CENTER FOR EVALUATION & EDUCATION POLICY

Education Policy Brief

Indiana's TIMSS 2011 Performance: Outperforming Much of the World in Math and Science, But Issues Remain for Gender Achievement and High Performers

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INTRODUCTION

Are U.S. and, in particular, Hoosier students competitive and ready to succeed in an ever-changing and increasingly global economic landscape? This question is frequently considered by K-12 education stakeholders at all levels, including national, state, and local officials. For example, President Obama contends that "providing a high-quality education for all children is critical to America's economic future. Our nation's economic competitiveness… depend[s] on providing every child with an education that will enable them to succeed in a global economy" (The White House, n.d.). Within Indiana, Tony Bennett, former State Superintendent of Schools, used increasing economic competitiveness as a cornerstone of the state's education reforms, stating that secondary and primary education partnerships with private industry and universities "will help Indiana develop the nation's best workforce, ready to tackle the challenges of our global economy" (University of Indianapolis, 2012). At the local level, school boards have also supported these perspectives, with the school board of Indianapolis Public Schools stating its vision for education as "innovative urban education, preparing all students to be successful in the global economy" (Indianapolis Public Schools, 2011). One of the central ways in which education systems can compare themselves internationally is through regularly administered education assessments, such as the Trends in International Mathematics and Science Study (TIMSS) or the Programme for International Student Assessment (PISA).

Both PISA and TIMSS are large-scale international assessments for students, while the National Assessment of Educational Progress (NAEP), also referred to as the "Nation's Report Card," is designed to gather information that meets national and state needs. The important distinction here is that NAEP is a national assessment, and PISA and TIMSS are international assessments.

The primary difference between PISA and TIMSS is what the assessments intend to measure. For example, PISA is concerned with how students are able to apply their knowledge to real life situations in reading, mathematics, and science. PISA is administered every three years to a sample of 15-year-old students who are nearing completion of compulsory schooling. TIMSS focuses on how students are learning specific material from an internationally agreed upon curriculum in mathematics and science, and is administered every four years to student samples from the 4th and 8th grades, in order to assess learning at different stages.

Historically, the U.S. ranks consistently in the middle of the pack among national participants in most international education assessments. Given that the U.S. is a large country with diverse state and local education systems that can and do vary meaningfully, aggregating and reporting at the national level provides useful information for national policymakers, but does little for state and local policymakers. Fortunately, in 2011 Indiana participated in the latest round of 8th grade TIMSS assessments.[1]

To that end, this policy brief examines the most recent TIMSS results for Indiana students in order to compare Hoosier 8th grad-

[1] Although Indiana participated in TIMSS at both the 4th and 8th grade in 2003, Indiana 4th graders did not participate in TIMSS 2011. Further, TIMSS only assessed 8th grade students in 1999.

ers with their global peers, looking at averages for the Top 10 performing countries (averaging education systems at the country level, excluding the state of Indiana), the U.S., and the world. This brief will present the results in terms of system-level populations. Disaggregated results by gender and system-level comparisons across TIMSS benchmarks are also presented and discussed. The brief will conclude with an examination of achievement trends in Indiana and internationally from 1999 to 2011, including a short discussion of what these results mean in the context of current education reforms in the state.

TIMSS RESULTS: A FOCUS ON INDIANA STUDENTS

Similar to how Indiana 8th grade students performed in 2003, Indiana's 2011 TIMSS performance was above the U.S. average for 8th grade students in both mathematics and science (Chien, Spradlin, & Plucker, 2007; Martin, Mullis, Foy, & Stanco, 2012; Mullis, Martin, Foy, & Arora, 2012). Table 1 shows that only six education systems around the world performed statistically significantly better in mathematics than Indiana. An important point here is that Indiana outperformed Finland, a country widely recognized in academic literature and popular media for its the success of its education system. Although Indiana's rank in science was lower than in mathematics, the state nonetheless performed well internationally in science, with only five education systems outperforming Hoosier 8th graders (see Table 2). In addition, Indiana's performance was not statistically significantly different from Hong Kong in science, which is typically a top-performer on a range of international education assessments.

Figure 1 represents Indiana's achievement in both mathematics and science in comparison to the international average, the U.S. average, and the average achievement of the Top 10 performing countries (excludes Indiana). From this graphic representation, several interesting findings emerge. First, Indiana has stronger performance in science than mathematics; this trend is consistent nationally and internationally; however, the opposite is true of the Top 10 countries, which excludes the state of Indiana. That is, the top performers have higher mathematics than science achievement. Next, Indiana's mathematics and science achievement is lower than the Top 10 countries, which, again, excludes the state of Indiana; however, Hoosier 8th graders perform above the international average in both mathematics and science. Further, Indiana's mathematics achievement is stronger than the rest of the U.S. and its science performance is on par with other U.S. students. Given the uncertainty around these achievement estimates (represented by the black brackets, described in the note below Figure 1), we can also see that Indiana is not far behind the highest performing countries in both mathematics and science; however, certain weaknesses should be addressed if Indiana aims to compete globally in terms of secondary education.

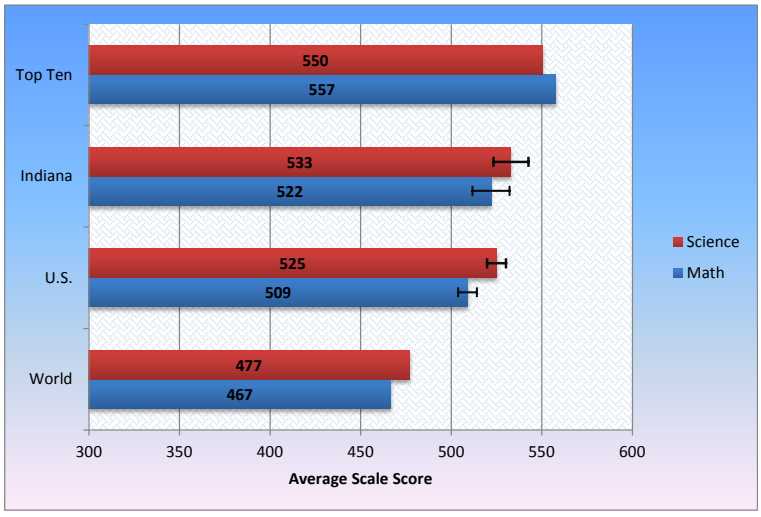
Gender Differences in Achievement

In both the U.S. and Indiana there has been a large emphasis on closing gender gaps in both mathematics and science. Overall no statistically significant math differences exist between boys and girls (see Table 3); however, a statistically significant gap in science exists nationally (see Table 4). Given no gender differences in mathematics but a statistically significant gap favoring U.S. boys in science, the evidence is mixed regarding whether efforts to close the gender gap are working at the national levels. Unfortunately, a more consistent picture emerges in Indiana. In both mathematics and science, a statistically significant gender gap favoring boys is present. Given a marked underrepresentation of women in science, technology, and engineering fields, both nationally and within Indiana, addressing these gender gaps could be an important step to improving economic competitiveness for Indiana in these areas.

Figure 2 further illustrates the discrepancies between boys and girls in mathematics achievement. Both internationally and among the Top 10 performers, small, non-significant gender gaps favoring girls exist. As previously noted, the opposite is true both nationally and in Indiana. That is, gender gaps tend to favor boys in mathematics and this gap is statistically significant in Indiana. This troubling finding suggests that further investigation in the Indiana context is warranted to ensure that boys and girls have equal opportunities to learn and succeed in these subject areas.

Figure 3 shows that the Top 10 performing countries have a small achievement gap in science that favors boys, while the international average score favors girls. Notable in this figure is the boys' performance in Indiana as compared to the Top 10 performing countries. Indiana boys perform nearly as well as their Top 10 counterparts when the uncertainty around achievement estimates is taken into account. Despite this positive finding, the science achievement gap

Figure 1. TIMSS 2011 Comparison of Mathematics and Science Average Scores



Note 1: The scale scores begin at zero, but no education system scored below 300 (Martin et al., 2012; Mullis et al., 2012).
Note 2: The brackets at the end of each bar represent plus and minus two standard errors.
Note 3: The 2011 TIMSS data did not provide standard errors for the international average, nor were standard errors calculated for the Top 10 performing countries averaged score.

Table 1. TIMSS 2011 Comparison of Grade 8 Mathematics Ave. Scores

Education System	Score	Significantly different from Indiana?**
South Korea	613	Yes
Singapore	611	Yes
Chinese Taipei (China)	609	Yes
Hong Kong (China)	586	Yes
Japan	570	Yes
Russian Federation	539	Yes
Indiana	**522**	-
Israel	516	No
Finland	514	No
United States	**509**	**Yes**
England	507	No*
Hungary	505	Yes
Australia	505	Yes
Slovenia	505	Yes
Lithuania	502	Yes
Italy	498	Yes
New Zealand	488	Yes
Kazakhstan	487	Yes
Sweden	484	Yes
Ukraine	479	Yes
Norway	475	Yes
Armenia	467	Yes
International Average	**467**	-
Romania	458	Yes
United Arab Emirates	456	Yes
Turkey	452	Yes
Lebanon	449	Yes
Malaysia	440	Yes
Georgia	431	Yes
Thailand	427	Yes
Macedonia	426	Yes
Tunisia	425	Yes
Chile	416	Yes
Iran	415	Yes
Qatar	410	Yes
Bahrain	409	Yes
Jordan	406	Yes
Palestinian Nat'l Auth.	404	Yes
Saudi Arabia	394	Yes
Indonesia	386	Yes
Syrian Arab Republic	380	Yes
Morocco	371	Yes
Oman	366	Yes
Ghana	331	Yes

* This seemingly anomalous finding is due to the measures of uncertainty around each parameter estimate. That is, the measure of uncertainty around England's estimate is wider than that of the U.S., which leads to a non-significant difference between Indiana and England and a significant difference between Indiana and the U.S.
**Statistical differences were estimated using Bonferroni corrections at an unadjusted Type I error rate of .05.

Table 2 TIMSS 2011 Comparison of Grade 8 Science Average Scores

Education System	Score	Significantly different from Indiana?*
Singapore	590	Yes
Chinese Taipei (China)	564	Yes
South Korea	560	Yes
Japan	558	Yes
Finland	552	Yes
Slovenia	543	No
Russian Federation	542	No
Hong Kong (China)	535	No
England	533	No
Indiana	**533**	-
United States	**525**	**No**
Hungary	522	No
Australia	519	Yes
Israel	516	Yes
Lithuania	514	Yes
New Zealand	512	Yes
Sweden	509	Yes
Italy	501	Yes
Ukraine	501	Yes
Norway	494	Yes
Kazakhstan	490	Yes
Turkey	483	Yes
International Average	**477**	-
Iran	474	Yes
Romania	465	Yes
United Arab Emirates	465	Yes
Chile	461	Yes
Bahrain	452	Yes
Thailand	451	Yes
Jordan	449	Yes
Tunisia	439	Yes
Armenia	437	Yes
Saudi Arabia	436	Yes
Malaysia	426	Yes
Syrian Arab Republic	426	Yes
Palestinian Nat'l Auth.	420	Yes
Georgia	420	Yes
Oman	420	Yes
Qatar	419	Yes
Macedonia	407	Yes
Lebanon	406	Yes
Indonesia	406	Yes
Morocco	376	Yes
Ghana	306	Yes

*Statistical differences were estimated using Bonferroni corrections at an unadjusted Type I error rate of .05.

between Hoosier boys and girls points to a need for efforts that will level the learning field in science for girls. Further, given that gender gaps exist in both mathematics and science, it might be sensible to also ask whether this gap extends into other learning areas for girls in Indiana.

COMPARISON TO TIMSS ACHIEVEMENT BENCHMARKS

As an additional means for comparing achievement, the TIMSS project developed four achievement benchmarks: advanced, high, intermediate, and low. These benchmarks provide a useful context for interpreting the meaning behind achievement scale scores (see Table 5 for an explanation of the benchmarks). From Figure 4, we see that Indiana has a higher percentage of students reaching the high level of performance in mathematics than in the U.S. as a whole, while it has the same percentage of students reaching the advanced level. Unfortunately, both the U.S. and Indiana fail to produce a high percentage of students in the advanced level, particularly in comparison to the Top 10 international performers. Figure 5 displays results from science, which are similar to the mathematics scores. From these data it appears that the U.S. and Indiana consistently struggle to produce significant numbers of advanced-level achievers, which is a notable weakness in both the U.S. and Indiana education systems.

Table 3. TIMSS 2011 Difference in Mathematics Average Score Between Genders

Education System	Girls	Boys	Difference (+/-)1	Significant Difference*
Korea, Rep. of	610	616	-6	Yes
Singapore	615	607	+8	Yes
Chinese Taipei (China)	613	606	+7	No
Hong Kong (China)	588	583	+5	No
Japan	566	574	-8	No
Russian Federation	539	539	0	-
Indiana	**518**	**526**	**-8**	**Yes**
Israel	520	512	+8	No
Finland	516	512	+4	No
United States	**508**	**511**	**-3**	**No**
England	508	505	+3	No
International Average	**469**	**465**	**+4**	**-**

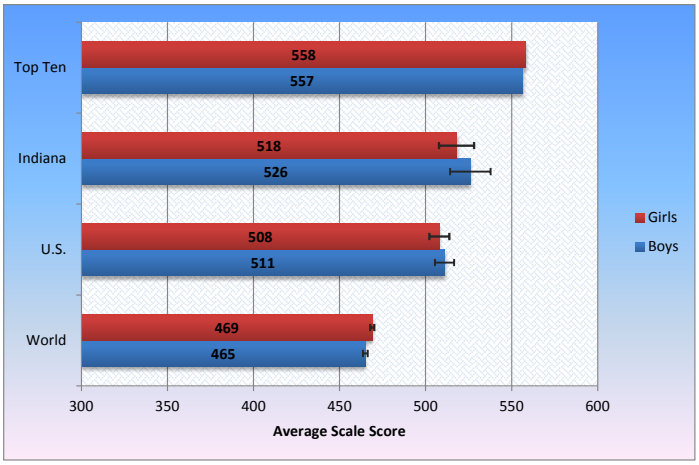
Note 1: A positive difference favors girls while a negative difference favors boys.
Note 2: Only the top ten performers, Indiana, and the international average are provided for comparison.
*Statistical differences were estimated using Bonferroni corrections at an unadjusted Type I error rate of .05.

Table 4: TIMSS 2011 Difference in Science Average Score Between Genders

Education System	Girls	Boys	Difference (+/-)1	Significant Difference*
Singapore	589	591	-2	No
Chinese Taipei (China)	564	564	0	-
Korea, Rep. of	558	563	-5	No
Japan	554	562	-8	Yes
Finland	555	550	+5	No
Slovenia	541	545	-4	No
Russian Federation	539	546	-7	Yes
Hong Kong (China)	536	534	+2	No
England	534	532	+2	No
Indiana	**526**	**541**	**-15**	**Yes**
United States	**519**	**530**	**-11**	**Yes**
International Average	**480**	**474**	**+6**	**-**

Note 1: A positive difference favors girls while a negative difference favors boys.
Note 2: Only the top ten performers, Indiana, and the international average are provided for comparison.
*Statistical differences were estimated using Bonferroni corrections at an unadjusted Type I error rate of .05.

Figure 2. TIMSS 2011 Comparison of Mathematics Average Scores Between Genders



Note 1: The scale scores begin at zero, but no education system scored below 300 (Martin et al., 2012; Mullis et al., 2012).
Note 2: The brackets at the end of each bar represent plus and minus two standard errors.
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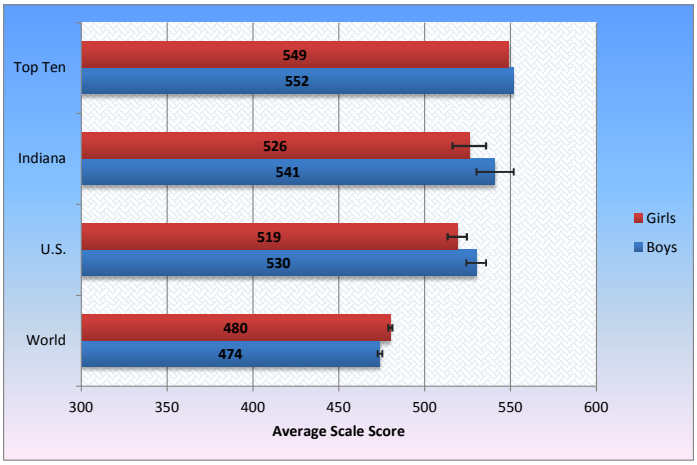
Figure 3. TIMSS 2011 Comparison of Science Average Scores Between Genders



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ACHIEVEMENT TRENDS

This policy brief has provided information concerning the 2011 TIMSS in which Indiana 8th graders participated. It has revealed the importance of comparison to groups of other education systems and several key policy areas that can be addressed by disaggregating results by gender and by examining benchmarks for student achievement.

As a final comparison, we present the trends in mathematics (Figure 6) and science (Figure 7) for the years in which Indiana's 8th grade students have participated. It appears that Indiana struggled with the 2003 TIMSS assessments, as evidenced by a dip in achievement when compared to 1999 and 2011 performance in both mathematics and science. This could be due to a variety of reasons, from the test being a bit more difficult to actual changes in student performance; however, given that the majority of countries saw lower performance in 2003—which stabilized over time—the deviation does not appear to merit policy concern.

Table 5. TIMSS Benchmark Definitions

Level	Score	Mathematics	Science
Advanced	625 or above	Reason, draw conclusions, make generalizations, and solve linear equations	Communicate an understanding of complex and abstract concepts in biology, chemistry, physics, and earth science
High	550-624	Apply knowledge and understanding in a variety of relatively complex situations	Demonstrate understanding of concepts related to science cycles, systems, and principles
Intermediate	475-549	Apply basic knowledge in a variety of situations	Apply understanding of basic scientific knowledge in various contexts
Low	474 or below	Some knowledge of whole numbers and decimals, operations, and basic graphs	Recognize some basic facts from the life and physical sciences

Sources: Mullis et al. (2012, p. 8) and Martin et al. (2012, p. 8).

Figure 4. TIMSS 2011 Comparison of Mathematics International Benchmarks

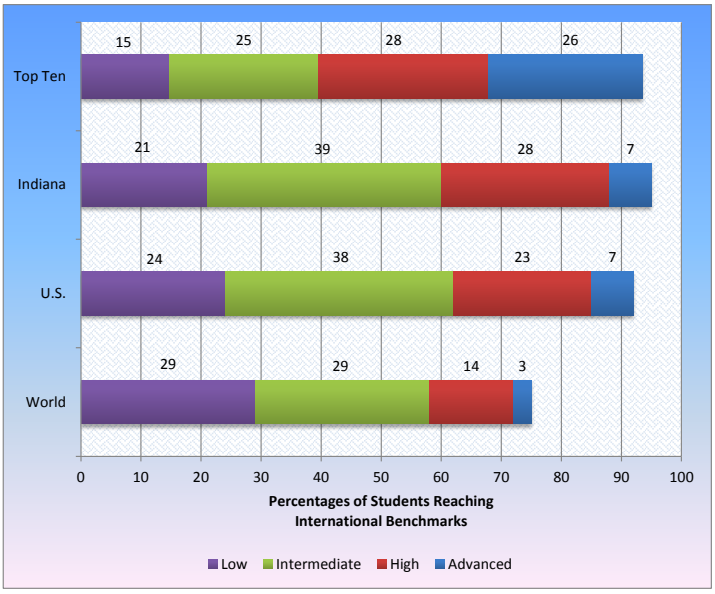


Figure 5. Comparison of Science International Benchmarks

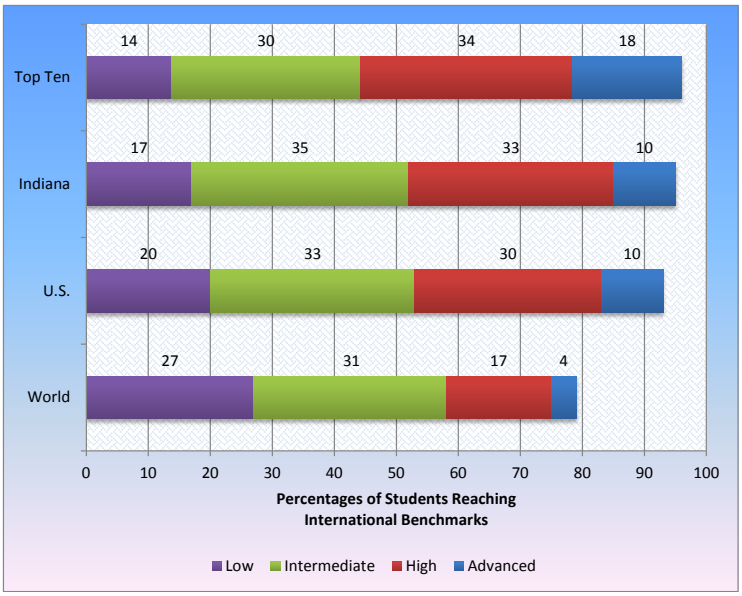
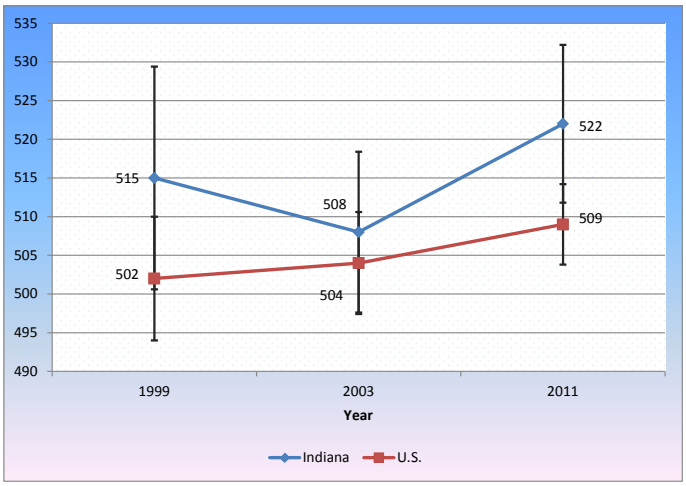
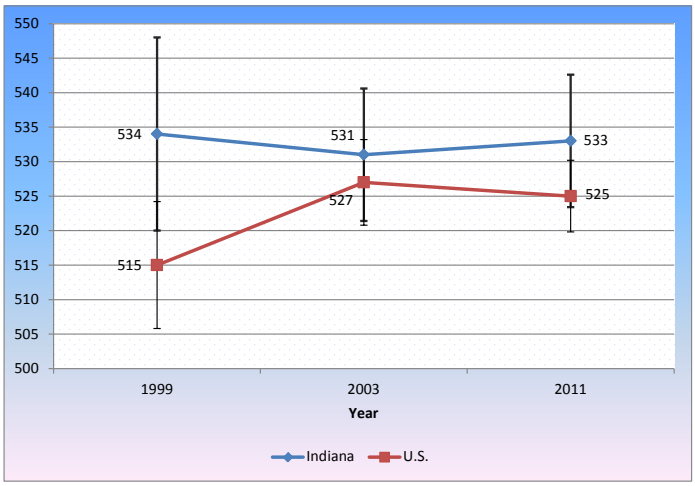


Figure 6. TIMSS 2011 Trends in Performance for Mathematics



Sources: Mullis et al. (2012).
Note 1: The brackets it juncture point represent plus and minus two standard errors.
Note 2: The 2011 TIMSS data did not provide standard errors for the international average, nor were standard errors calculated for the Top 10 performing countries averaged score.

Figure 7. TIMSS 2011 Trends in Performance for Science



Sources: Martin et al. (2012).
Note 1: The brackets it juncture point represent plus and minus two standard errors.
Note 2: The 2011 TIMSS data did not provide standard errors for the international average, nor were standard errors calculated for the Top 10 performing countries averaged score.

RECOMMENDATIONS

The TIMSS assessment is unique in that it provides an international perspective on how students perform within a broad international curriculum. Because Indiana state policymakers had the foresight to participate in this assessment, education stakeholders are able to see how Hoosier students are performing at the international level. With that said, the assessment only provides a snapshot of how education systems are functioning in science and mathematics. However, from the data presented in this policy brief we offer five recommendations:

1. The state of Indiana should capitalize on its success as a top-performing education system ready to compete in the global economy.

Students in the 8th grade performed better than their peers across the country in both mathematics and science, and compared favorably to the Top 10 performing countries. In addition, Indiana's boys performed very well in science when compared to their peers in the Top 10 performing countries. State lawmakers and educators can use this information to show that Indiana students are globally competitive in the fields of math and science. This evidence suggests that Indiana's future workforce is well positioned to be a leader in a high-tech global economy and the information should be used in economic development strategies.

2. The statistically significant gender gap between boys and girls should be a policy focus.

If Indiana desires to continue its economic competitiveness, then it should provide quality education in math and science for boys and girls. Yet, Indiana's results from the 2011 NAEP show no gender gap in mathematics (Institute of Education Sciences, 2012a) and a one-point gap favoring boys in science (Institute of Education Sciences, 2012b). The report does not indicate whether this difference is statistically significant, however. Taken together these tests paint an inconsistent picture suggesting that policymakers should seek to clarify this important issue.

3. Indiana needs more advanced-level students.

Although Indiana is fairly competitive in relation to high-performing students, it appears to have a low number of advanced-performing students when compared to top-performing countries. Closing this "achievement gap" (Chien, Spradlin, & Plucker, 2007) would improve Indiana's standing and better prepare its students to participate in many of the high tech professions that contribute to a growing economy within Indiana.

4. The results from TIMSS are only one piece of evidence and should be used in conjunction with other information to inform education policy decisions.

Education reform has been a hot topic within the U.S. and Indiana. The main arguments for education reform mirror those of No Child Left Behind, namely offering equal opportunities for all children, creating high-quality teachers (Burgess, 2012; *The Economist*, 2012), and developing an economically competitive youth (University of Indianapolis, 2012). The trends from TIMSS suggest current reforms have produced little change in Indiana's overall performance and international standing. Given these results, and the results of the 2003 TIMSS, the issue does not appear to be the underperformance of Indiana students or a threat to economic competitiveness. Rather there are other issues that warrant further investigation, such as gender inequality and a low percentage of advanced students.

5. Finally, Indiana teachers should be recognized and congratulated for producing consistently positive results from the TIMSS assessment.

The continued trend of performing above the national and world averages, as well as producing many high-level-achieving students is a testament to the quality of teaching that exists in the state of Indiana. Hoosier teachers should be praised for their efforts and encouraged to maintain our educationally competitive place in the global economy.

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