Ratio (5%)
- International Academic Staff (5%)

These studies are generally ranking and giving priority to the research efficiency in the university. Only the details distinguish each one from the other.

Webometrics: Webometrics obtains ranks based on academic studies published by universities. The ranking includes all universities in the world and covers all kinds of publications of universities. For this reason, the education and training activities of universities reflected in the internet play an important role in the ranking. On the other hand, it's the quantity rather than the quality of the publications determines the ranking. The emphasis is given to the publicity of research and the universities of the countries where the internet is widely used come to the forefront.

-HEEACT ranks the universities according to their publication performance within the last eleven years. This a disadvantage for the young universities and those who made important progress in international publications within the most recent years such as Turkey.



Leiden study: They provide a comparative evaluation by considering the limited number of universities according to the average number of publications and average number of citations collected by the publications. This approach, eliminates the inequality due to the unequal opportunity for publication between different fields. Because some universities are much larger than most of the others. Naturally the larger the university is the greater the number of publications due to a large number of staff members.

Scimago: They use objective criteria for publications and emphasizes international cooperation in research and publications. In the present evaluation methods, ARWU and URAP have come to the forefront only because they use the research outputs and performance based on objective measurements. In both studies, the data were easily accessible and transparency is prominent. On the other hand, there is a significant difference between URAP and ARWU. The ARWU uses individual achievements such as the Nobel Prize in research and the Fields medal as a ranking criterion. URAP emphasizes the productivity in research outputs which result from persistent institutional support and academic cooperation during the progress.

University ranking studies in the world attract the attention of all stakeholders; evaluations and discussions indirectly contribute to the efforts to increase the quality of universities. On the other hand, there are also active writers and thinkers against these rankings. Even the university rankings that are mentioned and considered are subject to hard criticism in the academic environment and in the media. The primary objection arises from the invalidity of the multi-dimensional qualifications of higher education, reducing the number of activities, inputs and contributions to a sequence. Which dimensions are chosen, how they are measured, and the weights given to the measurements lead to controversy in every ranking practice. In most of the rankings, "instruction" is of secondary importance. R & D and project applications are prominent. It is emphasized that one of the primary objectives of the universities is to create scientific, technological and cultural accumulation and to consolidate this accumulation (Savaş & Baykal, 2011).

Quality Level of Secondary Education: PISA

In this study, the results of International Student Assessment Program (PISA) was taken as a measure of quality level of secondary education. PISA is one of the most comprehensive educational assessment research in the world, which was initiated by the Organization for Economic Co-operation and Development (OECD) since 2000. PISA measures students' cognitive attainments. It covers three subject areas: Reading skills, science and mathematics achievements. It is applied with three-year cycles. In each application, one-third of the total test duration is given to one of the fields. For example, in 2003 and 2012 mathematics was measured in detail. PISA results are the data source of a large number of academic studies, since it provides a large representative sample and opportunity for objective international comparisons.

Özer (2016) outlines the scope of the work on PISA in Turkey. There are reports by non-governmental organizations and the Ministry of Education evaluating the PISA results. Also lots of research reports are available to examine student surveys. There is also large amount of data from graduate thesis studies.

In this study, the average of the scores obtained from the three subject areas in the PISA 2015 exam was taken for granted as the measure of level in secondary education. Since PISA covers only 15 years old students can be criticized as not being representative sample for secondary education (http01). Also, subject matter areas are limited with only three domains. Therefore, one can claim that it does not fully reflect the quality level of secondary education. However, a larger-scale data source common for all countries is not available.

METHOD

Spearman rank difference correlation coefficient is an appropriate quantifier to delineate the parallelism between secondary education and higher education levels across the countries. If the rankings of countries in terms of achievement in higher education is identical with the rankings of achievements in secondary education, this indicator will be (rho = +1.00). Because both of the qualifiers ascend or descend along the same direction. The extent to which the correlation between country rankings in higher education and secondary education is significant they can be considered as "compound vessels". As the correlation departs from unity and approaches to zero the validity of the compound vessels metaphor will be



vulnerable.

In this study The ranking of countries in the higher education was formed from the mix of THE-2019 and QS-2019 rankings. There are 1258 universities in the rank of THE2019. In the QS2019 ranking there are 1000 universities. 786 of these universities are in both rankings. There are 472 universities within the QS scope. 214 universities in the QS category were not included in THE rank. When placing in the last ranking, the highest possible rank is assigned to the university. For example, Oxford ranks first in THE and ranks 5th in the QS ranking. In the composite list Oxford is given the first rank. Similarly MIT ranks first in the QS rankings, but 4th in THE list, therefore MIT is also ranked 1st in the combined ranking. Consequently Cambridge and Stanford are both given 2nd rank in the final list because they are at the 2nd rank in THE and QS rankings respectively. The final list composed from THE and QS 2019 University Ranks can be accessed from academia.edu portal (Baykal, 2018).

The unit of analysis (i.e. subjects) of this study are countries, not universities. There are several measures that can be used as indicators of higher education level of countries: The number of universities entering the mixed rank from that country; the average rank number of , rank of the universities in each country, are indicators that come to mind. Through the intuitive evaluations however, it was thought that the number of queues at the top of the universities coming from that country would be the most fair indicator. For example, 23 universities from a large country with a population of 400-900, while six universities from a small country may have taken part in the top 300. Therefore, the rank number of each country's highest-ranking university is considered as the higher education level of that country. Although this measure is not perfect and complete, it is the least objectionable criterion.

FINDINGS

When interpreting the findings, it is envisaged that there will be indicators of human development (http03). Because, human development indicators are either means or the ends in both secondary and tertiary education. The list of these variables is shown in the table in Annex 1. These variables are compiled in 5 separate clusters: Educational (EDU), economic (ECO), general (GNL), health (HLT) and social (SOC). It is not conducive to collect numerical values of the values of these displays. Therefore, all of these indicators were transformed into standardized scores - the method described below.

In the first step, the mean and standard deviation of the raw data from the Human Development Reports of the variables in the table in Annex 1 were calculated. They are already shown in the chart in Annex 1. In the second step, the raw scores were converted to standardized scores (T scores).

The mathematical relationship used for this process is as follows where;

$$T_{ij} = \frac{X_{ij} - \overline{X}_j}{S_j} \times S_{\tau} + \overline{T}_{\tau}$$

- i: Rank indicator of the country in the data matrix
- j: The indicator of the ranking criterion
- T_{ij}: The standard score of the country "i" for the criterion "j"
- X_{ij}: The raw score of the country "i" for the criterion "j"
- X_i: The arithmetic average of the raw score for the criterion "j"
- S_i: The standard deviation of the raw scores for the criterion "j"
- S_s=10 Selected standard deviation which is common for all measurements
- X_s=50 Selected standard deviation which is common for all measurements

Thus, countries are given scores with an average of 50 and a standard deviation of 10 according to each criterion.



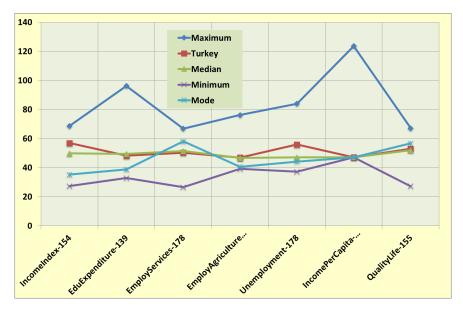


Figure 2: Economy (ECO) in the indicators related to Turkey's position in 2018

As the averages of the criteria indicators in the horizontal axis were all determined to be 50, the averages were not shown separately. The number next to each indicator indicates the number of countries that the indicator is calculated for. As can be seen from this description, each of the Highest, Lowest, and Median values may belong to a different country. Mode is a descriptive statistics covering different countries for each indicator.



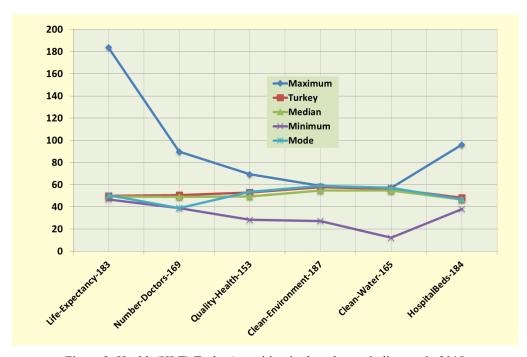


Figure 3: Health (HLT) Turkey's position in the relevant indicators in 2018

Figure 4 shows Turkey's international profile is shown for various social (SOC) indicators in 2018.



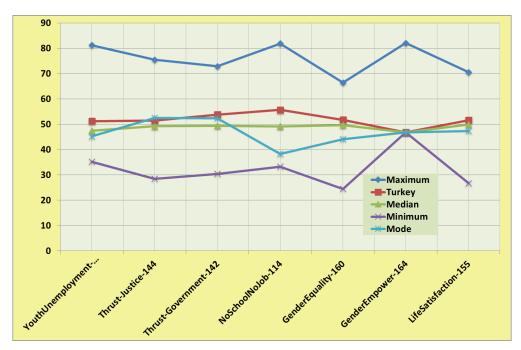
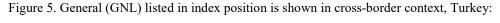


Figure 4: Turkey's position along the 2018 Miscellaneous Community (SOC) indices

It is worth recalling that each of the maximum, minimum and Highest, Lowest and Median values may belong to another country in each table.



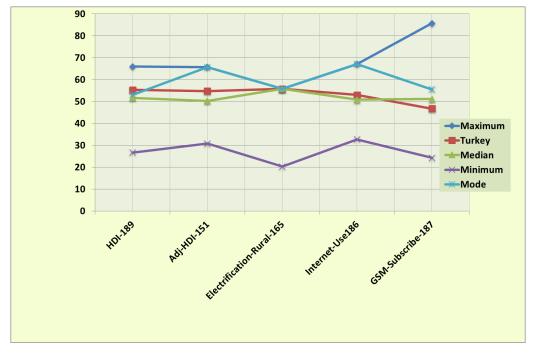


Figure 5: Turkey's position in the General (GNL) indicators in 2018.

Turkey's profile in terms of educational indicators appears in Figure 6 below.



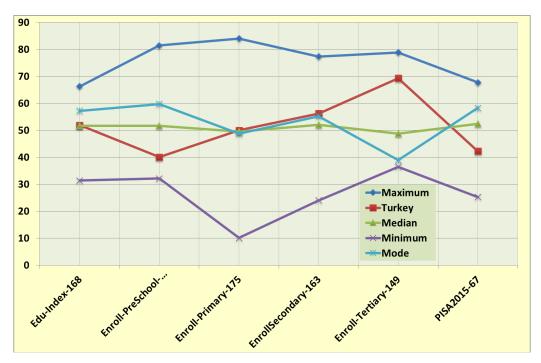


Figure 6: Turkey's position for the educational (EDU) indicators in 2018.

Friedman two way analysis of variance analysis was performed to determine whether 5 basic developmental criteria (ECO, HLT, SOC, GNL and EDU), depicted in the figures above as their components, showed a significant pattern within the countries. In other words the visual representation in Figure 7 can be observed in many countries.

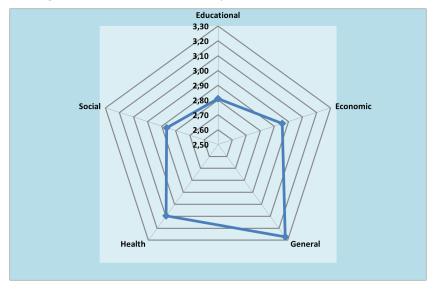


Figure 7: The rank-order of human developmental indices in Turkey

CONCLUSION AND DISCUSSION

Although Turkey is among the top 20 in terms of factors of economics (ECO) the findings regarding the extent of Turkey's GNP per capita income shows that even remained below the median. The highest per capita income indicator is not very common and representative for all countries. Maximum values represent usually a very special situation observed in small countries (city-states) with very little population. Turkey is at the median level of quality of education and education spending, but unfortunately in terms of unemployment is far above the median. It can also be seen that there are some countries of whom total incomes are less than the educational expenditures of some others. Turkey is far



below the maximum value of educational investment although she is a bit above the median.

All of the indicators relevant to health (HLT) in Turkey is above the median line. Unfortunately, the whole world is troubled by the clean environment and access to clean water. Even the maximum value achieved almost coincide with the median.

Social (TOP) indicators portray an interesting line in Turkey. Negative attributes like "youth unemployment" and "youth population without job and without schooling" are high above the median, but luckily in some positive indicators like "confidence in government" and "life satisfaction" Turkey seems to have managed to stay above the median. This situation can be explained by the large size of the young population. Perhaps young people can perpetuate their hopes against unemployment and poverty. It is understood that the majority of the countries on the issue of gender equality meet around the median and the median value is closer to the lowest value, not the highest value.

Within the span of General (GNL) human development indicators like "inequality adjusted human development" Turkey could have risen above the median line. Almost all countries have been equalized in "rural electricity". "Internet use" is also one of the indicators of which Turkey exceeded the median. What is interesting is that for the "cell phone ownership" Turkey is under the median. This can be explained by the fact that women in the rural areas of Turkey could not have had access to this gadget yet, although almost everyone has one. Another complementary reason is that Turkey has had completed main line investments for fixed home phones. So many under developed countries however skipped cable technology and jumped into GSM technology.

In terms of educational (EDU) indicators (i.e. school enrollments) Turkey refutes the compounds vessels law. In preschool education Turkey is far below the median among 162 countries in such a way that she is almost closer to the lowest level. In primary schooling she is around the median and among the most frequent point. In secondary education Turkey's position is very close to the most frequent level. In higher education however she has gone up above the median and the mode; and has almost reached the highest value. In terms of PISA achievement Turkey ranks 50th among 67 countries. Shortly Turkey performs at different competency levels in various school stages.

Almost every country and especially Turkey displays wavy line for educational indicators. For example, although US is very superior at tertiary education has some fall backs in secondary education. Turkey is far below the median in preschool schooling and in PISA, but she is far above the median in Tertiary education at least in terms of quantity. A correlational analysis may help to understand how these indicators go together. Table 2 shows the statistical relationships between 5 selected indicators and higher educational indicators plus PISA2015.

Table 2: Correlation coefficients between human development, higher education and PISA indicators

Indicators	PISA2015 Mean	Educational	Economics	General	Health	Social	Number of Universities
Educational	0,782**						
Economics	0,405**	0,447**					
General	0,677**	0,746**	0,568**				
Health	0,713**	0,765**	0,471**	0,810**			
Social	0,537**	0,256*	0,501**	0,315**	0,273**		
Number of Universities	0,239	0,15	0,074	0,165	0,208*	0,103	
Highest University Rank	0,503**	0,529**	0,483**	0,520**	0,506**	0,403**	0,467**

N=67 with PISA otherwise N=94 * p<0.050 ** p<0.001

Table 2 shows that as the number of universities from the countries in the ranking list increases the ranking of the universities tends to increase. But the correlations of between the other indicators and the number of universities from the countries are not significant at all. This means that it is not the number of universities but the ranking of universities matters. So far as the other indicators are concerned they are significantly inter-correlated. This is not a surprising result because these variables are either the ends or the means of the educational systems. Hence there is a spiraling intercorrelations between them



Table 2 delineates that mean achievement in PISA 2015 correlates significantly with the other developmental indicators of the participant countries. If PISA scores can be considered as an indicator of the secondary education levels of the countries, and if the world university rankings measure the efficacy of tertiary education then the significant correlations between them suggest dependency between them. However, development indicators other than educational indicators also show similar and significant relationships with others. In other words, health, economy, communication and social variables also contribute to the success of both PISA and higher education. More precise relationship between PISA and University rankings can be obtained by controlling the other indicators. Partial correlations in Table 3 imply that secondary education and tertiary education are not communicating vessels. There are other independent factors which determine their levels.

Table 3. Partial correlations between educational indicators

	PISA2015	Educational	Number of
	Mean		Universities
Educational	0,553**		_
Number of Universities	0,211	-0,040	
Highest University	0,203	0,057	0,474**
Rank			
N=56 ** p=0,001			_

Control Variables: Economics & General & Health & Social

The evidence in Table 3 shows that the secondary education and higher education are not significantly correlated. As a result, although secondary education and higher education are interconnected, they may not be interdependent on each other. On the positive side, improvement studies at these two levels can be done independently of the other. However, low relations do not mean that these two levels are disconnected from each other. Mandatory links in educational variables can already pave the way for interaction between these two levels (Murray, 2011).

Annex 1. Descriptive statistics of indicators of countries

HDI Labels	Human Development Indicators	N	Average	St. Dev.
EDU-Edu-Index	Education Index	168	0,6	0,2
EDU-Enroll-Primary	Enrollment rate in Primary School	175	102,5	12,2
EDU-GenderEmpower	Gender Empowerment	164	93,6	292,9
EDU-Enroll-PreSchool	Enrollment in Pre-School Education	162	64,3	35,5
EDU-Enroll-Secondary	Enrollment in Secondary School	163	84,9	28,9
EDU-PISA2015	PISA 2015 Mean Score	67	462,9	50,0
EDU-Enroll-Tertiary	Enrollment in Tertiary Education	149	40,3	28,3
ECO-IncomeIndex	Natiional Income Index	154	0,5	0,2
ECO-EduExpenditure	Educational Expendture by	139	4,7	1,7
ECO-EmployServices	Employment in the Services Sector	178	53,2	20,1
ECO-EmployAgriculture	Employment in the Agricultural	178	26,9	24,7
ECO-Unemployment	Total Unemployment Rate	178	7,8	5,9
ECO-IncomePerCapita	Income per Capita	189	4380,9	15262,1
ECO-LifeSatisfaction	Perceived Life Satisfaction	155	62,3	19,1
GNL-Adj-HDI	Inequality Adjusted Human	151	0,6	0,2
GNL-Electrification-Rural	Electrification in the Rural Area	165	84,1	27,6
GNL-HDI	Human Development Index	189	0,7	0,2
GNL-Internet-Use	Total Internet Usage	186	49,9	28,2
GNL-GSM-Subscribe	Mobile Phone Subscribers	187	106,6	37,6
HLT-Life-Expectancy	Average Life Expectancy	183	0,8	1,5
HLT-Number-Doctors	No of Doctors per 10 Thousand	169	16,6	14,7



HLT-Quality-Health	Perceived Quality of Health Services	153	56,2	19,0
HLT-Clean-Environment	Clean Environmental Conditions	187	73,9	29,3
HLT-Clean-Water	Access to Clean Water	165	89,9	14,1
HLT-HospitalBeds	Hospital Beds per Tousand Citizens	184	29,2	23,4
SOC-YouthUnemployed	Youth Unemployment	115	18,8	12,4
SOC-Thrust-Justice	Confidence in Jurisdiction	144	50,4	18,3
SOC-Thrust-Government	Thrust in Government	142	51,2	20,5
SOC-NoSchoolNoJob	Youth neither in School nor at Work	114	17,9	10,7
SOC-GenderEquality	Gender Equality	160	0,7	0,2

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