Science achievement gaps begin by kindergarten

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Large science achievement gaps at the end of eighth grade between white and racial/ethnic minority children and between children from higher- and lower-income families are rooted in large yet modifiable general knowledge gaps already present by the time children enter kindergarten, according to new research published today in Educational Researcher, a peer-reviewed journal of the American Educational Research Association.

Analyzing data from the National Center for Education Statistics on over 7,750 children from kindergarten entry to the end of eighth grade, a team of researchers-Paul L. Morgan (Pennsylvania State University), George Farkas (University of California, Irvine), Marianne M. Hillemeier (Pennsylvania State University), and Steve Maczuga (Pennsylvania State University)—found that kindergarten children's general knowledge about the world was the strongest predictor of their general knowledge in first grade, which in turn was the strongest predictor of their science achievement in third grade. Children's science achievement gaps were then fairly stable from third through eighth grade.

Mathematics and reading achievement were associated with science achievement during third to eighth grades, suggesting that increasing math and reading skills for lower performing children may help to address science achievement gaps. The findings are consistent with prior research showing that the level of children's achievement in reading or mathematics by kindergarten is strongly predictive of their achievement

throughout elementary school, and that achievement gaps begin very early.

"If you enter kindergarten with very little knowledge about the natural and social world, you are likely to be struggling in science by third grade, and you are then likely to still be struggling in science by eighth grade," said Paul L. Morgan, an associate professor of education policy studies at Pennsylvania State University.

Among children entering kindergarten with low levels of general knowledge, 62 percent and 54 percent were struggling in science in third and eighth grade, respectively.

General knowledge gaps between racial/ethnic minority and white children were already large at kindergarten entry. For example, 58 percent, 41 percent, and 52 percent of black, Hispanic, and American Indian children had general knowledge scores in the bottom 25 percent at kindergarten entry. The contrasting percentage for white children was only 15 percent. About 65 percent of low-income children entered kindergarten with low levels of general knowledge. Only 10 percent of high-income children did so.

"We were dismayed by how early the gaps emerged," said Morgan. "However, the gaps were also largely explained by modifiable factors, including those that can be addressed by policymakers. Our findings argue for the importance of intervening early, particularly for children who may be at risk because of fewer opportunities to informally learn about science prior to beginning elementary school."

The researchers noted that children from traditionally marginalized groups have lower access to high-quality childcare and preschools, a circumstance that limits their learning opportunities prior to entering kindergarten. Income inequality and racial segregation in schools then

perpetuate the disparities in learning opportunities and contribute to science achievement gaps throughout the elementary and middle grades.

"Science achievement gaps are themselves mostly explained by underlying inequities that we, as a society, too often tolerate or simply decide not to fully address," Morgan said.

The findings suggest that, for the United States to retain its long-term scientific and economic competitiveness, policymakers should redouble efforts to ensure access to high-quality early learning experiences in childcare settings, preschools, and elementary schools, particularly for children who are at risk. According to a 2010 National Academies report , low levels of science achievement in the United States are no longer a "gathering storm" but now are "rapidly approaching a Category 5" in their potential to derail the nation's long-term global competitiveness. Waiting to address science achievement gaps by middle or high school may be waiting too late.

At the family level, Morgan said that regularly talking and interacting with very young children, pointing out and conversing about physical, natural, and social events that are occurring around them, and supportively extending their general knowledge about the world may be ways that parents can help their children learn the facts and concepts that will prepare them to take full advantage of the science instruction they receive during elementary and middle school.

More information: P. L. Morgan et al. Science Achievement Gaps Begin Very Early, Persist, and Are Largely Explained by Modifiable Factors, *Educational Researcher* (2016). DOI: 10.3102/0013189X16633182