Analyzing the Relationships among the Factors Affecting Educational Competitiveness: An Application of the Structural Equation Modeling Approach[1]

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ABSTRACT

This study was conducted in order to investigate the relationships between different factors affecting educational competitiveness crucial to enhancing national competitiveness in every country, and to put forward policy implications whereby each country may raise the level of its educational competitiveness. PISA score was selected as an indicator representing the educational competitiveness of OECD countries, and this included a number of independent variables, such as per capita GDP, total public expenditure on education as a percentage of GDP, and total per capita public expenditure on education (US dollars), affecting educational competitiveness. We employed the structural equation modeling approach to analyze the complex causal relationships among the factors affecting educational competitiveness. The research results show that the significant factors affecting PISA are: *edusys* (educational system), *puptec* (pupil–teacher ratio), and *privat exp* (total expenditure on education by private source as a percentage of GDP), and that the most influential factor affecting PISA directly is *edusys* (the extent to which the education system meets the needs of a competitive economy). Finally, the study suggests that each country should endeavor to enhance its own educational competitiveness, considering how the factors associated with this relate to each other.

1. Introduction

It is generally accepted that educational competitiveness can greatly affect national competitiveness. International institutions such as the International Institute of Management and Development (IMD) and the World Economic Forum (WEF) have published reports on the national competitiveness of different countries. Educational competitiveness, as a sub-branch of *national competitiveness*, is regarded as an important element in national development. Hence, researchers and practitioners have primarily concentrated on which factors are most strongly associated with enhancing educational competitiveness, and on how to strengthen it. Most studies have tended to select educational infra, including the percentage of secondary student enrollments among persons of the same age or the percentage of illiterate persons among people over fifteen years of age, as a dependent variable representing educational competitiveness. Although factors connected with educational infra can be components of educational competitiveness, they are not suited to representing the final variable which educational competitiveness is oriented towards. With this background in mind, this study selects *international educational achievement score* as a final dependent variable to denote educational competitiveness, which is understood as a tool for evaluating the learning achievements of students and how these change over time.

The main reason for selecting the variable *educational competitiveness* as a dependent variable is that most countries in the world are now trying to strengthen their educational competitiveness and the quality of the education they provide on the basis of their international educational achievement score, which they are also using as objective evidence in their attempts to ameliorate their educational environment (KEDI, 2010). The international institutions which evaluate students' achievements from a comparative perspective are the International Association for the Evaluation of Educational Achievement (IEA) and the OECD. The former publishes *Trends in International Mathematics and Science Study* (TIMSS), while the latter publishes

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the reports of the Programme for International Student Assessment (PISA). TIMSS and PISA are concerned with evaluating students' achievements in, respectively, mathematics and science, and reading, mathematics, and science.

This study selects PISA score as a final indicator to represent educational competitiveness. PISA, as mentioned above, is organized by the OECD, and assesses the extent to which 15-year-old students have acquired key knowledge and skills that are essential for full participation in modern society. It is assumed that PISA score differences between countries are attributable to differences in administrative and financial infras. Empirical studies in these areas have so far been limited. With this background in mind, this study attempts to identify factors associated with educational competitiveness, to investigate which factor is most strongly related to it, and to analyze how these factors may be causally interrelated, using the structural equation modeling approach. Through this study, scholars and policy practitioners involved in educational policy are expected to understand the factors affecting educational competitiveness and to utilize them in order to enhance the quality of education at central and local levels.

2. Theoretical background

2.1 Educational competitiveness

It is assumed that the term 'competitiveness' is derived from the term 'national competitiveness', or 'regional competitiveness'. International institutions such as the International Institute of Management Development (IMD) and the World Economic Forum (WEF) have used the term 'national competitiveness' or 'global competitiveness'. The IMD publishes the *World Competitiveness Yearbook*, while the WEF publishes its *Global Competitiveness Report* annually. These bodies define the term 'national competitiveness' as the ability of a nation to create and maintain an environment that sustains greater value creation in its enterprises and more prosperity for its people (IMD, 2013: 480–1); however, the term is sometimes defined differently. The IMD and WEF categorize the field of national competitiveness into a dozen sub-categories, with education normally being contained in the sub-category *infra*. Consonant with the definition of the term 'competitiveness', educational competitiveness can be defined as the ability of a nation to create and maintain an environment which sustains quality of education and greater prosperity for its people. This definition can cause some confusion or differences of opinion among scholars. On the assumption that any area of national competitiveness has to make contributions toward enhancing the quality of life of ordinary people and making their lives more comfortable, it would be possible for us to define 'educational competitiveness' in the same way as the term 'national competitiveness' is defined. What, then, are the components of educational competitiveness?

WEF's *Global Competitiveness Report* classifies national competitiveness into 12 pillars. Of these, pillar 4 is made up of factors relating to primary education and pillar 5 of factors relating to higher education. In this paper, educational competitiveness includes primary education and secondary education and excludes higher education, and so it is more related to the indicators contained in pillar 4. In order to measure educational competitiveness, researchers can use composite indicators or a single indicator, and either quantitative or qualitative indicators. In this regard, the IMD uses 15 composite plural indicators, including hard and soft education data, to measure educational competitiveness. This is different from the method the WEF uses, in that the WEF distinguishes primary- and secondary-education-related indicators from higher-education-related indicators.

Today, primary and secondary education is believed to foster innovation and creativity, which are crucial for strengthening national competitiveness. In other words, if a country's primary and secondary education is not competitive, this can prove an obstacle to the innovativeness of that country, weakening its growth potential and the creativity of its young people (WEF, 2013: 5). As regards the contribution of educational competitiveness to national competitiveness, primary and secondary education is more important than higher education. Therefore, in this study, authors focus on primary and secondary education, rather than on higher education, in dealing with educational competitiveness.

The next important factor is which indicators can be included in the indicator set for constructing national competitiveness. Indicators can be composite or single, or hard data or soft data. Here, seeing that authors focus primarily on primary and secondary education, and that authors also believe that creativity and innovation in terms of national human resources are highly important for national development, authors

adopt PISA score as a representative indicator for educational competitiveness. In this study, the PISA score published in 2013 by the OECD is used. PISA evaluates the extent to which 15-year-old students have acquired mathematics, science and reading skills, which are essential for their successful activity in society. PISA results reveal what is possible in the field of education, by showing what students in the highest-performing and most rapidly improving education system can do (OECD, 2013: 3). It is hypothesized that the higher the PISA score, the stronger will be educational competitiveness.

2.2 Factors affecting educational competitiveness

It is generally understood that some factors can affect the educational competitiveness of a country, and some studies have indicated that a number of factors can be involved in improving the educational sector in one country. Here, authors emphasize the potential factors associated with educational competitiveness and their interrelationships.

First, authors hypothesize that per capita GDP is associated with total expenditure on education. In OECD member countries, the proportion of total expenditure on education as a percentage of GDP is relatively high, accounting for approximately 5.6 percent of GDP in 2006. The proportion of expenditure on primary and secondary education is 3.7 percent of GDP, whereas that of expenditure on higher education is 1.4 percent of GDP (OECD, 2010). The expenditure of OECD member countries on education increased by 28 percent between 2000 and 2006, reaching an average annual growth rate of 4 percent. In spite of the fact that expenditure on education in recent times accounts for a large proportion of GDP, and also has been increasing constantly, there have been few studies proving that growth in education spending leads to growth in educational quality. In the meantime, some studies (Choi, 2008; Shin and Joo, 2013) have concluded that accumulated per capita expenditure on education has positively affected PISA score. On the basis of these research findings, this study hypothesizes that per capita GDP, total expenditure on education, and total per capita expenditure on education affect educational competitiveness, and that per capita GDP also affects total expenditure on education as a percentage of GDP, and total per capita expenditure on education.

Second, authors hypothesize that education system is associated with educational competitiveness. Here, we include education system as a variable in the analysis. It is not easy to operationalize education system, because it is a broad concept. Some studies, including KEDI (2010) and Borgonovi (2012), maintain that education system is associated with students' academic achievement and educational competitiveness. Here, authors hypothesize that the education system of each country may have an effect on education. Education system here is measured by the extent to which it meets the needs of a competitive economy (OECD, 2013).

Third, authors hypothesize that parents' concerns about education is associated with educational competitiveness. It is important, in relation to educational competitiveness, whether parents are strongly concerned about a student's future career or not. This is more important in Asian than in Western countries. Parental concerns about children's education can be represented by total expenditure on education burdened by the private sector. There have been few studies examining the relationships between total expenditure on education burdened by the private sector and educational competitiveness. Here, following the work of some scholars (Choi, 2008; KEDI, 2010), authors hypothesize that private-source expenditure on education as a percentage of GDP is positively associated with educational competitiveness.

Fourth, authors hypothesize that educational decentralization is associated with educational competitiveness. It has long been recognized that governments differ significantly as regards efficiency in delivering public services (see e.g. Tanzi and Schuknecht, 1998; Adam *et al.*, 2008). Some are extremely wasteful and ineffective in performing basic activities, whereas others achieve their objectives in a systematic and decentralized way (Adam *et al.*, 2008: 2). The striving to increase public sector efficiency has produced a vigorous theoretical literature on the channels that may affect it, one important such channel being the design of decentralization across the levels of government. In recent years, a lot of research (Fisman and Gatti, 2002; Enikolopov and Zhuravskaya, 2007) has argued that centralization undermines government efficiency, whereas decentralization enhances quality of government. We hypothesize that this argument can apply to the educational sector – hence our hypothesizing that educational decentralization can increase educational competitiveness.

Fifth, authors hypothesize that pupil–teacher ratio can affect educational competitiveness. The ratio of students to teaching staff is an important issue as regards the quality of education worldwide. It is assumed that the smaller the number of students a teacher can teach, the greater will be the effectiveness of the teaching.

In summary, authors include per capita GDP, total expenditure on education as a percentage of GDP, total per capita expenditure on education, education system, ratio of students to teaching staff, parents' concerns about education, and educational decentralization as independent variables affecting the dependent variable, educational competitiveness.

2.3 Research questions

On the basis of the theoretical discussion above, we suggest the following two research questions:

Which variable most strongly affects educational competitiveness as a dependent variable?

What are the structural causal relationships among the variables affecting educational competitiveness as a dependent variable?

3. Research design

3.1 Variables

The countries to be included in this analysis are OECD member countries. Among these, two countries, Mexico and New Zealand, are excluded because of problems with data. The variables analyzed in this research consist of seven independent variables and one dependent variable. The seven independent variables are: per capita GDP, total expenditure on education as a percentage of GDP, total per capita expenditure on education, education system, ratio of students to teaching staff, parental concerns about children's education, and educational decentralization. The one final dependent variable is educational competitiveness. Table 1 explains the names of the variables, their measurement, and their data source.

Table 1 Variables and data source

Variable name	*Measurement*	*Data source*	*Variable abbreviation*	*Remarks*
Educational competitiveness	Average of PISA scores including three subjects (reading, mathematics, and science)	OECD (2012), PISA Results (2013)	PISA	Latent variable in this model.
Per capita GDP	Per capita GDP	IMD, *World Competitiveness Yearbook* (2013)	gdp	
Total expenditure on education	Total expenditure on education as a percentage of GDP	IMD, *World Competitiveness Yearbook* (2013)	tee	
Total per capita expenditure on education	Total per capita expenditure on education	IMD, *World Competitiveness Yearbook* (2013)	tepc	
Education system	The extent to which the education system meets the needs of a competitive economy	IMD, *World Competitiveness Yearbook* (2013)	edusys	Executive survey based on an index from 0 to 10.
Pupil–teacher ratio	Ratio of students to teaching staff	OECD, *Education at a Glance* (2013)	puptec	Average score of two pupil–teacher ratios: primary and secondary school (latent variable in this model).
Educational decentralization	Percentage of decisions taken at the school rather than by central, regional or local government	OECD, *Education at a Glance* (2013)	sch	
Parental concerns about children's education	Ratio of private-source expenditure on education to GDP	OECD, *Education at a Glance* (2013)	privat exp	

3.2 Analysis method

The analytical methods employed in this study are as follows. First, using the SPSS 18.0 program, authors produced descriptive statistics on *gdp*, *tee*, *tepc*, *edusys*, *private exp*, *puptec*, *sch*, and *PISA*, and correlation coefficients among those variables. Second, an analysis through SEM (structural equation modeling) was conducted using the AMOS 20.0 program. In the structural equation modeling, the Maximum Likelihood Method was employed to estimate coefficients. There are two kinds of methods to evaluate the fitness of model in SEM: the X2 test and the fitness test. Because the X2 Test is too sensitive to sample size, and because it is too difficult to construct and test null hypotheses, we do not depend on X2 completely. In this study, both the X2 test and the fitness test are carried out to test model fitness, reflecting model simplicity. The criteria for many fitness tests are TLI (Turkey Lewis Index) and RMSEA (Root Mean Square Error of Approximation), because these criteria are less sensitive to sample size, and are suitable in terms of simplicity (Hong, 2000: 342). Third, in case the hypothetical model constructed should not prove suitable, authors conducted model revision using the modification index to find the optimal model for explaining the relationships among variables, including direct and indirect relationships. Fourth, authors tested the mediating effects of the variables -*tee*, *tepc*, *edusys*, *private exp*, *puptec*, and *sch*- by employing the bootstrap method.

3.3 Hypothetical model

In this study, a hypothetical model was constructed in order to test complex interrelationships between variables affecting educational competitiveness, on the basis of the theoretical background and research questions discussed above. *gdp* was treated as an exogenous variable, and the rest of the variables were treated as endogenous variables. According to the hypothetical model, *gdp* affects PISA directly, and the rest of the variables, excluding *private exp*, indirectly. *private exp*, representing parental concerns about children's education, means private-source expenditure on education as a percentage of GDP. It is difficult to believe that as the economy develops parental concerns about children's education will necessarily increase, and it is difficult also to hypothesize that GDP affects private-source expenditure on education directly. Figure 1 shows the hypothetical model used in this study.

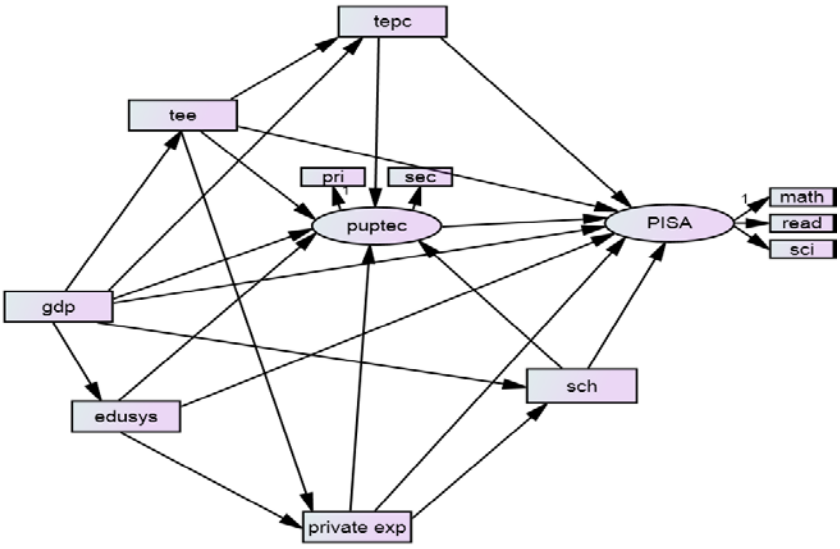


Figure 1 Hypothetical research model

4. Research results

4.1 Descriptive statistics

Table 2 presents descriptive statistics for the constructs analyzed in our study, including means, standard deviations, and the minimum and maximum of the variables contained in the final sample of 32 OECD countries. (New Zealand and Mexico were excluded owing to a lack of available data.) For reference purposes, data for mainland China are included in the comparison with Korea.

Table 2 Descriptive statistics

Variable	OECD countries				Korea	China
	Minimum	*Maximum*	*Mean*	*SD*		
GDP (US dollar)	10522	113533	41714.57	24359.15	22,778	
tee (%)	3.50	8.30	5.41	1.25	4.60	3.13
tepc (US dollar)	393.00	5437.0	2248.53	1407.02	785.0	
edusys (scale)	3.42	8.64	5.99	1.39	5.71	
private exp (%)	0	3	.69	.77	3.10	
puptec (no of students)	8.75	25.20	13.28	3.80	19.26	16.8
sch (%)	0	86.0	39.17	22.49	39.0	
PISA (score)	436.33	542.67	499.31	27.78	542.67	587.67

4.2 Correlations of the variables

Table 3 shows the correlations of the variables included in the hypothetical model. In the conceptual model, seven endogenous variables are interconnected directly or indirectly. This structure implicitly suggests possible correlations among the variables. In the final model, the correlations of *tepc* and *gdp*, *tepc* and *tee* are 0.927 and 0.532 respectively, and are all significant at the 0.01 level. The correlations of *edusys* and *gdp*, of *edusys* and *tee,* and of *edusys* and *tepc* are 0.566, 0.531, and 0.672, respectively, and are all significant at the 0.01 level. In the case of the final dependent variable, *PISA*, it has only a significant correlation with *edusys*.

Table 3 Correlations of variables

	1	2	3	4	5	6	7	8
1. gdp	1							
2. tee	.222*	1						
3. tepc	.927**	.532**	1					
4. edusys	.566**	.531**	.672**	1				
5. private exp	-.251*	-.178	-.271**	-.172	1			
6. puptec	-.354**	-.399**	-.385**	-.229*	.575*	1		
7. sch	-.239*	.265*	-.106	-.019	.129	.157	1	
8. pisa	.195	.140	.173	.549**	.134	-.152	-.023	1

**p<.05, **p<.01.*

4.3. Goodness of fit of the SEM

In contrast to a linear regression model, the SEM does not have a unique goodness of fit measure that is widely accepted (Gao *et al*., 2006: 349). Following the principles suggested by Huh (2013), authors report the model fit from X2, RMSEA, and TLI. All the indices in Table 4 suggest a good fit of the hypothesized model.

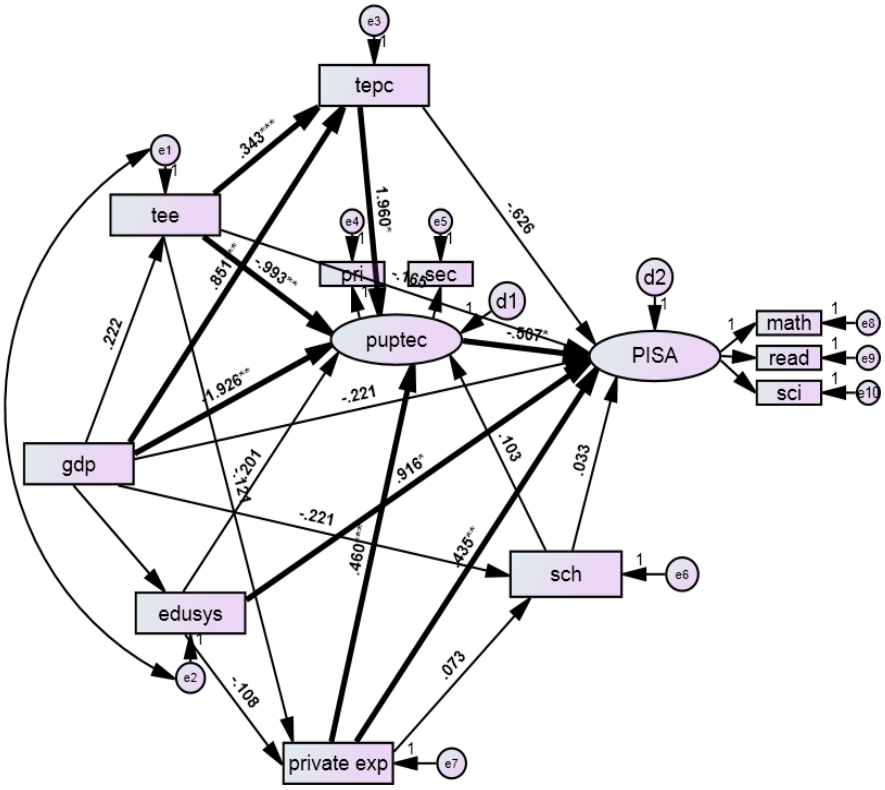
Table 4 Goodness of fit of the SEM

Fit index	x^2	RMSEA	TLI
Criteria	Higher than .05	Between .05 and .08:	Higher than .9
Final model	32.290 (df = 28, p = .000)	.073	.970

4.4. Structural Equation Model

The Maximum Likelihood Method was chosen as the estimation procedure since, according to Boomsma and Hoogland (2001), this method can produce good results even under conditions of multivariate non-normality for a moderate sample size such as ours. The final structural equation model is shown in Figure 2.

Figure 2 Structural Equation Model



The overall fit measures indicate that the model fits the data well: X2 = 32.290 (p = 0.000); n = 32; df = 28; RMSEA = 0.073; TLI = 0.970. All the values obtained are above the recommended thresholds and most can be described as acceptable. Direct and indirect, and total, effects of the variables on PISA are shown in Table 4. The table shows the significant standardized direct and indirect effects of the final model. As was predicted in the hypothetical model, PISA is significantly affected by some variables positively, and by other variables negatively.

Table 4 Variables affecting PISA and their effects

Path	*Direct effect*	*Indirect effect*	*Total effect*
gdp → tee	.222	-	.222
gdp → tepc	.851***	.076	.927*
gdp → edusys	.566***	-	.566***
gdp → puptec	-1.926**	1.647*	-.279***
gdp → school	-.221	-.006	-.227
gdp → private exp	-	-.088	-.088
gdp → PISA	.226	-.003**	.223**
tee → tepc	.343***	-	.343***
tee → private exp	-.121	-	-.121
tee → puptec	-.993**	.615**	-.378***
tee → school	-	-.009	-.009
tee → PISA	-.165	-.076	-.241
tepc → puptec	1.960*	-	1.960*
tepc → PISA	-.626	-.994	1.62
edusys → private exp	-.108	-	-.108
edusys → puptec	.201	-.051	.15
edusys → school	-	-.008	-.008
edusys → PISA	.916*	-.124	.792*
puptec → PISA	-.507*	-	-.507*
private exp → school	.073	-	.081
private exp → puptec	.460***	.008	.476*
private exp → PISA	.435**	-.234**	.201**
sch → puptec	.103	-	.103
sch → PISA	.033	-.052	-.019

**ρ<.05, **ρ<.01, ***ρ<.001.*

The direct effect of a variable is its structural coefficient, which is interpreted as the initial response (i.e. without taking into account any feedback effect through the loops) of the 'effect' variable to change in a 'cause' variable (Hayduk, 1987; Gao *et al*., 2008: 349). As was predicted in the conceptual model, *private exp* and *edusys* affect *PISA* positively, and *puptec* affects it negatively. The direct effects of *edusys* (education system) and *private exp* on *PISA* (educational competitiveness) are key structural paths. Their positive sign implies that an educational system that is more responsive to a competitive economy and more private-source expenditure on education will lead to stronger educational competitiveness.

As Table 3 indicates, it was found that *gdp* affects *tepc* (β = 0.851, p = 0.000), *edusys* (β = 0.566, p = 0.000), and *puptec* (β = -1.926, p = 0.005) at a significant level. Also, *tee* affects *tepc* (β = 0.343, p = 0.000) and *puptec* (β = -0.993, p = 0.001), *tepc* affects *puptec* (β = 1.960, p = 0.11), and *edusys* affects *PISA* (β = 0.916, P = 0.000) at a significant level. In addition, it is found that *private exp* affects *puptec* (β = 0.460, p = 0.000) and *PISA* (β = 0.435), while *puptec* affects *PISA* (β = -0.507, P = 0.13). Via the results indicated above, we find that the variables significantly affecting *PISA* as an indicator of educational competitiveness are *edusys*, *puptec*, and *private exp*, and that among these three variables *edusys* is the strongest variable affecting education competitiveness.

Table 5 Indirect effects of variables on PISA

Path	*Indirect effects on PISA*
gdp→tepc→puptec→PISA	-.846
gdp →puptec→PISA	.976
private exp →puptec→PISA	-.233

The indirect effect is the effect that a variable exerts on another variable through one or more endogenous variables. Depending on the sign, the indirect effect of one variable on another variable may strengthen or offset its corresponding direct effect. The sum of the direct and indirect effects of a variable is the total effect (Gao *et al*., 2008: 352). Regarding the indirect effects of the variables on *PISA*, using the bootstrap analysis method it was found that the paths from both *gdp* and *tec* to *puptec*, and from *private exp* to *PISA*, were statistically significant at the 0.05 level. As regards the paths linked to *PISA* (educational competitiveness), on the basis of the significance test for direct and indirect effects it was shown that a path to and from *PISA* via the mediating variable *puptec*, and a path to and from *PISA* via the mediating variables *tepc* and *puptec*, are statistically significant. The analysis result for these three indirect paths linking to *PISA* is shown in Table 4. As the table indicates, a path from *gdp* to *puptec*, and from *puptec* to PISA, has the strongest indirect effect by the value of 0.976, followed by a path from *gdp* to *tepc*, from *tepc* to *puptec* and from *puptec* to *PISA*, by the value of -0.846. A path from *private exp* to *puptec*, and from *puptec* to *PISA*, has the relatively low value of -0.233. Hence, it is suggested that authors enhance *puptec* by elevating *gdp* in order to strengthen educational competitiveness.

5. Policy implications and conclusions

The main purpose of this study is to demonstrate a generalized structural equation model, in order both to portray the causal connections between GDP, total expenditure on education as a percentage of GDP, total per capita expenditure on education, private-source expenditure on education as a percentage of GDP, school decentralization, education system, and educational competitiveness, and to put forward policy implications whereby each country can strengthen its educational competitiveness. Following the requirements of the SEM for model specification, identification and assessment of model fit, authors estimate the direct, indirect, and total effects of the SEM using aggregate data on OECD member countries. The model fit indices show that the model is statistically significant and is acceptable. Therefore, the hypothesized model cannot be rejected.

The implications of this study are, then, as follows. First, the hypothetical model including GDP per capita as an exogenous variable, and total expenditure on education as a percentage of GDP, total per capita expenditure on education, education system, pupil–teacher ratio, parental concerns about children's education and educational decentralization as variables affecting educational competitiveness, was proved to be statistically significant, with $X2 = 32.290$, $df = 28$, $p = 0.00$, $RMSEA = 0.073$, and $TLI = 0.970$. Hence the relationships between the variables affecting educational competitiveness – total expenditure on education as a percentage of GDP, total per capita expenditure on education, education system, pupil–teacher ratio, parental concerns about children's education, and educational decentralization – have strong implications. One of these is that all countries ought to take comprehensive measures to enhance their own educational competitiveness, rather than focus primarily on a specific measure.

Second, it is suggested that the strongest variable affecting educational competitiveness is the education system. This implies that we need to highlight the close links between the education system and educational competitiveness. In other words, whether the education system meets the needs of the competitive economy well or not does matter in terms of strengthening educational competitiveness. This indicates that the education system of each country needs to be transformed into a system in which the curriculum, teaching methods and other related factors can make children engage with society in a competitive and efficient way. In particular, the education system should respond to changing needs from the customers' side.

Third, the study indicates that, from a long-term perspective, authors need to take measures to decrease the students to teacher ratio, so that teaching can be more intensive, thus helping teachers to foster their students' creativity. In the final model, pupil–teacher ratio acts as a moderating factor in the relationships between *private exp* (private-source expenditure on education) and educational competitiveness. Emphasis should be given to the key role played in the model by pupil–teacher ratio, this being the mediating variable that acts as a link between the final dependent variable, educational competitiveness, and private-source expenditure on education. However, it should be noted that improvement in the variable pupil–teacher ratio is not immediate. Government cannot achieve its goals in the short term, owing to financial constraints. Even so, the ratio needs to be improved in the long term, for the sake of educational competitiveness.

A number of limitations of this study can be identified. First, it is important to remember that this study has focused primarily on OECD member countries. Even though this research result supports the constructed hypotheses, it could result in a narrow view of the effects of educational competitiveness effects, one that it might not be possible to extrapolate to other country groups less sensitive to the influence of economic and financial factors. Second, many variables exist which could influence the variables considered in the study, but which are not present in the study's conceptual model. More interesting and valid conclusions could be drawn from a more global study that could consider non-economic and non-financial factors, such as organizational structure and adequacy of teaching method.

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