Federal Spending on Education and Its Relation to Global and Provincial Standardized Testing Scores*

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This paper provides a comprehensive analysis of government spending on education policies and their correlation with academic performance, as indicated by scores from the Programme for International Student Assessment (PISA) and the Ontario Secondary School Literacy Test (OSSLT). By examining various countries' financial investments in their education systems, such as Chile, Finland, and Canada, this paper aims to identify patterns and outcomes that highlight the effectiveness of these expenditures. Through a comparative approach, it assesses how different levels and methods of funding impact student achievement in international benchmarks like PISA, which evaluates reading, mathematics, and science literacy among 15-year-olds, and in specific contexts such as Ontario's literacy requirement, the OSSLT.

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*Code and data are available at: https://github.com/davidjamesdimalanta/Federal_Education_Policy

1 Introduction

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2 Data

2.1 Data Collection

Data for this study was meticulously sourced to analyze the impact of government educational spending on academic performance. This involved collecting data from the Programme for International Student Assessment (PISA) and the Ontario Secondary School Literacy Test (OSSLT).

- PISA Data: Acquired from the Learning Tower package, this dataset provides international assessment scores of 15-year-old students in reading, mathematics, and science, capturing student performance across various countries and assessment years.
- OSSLT Data: Obtained from Data Ontario, these datasets span from the academic years 2017-2018 through 2021-2023, including detailed literacy test results and additional demographic information from Ontario students.

- Government Spending Data: Sourced from Statistics Canada, this dataset details educational expenditures from public and private sources across different education levels, facilitating an analysis of spending patterns related to PISA and OSSLT outcomes.

2.2 Data Cleaning Tools and Procedure

R (R Core Team 2023) was the language and environment used for this paper as well as throughout the data cleaning process, with different packages such as tidyverse (Wickham et al. 2019), ggplot2 (Wickham 2016), dplyr (Wickham et al. 2023), tidyr (Wickham et al. 2024), knitr (Xie 2023), janitor (Firke 2023), lubridate (Spinu, Grolemund, and Wickham 2023) packages. PISA data from the Wang et al. (n.d.) R package and OSSLT scores from (2021) underwent extensive cleaning and transformation processes to ensure consistency and accuracy for analysis.

2.2.1 Loading and Initial Cleaning

- OSSLT and PISA data were loaded using `read_xlsx` and `load_student("all")` functions respectively.
- Government spending data from (2023) was imported using `read_csv` from the Wickham et al. (2024) package.

2.2.2 Filtering and Selecting Relevant Data

- PISA datasets and federal education spending data were filtered to include only the relevant countries (Finland, Hong Kong, Canada, and Chile) and necessary columns (year, country, math, reading, science scores).
- Missing values were systematically removed with `na.omit()`.

2.2.3 Data Aggregation

PISA data was grouped by year and country to compute minimum, maximum, and average reading scores to observe trends over time.

2.2.4 OSSLT Data Processing

Data was cleaned to ensure uniformity across all years, focusing on demographics that could impact literacy rates, such as income levels and ESL status.

2.2.5 Government Spending Data Cleaning

This dataset was refined to include only fields relevant to educational expenditures, ensuring alignment with the study's analytical needs.

2.2.6 Integration and Consolidation

All cleaned datasets were integrated into a comprehensive data frame to facilitate a comparative analysis between educational spending and academic performance.

2.3 Ethical Considerations

All datasets utilized in this study are publicly available and anonymized, adhering to strict ethical guidelines to protect individual privacy. The data was used solely for academic purposes, in accordance with the provisions set by the respective data providers, ensuring that all analyses uphold the highest standards of research integrity.

3 Results

In the analysis of PISA scores for literacy, mathematics, and science across three distinct countries—Canada, Chile, and Finland—we observe varied performance trends which may reflect the impact of different educational policies and investments. The following tables summarize the results extracted from the cleaned datasets for each country and subject:

- **?@fig-literacy** depicts the literacy scores for Canada, Chile, and Finland.
- Figure 4 depicts the mathematics scores for the same countries.
- Figure 5 depicts the science scores, completing a comprehensive overview of PISA outcomes across these nations.

3.1 Literacy Scores

3.2 Federal Education Budget Analysis

Figure 6 depicts the federal education budgets of Canada, Chile, and Finland. The allocation of federal funds towards education can significantly influence the effectiveness of educational policies and the academic performance of students. The following table provides a detailed breakdown of the educational spending as a percentage of GDP for these countries over recent years. This financial commitment reflects the priority each government places on education and its potential correlation with the PISA scores observed.

Table 1: PISA Literacy Scores Canada

year	lowest	highest	average
2000	153.3700	881.3800	526.4042
2003	100.3026	818.6678	516.0883
2006	7.7413	826.5329	512.4287
2009	45.8200	871.1200	511.5319
2012	131.5007	822.9887	511.2359
2015	109.4520	812.4140	514.9260
2018	130.6070	878.8620	509.4665

Figure 1: PISA Literacy Scores

Table 2: PISA Literacy Scores Chile

year	lowest	highest	average
2000	135.1900	660.5100	417.3755
2006	0.1215	771.7155	447.8332
2009	145.7900	710.9700	453.4669
2012	186.1934	720.9304	459.9996
2015	96.0190	772.6280	474.8886
2018	146.7130	763.4630	469.8036

Figure 2: PISA Literacy Scores

Table 3: PISA Literacy Scores Finland

year	lowest	highest	average
2000	160.2800	808.6600	550.5784
2003	162.3844	817.2378	541.1218
2006	234.2518	810.6438	547.2232
2009	146.4400	802.8800	530.9767
2012	74.5626	827.7545	510.9055
2015	73.3770	778.1980	527.8609
2018	153.1810	812.0930	519.9440

Figure 3: PISA Literacy Scores

Table 4: PISA Mathematics Scores by Country

year	lowest	highest	average
2000	180.8800	841.7900	522.7178
2003	160.3365	859.2771	521.6319
2006	139.6557	823.1734	517.4461
2009	85.5400	846.0900	516.3924
2012	195.4432	828.4079	509.3290
2015	201.9100	810.8750	504.3299
2018	133.3550	888.0640	503.4503
2000	48.8200	628.0900	384.1862
2006	79.6775	719.2631	417.4584
2009	194.7400	782.0600	424.8205
2012	172.3867	748.9562	444.4196
2015	155.1350	694.6480	442.0901
2018	110.6940	753.0360	434.2785
2000	222.4000	775.3900	537.6092
2003	235.7377	812.9304	542.5087
2006	182.1078	790.8475	549.9341
2009	217.1000	785.3300	537.4810
2012	169.3488	769.8317	507.5258
2015	208.4860	755.7850	511.2831
2018	201.2350	799.7650	508.1755

Figure 4: PISA Math Scores

Table 5: PISA Science Scores by Country

year	lowest	highest	average
2000	222.0100	861.5800	525.3504
2003	83.3467	892.0179	508.4973
2006	126.1079	834.9745	522.5038
2009	130.1200	861.1000	518.1170
2012	131.2383	840.8616	514.7129
2015	190.0470	828.1420	516.4603
2018	65.1300	886.0810	509.8942
2000	167.8900	766.9300	420.0443
2006	73.6097	726.8076	442.5532
2009	144.2900	730.8300	451.6456
2012	153.6181	782.3946	464.5728
2015	186.8320	732.8760	464.9834
2018	142.2520	732.1390	460.0079
2000	271.6300	793.9300	531.4143
2003	122.3822	847.5355	543.7148
2006	210.0306	851.4793	563.7484
2009	229.9000	856.5300	548.6000
2012	127.5084	836.1992	527.9748
2015	199.6780	852.9020	531.9849
2018	139.9760	804.4590	519.4270

Figure 5: PISA Science Scores

Table 6: Federal Education Spending as a Percentage of GDP

country	country_code	x1974	x1975	x1980	x1981	x1990	x2002	x2005	x2007	x2008	x2009	x2010	x2011	x2012	x2013	x2014	x2015	x2016	x2017	x2018	x2019	2020
Canada	CAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Chile	CHL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Finland	FIN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hong Kong SAR, China	HKG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 6: Federal education Budget as % of GDP

4 Discussion

5 Conclusion

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