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A Study of Cross-Cultural Equivalence of Computer Attitude in PISA 2009 Student Questionnaire

PISA 2009 Öğrenci Anketinde Yer Alan Bilgisayar Tutum Boyutunun Kültürlerarası Eşitliğinin İncelenmesi

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Abstract

This study aims to examine factorial structure of computer attitude of Programme for International Student Assessment (PISA) and the equality of questionnaire across 10 countries by a multi-group confirmatory factor analysis model. For this purpose, 8 OECD and 2 non-OECD states were included in the sampling. No other selection was applicable for this sampling and data of 90, 393 individuals were used. Satisfactory values were obtained for the results of confirmatory factor analysis and reliability analysis for all sub-groups. The multi-group confirmatory factor analysis results showed that computer attitude has cross-cultural equivalence.

Keywords: PISA, measurement equivalence, multi-group confirmatory factor analysis

Öz

Bu araştırmada, Programme for International Student Assessment (PISA) anketinde yer alan bilgisayar tutum faktör yapısının 10 ülke örnekleminde eşitliğinin çoklu grup doğrulayıcı faktör analizi ile incelenmesi amaçlamıştır. Bu amaç doğrultusunda, 8 OECD ve 2 OECD dışı ülke örnekleme alınmıştır. Bu örneklemden ayrıca bir seçim yapılmamış ve 90,393 bireyin verileri kullanılmıştır. Tüm alt gruplar için yapılan doğrulayıcı faktör analiz ve güvenirlik analiz sonuçlarında tatmin edici değerler elde edilmiştir. Ardından gerçekleştirilen çoklu grup doğrulayıcı faktör analizi sonuçları, bilgisayar tutumunun kültürlerarası eşdeğerliğe sahip olduğunu göstermiştir.

Anahtar Sözcükler: PISA, Ölçme Eşdeğerliği, Çoklu Grup Doğrulayıcı Faktör Analizi.

Introduction

Every country should put emphasis on education to have an important place in the globalizing world. Each education system in the world aims to educate qualified, successful individuals who can keep up with the changes in the age of globalization. For this purpose, countries make their education systems subject to continous change. Some countries take international exams such as Programme for International Student Assessment (PISA), *Progress in International Reading Literacy Study (*PIRLS) and The Trends in International Mathematics and Science Study (TIMSS) to examine their education programs comparatively. Student, parent and school questionnaires are utilized in these examinations and data about teacher and student characteristics, and learning environments at schools are collected. TIMSS, PISA, PIRLS are performed after being adapted to various languages in different countries.

PISA, as a programme of international student assessment, is a survey research organized by Organization for Economic Cooperation and Development (OECD) once in every three years. It assesses knowledge and skills of 15-year –old students. PISA examines the concept of literacy in many areas. PIS 2000 collected data about reading skills, 2003 collected data about mathematics

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literacy and 2006 was organized for science literacy and 2009 was organized to collect data about reading skills from participating countries. With its student and ICT questionnaire, the PISA also collects data concerning students' socio-demographic status, school environments, learning styles, parents, views about themselves, motivation to perform well in related domains and computer familiarity.

In PISA 2009 questionnaire of information and communication technologies, items about ICT access levels of students at school and home, frequency of ICT use at home and school, self-confidence of advanced use and computer attitude are seen.

One of the most important variables affecting computer use is the computer attitude (Myers & Halpin, 2002). Computer attitude is the tendency consisting of thought, emotion and behaviours of the individual towards computer, computer use, computer users and social or personal affects of computers. In other words, computer attitude is the reactions of individual towards computer (Liao, 1999). Computer attitude of the individuals comprises of concern for the computer, computer competence, computer interest, enjoying computer and bias of computer (Deniz, 1994). Studies on computer attitude, (e.g: Deniz, 2000; Gardner, Dukes, & Discenza, 1993; Hashim & Mustapha 2004; Levine & Donitsa-Schmidt, 1998; Thomson & De Bortoli, 2007; Topçu, 2009) examined the relation between computer attitude and computer self-confidence and affect of variables related to demographic characteristics (e.g.: sex, region, type of school, experience, etc.) on computer attitude.

It is seen in the literature that studies on the analysis of equivalence of cognitive tests are more in international comparative examinations and studies on testing equivalence of equivalence are limited and are not deemed as important adequately (Schulz, 2003, 2005, 2008). It should be ensured whether each questionnaire adopted in international examinations measures a different construction or not in forms of comparative studies. Each item used should express the same situation for the individuals in other cultures as what it means for the individuals in a culture (Hui and Triandis, 1985). If construction and items measured do not express the same case, it can be expressed that tests in different cultures are not equal (Allalouf, Hambleton, & Sireci, 1999; Çetin, 2010; Ercikan, 2002; Hui & Triandis, 1989; Robin, Sireci, & Hambleton, 2003; Yıldırım, 2006). A four-stage process, namely, configural invariance, metric invariance, scalar invariance and strict invariance is recommended to show the measurement equivalence (Meredith, 1993; Akt.: Uzun ve Öğretmen, 2010).

I.) Configural invariance: Conceptual construction depending on institutional theory is similar for all sub-groups and it is possible to compare this basic construction to all sub-groups.

II.)Metric invariance: Constructional relation of a model established is similar and comparison of construction in terms of variances and examination may be significant and proper for sub-groups.

III.) Scalar invariance: Since conceptual construction, constructional association and error sources are similar in sub-groups, it is significant to compare the averages of implicit variances.

IV.) Strict invariance: Since conceptual construction, constructional association, error mistakes and variances of item residuals are similar in all groups, it is significant to compare the averages of implicit variances.

These equivalence stages are of a hierarchical construction as one will be the pre-requisite of the other. For instance, to analyze strict invariance stage, configural and metric invariance should be examined respectively and revealed. Many fit indexes can be used for assessment each stage.

There are many studies examining the factors affecting the computer attitude in PISA. However, no study has examined the measurement equivalence in different cultural and linguistic groups of computer attitude. Hence, this study aims to examine computer attitude factor construction in PISA questionnaire and equivalence of 10 countries sampling by multi-group confirmatory factor analysis. Model of multi-group confirmatory factor analysis (MGCFA)

is known as the method of assessment of cross-cultural validity of a measurement tool by testing equality or invariance of error variances, factor correlation, factor structure of the test and factor loads.

Method

Since the study aims to examine measurement of PISA 2009 student questionnaire computer attitude in different cultural and language groups, it is a descriptive study. Descriptive studies are the reviews trying to describe and explain events, objects, subjects, institutions, groups and various areas" (Kaptan, 1998, p. 59).

Participant and Data

A total number of 475460 students who are 15-years old in 65 countries, 33 of them are the members of OECD participated in PISA 2009. Then, 9 countries and 50000 students were added to these participants. In this study, 8 OECD and 2 non-OECD countries were taken in the sampling. However, the total number of the sampling was reduced to 90393 from 108252, due to data cleaning of missing values and outliers. Distribution of 10 different countries within the scope of study is presented in Table 1.

Table 1.

Distribution of sampling

Countries	N
Australia	13212
Belgium	7776
Czech Republic	5792
Denmark	5512
Hungary	4514
Ireland	3525
Israel	4999
Japan	4451
Norway	36286
Shanghai-China	4326
Total	90393

Data collection tools

In this study, data were used based on the responses given to the questions, in relation to attitudes towards computer, included in the PISA student questionnaire administered by OECD. Computer attitude within the scope of PISA 2009 was tried to be measure with 4 items (Annex 1). Items in the scale were regulated with 4 grading scale stated as "strongly disagree" (=1), "disagree"(=2), "agree" (=3), "strongly agree" (=4) (PISA, 2009).

Analysis of data

Three different analysis methods were used in this study. First, confirmatory factor analysis (CFA) was implemented in structural equation modelling (SEM).

CFA is used to analyse the validity and fit of factor structure of scale described by empiric or theoretical studies with data collected. In other words, there is a measurement model determined by the researcher and the validity of this model is tested in this analysis (Kline, 2005; Sümer, 2000; Tabachnick & Fidell 2001). The evaluation of model fit was done by using confirmatory factor analysis (CFA). Three types of overall model fit measures useful in CFA can be represented by absolute, incremental and parsimonious fit (Schumacker & Lomax, 1996). Maximum likelihood estimates were calculated from covariance matrix and several fit indexes were computed. In order to evaluate the absolute fit, X2 (X2: minimum fit function test), the Root Mean Square Error of Approximation (RMSEA), goodness of fit index (GFI) and standardized root mean square residual

(SRMR) were used. Adjusted goodness of fit index (AGFI), Normed fit index (NFI), Tucker-Lewis index (TLI), comparative fit index (CFI), were used as incremental fit measures.

Second, reliabilities of the computer attitude were assessed by the Cronbach's coefficient and each dimension's item-total correlations. Here, acceptable criteria were ≥.70 for the Cronbach's coefficients (Hair et al. 1998; Nunnally & Bernstein, 1994).

Following the evidence of reliability and validity for every country of measurement tool, third, a multi-group confirmatory factor analysis (MGCFA) in cultural equivalence SEM of measurement tool was implemented. MGCFA is the analysis of a CFA model simultaneously in two or more groups (Brown, 2006). MGCFA is realized by testing nested 4 models. In the first model, factor loads, correlations and error variances are free (a), in the second model, factor loads and correlations are free for each group (b), in the third model, factor loads and error variances were free (c) and in the fourth model, error variances are free (Brown 2006; Cheung & Rensvold 2002; Çetin, 2010; Jöreskog and Sörbom, 2004; Somer, Korkmaz, Dural, Can, 2009; Şekercioğlu, 2009). In MGCFA assessment, chi-square difference tests were used (Cheung & Rensvold, 2002; Rusticus & Hubley, 2006). However, it is known that chi-square difference tests are affected by big sampling (Brannick, 1995; Cheung & Rensvold, 2002; Kelloway, 1995). For this reasons, alternative indexes (CFI, NNFI, RMSEA) are used and it is shown with the symbol of Δ Δ (Akyıldız, 2009;. Cheung & Rensvold, 2002; Öğretmen and Uzun, 2010). In cases of size of sampling is higher, it is recommended to use RMSEA value (Cheung & Rensvold, 2002). In this study, RMSEA value was used and it was examined whether this value met the conditions of the limit $-0.01 \leq \Delta \leq \Delta$ RMSEA $\leq \leq 0.01$ or not. If the value of Δ Δ RMSEA does not meet this condition, it is accepted that factor structures are not equal and the model RMSEA value of which is lower is fitter (Akyıldız, 2009; Brown, 2006; Kline, 1998) In this respect, configural, metric, scalar and strict measurement invariance was analyzed in stages.

Before the analysis was performed, to determine whether there was a problem of multi-colinearity was present or not correlations between the variables were examined, it was observed that correlation values between variables were .80 (Stevens, 2002) and lower. Then Condition Index (CI), Variance Inflation Factor (VIF) and Tolerance (Tolerance) values were calculated. It was determined that CI value was 30 and lower, VIF value was lower than 10 or tolerance values were 0,10 or lower (Çokluk, Şekercioğlu, & Büyüköztürk, 2010; Hair, Anderson, Tatham and Black, 1998). All of these values show that multicolinearity problem is not present in data set of each country.

In the study, Linear Structural Relations (LISREL 8.7) was used and the model parameters were estimated by Weighted Least Squares (WLS) (Jöreskog & Sörbom, 2004) and Statistical Package for the Social Sciences (SPSS 16.0) package program was used. WLS method was used since it did not require multi-variance normality premises and it was recommended to use in major sampling (Brown, 2006).

Results

Table 2.

Goodness of Fit in Confirmatory Analysis and Cronbach Alpha in Each 10 Countries

Countiries	X^2	*df*	NFI	TLI	CFI	GFI	AGFI	RFI	RMSEA	RMR	Cronbach Alpha
All 10 countries	321.35	2	1	0.99	1	1	0.99	0.99	0.042	0.008	0.768
Australia	4.61	2	1	1	1	1	1	1	0.079	0.004	0.720

Belgium	87.09	2	0.99	0.97	0.99	0.99	0.97	0.97	0.074	0.019	0.743

Tablo 2 continued

Czech Republic	42.88	2	1	0.99	1	1	0.98	0.99	0.059	0.015	0.779
Denmark	37.64	2	0.99	0.99	1	1	0.98	0.98	0.057	0.014	0.764
Hungary	34.39	2	0.99	0.98	0.99	1	0.98	0.98	0.060	0.016	0.766
Ireland	32.52	2	0.99	0.98	0.99	1	0.98	0.98	0.066	0.017	0.768
Israel	59.49	2	0.99	0.98	0.99	0.99	0.97	0.98	0.076	0.018	0.791
Japan	16.95	2	1	1	1	1	0.99	1	0.036	0.007	0.876
Norway	29.02	2	1	0.99	1	1	0.98	0.99	0.055	0.014	0.760
Shanghai-China	202.54	2	1	0.99	1	1	0.99	0.99	0.053	0.013	0.778

When Table 2 is examined, it can be seen that the probability levels of all X^2 statistics were less than 0.01, indicating a rather poor absolute fit (Timm, 2002). X^2 value, generally gives reasonable value in big samples (Byrne, 1994). Therefore, instead of using the X^2 value alone, the rate of the calculated X^2 value to the degree of freedom is recommended, The required condition is that this ratio is smaller than (X^2/df) 3 (Bollen, 1989). However, values lower than 5 are accepted (Klem, 2000). Table 1 shows that the X^2 value is meaningful. In consistency indices, GFI, AGFI, NFI, TLI and CFI values bigger than .90 are a good condition (Hair, Anderson, Tapham & Black, 1998; Kline, 2005). For RMSEA and SRMR values, it needs to be lower than <0.08 (Anderson & Gerbing, 1984; Hu & Bentler, 1999) is required. Results for each of the 10 countries fitted the data well, in relation to previously mentioned standards of acceptable and excellent fits for nine countries. The inter-item correlation and the Cronbach's alpha coefficients found in the present sample show acceptable reliabilities of the tool.

Results of multi-group confirmatory factor analysis results following confirmatory factor analysis are shown in Table 3.

Table 3.

Goodness of Fit in Confirmatory Factor Model Across Multiple Countries

Model	X^2	*df*	NFI	TLI	CFI	GFI	RFI	RMSEA	ΔΔ RMSEA
Model 1[a]	2437.17	92	0.92	0.95	0.92	0.99	0.95	0.053	-
Model 2[b]	1221.43	56	0.96	0.96	0.96	0.99	0.96	0.048	0.005
Model 3[c]	383.79	20	0.99	0.96	0.99	1	0.96	0.045	0.008
Model 4[d]	1181.70	56	0.96	0.96	0.96	0.99	0.96	0.047	0.006

[a] Factor loads, factor correlations and error variances are fixed, [b] Factor loads are free, [c] Factor loads and error variances are free, [d] error variances are free

If we analyse the values of NFI, TLI, CFI, GFI, RFI and RMSEA in table 3, it can be said that these values are within acceptable limit and even show perfect fit. Fit indexes of all these models yielded values close to each other. If we analyse model 2 (RMSEA=0.048; ΔΔ RMSEA=0.005), Model 3 (RMSEA=0.045; ΔΔ RMSEA=0.008) and Model 4 (RMSEA=0.047; ΔΔ RMSEA=0.006) ΔΔ RMSEA value, it is seen that it does not exceed limit value for all models. In this case, model 1 is accepted as the best model explaining the existing condition. Findings show that factor construction for computer attitude has configural, metric, scalar and strict invariance. It is expressed the structure of factor for computer attitude implemented in all countries are invariant/equal for the countries examined within the scope of sampling. In other words, computer attitudes can be compared in all sub-groups.

Discussion

In this study, the cross-cultural equivalency of the survey questionnaires in computer attitude, that was administered in PISA 2009, was examined. Marsh and others (2006) classified the studies as cross-cultural comparison and cross-cultural generalization. The purpose of this study is not to compare the countries. Accordingly, first of all, single factor structure comprising of 4 items was examined in all countries with CFA and it was observed that fit indexes met the criteria. Internal consistency coefficient was calculated for reliability analysis and it was determined that it was higher than limit values. Following results, cross-cultural invariance of measurement tool was examined by MGCFA. It can be said that computer attitude has the measurement equivalence in the countries within the scope of sampling in other words, all countries are equal to each other by results. Therefore, it can be expressed that the averages of these countries can be compared and computers with high average have more positive computer attitudes.

In this study, computer attitude of PISA 2009 application was used. Other sections can be examined in the future studies. Moreover, equivalence of factor structures of tools used in PISA in terms of variables such as sex, socio-economic variables for all countries participating in PISA 2009.

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