The Relation of Motivational Constructs to Reading Achievement in EU Countries from PISA2018

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Researchers usually focus on student achievement when analysing the quality of education. The Programme for International Student Assessment (PISA), is a large-scale assessment that provides data on mathematical, science, and reading literacy for 15-year-old students. PISA also collects information about students' motivational, family, and institutional factors, which can explain differences in student achievement at the individual, school, and country levels. The effect of motivational constructs on students' achievement is very rare in literature. Starting to look at the impact of motivational constructs first requires sufficient evidence of the measurement invariance (MI).

DATA

26 EU countries

183,824
15-years-old students

Reading achievement – educational outcome.

Reading achievement is measured by 10 plausible values (PVs). All calculations are performed with each PV separately and then combined according to the Rubin's rules (1987).

Economic, social and cultural status, and **gender** – control variables

Table 1. Descriptive statistics

Country	Sample size	Number of schools	Gender (% of female)	Reading achievement* (Mean (SD))
Austria	6802	291	49.25	484.4 (99.4)
Bulgaria	5294	197	46.92	419.8 (101.4)
Czech Republic	7019	333	48.90	490.2 (97.3)
Germany	5451	223	46.22	498.3 (105.8)
Denmark	7657	348	49.95	501.1 (92.1)
Spain	35943	1089	49.37	476.5 (92.8)
Estonia	5316	230	49.98	523.0 (93.2)
Finland	5649	214	49.05	520.1 (99.6)
France	6308	252	49.33	492.6 (101.2)
United Kingdom	13818	471	51.45	503.9 (100.2)
Greece	6403	242	49.29	457.4 (97.4)
Croatia	6609	183	50.33	479.0 (89.2)
Hungary	5132	238	50.47	476.0 (97.6)
Ireland	5577	157	50.29	518.1 (90.7)
Italy	11785	542	48.26	476.3 (96.9)
Lithuania	6885	362	48.91	475.9 (94.3)
Luxembourg	5230	44	49.31	470.0 (108.4)
Latvia	5303	308	50.78	478.7 (90.0)
Malta	3363	50	47.85	448.2 (112.8)
Netherlands	4765	156	49.87	484.8 (104.8)
Poland	5625	240	50.03	511.9 (97.3)
Portugal	5932	276	49.28	491.8 (96.1)
Romania	5075	170	48.49	427.7 (98.4)
Slovak Republic	5965	376	50.34	458.0 (100.3)
Slovenia	6401	345	48.79	495.3 (93.6)
Sweden	5504	223	49.98	505.8 (107.5)

*The average of the ten plausible values of reading achievement in PISA 2018.

Motivational constructs for which measurement invariance is evaluated: **the work mastery** (WORKMAST), **the competitiveness** (COMPETE), **the fear of failure** (GFOFAIL).

Table 2. PISA 2018 indices and sub-items.

PISA Index	Latent variable	PISA code	Explanatory variable	PISA sub-item*	Reliability (Cronbach's alpha)**
WORKMAST	W	ST182Q03HA	W^1	"I find satisfaction in working as hard as I can"	.65 - .82
		ST182Q04HA	W^2	"Once I start a task, I persist until it is finished"	
		ST182Q05HA	W^3	"Part of the enjoyment I get from doing things is when I improve on my past performance"	
COMPETE	C	ST181Q02HA	C^1	"I enjoy working in situations involving competition with others"	.68 - .80
		ST181Q03HA	C^2	"It is important for me to perform better than other people on a task"	
		ST181Q04HA	C^3	"I try harder when I'm in competition with other people"	
GFOFAIL	F	ST183Q01HA	F^1	"When I am failing, I worry about what others think of me"	.75 - .85
		ST183Q02HA	F^2	"When I am failing, I am afraid that I might not have enough talent"	
		ST183Q03HA	F^3	"I try harder when I'm in competition with other people"	

*Source: OECD, 2019.
**Source: OECD, 2020.

The sub-item is measured in a four-point Likert scale (1 - "strongly disagree", 2 - "disagree", 3 - "agree", 4 - "strongly agree"). Higher values indicate stronger motivation. Cross-country comparability of indices, tested using Cronbach's alpha. Cronbach's alpha ranges from 0 to 1, with higher values indicating higher internal consistency (OECD, 2020).

1 CONFIRMATORY FACTOR ANALYSIS (CFA)

The CFA models were constructed for each EU country and for the overall sample in order to test the MI of motivation constructs.

All three latent variables are tested in one model.

Figure 1. Overall sample single group CFA model with standardized item loadings (standard error)

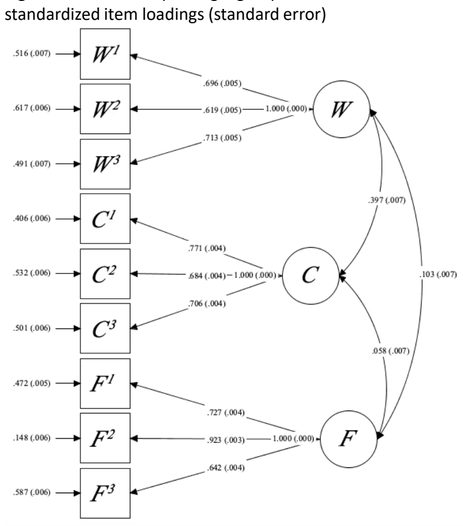


Table 3. Model fit indices and standardized item loadings for the CFA model, by country

Countries (regions)	CFI	TLI	RMSEA (90% C.I.)	SRMR	Standardized item loadings W	C	F
Overall sample	.98	.97	.020 (.019, .021)	.029	.619 - .713	.684 - .771	.642 - .923
Austria	.97	.95	.047 (.043, .051)	.038	.648 - .689	.699 - .736	.678 - .907
Bulgaria	.98	.97	.040 (.035, .045)	.033	.745 - .801	.696 - .818	.728 - .881
Croatia	.96	.95	.058 (.054, .062)	.045	.610 - .753	.686 - .805	.643 - .866
Czech Republic	.97	.96	.043 (.039, .047)	.038	.608 - .646	.688 - .745	.680 - .907
Denmark	.96	.95	.047 (.042, .051)	.042	.624 - .724	.686 - .791	.656 - .926
Estonia	.96	.95	.048 (.044, .053)	.041	.599 - .748	.669 - .804	.556 - .918
Finland	.97	.95	.059 (.054, .064)	.047	.600 - .675	.641 - .741	.688 - .915
France	.98	.97	.036 (.032, .041)	.029	.654 - .773	.709 - .837	.746 - .947
Germany	.97	.96	.043 (.038, .049)	.035	.616 - .723	.656 - .784	.619 - .942
Greece	.98	.97	.039 (.034, .043)	.031	.645 - .722	.707 - .825	.714 - .936
Hungary	.98	.98	.035 (.031, .040)	.029	.647 - .703	.670 - .699	.586 - .895
Ireland	.98	.97	.040 (.036, .045)	.031	.631 - .732	.700 - .795	.654 - .909
Italy	.98	.98	.025 (.022, .028)	.026	.646 - .671	.675 - .735	.731 - .937
Latvia	.98	.96	.042 (.037, .047)	.035	.615 - .706	.666 - .828	.727 - .912
Lithuania	.98	.98	.034 (.030, .038)	.030	.625 - .793	.677 - .794	.615 - .913
Luxembourg	.98	.96	.046 (.041, .051)	.034	.661 - .718	.607 - .783	.666 - .865
Malta	.99	.98	.032 (.026, .039)	.025	.670 - .715	.707 - .798	.653 - .907
Netherlands	.98	.97	.039 (.033, .044)	.032	.572 - .727	.652 - .812	.645 - .860
Poland	.97	.95	.047 (.042, .051)	.038	.698 - .786	.697 - .779	.639 - .924
Portugal	.97	.96	.042 (.037, .046)	.035	.624 - .634	.625 - .764	.662 - .942
Romania	.98	.97	.036 (.031, .041)	.029	.553 - .806	.624 - .657	.639 - .888
Slovak Republic	.98	.98	.033 (.028, .038)	.028	.637 - .753	.630 - .773	.626 - .941
Slovenia	.97	.95	.045 (.040, .049)	.041	.558 - .662	.676 - .717	.644 - .833
Spain	.98	.96	.028 (.026, .030)	.029	.639 - .731	.673 - .754	.700 - .867
Sweden	.97	.96	.049 (.044, .053)	.039	.603 - .776	.681 - .745	.679 - .923
United Kingdom	.98	.96	.034 (.031, .037)	.037	.708 - .733	.645 - .821	.710 - .953

CFA models fit criteria: CFI and TLI acceptable fit ≥ .90, good fit ≥ .95, RMSEA and SRMR acceptable fit ≤ .10, good fit ≤ .05 (Hu & Bentler, 1999).

MI of motivational constructs confirmed

2 MULTI-GROUP CONFIRMATORY FACTOR ANALYSIS (MG-CFA)

In order to examine MI of motivational constructs between 26 EU countries, the MG-CFA models were performed at *configural* (confirm the conceptual comparability of constructs across countries), *metric* (confirm the comparability of correlations across countries) and *scalar* (confirm the comparability of means across countries) steps.

MG-CFA model fit criteria: ΔCFI ≤ .02, ΔTLI ≤ .02, ΔRMSEA ≤ .03, ΔSRMR ≤ .03 (Rutkowski & Svetina, 2014).

Table 4. Model fit indices and MI results for the MG-CFA

Invariance Level	CFI	TLI	RMSEA (90% C.I.)	SRMR	Model compare	ΔCFI	ΔTLI	ΔRMSEA	ΔSRMR	Decision
Configural	.98	.96	.040 (.040 .041)	.034						
Metric	.97	.97	.039 (.038 .040)	.041	Configural	**-.004**	**.002**	**-.001**	**.007**	Invariant
Scalar	.90	.90	.066 (.065 .066)	.064	Metric	**-.069**	**-.064**	**.027**	**.023**	Invariant

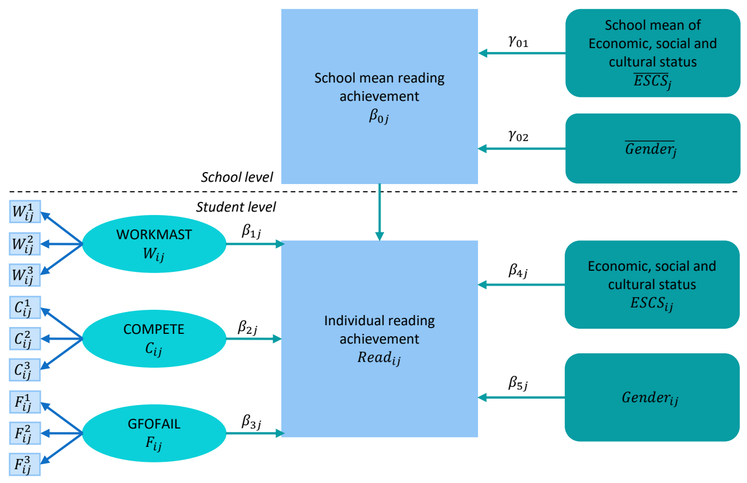
Notes: in bold ΔCFI ≤ .02, ΔTLI≤ .02, ΔRMSEA ≤ .03, ΔSRMR ≤ .03

MI of motivational constructs confirmed

3 MULTI-GROUP STRUCTURAL EQUATION MODELING (MGSEM)

We developed two level (students at level-1, schools at level-2) MGSEM to examine the effect of selected motivational constructs on reading achievements.

Figure 2. Two level MGSEM model



Student level:

$$Read_{ij} = \beta_{0j} + \beta_{1j} * W_{ij} + \beta_{2j} * C_{ij} + \beta_{3j} * F_{ij} + \\ + \beta_{4j} * ESCS_{ij} + \beta_{5j} * Gender_{ij} + \varepsilon_{ij}$$

School level:

$$\beta_{0j} = \gamma_{00} + \gamma_{01} * \overline{ESCS}_j + \gamma_{02} * \overline{Gender}_j + u_{0j}$$

$$\beta_{1j} = \gamma_{10}; \beta_{2j} = \gamma_{20}; \beta_{3j} = \gamma_{30}; \beta_{4j} = \gamma_{40}; \beta_{5j} = \gamma_{50}$$

where student i enrolled in school j.

Table 5. Model fit indices for the MGSEM model by country

Country	CFI	TLI	RMSEA	SRMR
Austria	.93	.90	.054	.052
Bulgaria	.95	.93	.049	.053
Croatia	.92	.88	.066	.059
Czech Republic	.92	.89	.054	.062
Denmark	.89	.84	.061	.074
Estonia	.90	.86	.064	.067
Finland	.91	.87	.075	.082
France	.92	.89	.058	.062
Germany	.91	.87	.059	.060
Greece	.93	.90	.054	.053
Hungary	.94	.91	.054	.057
Ireland	.92	.89	.063	.065
Italy	.94	.91	.037	.050
Latvia	.92	.89	.058	.061
Lithuania	.94	.92	.048	.050
Luxembourg	.92	.88	.061	.061
Malta	.94	.91	.060	.054
Netherlands	.92	.88	.053	.062
Poland	.92	.88	.061	.062
Portugal	.89	.85	.064	.070
Romania	.92	.88	.055	.049
Slovak Republic	.94	.92	.047	.053
Slovenia	.91	.87	.059	.071
Spain	.93	.90	.036	.051
Sweden	.92	.89	.062	.068
United Kingdom	.91	.87	.050	.073

MGSEM models fit criteria: CFI and TLI acceptable fit ≥ .90, good fit ≥ .95, RMSEA and SRMR acceptable fit ≤ .10, good fit ≤ .05 (Hox 2002; Ryu & West, 2009).

At least one motivational construct is statistically significant for reading achievement in all analysed EU countries

Table 6. Results for the MGSEM by country

Variables	Estimates (SE)																							
	Austria	Bulgaria	Croatia	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Latvia	Lithuania	Luxembourg	Malta	Netherlands	Poland	Portugal	Romania	Slovak Republic	Slovenia	Spain	Sweden	United Kingdom
Intercepts	7.970*** (.394)	6.344*** (.372)	9.192*** (.557)	8.380*** (.386)	18.050*** (1.382)	14.679*** (1.187)	26.199*** (3.030)	7.841*** (.486)	7.555*** (.521)	8.538*** (.618)	6.593*** (.374)	22.366*** (2.099)	8.185*** (.425)	12.430*** (.844)	8.485*** (.527)	9.657*** (1.260)	9.323*** (2.546)	5.486*** (.452)	15.901*** (1.216)	11.959*** (.941)	7.193*** (.469)	7.363*** (.366)	8.217*** (.482)	16.381*** (.930)	14.252*** (1.437)	14.320*** (.928)
Student level																										
Workmast	.114*** (.023)	.143*** (.028)	.083*** (.021)	.113*** (.024)	.169*** (.026)	.165*** (.025)	.257*** (.020)	.108*** (.020)	.101** (.031)	.232*** (.020)	.105*** (.027)	.068** (.022)	.183*** (.021)	.189*** (.026)	.028* (.022)	.171*** (.018)	.230*** (.031)	.030* (.026)	.224*** (.023)	.173*** (.019)	.128*** (.034)	.192*** (.025)	.218*** (.020)	.168*** (.012)	.121*** (.020)	.142*** (.021)
Compete	.076*** (.020)	.091** (.028)	.055** (.019)	.028* (.022)	.041* (.021)	.044* (.026)	.017* (.020)	.012 (.018)	.045* (.028)	-.026* (.020)	-.013 (.025)	.069*** (.018)	.023* (.019)	.017* (.025)	.106*** (.018)	-.004 (.019)	.031* (.020)	.024* (.025)	-.035* (.025)	-.012* (.018)	-.034* (.028)	-.067** (.023)	-.014* (.020)	-.005 (.012)	.064** (.021)	.032* (.018)
Gfofail	-.008 (.017)	-.051* (.021)	.051** (.016)	.022* (.017)	-.034* (.019)	.038* (.019)	.092*** (.016)	.001 (.017)	.036* (.021)	.023* (.017)	.015* (.017)	.057*** (.015)	.002 (.017)	.037* (.018)	-.012* (.016)	.020* (.017)	.079*** (.021)	.067*** (.019)	.036* (.018)	.038* (.018)	.002 (.019)	.043* (.018)	.010 (.018)	.015* (.010)	.035* (.017)	.065*** (.015)
ESCS	.131*** (.018)	.090*** (.022)	.091*** (.017)	.144*** (.020)	.244*** (.016)	.142*** (.019)	.243*** (.016)	.202*** (.017)	.183*** (.021)	.155*** (.016)	.036* (.023)	.235*** (.017)	.053** (.019)	.111*** (.018)	.150*** (.018)	.216*** (.027)	.187*** (.032)	.064** (.020)	.224*** (.019)	.263*** (.019)	.167*** (.020)	.117*** (.024)	.056** (.020)	.248*** (.010)	.250*** (.017)	.173*** (.017)
Gender	.117*** (.022)	.164*** (.019)	.110*** (.019)	.114*** (.018)	.160*** (.016)	.172*** (.021)	.212*** (.014)	.069*** (.016)	.066*** (.017)	.173*** (.015)	.049** (.018)	.097*** (.021)	.083*** (.017)	.170*** (.019)	.176*** (.014)	.131*** (.021)	.076* (.047)	.128*** (.020)	.135*** (.014)	.088*** (.017)	.107*** (.017)	.094*** (.018)	.098*** (.024)	.115*** (.009)	.158*** (.016)	.082*** (.016)
School level																										
School mean of ESCS	.812*** (.026)	.735*** (.068)	.727*** (.042)	.812*** (.026)	.596*** (.056)	.568*** (.065)	.284* (.116)	.774*** (.030)	.803*** (.036)	.644*** (.045)	.840*** (.028)	.755*** (.055)	.794*** (.026)	.697*** (.048)	.745*** (.032)	.957*** (.019)	.602*** (.071)	.783*** (.037)	.687*** (.051)	.590*** (.055)	.762*** (.038)	.794*** (.034)	.830*** (.028)	.416*** (.038)	.641*** (.058)	.754*** (.039)
School mean of Gender	.046* (.050)	.148** (.053)	.249*** (.054)	.138*** (.039)	.136* (.065)	-.029 (.085)	.047 (.116)	.184*** (.053)	.170** (.056)	.246*** (.060)	.169*** (.040)	.063* (.089)	.050* (.041)	.076* (.058)	.288*** (.038)	.052* (.047)	.381*** (.108)	.135* (.053)	.079* (.070)	.243*** (.066)	.259*** (.047)	.165*** (.036)	.155** (.045)	.149*** (.042)	.077* (.070)	.065* (.063)
Variance explained																										
Within-study variance	.942*** (.008)	.924*** (.010)	.964*** (.007)	.947*** (.009)	.879*** (.010)	.913*** (.010)	.811*** (.010)	.941*** (.008)	.943*** (.010)	.895*** (.010)	.986*** (.005)	.916*** (.009)	.953*** (.007)	.917*** (.010)	.932*** (.008)	.905*** (.018)	.888*** (.021)	.973*** (.007)	.883*** (.010)	.892*** (.011)	.949*** (.009)	.944*** (.010)	.941*** (.009)	.895*** (.006)	.887*** (.010)	.934*** (.008)
Between-study variance	.328*** (.043)	.397*** (.090)	.364*** (.054)	.281*** (.037)	.605*** (.071)	.678*** (.073)	.911*** (.066)	.303*** (.037)	.257*** (.037)	.431*** (.051)	.213*** (.036)	.411*** (.078)	.354*** (.040)	.505*** (.065)	.259*** (.037)	.082* (.032)	.513*** (.100)	.320*** (.051)	.494*** (.067)	.556*** (.067)	.255*** (.043)	.306*** (.050)	.226*** (.036)	.800*** (.034)	.576*** (.074)	.425*** (.059)
Within-study R-square	.058	.076	.036	.053	.121	.087	.189	.059	.057	.105	.014	.084	.047	.083	.068	.095	.112	.027	.117	.108	.051	.056	.059	.105	.113	.066
Between-study R-square	.672	.603	.636	.719	.395	.322	.089	.697	.743	.569	.787	.589	.646	.495	.741	.918	.487	.680	.506	.444	.745	.694	.774	.200	.424	.575
ICC	.390	.454	.342	.402	.066	.147	.038	.376	.381	.267	.528	.059	.403	.177	.289	.205	.166	.506	.107	.168	.348	.414	.405	.086	.095	.117

Notes: SE - robust standard error; *p < .05, **p < .01, ***p < .001

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