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Examining the relationship of a survey based measure of math creativity with math achievement: Cross-national evidence from PISA 2012

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ABSTRACT

Developing creative thinking skills in school children has become an important topic of discussion for education research and policy. International assessments of students' academic learning skills have started to consider students' creative thinking and problem solving skills along with assessments of traditional academic subjects. In this study we use the Program for International Student Assessment (PISA) 2012 data to propose a survey based measure of math-creative thinking skills and further examine its relationship to math achievement. The results show that within schools, at the student-level, math-creativity is positively related to student achievement. Between countries, average math performance is negatively related to average math-creativity skills. Many countries that performed poorly on the 2012 math assessment have relatively higher proportions of students who consider themselves open problem solvers. Our findings highlight the importance of considering level of analysis when examining the relationship of creativity with achievement.

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1. Introduction

> " . . . we're now running national education systems where mistakes are the worst thing you can make. And the result is that we are educating people out of their creative capacities." (Ken Robinson, 2006)

Discussions on the topic of creativity, particularly around developing creativity among school children and understanding its relationship to academic performance have gained increased attention in recent educational research and policy debates. The quote shown above is from the most watched TED talk of all time, presented by educational researcher and philosopher Ken Robinson, describing how today's educational systems are perhaps squandering children's creative capacities. Some researchers and educators argue that academic performance as measured through standardized tests promotes a narrow focus on a few subjects, emphasizes identifying correct answers and avoiding mistakes, and ultimately discourages student creativity and critical thinking (e.g., Chomsky & Robichaud, 2014; Moxey, 2005; Turnipseed & Darling-Hammond, 2015;

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Zhao, 2012a, 2012b). Zhao (2012a, 2012b) found that nations that performed well on an international assessment of academic proficiency, conducted by the Program for International Student Assessment (PISA),[1] tended to fare poorly on an independent assessment conducted by the Global Entrepreneurship Monitor (GEM; Xavier, Kelley, Kew, Herrington, & Vorderwülbecke, 2013)[2] of perceived entrepreneurial capability among youth. Zhao (2012a) suggested that the significant negative correlation between performance on PISA and youth entrepreneurship could be causal, meaning that "pursuing academic achievement may come at the cost of entrepreneurial qualities" (p. 60). Indeed, consistent top performers on PISA such as Shanghai, Singapore, Korea, and Japan have started revising their curriculum to place greater emphasis on creative thinking skills (Kim, 2005; Shaheen, 2010).

PISA itself recently released a report titled 'Creative Problem Solving: Students' Skills in Tackling Real-life Problems' describing the results of an international computer based assessment that examined students' creative problem solving skills. The assessment on problem solving was administered to students in addition to the regular PISA assessments on mathematics, reading, and science. The report showed that students' creative problem solving skills were highly correlated with performance on the main PISA math assessment (OECD, 2014a). The strong positive student and national level correlations between math performance and creative problem solving reported by PISA, stand in contrast to the conclusions of Zhao (2012a). Thus, depending on the source, conclusions about the relationship between creativity and student academic performance varies, even within the context of the same reference such as the PISA assessments; the true relationship is still unclear.

The study by Zhao (2012a) compared country level averages of PISA performance and a measure of creativity from a separate study on youth entrepreneurial abilities. Individual level comparisons were not possible due to the different samples used for both studies. The findings and substantive interpretations of Zhao's studies were all at the country level. It would be incorrect to extend those findings to make inferences at the student level – for example, to conclude that within-countries, individual students who are creative perform poorly in standardized assessments in comparison to less creative peers. Moreover, Zhao's findings were primarily based on simple correlations between entrepreneurial capability and PISA performance at the country level. Prior research has established that national income as measured by per capita Gross Domestic Product (GDP) is strongly related to national performance on PISA (OECD, 2012, 2013a). GDP is also related to the measures of entrepreneurship collected by the GEM study (Xavier et al., 2013). The negative relationship between creativity and student performance at the country level might be explained, at least partially, by GDP. Furthermore, wealth or school resources could also be important predictors of creativity at the individual and school level respectively. Therefore, to explore the relationship between creativity and academic performance at the student, school, and national levels, it is important to control for wealth and resources appropriately. The PISA study on problem solving did not include these covariates in linking creative problem solving skills with math performance (OECD, 2014a).

In this study we use a measure of creativity based on student surveys administered by the PISA 2012 study to examine its relationship to math achievement. This survey based measure of creativity aligns closely with a framework for assessing creativity proposed by Lucas, Claxton, and Spencer (2013), in a recent study published in the OECD working paper series.[3] Their framework proposes that a creative mind is inquisitive, persistent, imaginative, collaborative, and disciplined. As the relevant items for each of these dimensions in the PISA student surveys were specific to creativity in solving math problems, we labeled our survey measure as 'math-creativity'. The PISA surveys can be linked to student math performance and also to students' demographic background characteristics. Therefore, we are able to address some of the issues we raised earlier about previous research to examine the relationship between student creativity and test performance at the individual, school, and country level, while also controlling for important individual and contextual variables. Our use of a survey based measure of math creativity adds a separate piece of empirical evidence to the emerging debate on the relationship between creativity and achievement. The specific research questions we address in this study are:

(1) How does a survey based measure of math creativity relate to student performance on the PISA math assessment?
(2) How is math creativity related to differences among countries in PISA math performance?
(3) Does student socioeconomic status (SES), school average poverty (school average of student SES), and national GDP influence the relationship between math creativity and PISA math performance?

2. Background

Interest in the topic of developing creativity among school children has been gaining traction throughout the world and has moved from being a fringe topic to a core issue in education policy debates (Craft, 2006; Pang & Plucker, 2012; Shaheen, 2010). Many rationales have been proposed for developing creativity in school children, including their having to cope with

[1] PISA is an international assessment conducted by the Organization for Economic Co-operation and Development (OECD). 64 countries took part in the 2012 PISA assessment that focused on math and also assessed students in reading, science, and creative problem solving

[2] The Global Entrepreneurship Monitoring (GEM) project is an annual international assessment of entrepreneurial activity and aspirations. For the 2012 GEM study 69 countries took part. The GEM data comes from surveys administered to at least 2000 adults (18-24 years) in each participating country.

[3] See http://www.oecd-ilibrary.org/education/oecd-education-working-papers_19939019.

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