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Exploring the Effects of Socio-Economic Status, Motivation and ICT Use on Science Achievement: Findings from PISA 2015

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Abstract: The present study used the PISA 2015 dataset (n = 39,297) of six East Asian economies to investigate the relationship between students' ICT-based learning and their science proficiency level. Using Mplus 7, CFA and SEM were conducted to obtain the three major findings. Firstly, students' socio-economic status is highly related to students' science proficiency level but is weakly related to ICT-based learning. Secondly, although both learning enjoyment and instrumental motivation are weakly, positively related to ICT-based learning, the association between learning enjoyment and students' science proficiency level is much stronger than that between instrumental motivation and science proficiency level. Lastly, ICT efficacy is positively related to ICT-based learning, which in turn, is significantly and negatively related to science proficiency level.

Keywords: socio-economic status, motivation, ICT use, science achievement, PISA

1. Introduction

Students' science literacy and performance are considered closely related to 21st century skills and their future life in modern society (Millar, 2006; Tsai, 2015). With the mushrooming of internationally large-scale surveys and related research, contradictory findings have been obtained regarding how students' science achievement has been influenced. Since PISA 2015 is the most up-to-date measurement with a focus on students' science achievement, the present study targets at exploring the relationships between students' science achievement and its major influencing factors.

2. Research Hypotheses

H1a: Students' SES is positively related to their science proficiency level.
H1b: Students' SES is positively related to their ICT-based learning.

H2: Both science learning enjoyment and instrumental motivation in science learning are positively related to science proficiency level.

H3: Both science learning enjoyment and instrumental motivation in science learning are positively related to ICT-based learning.

H4a: ICT efficacy is positively related to ICT-based learning.
H4b: ICT-based learning is positively related to students' science proficiency level.

3. Method

3.1 Participants

The participants of this study thus were 15-year-old students from Japan (16.8%), Korea (14.1%), Mainland China (Beijing, Shanghai, Jiangsu and Guangdong Provinces) (24.8%), Chinese Taipei

(19.5%), Hong Kong (13.5%) and Macao (11.3%). After removing missing data, a final sample of 39,297 students was used in our study.

3.2 Measures

3.2.1 Scales

The present study adopted four scales from PISA 2015 survey, measuring science learning enjoyment, instrumental motivation for learning science, ICT efficacy and ICT-based learning. See brief information about the scales below.

Table 1

Scales involved in the present study

Scales	Likert scale	No. of items	Cronbach's α
Science learning enjoyment	4-point (1 = *strongly disagree*' to '4 = *strongly agree*')	5	0.95
Instrumental motivation for learning science	4-point (1 = *strongly disagree*' to '4 = *strongly agree*')	4	0.93
ICT efficacy	4-point (1 = *strongly disagree*' to '4 = *strongly agree*')	5	0.85
ICT-based learning	5-point (1 = *never or hardly ever*' to '5 = *every day*)	12 (6 parcels)	0.91

3.2.2 ESCS

The index of economic, social and cultural status (ESCS) for each student was calculated and provided by OECD, and it is operationalized as a comprehensive measure of students' socio-economic status in the present study.

3.2.3 Science Proficiency Level

Science proficiency levels were derived from the plausible values provided in PISA dataset and taken as a measure of students' science achievement. Using cut-off scores for proficiency level provided by OECD (2015), the 10 plausible values were recoded into 10 proficiency levels.

3.3 Data Analysis

Using Mplus 7, confirmatory factor analysis (CFA) was conducted to ensure the validity of the measurement model, and structural equation modeling (SEM) was then conducted to estimate all path coefficients. SPSS 21 was also used to generate descriptive data and synthesize replicate estimates.

4. Results and Conclusion

4.1 Reliability, Descriptive Statistics, and Correlations

Table 2

Reliability, descriptive statistics, and correlations

	M	SD	1	2	3	4	5	6
1. sci-enj	2.62	.79	(.95)					
2. sci-mot	2.85	.77	.47**	(.93)				
3. ICT-eff	2.50	.65	.18**	.09**	(.85)			
4. ICT-L	1.70	.70	.20**	.16**	.31**	(.91)		

5. ESCS	-.55	.99	.01**	-.06**	.09**	.06**	-	
6. spl 1	3.09	1.29	.26**	.09**	.10**	-.06**	.36**	-

*Notes: the Cronbach's α coefficients were in parentheses; ** p < 0.01.*

4.2 CFA Results

A four-factor model was tested using CFA. The four factors were science learning enjoyment, instrumental motivation for learning science, ICT efficacy, and ICT-based learning, respectively. When conducting CFA with the final weight, the results generally confirmed the construct validity of the measurement with an acceptable model fit (χ^2 = 6388.203, df = 164, p < .001, CFI =.97, TLI = .96, RMSEA = .031, SRMR = .032).

4.3 SEM Results

The final results of SEM were obtained by synthesizing 90 replicate estimates. To be specific, for the ten models estimated with 10 science proficiency levels by the final weight, χ^2 = 8846.50~8923.15, df = 200, p < .001, CFI = .96, TLI = .95, RMSEA = .033, SRMR = .037~.038; for the model estimated with the first science proficiency level by the 80 replicate weight, RMSEA = .052, SRMR = .038.

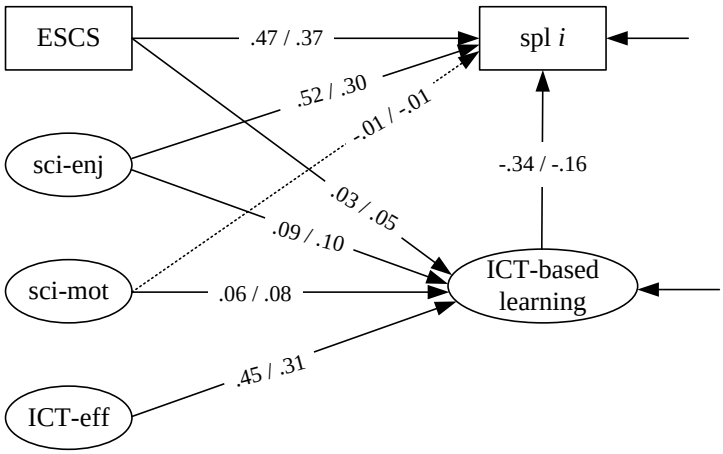

Figure 1. The SEM results of the hypothesized model.

Notes: all significant paths (significant at .001 level) were presented as solid lines, and a non-significant path presented as a dotted line; numbers before the slashes were unstandardized estimates of the path coefficients, and numbers after the slashes were standardized estimates.

As is shown in Figure 1, the findings were threefold. First, ESCS was highly related to students' science proficiency level (β = .37, p < .001), but was weakly, though significantly, related to ICT-based learning (β = .05, p < .001). Second, although both learning enjoyment and instrumental motivation were weakly and positively related to ICT-based learning (sci-enj: β = .10, p < .001; sci-mot: β = .08, p < .001), the association between learning enjoyment and students' science proficiency level (β = .30, p < .001) was much stronger than that between instrumental motivation and science proficiency level (β = -.01, n.s.). Third, ICT efficacy was positively related to ICT-based learning (β = .31, p < .001), which in turn, was significantly and negatively related to science proficiency level (β = -.16, p < .001). Thus, hypotheses H1, H3 and H4 were supported but hypotheses H2 was rejected due to a non-significant negative association between instrumental motivation and science proficiency level.

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