*Beyond performance: do 15 year old urban students perceive science issues differently than their rural peers?*

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**Introduction**

In the United States, science has become increasingly politicized, with public trust in the scientific community decreasing, *despite* increasing education levels. Between 1974 and 2010, conservatives in particular went from being the group with the highest trust in science, and ended the period with the lowest trust in science (Gauchat, 2012). Likewise, rural and urban voters have become increasingly polarized, with the former group increasingly voting for the conservative Republican Party and the latter increasingly voting for the liberal Democratic Party (McKee, 2008).

In most countries and economies, students who attend schools in urban areas tend to perform at higher levels than students in non-urban areas (OECD 2013). And yet, in the U.S., urban students have performed worse than their non-urban peers in the science portion of the Program for International Student Assessment (PISA) in two of the last four cycles of the assessment.[[1]](#footnote-1)

Using PISA data, this paper examines the relationship between perception of science issues and science performance cross-nationally, while also focusing on the divide between urban and non-urban students. Measuring average academic performance across countries can mask inequities by subgroups such as school location. Understanding how variables that are connected to students’ perception and beliefs about science and science issues will provide insight into how to improve the overall learning environment.

First, I use PISA data to demonstrate the differences in student science performance by school community (urban vs. non-urban) across PISA countries over four separate cycles (2006, 2009, 2012, and 2015).

Using PISA 2015 data on student attitudes toward learning science, this analysis also examines (1) students’ awareness of environmental issues and (2) students’ beliefs about scientific epistemology and how these three learning outcomes vary across urban and non-urban schools. This paper also shows that these two variables, along with student optimism about environmental issues, are highly related.

Finally, I use the variable concerning students’ optimism about environmental issues, which appeared in both the 2006 and 2015 versions of PISA to determine how student beliefs about environmental issues have changed over nine years.

Statistical *t*-tests are performed for the comparison of achievement scores and percentage of students’ responses to the aforementioned questions. Linear, logit, and probit regression analyses are used to control for performance when using the non-cognitive variables as outcomes.

**Urban students perform better in science than their non-urban peers**

This paper uses the school location variable of the PISA school questionnaire to define urbanicity. This variable asks principals in what kind of community their school is located and provides the following options: (1) a village, hamlet, or rural area (fewer than 3,000 people), (2) a small town (3,000 to about 15,000 people), (3) a town (15,000 to about 100,000 people), (4) a city (100,000 to about 1,000,000 people), and (5) a large city (with over 1,000,000 people). This analysis considers schools located in the last two options as “urban,” while all other schools are defined as non-urban.

Though in its simplest definition, an urban area is a human settlement with high population density and infrastructure of built development, the definition of urbanicity varies across countries and across scholars, with definitional factors ranging from population and population density to functional factors and even symbolic statuses (Lynch 1984, missing page number). Across all PISA countries and each of these cycles, the average percentage of urban students was 36%, while the average percentage of non-urban students was 61%. Figure X shows the percentage of students who live in urban versus non-urban settings in 2006, 2009, 2012, and 2015.

[Figure X]

In this sense, the cut-off of 100,000 people by the OECD is somewhat arbitrary, though necessarily so. However, cities of more than 100,000 people generally host schools that are “larger, tend to benefit from better educational resources, and often enjoy greater autonomy in how they can allocate those resources” (OECD 2013). As a result of these factors they are less likely to experience staff shortages, are more likely to have a higher proportion of qualified teachers, and have higher student-teacher ratios than schools in rural areas and towns. Socioeconomic status explains only part of the performance difference between students who attend urban schools and other students (ibid).

Science is no exception to the general trend. Figure X shows science performance by school location in PISA for the following cycles: 2006, 2009, 2012, and 2015, the four in which the school location variable as it exists today has been included.

[Figure X]

In 2006, urban students performed better than their non-urban peers in 62% of countries. In 2009, this percentage was 67%, in 2012 it was 62%, and in 2015, urban students performed better than their non-urban peers in 78% of countries. Across the four cycles, the average score difference between urban and non-urban students was 20 points in favor of the urban students, the equivalent of around half a year of schooling.

**Urban students generally agree more with statements about scientific epistemology**

Beliefs about scientific epistemology are collected by students’ responses on a four-point Likert scale to six statements about scientific epistemology. The six statements are the following: (1) a good way to know if something is true is to do an experiment, (2) ideas in science sometimes change, (3) good answers are based on evidence from many different experiments, (4) it is good to try experiments more than once to make sure of your findings, (5), sometimes scientists change their minds about what is true in science, and (6) the ideas in science books sometimes change. The Likert scale is converted into a two-point scale for the binary analyses.

**Urban students are more familiar with environmental issues**

Students’ awareness of environmental issues is collected by students’ responses to a question about how informed students are about the following environmental issues: (1) the increase of greenhouse gases in the atmosphere, (2) the use of genetically modified organisms, (3) nuclear waste, (4) the consequences of clearing forests for other land use, (5) air pollution, (6) extinction of plants and animals, and (7) water shortages.

Results show the percentages of students who *have never heard about this,* and *have heard about this but would not be able to explain what it is really about*. Students who select these two responses are considered to be “unfamiliar.” Students who select that they *know something about this and could explain the general issue* or select that they are *familiar with this and would be able to explain this well* are considered to be “familiar.”

**Urban students are less optimistic about environmental issues, and have gotten [more/less] optimistic over time**

In 2015, students’ optimism about environmental issues concerns the same seven topics as the awareness question, and students are classified into three groups: whether the students think the issues will *improve*, *stay about the same*, or *get worse*. For binary analyses, the response improve is coded as “optimism” and get worse and stay about the same are considered as “less optimistic” responses. Though the responses to the questions are the same in the question posed in the 2006 cycle of PISA, the issues are slightly different. The list of issues posed in 2006 is: (1) air pollution, (2) energy shortages, (3) extinction of plants and animals, (4) clearing of forests for other land use, (5) water shortages, and (6) nuclear waste. I consider air pollution, the extinction of plants and animals, the clearing of forests for other land use, water shortages, and nuclear waste to be comparable across years. Table X below summarizes these differences.

|  |  |
| --- | --- |
| PISA 2006 | PISA 2015 |
| Air pollution | Air pollution |
| Extinction of plants and animals | Extinction of plants and animals |
| Clearing of forests for other land use | The consequences of clearing forests for other land use |
| Water shortages | Water shortage |
| Nuclear waste | Nuclear waste |
| Energy shortages |  |
|  | The increase of greenhouse gases in the atmosphere |
|  | The use of genetically modified organisms (GMO) |

**Conclusion**

This paper provides a cross-national picture of student performance in science and explores how student awareness of environmental issues, optimism about environmental issues, and approaches to scientific epistemology varies by school location. Preliminary results show that in most countries, based on the PISA variables, urban students are more aware of environmental issues, less optimistic about the future with regard to the problems associated with environmental issues, and agree with epistemological questions of science.

**References**

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Lynch, K. (1984). Good City Form. MIT press.

McKee, S. C. (2008). Rural voters and the polarization of American presidential elections. PS: Political Science & Politics, 41(1), 101-108.

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**Reviewer notes:**

* What logic/literature led to the determination of the 100,000 person cut-off for urban and rural? These two are often distinguished by access to important amenities such as healthcare, education, basic living infrastructure, and so on. Where there any indicators to suggest that this 100,000 cut-point really distinguished rural and urban in terms of the features/quality of living?
* Moreover, if this has a clear population correlate, is it expected to be roughly the same across all of these countries?
* I think there is an implicit value to looking at science performance and epistemology and attitudes, but the argument for looking at these things in unison is not well made in the discussion of the motivation for the study. What can looking at these factors in unison tell us about urban and rural differences in science? How is that of greater value than just looking at test performance?
* Another question is how much other identity factors that might correlate with urban and rural might be influencing student response. For instance, do you see clear patterns of differences in affluence/class by rural and urban communities? If so, controlling for some of these other identity factors could be important to your analysis to determine if differences in response might be attributable to other factors than the rural-urban divide.
* The other thing I would want to know about is any limitations or concerns with the PISA data or indicators for investigating these issues.
* It was not entirely clear if you want to show that there are differences in students perceptions despite differences in learning. In other words, I do not know if you want to show that there urban students still lack of correct knowledge regarding environmental issues despite of their schooling presuming to be better than in rural settings. I think that part is confusing because although you mention controls and/or analysis of school performance, it is not clear how you will control if that is the case.

1. Urban students performed significantly worse in 2015 and 2006. There was no difference between the performance of urban or rural students in 2012 or 2009. [↑](#footnote-ref-1)