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The Relationship of Problem-Solving in Technology-rich Environments to Literacy and Numeracy: Insights from PIAAC

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OUTLINE

- Background
- Preliminary data summaries
- Using quantile regression (QR) to examine the relationship of PS-TRE to Literacy
- Using OLS regression to study the relationship of PS-TRE to Literacy, Numeracy and other individual characteristics
- Conclusions and implications

Preliminaries (1)

- Data derived from PUFs for U.S. and Canada
- Focus on Canadian data (N = 25,000)
- Compare to U.S. data (N= 5,000)
- Used PV 1 for some initial analyses
- Regression results obtained from IDB analyzer

Preliminaries (2)

- Approximately 10% of respondents did not take CBT administration
- Of those who took the CBT admin, about
- 1/3 took one PS-TRE module (7 items) and about
- 1/6 took two PS-TRE modules (14 items)

Growing Interest in 21st Century Skills

- Equipped for the Future (U.S.)
- Secretary's Commission for Assessing Necessary Skills (SCANS – US)
- Documenting and Selecting Key Competencies (OECD)
- Partnership for 21st Century Skills
- ATC21S
- National Research Council Report: Education for Life and Work

Technology in Assessment

- NAEP: Science assessment in TRE
- PIAAC: Problem Solving in TRE
- PISA 2015
- PARCC and SBAC (Summative K-12 tests)
- Netherlands, Singapore, Australia, ?? are all implementing technology-based assessments (mostly formative)

Research Questions

1. What are the distributions of PS-TRE across different sub-populations?
2. What is the relationship of PS-TRE to Literacy and Numeracy?
3. What is the relationship of PS-TRE to other combinations of skills and characteristics?
4. How do the U.S. and Canada compare on various metrics?

Canada: Data Counts

	MALES		FEMALES	
	P/P	CBT	P/P	CBT
AGE CLASS				
16-24	81	2052	76	2049
25-34	88	1734	103	2301
35-44	156	1973	197	2485
45-54	270	2086	283	2552
55-65	380	1728	425	1955
TOTAL	975	9573	1084	11342

US: Data Counts

	MALES		FEMALES	
	P/P	CBT	P/P	CBT
AGE CLASS				
16-24	11	396	14	384
25-34	21	427	27	531
35-44	27	389	26	471
45-54	42	407	34	492
55-65	60	338	70	465
TOTAL	161	1957	171	2343

Canada & US & OECD Averages

	Literacy (mean)	Numeracy (mean)	PS-TRE (% in L2 & L3)
OECD Average	273	269	34
Canada	273	265 <	37 >
US	270 <	253 <	31 <

Distributions of Literacy and Numeracy

				LITERACY: Percentiles		
	MEAN*	10	25	50	75	90
CANADA	274 [274]	208	243	278	309	334
USA	270 [261]	204	238	273	305	330
				NUMERACY: Percentiles		
CANADA	265 [271]	194	231	270	304	332
USA	253 [240]	178	217	256	293	323

*[ ] Displays mean for age class [16-24]

Literacy: Comparisons

	LITERACY (means)					
	MALES			FEMALES		
AGE CLASS	CANADA		US	CANADA		US
	P/P	CBT	CBT	P/P	CBT	CBT
16-24	282	280	270	301	280	274
25-34	288	290	285	296	291	279
35-44	246	290	285	263	289	279
45-54	256	283	281	254	279	279
55-65	267	276	278	255	271	276

Numeracy: Comparisons

	NUMERACY (means)					
	MALES			FEMALES		
AGE CLASS	CANADA		US	CANADA		US
	P/P	CBT	CBT	P/P	CBT	CBT
16-24	264	280	254	276	269	248
25-34	248	292	280	260	278	259
35-44	227	292	274	226	276	259
45-54	234	285	276	241	269	258
55-65	247	277	273	225	259	256

Canada: Comparing P/P and CBT

Males L: CBT > P/P N: CBT >> P/P

P/P: L ↓ Age N ↓ Age CBT: L~ Age N ~ Age

Females L: CBT > P/P* N: CBT > P/P

P/P: L ↓ Age N ↓ Age CBT: L~ Age N ~ Age

[* = older age classes only]

US: Comparing P/P and CBT

Males L: CBT > P/P N: CBT >> P/P

P/P: L ~ Age N ↑ Age CBT: L~ Age N ↑ Age

Females L: CBT > P/P* N: CBT > P/P*

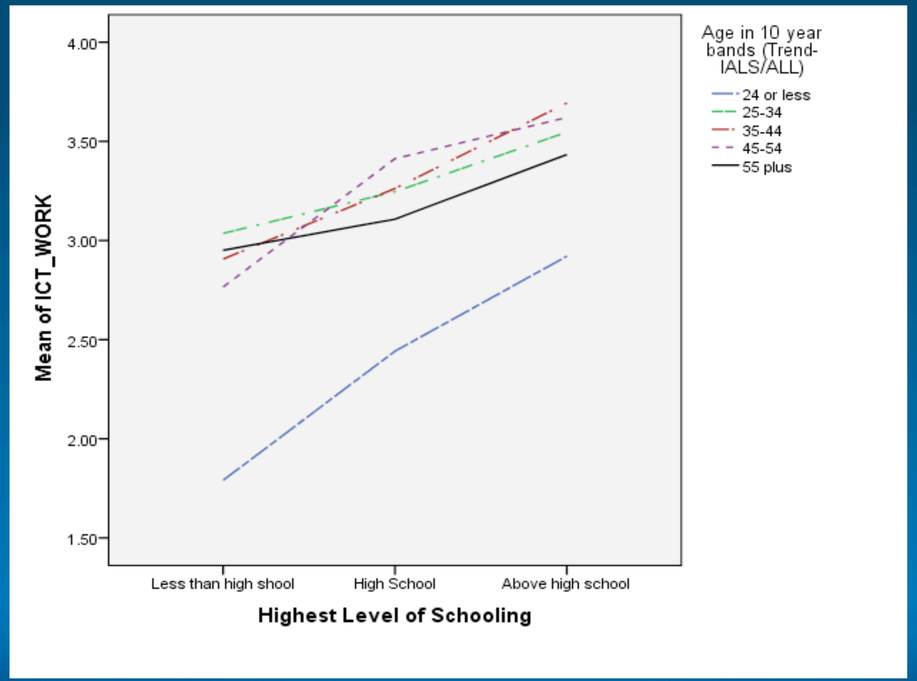
P/P: L ~ Age* N ~ Age CBT: L ~ Age N ~ Age

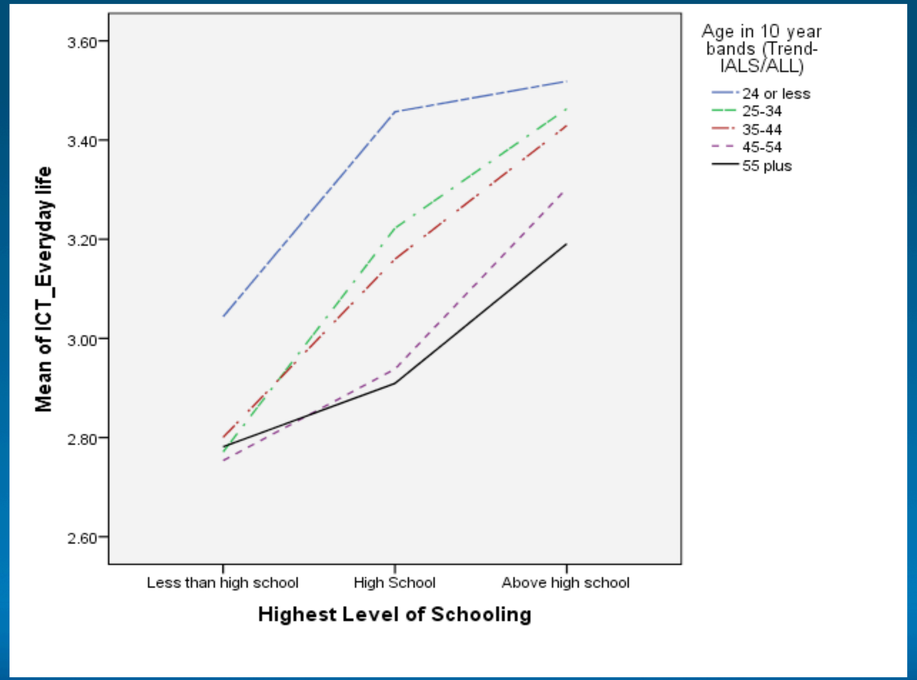
[* = older age classes only]

Canada: ICT Usage by Age and Education

- Considerable interest in the relationship between PS and ICT usage.

- Constructed crude indices of ICT usage (at work and in everyday life) based on (i) Averaging Likert responses to two parallel sets of 5 questions; (ii) Levels (3) of computer use at work.


Mean of ICT_WORK
4.00
3.50
3.00
2.50
2.00
1.50
Less than high shool
High School
Above high school
Highest Level of Schooling
Age in 10 year bands (Trend-IALS/ALL)
24 or less
25-34
35-44
45-54
55 plus


Mean of ICT_Everyday life
3.60
3.40
3.20
3.00
2.80
2.60
Less than high school
High School
Above high school
Highest Level of Schooling
Age in 10 year bands (Trend-IALS/ALL)
24 or less
25-34
35-44
45-54
55 plus

PS-TRE: % Above L1 by Age

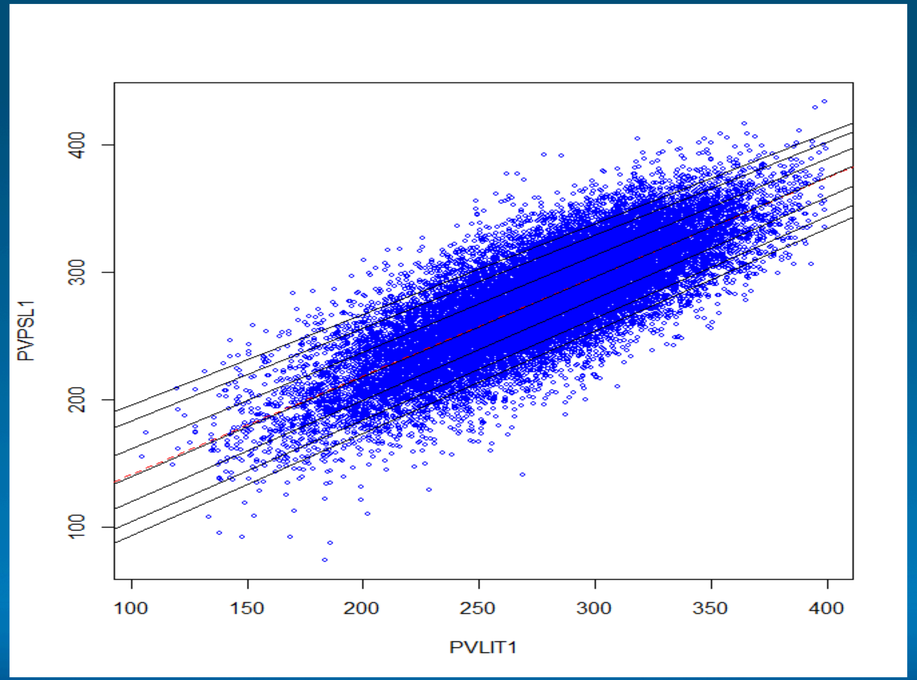
	CANADA				USA		
AGE CLASS	L2	L3	L2 + L3		L2	L3	L2 +L3
16-24	41	10	50.8		31	7	37.6
25-34	38	11	49.0		32	7	38.9
35-44	33	9	42.1		28	6	34.3
45-54	23	5	28.2		22	3	25.6
55-64	15	2	16.4		17	3	19.7
ALL	29	7	36.5		26	5	31.1

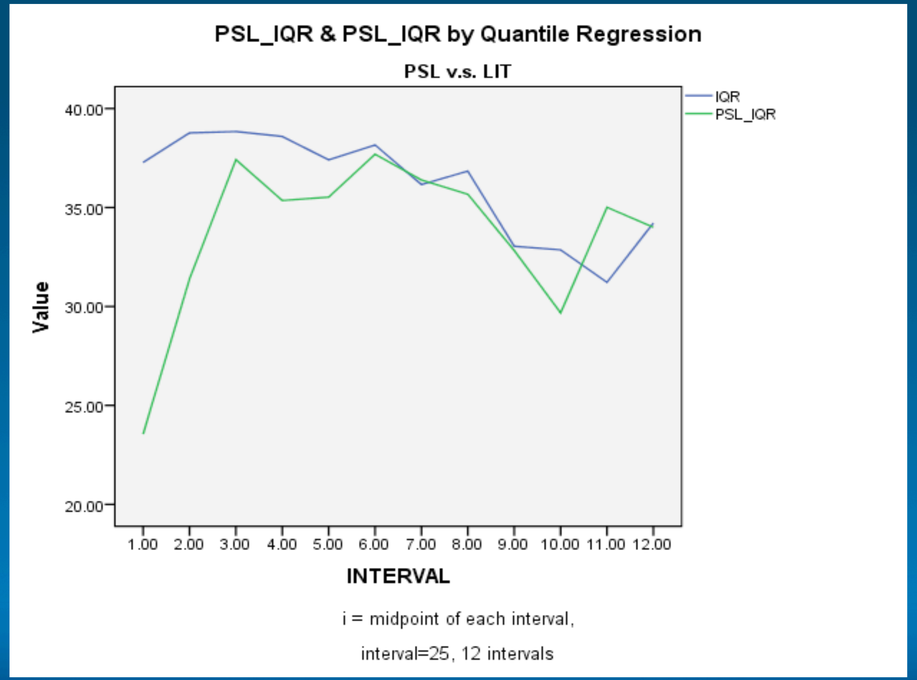
PS-TRE: % Above L1 by Education & Immigration/Language

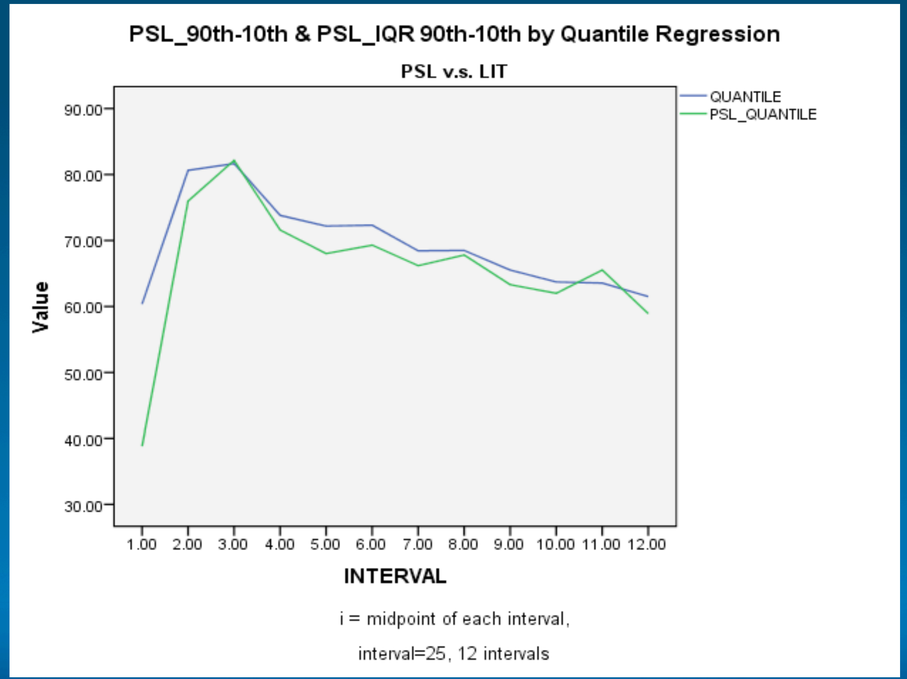
	CANADA				USA		
	L2	L3	L2 + L3		L2	L3	L2+ L3
CATEGORY							
ED 1	16	3	18.8		12	2	13.6
ED2	27	5	32.1		22	3	24.8
ED3	36	10	46.6		41	10	51.3
NB/NL	32	8	40.3		30	6	35.7
NB/FL	32	8	39.9		26	7	32.8
FB/NL	27	6	33.4		22	2	24.1
FB/FL	20	4	24.0		11	1	12.1

Quantile Regression (QR)

- QR yields a more detailed picture of the relationship between variables – especially how the variability in the criterion (e.g. PS-TRE) changes as a function of the predictor (e.g. Lit) →
- Can OLS provide a reasonable summary of the relationship?


PVPSL1
100
200
300
400
100
150
200
250
300
350
400
PVLIT1


PSL_IQR & PSL_IQR by Quantile Regression
PSL v.s. LIT
IQR
PSL_IQR
Value
40.00
35.00
30.00
25.00
20.00
1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.00 11.00 12.00
INTERVAL
i = midpoint of each interval,
interval=25, 12 intervals


PSL_90th-10th & PSL_IQR 90th-10th by Quantile Regression
PSL v.s. LIT
QUANTILE
PSL_QUANTILE
Value
90.00
80.00
70.00
60.00
50.00
40.00
30.00
1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.00 11.00 12.00
INTERVAL
i = midpoint of each interval,
interval=25, 12 intervals

Canada: Regression Analyses (1)

- How much of the variability in PS-TRE is accounted for by Lit, Num?
- What are the incremental contributions of other characteristics?

Note: Analyses conducted separately for each age class

Canada: Regression Analyses (2)

- ICT usage +
- Education level +
- Work type +
- Immigration/language +
- Parental education (highest)

Canada Regression Findings: R^2 for PS-TRE Outcomes

Model Predictors	16-24	25-34	35-44	45-54	55-65
Lit, Num	.64	.69	.69	.71	.70
Lit, Num, AUX (no	.66	.70	.70	.72	.71
AUX (no ICT)	.10	.20	.19	.19	.16
ICT (only) *	.10	.13	.13	.14	.16

* = Reduced sample because of missing ICT data
AUX = Individual characteristics (no cognitive scores)

Canada Regression Findings: Coefficients for PS-TRE Outcomes

- **Full Model:**
  - b(Lit) ~ 3 x b(Num)
  - No AUX variables consistently significant (ParED is closest)
- **Aux (no ICT):**
  - ED (2); Work (2,3); ParED

Canada: Achieving PS-TRE Proficiencies

	AGE CLASS					
PS-TRE Thresholds	16-24	25-34	35-44	45-54	55-65	Max Diff
	Required Lit = Num scores					
L1/L2 = 290	280	285	297	300	309	**29**
L2/L3 = 340	346	346	358	359	369	**23**

Canada Regression Findings: R^2 for Literacy Outcomes

Model Predictors	16-24	25-34	35-44	45-54	55-65
AUX (no ICT)	.15	.24	.22	.22	.20
ICT (only) *	.09	.11	.10	.11	.13

* = Reduced sample because of missing ICT data
AUX = Individual characteristics (no cognitive scores)

USA Regression Findings

- Very similar to Canadian results – especially for R^2
- When PS-TRE regressed on AUX variables, more are significant (than CA)
- When Lit regressed on AUX variables, more are significant (than CA)

What Have We Learned (I)?

- Strong link between PS-TRE and Lit & Num
- Relatively high scores on Lit & Num needed to achieve Level 2 on PS-TRE
- Weak link between PS-TRE and other characteristics
- Structural consistencies across age classes

What Have We Learned (II)?

- Criticality of super-sized data sets (e.g. CA) for disaggregated analyses
- Importance of cross-country comparisons at lower levels of aggregation (e.g. by age class) → "Disutility" of league tables
- Importance of tracking age cohorts through time → Design and timing issues for future assessments
- Potential of "data mining" to find auxiliary predictors for PS-TRE (after including Lit and Num)

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Thank you for your attention