

Indiana's Mathematics and Science Performance: Do We Measure Up?

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UPCOMING POLICY BRIEFS

- ✓ *Outcomes of the School Choice and Supplemental Services Provisions of NCLB*
- ✓ *Models of State K-12 Education Governance: How Does Indiana's K-12 Model Compare?*
- ✓ *An Alternative Discipline Approach: Positive Behavior Supports*

There is an increasing concern that American students are being outperformed by their international peers in the areas of science and mathematics. Many statistics have been cited to support this argument. For example, more than 50 percent of the undergraduate degrees awarded in China are in the fields of science, technology, engineering, and mathematics, whereas only 16 percent of the undergraduate degrees awarded in the U.S. are in those fields.¹ In addition, in 2004, India graduated 350,000 engineering students, whereas the U.S. graduated 70,000 engineering students.²

Several of the fastest growing occupations projected through 2010 will require a substantial mathematics or science background.³ In fact, the demand for scientists and engineers is expected to increase at a rate four times greater than that of other occupations. Countries like India and China are moving forward in the global economy, and thus appear well positioned for significant economic expansion.

In response to the workforce trends internationally, President George W. Bush has called for multiple P-16 educational programs addressing science, technology, engineering, and mathematics (STEM) as a part of his American Competitiveness Initiative (ACI). Additionally, individual states are beginning to evaluate their own educational systems while considering an array of strategies to improve student achievement outcomes for high school students and to align their curricular offerings with the emerging workforce trends. Such strategies include programs targeting a reduc-

tion in dropout rates, increasing the rigor of the high school curriculum, and aligning K-12 expectations with the needs of business and industry and the demands of postsecondary education. Will these efforts help to ensure that America will remain at the forefront of scientific innovation and continue to lead the world in research and development?

Several states are taking action to respond to the call for STEM initiatives to improve K-12 education. STEM initiatives have been implemented recently in at least 16 states (including Indiana) and have diverse origins. The states' initiatives were established through executive orders, legislation, or agreements between national organizations and states, and include:⁴

- Convening councils, commissions, or roundtables to provide recommendations and guidance on how STEM education can be improved in the state (Arizona, Arkansas, Connecticut, Minnesota, Missouri, Rhode Island, and West Virginia).
- Creating specialized grant programs to be utilized to improve STEM education in the state. These funds are used to employ a variety of strategies for improving STEM achievement (Florida, Illinois, Indiana, Massachusetts, Virginia, and West Virginia).
- Improving the skills of teachers in STEM subjects (Indiana, Massachusetts, Minnesota, Ohio, and Texas).
- Providing additional opportunities for students to earn college credit while in high school (including, but not limited to, Minnesota, Ohio, New York, Washington, Wisconsin, and Indiana).

Indiana has been recognized as a state that values the importance of STEM education as a potential means through which to improve its state economy. As a participant in the National Governors Association Honor States Grant Program, Indiana has pledged to improve high school STEM education by focusing and improving the skills of STEM teachers through teacher training and by funding locally designed STEM initiatives.

In addition, there is a push for all public colleges and universities in Indiana to require future teachers to acquire a major in both education and a subject area, and to place a greater emphasis on increasing the number of students majoring in STEM-related areas. Another objective identified for Indiana in its grant proposal is to link student performance to teachers and the postsecondary institutions from which the teachers graduated. This will, in turn, hold higher education institutions accountable for adequately preparing their pre-service teachers.⁵ As a result of these objectives, the question of “How do Indiana students perform in mathematics and science?” has become an increasingly relevant and timely matter.

In this Education Policy Brief, the Center for Evaluation & Education Policy at Indiana University describes how Indiana performs as a whole in the areas of mathematics and science, examines Indiana’s academic progress in these subject areas compared to neighboring Midwestern states and nationally, and explores how Indiana compares on an international level. For Indiana to be better prepared to participate and compete in the global economy, the level of student competency in mathematics and science should meet or exceed the student competency levels found in other states. If this goal is accomplished, Indiana will be well positioned to attract employers and therefore acquire an increase in job opportunities in the rapidly changing world.

COMPARISON MEASURES

Three assessments were used to evaluate Indiana’s progress in mathematics and science: the Indiana Statewide Testing for Educational Progress-Plus (ISTEP+), the National Assessment of Educational Progress (NAEP), and the Trends in International Mathematics and Science Study

(TIMSS). Data were analyzed to determine the progress Hoosier students are making and how they compare to other students nationally and internationally. In addition, the ISTEP+ passing rates and scale scores were examined and compared to national outcomes on NAEP and to other state assessments as a way to determine if the passing rate of the ISTEP+ parallels other assessments. Data were analyzed at the aggregate level and were not disaggregated by subgroup where achievement gaps exist.⁶

INDIANA STATEWIDE TESTING FOR EDUCATIONAL PROGRESS-PLUS (ISTEP+) DATA

The Indiana Statewide Testing for Educational Progress-Plus (ISTEP+), created in 1987 by the Indiana General Assembly, was designed to make inferences about students’ achievement and proficiency (as defined by the Indiana’s Academic Standards) in the core curricular areas (presently English, mathematics, and science) which are critical for success in the students’ current grade level and beyond. Student proficiency of Indiana’s Academic Standards is reflected in higher ISTEP+ scores. The ISTEP+ results identify three general levels of student achievement as follows: (1) Did Not Pass, (2) Pass, and (3) Pass-Plus.⁷

From 1998 to 2006, an increase in scores for the mathematics portions of the ISTEP+ was demonstrated by students in Grades 3, 6, 8, and 10 (the previous set of grades included in the state assessment program prior to the new testing requirements imposed by state and federal law) (see Table 1). The overall increase over the nine years demonstrates a greater percentage of students passing the ISTEP+ mathe-

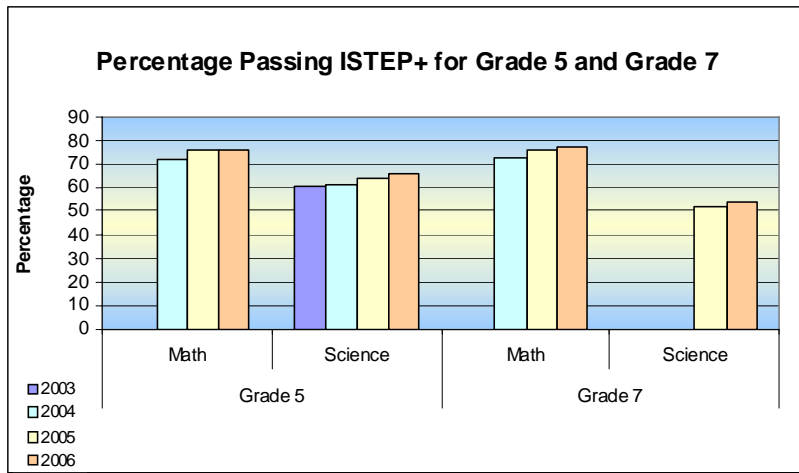
matics portion. Students in Grade 6 showed the greatest amount of improvement annually from 1998 to 2006, with a total increase of 2.7 percent more students passing annually, thereby resulting in 20 scale score points over the nine years. Similarly, Grade 6 students had the fewest percentage of students passing in 1998 (60 percent), and subsequently had the highest percentage of students passing in 2006 (80 percent) when compared among these four grades. In addition, students in Grades 3 and 10 had the smallest average annual increase per year (0.2 percent and 0.3 percent, respectively). Grades 3 and 10 are the first and the last grades in which the ISTEP+ is administered.

Students in Grades 4, 5, 7, and 9 were included in the ISTEP+ assessment for English/language arts and mathematics in 2004. Additionally, in 2003 and 2005, students in Grades 5 and 7, respectively, began to be assessed in science on the ISTEP+. Figure 1 shows the mathematics and science passing percentages for students in Grades 5 and 7 for 2004-06. An increase occurred in the number of students passing the mathematics and the science components of ISTEP+ for both Grades 5 and 7 over this time period. From 2004 to 2006, a four percentage point increase was displayed for the percentage of students passing the mathematics portion for both Grades 5 and 7 (72 percent to 76 percent for Grade 5, and 73 percent to 77 percent for Grade 7). In science, Grade 5 students demonstrated a five percentage point increase in passing from 2003 to 2006 (61 percent to 66 percent). Grade 7 students showed a two percentage point increase for the percent passing the science portion from 2005 to 2006 (52 percent to 54 percent).

TABLE 1. ISTEP+ Mathematics Percent Passing from 1998-2006^{8, 9, 10}

	Percent Passing Total (1998)	Percent Passing Total (2006)	Average Annual Increase (percent)	Overall Increase (percentage points)
Grade 3	71	72	0.2%	1
Grade 6	60	80	2.7%	20
Grade 8	64	71	1.2%	7
Grade 10	60	65	0.3%	5

Figure 1¹¹



NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS (NAEP) DATA

The National Assessment of Educational Progress (NAEP), also known as “The Nation’s Report Card,” is the only uniform, representative, and continuous assessment of American students. Since 1969, the National Center for Education Statistics has collected NAEP data on a sample of students in Grades 4, 8, and 12, and today students in all 50 states and the three U.S. territories participate. Student achievement is assessed in the areas of reading, mathematics, science, writing, U.S. history, civics, geography, and the arts.¹² Although both public and private schools participate in NAEP, state-level data are reported for public school students only. Therefore, all state and national data reported by NAEP are only for students in public schools.

NAEP reports data by achievement levels, that indicate the percentages of students in the nation or state who have reached certain levels of performance. There are four achievement levels for each subject: Below Basic, Basic, Proficient, and Advanced.¹³

- *Below Basic:* Student has not mastered the fundamental knowledge and skills to perform satisfactorily.
- *Basic:* Student has obtained partial mastery of prerequisite knowledge and skills that are fundamental for proficient work.
- *Proficient:* Student has acquired competency over challenging subject matter and has shown solid academic performance.

- *Advanced:* Student has demonstrated superior performance.

Grade 4 Mathematics

Data are available every few years for Grade 4 mathematics, from 1992 to 2005. It is important to note that the scale score averages for Indiana and the nation have increased with each subsequent year. Each time interval (1992, 1996, 2000, 2003, and 2005) illustrates that Indiana is performing higher than the national average (see Figure 2). In 1992, this difference was two scale score points, seven points in 1996, nine points in 2000, four points in 2003, and three points in 2005. In 2005, 84 percent of Grade 4 students in Indiana and 79 percent of Grade 4 students nationally received a score that was at or above Basic in mathematics (see Figure 3).

When compared to its neighboring Midwestern states (i.e., Kentucky, Ohio, Michigan, and Illinois), Indiana outperformed the other four states in 2000 for students in Grade 4. In 2003, Indiana performed better than three states and earned the same score as Ohio. In 2005, however, Ohio surpassed Indiana’s performance, placing Indiana second among these five Midwestern states (see Figure 4). Nationally, Massachusetts was the top performing state with 91 percent of students in Grade 4 receiving a score that was at or above Basic in mathematics in 2005, outperforming Indiana by seven percentage points.

Grade 8 Mathematics

Grade 8 students also displayed increases in mathematics scores for Indiana and nationally over the six iterations of NAEP

between 1990-2005 (1990, 1992, 1996, 2000, 2003, and 2005) (see Figure 5). Once again, Indiana students performed better than the national average. This difference was five scale score points in 1990, three points in 1992, seven points in 1996, nine points in 2000, five points in 2003, and four points in 2005. In 2005, 74 percent of Grade 8 students in Indiana and 68 percent of Grade 8 students nationally received a score that was at or above Basic in mathematics (see Figure 6).

When compared to its neighboring states in the Midwest, Indiana equaled the performance of Ohio and fared better than the other three states in 2000. In 2003 and 2005, Ohio’s performance exceeded that of Indiana, each year by only one point, placing Indiana second among these five Midwestern states for both years (see Figure 7). Nationally, North Dakota was the top performing state with 81 percent of students in Grade 8 receiving a score that was at or above Basic in mathematics in 2005, outperforming Indiana by seven percentage points.

Grade 4 Science

Science was assessed on NAEP for students in Grade 4 in 2000 and again in 2005. Similar to the mathematics scores, Indiana’s performance was greater than that of the national average by six scale score points in 2000 and by three points in 2005 (see Figure 8). In 2005, the percentage of students in Grade 4 receiving a score that was at or above Basic in science was 70 percent for Indiana and 66 percent nationally (see Figure 9). When compared to other states in the Midwest in 2000, Indiana placed second, one point behind Ohio. However, in 2005, Indiana’s placement dropped behind Kentucky and Ohio (by six and five points, respectively), and equaled that of Michigan (see Figure 10). From 2000 to 2005, Indiana’s average scale score dropped from 154 scale score points to 152 scale score points. Nationally, New Hampshire was the top performing state with 83 percent of students in Grade 4 receiving a score that was at or above Basic in science in 2005, outperforming Indiana by 13 percentage points.

Grade 8 Science

Grade 8 students were assessed in science in 1996, 2000, and 2005. Though data indicate that students from Indiana outperformed the national average by five scale score points in 1996, Grade 8 students from

Indiana performed below their national peers by two points in 2000. In 2005, however, Indiana once again outperformed the national average by three scale score points (see Figure 11). The percentage of students in Grade 8 passing science in 2005 for Indiana and nationally was 62 and 57 percent, respectively (see Figure 12). Comparing Indiana to its neighboring Midwestern states in 2000, it performed behind Ohio and Michigan by five and one points, respectively. In 2005, Indiana's performance fell behind Ohio, Michigan, and Kentucky by five, five, and two points, respectively (see Figure 13). Indiana's

average scale score dropped from 154 scale score points in 2000 to 150 scale score points in 2005. Nationally, North Dakota was the top performing state with 77 percent of students in Grade 8 receiving a score that was at or above Basic in science in 2005, outperforming Indiana by 15 percentage points.

in Indiana in 2005. The content that is tested on the ISTEP+ early in the fall semester annually for Grades 5 and 9 covers academic standards taught through Grade 4 and in Grade 8, respectively. Therefore, the comparable NAEP assessments used for analysis were of students in Indiana in Grade 4 and Grade 8.

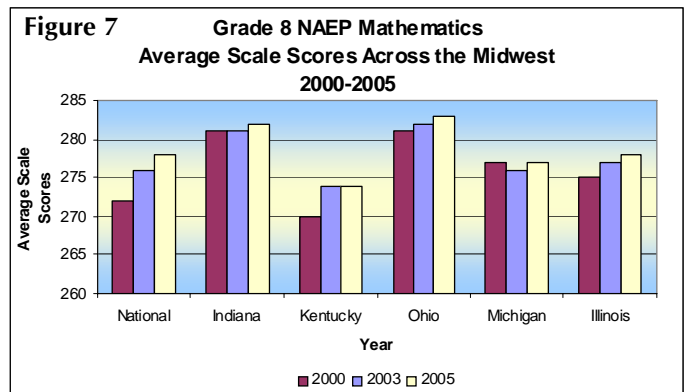
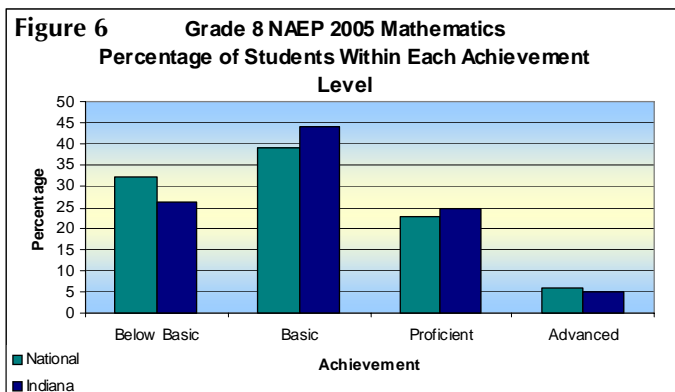
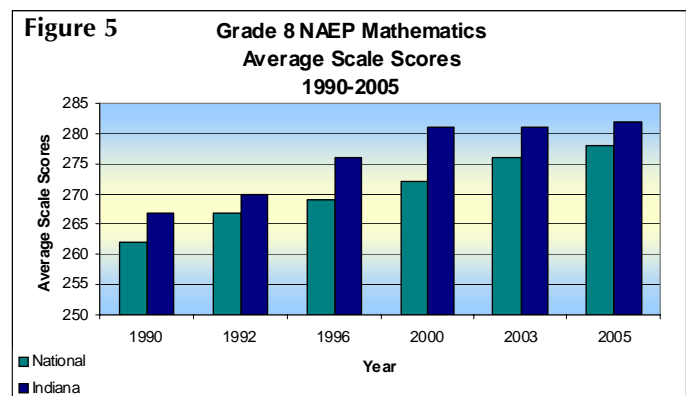
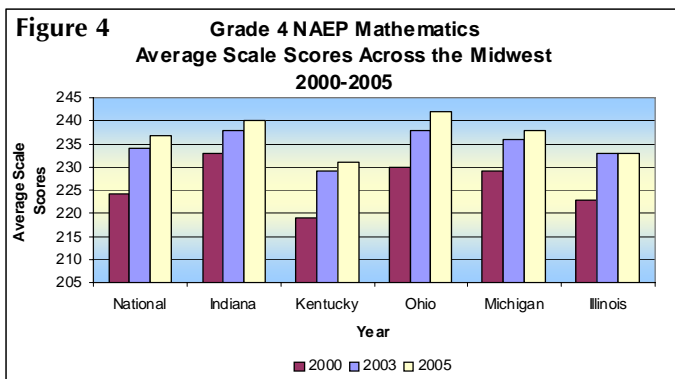
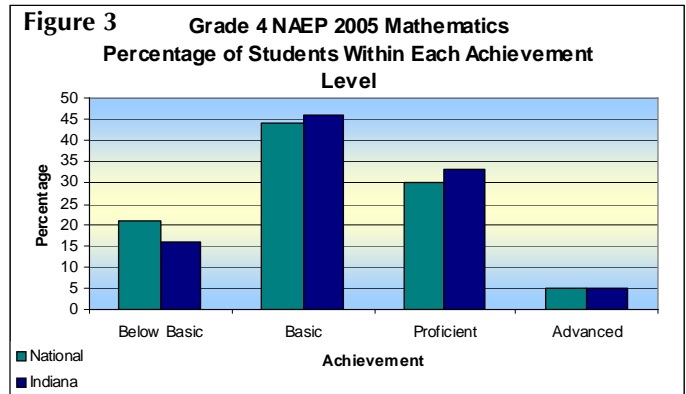
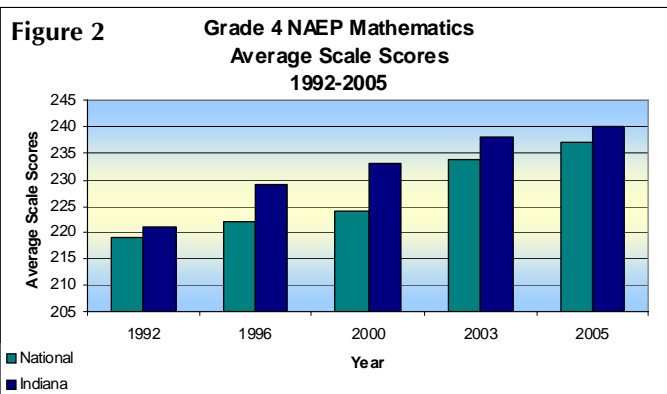
Comparing ISTEP+ with NAEP Assessments

ISTEP+ mathematics and science results for Grades 5 and 9 were compared with NAEP results for students in Grade 4 and Grade 8

ISTEP+ Pass Versus NAEP at or Above Basic

For all three areas of comparison (Grade 4 mathematics, Grade 8 mathematics, and Grade 4 science — Grade 8 science was

NAEP MATHEMATICS^{14, 15}



not part of the comparison due to the fact that the science portion of the ISTEP+ is not yet administered in Grade 9), the percentage of students passing the ISTEP+ portions was lower compared to the percentage of students scoring at or above Basic on the NAEP assessment. For Grade 4 mathematics, 76 percent of students passed the ISTEP+, whereas 84 percent of students scored at or above Basic on the NAEP assessment. Likewise, for Grade 8 mathematics, 70 percent of students passed the ISTEP+, whereas 74 percent of students earned scores at or above Basic on the NAEP assessment. Similar trends were also apparent for Grade 4 science content

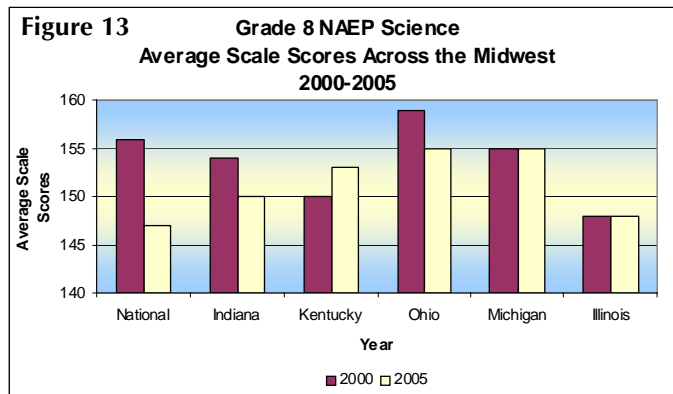
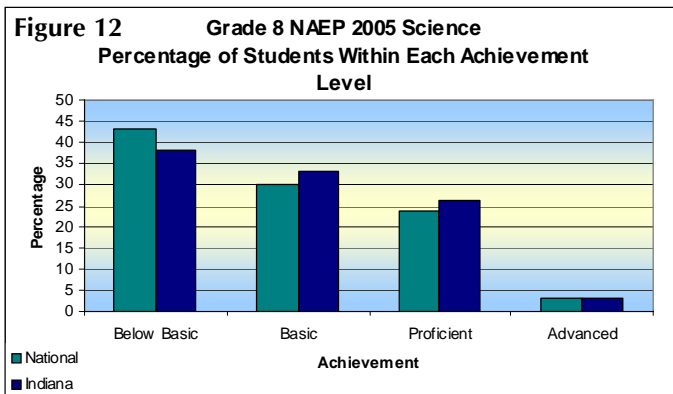
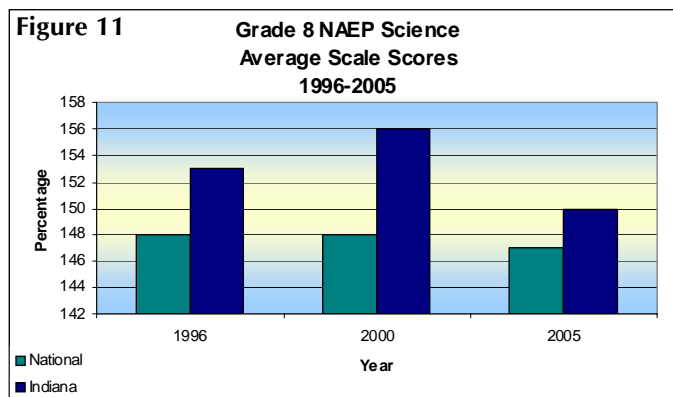
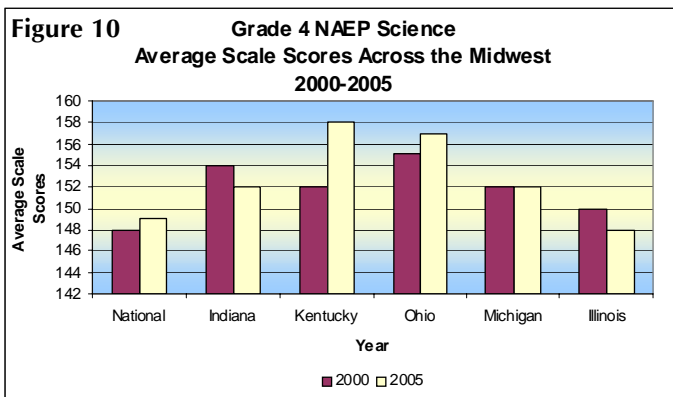
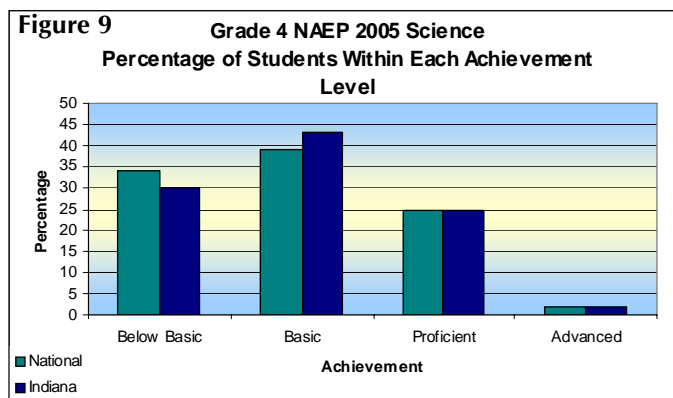
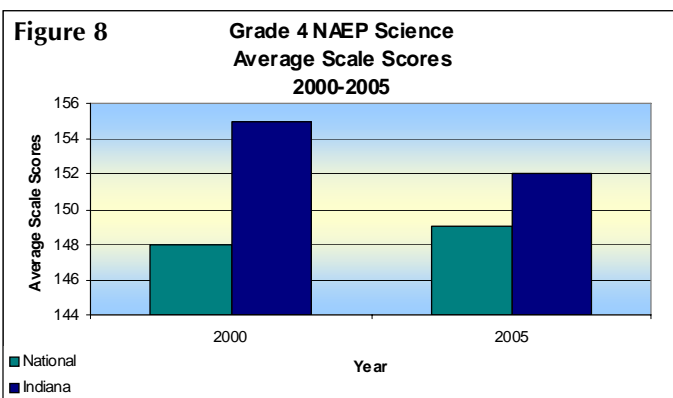
knowledge, as 64 percent of students passed the ISTEP+ and 70 percent of students scored at or above Basic on the NAEP assessment.

ISTEP+ Pass versus NAEP Proficient and Above

Next, comparisons of state assessments were made between Indiana and its neighboring Midwestern states for mathematics for students in Grade 4 and Grade 8. The percentage of students who scored at a proficient or above level on their state assessment was compared to the percentage of

students in that state who scored at the proficient and advanced levels on the NAEP. Large differences between these two percentages indicate a warning that should be noted by educators, policymakers, and the public.¹⁸ However, this variation could derive from differences in both content standards and student academic achievement from state to state, as well as from differences in the stringency of the standards adopted by the states. Unfortunately, there is no way to directly compare state proficiency standards because states are free to select the tests they employ and to establish their own performance standards.

NAEP SCIENCE^{16, 17}



The difference in the percentages between Indiana's state assessment (i.e., ISTEP+) and NAEP (percentage Proficient and Advanced) for students in Grade 4 on the mathematics assessment is large, with a difference of 35 percentage points. This compares to neighboring Midwestern states, such as Kentucky and Ohio, which have discrepancies of 19 percentage points and 23 percentage points, respectively (see Table 2). The differences in the percentages on Indiana's state assessment (i.e., ISTEP+) and the NAEP assessment for mathematics for students in Grade 8 show that Indiana has the largest discrepancy when compared to neighboring Midwestern states, with a difference of 41 percentage points (see Table 3).¹⁹

TRENDS IN INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS)

The Trends in International Mathematics and Science Study (TIMSS) compares mathematics and science achievement by the International Association for the Evaluation of Educational Achievement (IEA), an international organization of national research institutions and governmental research agencies. The TIMSS tracks changes in achievement over time, thereby providing an indication of the degree to which students at the Grade 4 and Grade 8 levels in 46 countries, drawn randomly, have learned concepts in mathematics and science they have encountered in school.²⁰

For Grade 4, comparisons are made among students in 25 countries that participated in the mathematics and science portions of the TIMSS 2003. For Grade 8, comparisons covered students in 45 countries that participated in TIMSS 2003. Indiana students outperformed the international average in the areas of mathematics and science for students in both Grades 4 and 8. Indiana surpassed the international average by 38 points for Grade 4 mathematics (see Figure 14). Similarly, Grade 8 students scored higher than the average score of their international peers by 42 points in the area of mathematics. With respect to science, students in Grade 4 outperformed the international average by 64 points (see Figure 15). Likewise, Indiana exceeded the international average by 57 points for Grade 8 science.

TABLE 2. Comparison of Differences Between Grade 4 Mathematics State Assessment 2005 and NAEP 2005 (Proficient and Advanced) Across the Midwest^a

State	Percentage Proficient and Above on State Assessment	Percentage Proficient and Advanced on NAEP	Percentage Point Difference Between State Assessment and NAEP
Indiana	73	38	35
Kentucky	45	26	19
Ohio	66	43	23
Michigan	72	38	34
Illinois	73	32	41

^a Hall, D., & Kennedy, S. (2006). *Primary progress, secondary challenge: A state-by-state look at student achievement patterns*. The Education Trust (March 2006). Retrieved September 26, 2006, from <http://www2.edtrust.org/NR/rdonlyres/15B22876-20C8-47B8-9AF4-FAB148A225AC/0/PPSCreport.pdf>

TABLE 3. Comparison of Differences Between Grade 8 Mathematics State Assessment 2005 and NAEP 2005 (Proficient and Advanced) Across the Midwest^a

State	Percentage Proficient and Above on State Assessment	Percentage Proficient and Advanced on NAEP	Percentage Point Difference Between State Assessment and NAEP
Indiana	71	30	41
Kentucky	36	23	13
Ohio	63	33	30
Michigan	62	29	33
Illinois	54	29	15

^a Hall, D., & Kennedy, S. (2006). *Primary progress, secondary challenge: A state-by-state look at student achievement patterns*. The Education Trust (March 2006). Retrieved September 26, 2006, from <http://www2.edtrust.org/NR/rdonlyres/15B22876-20C8-47B8-9AF4-FAB148A225AC/>

TABLE 4. TIMSS 2003 Comparison of Mathematics for Grade 4 Students

Country	Grade 4
Singapore	594
Hong Kong SAR	575
Japan	565
Chinese Taipei	564
Belgium-Flemish	551
Netherlands	540
Latvia	536
Lithuania	534
INDIANA	533
Russian Federation	532
England	531
Hungary	529
United States	518
Cyprus	510
Moldova, Republic of	504
Italy	503
Australia	499
International Average	495

Note: A total of seven countries scored below the international average

TABLE 5. TIMSS 2003 Comparison of Science for Grade 4 Students

Country	Grade 4
Singapore	565
INDIANA	553
Chinese Taipei	551
Japan	543
Hong Kong SAR	542
England	540
United States	536
Latvia	532
Hungary	530
Russian Federation	526
Netherlands	525
Australia	521
New Zealand	520
Belgium-Flemish	518
Italy	516
Lithuania	512
Scotland	502
Moldova, Republic of	496
Slovenia	490
International Average	489

Note: A total of 7 countries scored below the international average.

TABLE 6. TIMSS 2003 Comparison of Mathematics for Grade 8 Students

Country	Grade 8
Singapore	605
Korea, Republic of	589
Hong Kong SAR	586
Chinese Taipei	585
Japan	550
Belgium-Flemish	537
Netherlands	536
Estonia	531
Hungary	529
INDIANA	508
Malaysia	508
Latvia	508
Russian Federation	508
Slovak Republic	508
Australia	505
United States	504
Lithuania	502
Sweden	499
Scotland	498
Israel	496
New Zealand	494
Slovenia	493
Italy	484
Armenia	478
Serbia	477
Bulgaria	476
Romania	475
International Average	466

Note: A total of 19 countries scored below the international average.

TABLE 7. TIMSS 2003 Comparison of Science for Grade 8 Students

Country	Grade 8
Singapore	578
Chinese Taipei	571
Korea, Republic of	558
Hong Kong SAR	556
Estonia	552
Japan	552
Hungary	543
Netherlands	536
INDIANA	531
United States	527
Australia	527
Sweden	524
Slovenia	520
New Zealand	520
Lithuania	519
Slovak Republic	517
Belgium-Flemish	516
Russian Federation	514
Latvia	512
Scotland	412
Malaysia	510
Norway	494
Italy	491
Israel	488
Bulgaria	479
Jordan	475
International Average	474

Note: A total of 20 countries scored below the international average.

international average is significantly influenced by the presence of low-performing countries (South Africa, Ghana, Saudi Arabia with scores 264, 276, and 332, respectively) and is significantly lower than the average score of the top performing country (Singapore, with a score of 605).

It should also be noted that the differences in average mathematics scale scores for students from Indiana and the top performing country, Singapore, were larger for Grade 8 students (a difference of 97 points) than for Grade 4 students (a difference of 61 points).

Indiana's Grade 4 students displayed their best performance on the TIMSS 2003 science assessment. These students earned a score of 553 and were outperformed only by one country, Singapore, thereby placing Indiana second among all participating countries and jurisdictions (see Table 5). In fact, Indiana's score of 553 is just 12 points below that of Singapore's.

The performance of the Grade 8 students from Indiana enabled the state to place ninth with an average scale score of 531 points (see Table 7). The national average scale score was 527 points; thus the difference between Indiana's performance and the national performance was not significant.

INDIANA STEM INITIATIVES

A number of initiatives have been undertaken in Indiana to reposition the state as an engine for economic development and to ensure its citizens have the skills to compete in the 21st century global economy. A few key K-12 education initiatives include the increased rigor of the

Indiana's Grade 4 students achieved a score of 533 in mathematics, placing them ninth among all participating countries²¹ (see Table 4). This average score exceeded the international average of 495. Grade 8 students for Indiana scored 508 in mathe-

tics and were outperformed by their peers in nine countries, thereby ranking 10th overall (see Table 6). Indiana's Grade 8 mathematics score exceeded the international average score by 42 scale score points. However, it should be noted that the

Figure 14²²

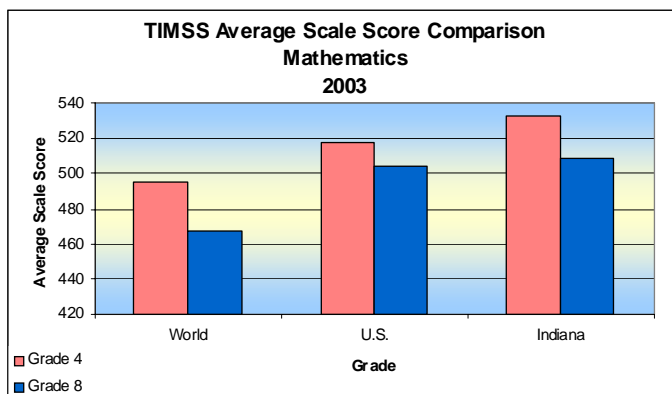
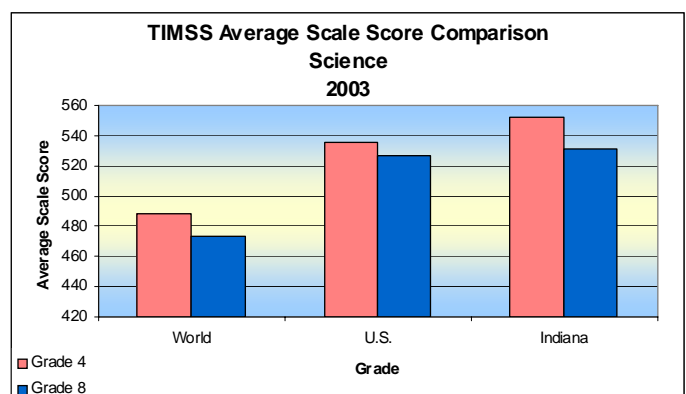


Figure 15²³



high school curriculum, advocacy of and participation in Project Lead the Way, and participation as a National Governors Association Honor State.

High School Course and Credit Requirements

A focal point of high school reform has been the push to increase the rigor of the high school curriculum by increasing credit requirements in the core subjects. Indiana's current minimum high school curriculum for graduation, the General Diploma, will be replaced by the Core 40 Diploma for all students beginning with the graduating class of 2011. The Core 40 has been designed to prepare students for success in college and in the workforce. Presently, Indiana's General Diploma requirements in mathematics and science are generally less than those required by neighboring Midwestern states and the national average (see Table 8). However, Indiana's Core 40 Diploma requirements exceed that of the national average in both mathematics and science and are comparable to the diploma requirements for Kentucky and Ohio.²⁴ In addition, the Indiana State Board of Education has eliminated some lower level mathematics and science courses at the secondary level, added advanced courses in the life sciences, and now requires all high

school students to complete Biology 1. This information indicates that Indiana's new graduation requirements exceed or are on par with the requirements seen in neighboring Midwestern states.

Project Lead the Way

Project Lead the Way (PLTW) is a national initiative that seeks to increase the number and quality of engineers and engineering technologists in the United States through collaborations among K-12 education, higher education, and industry. Program participants, who often are enrolled in college preparatory mathematics and science classes, are introduced to the rigors of the engineering field through hands-on projects such as computer-aided design, robotics, electronics, and engineering design. Project Lead the Way forms partnerships among middle schools, high schools, colleges and universities, and business and industry to provide students with the rigorous, relevant, reality-based knowledge necessary to pursue engineering or engineering technology programs in college. With PLTW, middle school and high school students:

- meet national standards for mathematics, science, technology education, and English/language arts;

- engage in a complete career/technical concentration with an emphasis on both mathematics and science; and
- link demanding mathematics and science courses with quality academic/technical courses.

The Indiana State Partnership of Project Lead the Way is administered by the Purdue College of Technology, the Indiana Department of Education, and the Department of Workforce Development. In addition, three universities are part of the PLTW network: IUPUI (Indianapolis), Ivy Tech Community College, and Purdue University. However, Purdue University is the only PLTW-certified university. Last year, its technological teacher education program received the nation's first PLTW certification to offer its graduates PLTW engineering teacher credentials at the same time they received their degrees and Indiana technology education teaching licenses. Of the 227 high schools and middle schools that are part of the PLTW network in Indiana, 43 are PLTW-certified schools.

National Governors Association Honor States Grant Program

The state of Indiana, through a partnership of the Indiana Department of Education, BioCrossroads, and the Office of Governor Mitch Daniels, was awarded a National Governors Association (NGA) Honor States grant in 2005. The grant focuses on STEM education and Indiana's plan contains two primary STEM-related components that involve the development of high school redesign models and enhancing middle school algebra instruction. As a result of this emphasis, grants have been provided to fund a number of high school redesign initiatives in Indiana, including New Tech High Schools in Rochester Community School Corporation, Arsenal Tech High School in IPS, Metropolitan School District (MSD) of Decatur Township, Bartholomew Consolidated School Corporation, and Monroe County Community School Corporation. In addition, grants have been awarded to fund Early College High Schools, including: Bartholomew Consolidated School Corporation in partnership with Ivy Tech and Vincennes University; Center Grove Community School

TABLE 8. Number of Credits Required by State to Earn a Standard High School Diploma^a

State	Number of mathematics credits required by state to earn a standard high school diploma (2006) ^b	Number of science credits required by state to earn a standard high school diploma (2006) ^b
Indiana	2 (3) ^c	2 (3) ^c
Kentucky	3	3
Ohio	3	3
Illinois	2	1
National Average	2.7	2.5

^a Editorial Projects in Education. (2006). *Education counts: Research center*. Retrieved October 18, 2006, from <http://edcounts.edweek.org>

^b Number of math credits required by state to earn a standard high school diploma. Course requirements are expressed in Carnegie units with one Carnegie unit equivalent to one year of coursework. Credits reflect the minimum course requirements mandated by the state for a standard high school diploma.

^c Data represent requirements set forth by the Core 40 Diploma. Starting with the class of 2011, number of mathematics credits required to earn a standard high school diploma will be three, and the number of science credits required to earn a standard high school diploma will also be three.

Corporation in partnership with Franklin College; Connersville High School in partnership with Ivy Tech; MSD of Decatur Township in partnership with Ivy Tech, Vincennes University, and University of Indianapolis; Franklin Community School Corporation in partnership with Franklin College; Herron High School in partnership with Marian College; Lawrence Early College High School in the MSD of Lawrence Township in partnership with Ivy Tech; Monroe County Community School Corporation in partnership with Ivy Tech; Richmond Community School Corporation in partnership with Ivy Tech-Richmond and IU-East; and Charles A. Tindley Accelerated High School in partnership with Anderson University. The Center of Excellence in Leadership of Learning (CELL) at the University of Indianapolis has formed support networks for both types of school models to assist these schools with implementation challenges and to bring new partners to the table for them.

The other aspect of this grant program is to address the fact that many middle school mathematics teachers are either teaching out-of-field or have an elementary education license. As a result, a sub-grant was awarded for the development of an I-STEM Resource Network, led by Purdue and four other colleges and universities from around the state, including Indiana University. The universities collectively developed a teacher professional development course for middle school algebra that was piloted this summer. The program is very likely to expand in the future to include more teachers and more subjects.

The future of these initiatives in Indiana hinge on the continuation of funding for the grant program or on the development of central organization to facilitate and fund ongoing initiatives, such as the I-STEM Resource Network. Indiana's receipt of the NGA Honor States funding is scheduled to expire at the end of 2007. If funding is continued, plans are to expand the funding of high school redesign initiatives across the state. The I-STEM Resource Network will likely play a more prominent role in facilitating STEM initiatives moving forward with funding from the Lilly Endowment and other grant sources.

FEDERAL STEM INITIATIVES

In response to the rankings of the U.S. on international assessments in mathematics and science, and as a means to address a 2005 National Academies report urging the improvement of scientific and technological skills in the workplace, President George W. Bush announced the American Competitiveness Initiative (ACI) in 2006. This initiative was touted as a way to increase investments in research and development, strengthen education, and encourage entrepreneurship, to help ensure that our future generations have an even brighter future.

The American Competitiveness Initiative goals were announced to include:²⁵

- 300 grants for schools to implement research-based math curricula and interventions;
- 10,000 more scientists, students, post-doctoral fellows, and technicians with opportunities to contribute to the innovation enterprise;
- 100,000 highly qualified math and science teachers by 2015;
- 700,000 advanced placement tests passed by low-income students; and
- 800,000 workers getting the skills they need for the jobs of the 21st century.

The ACI proposed \$380 million in Fiscal Year (FY) 2007 to strengthen the nation's K-12 education system by improving the quality of mathematics, science, and technological education and by engaging students in rigorous courses that teach important analytical, technical, and problem-solving skills. If successful, the ACI will help better prepare students to compete more effectively in the global marketplace.

In addition, President Bush has proposed extending key aspects of NCLB to include the high school years. This High School Reform Initiative will:²⁶

- Provide grants through state educational agencies to local educational agencies for targeted, proven interventions that increase the achievement of high school students, eliminate the achievement gap, and prepare all students to graduate with the knowledge and skills they need to enter college or the workforce; and
- Require testing in two additional high school grades to inform schools of the

efficacy of their curriculum and identify students in need of additional help.

Since its announcement and partial funding, the ACI has had an impact as K-12 mathematics and science education continues to be strengthened. These steps include:²⁷

- The Deficit Reduction Act, which was signed in February 2006, created Academic Competitiveness Grants and National SMART Grants. These grants provide additional need-based aid for first- and second-year college students who complete a rigorous high school curriculum, and for third- and fourth-year college students who choose to major in the fields of math, science, engineering, or critical foreign languages.
- The Academic Competitiveness Council was established in the Deficit Reduction Act to assess the effectiveness of the federal STEM education investment.
- An Executive Order was issued in April 2006, creating the National Math Panel to evaluate the scientific evidence related to teaching and learning mathematics, and to make recommendations on how to improve student readiness for, and success in, algebra and higher-level mathematics courses.

To continue the progress made in K-12 mathematics and science education, the following steps are proposed for FY2008:²⁸

- Advanced Placement/International Baccalaureate — \$122 million (a \$90 million increase) to expand access to rigorous curricula in high school for low-income students, particularly in mathematics and science, and to increase the number of teachers trained to instruct these courses.
- Adjunct Teacher Corps — \$25 million to encourage well-qualified professionals, particularly in the fields of mathematics and science, to become adjunct secondary school teachers and share their expertise with students.
- Math Now Program — \$250 million to ensure that students benefit from our improved understanding of how they best learn math.
- Science assessments — to be added into state accountability calculations under NCLB at three grade levels by 2008 and to require science proficiency of all students by 2020.

In addition to the President's initiatives, the United States Congress has considered multiple STEM initiatives in 2007. Most recently, the America Competes Act (S.761) was introduced on March 5, 2007, and was passed by the Senate 88-8 on April 25, 2007.²⁹ A similar bill, HR 2272, passed the House of Representatives during Spring of 2007. On August 2, 2007, Congress passed compromise language that consolidated S.761 and HR 2272 into one measure, also known as the America Competes Act.

Although the Bush administration opposed some provisions of this legislation, the bill did incorporate components of the ACI, including:³⁰

- Teacher training programs for Advanced Placement courses in mathematics, science, and critical foreign languages;
- Math Now programs; and
- National Security Language Initiatives.

As a part of this Act, grants are awarded to develop educational partnerships to provide courses in the STEM areas. Furthermore, Advanced Placement and International Baccalaureate programs are supported with grants to increase the number of qualified teachers as well as student enrollment. Additionally, a national panel is to be convened to identify the promising practices in the teaching of mathematics, science, technology, and engineering for K-12 education.

CONCLUSIONS AND RECOMMENDATIONS

Science, technology, engineering, and mathematics (STEM) education is becoming increasingly important as Indiana continues to strive to be competitive in today's global economy. Many steps have been taken in several states, including Indiana, and comparison and trend data help determine what progress has been made in K-12 education. Such information better informs us of what Indiana needs to do to move to the forefront of STEM education.

Conclusion

Indiana has been identified as working towards improving STEM education and has shown progress as a state.

To accommodate for the need to address STEM education, Indiana is in the process of phasing out the General Diploma and replacing it with a more rigorous high school curriculum, the Core 40. Likewise, scores on the mathematics and science portions of the ISTEP+ assessment have increased with each subsequent year, indicating that more students are demonstrating strong academic performance and mastery of these state standards.

Recommendation

As the global economy becomes increasingly competitive regarding STEM activities, greater demands will be placed on our public education system. A variety of rigorous STEM courses, such as more advanced levels of mathematics and science, should be provided to Indiana's students through dual credit and Advanced Placement Programs or Middle/Early College high school programs.

Conclusion

Compared to other states, Indiana students score favorably in mathematics, but trends in science scores are cause for concern.

Indiana has demonstrated strong performance as students taking the NAEP assessment for Grade 4 mathematics, Grade 8 mathematics, and Grade 4 science have consistently higher average scale scores compared to the national average. Yet the percent of students who received a score that was at or above Basic in Grade 4 mathematics, Grade 8 mathematics, Grade 4 science, and Grade 8 science in Indiana trailed the top performing state(s) by up to 15 percentage points.

When compared to four neighboring Midwestern states (Illinois, Kentucky, Michigan, and Ohio), Indiana placed either first or second in the NAEP assessments for Grade 4 and Grade 8 mathematics when comparing average scale scores and the percentage of students receiving scores at or above Basic. However, the scores for the

NAEP assessments for Indiana students in Grade 4 and Grade 8 revealed science achievement placed Indiana third or fourth when compared to the neighboring Midwestern states. Furthermore, Indiana's average scale scores on the NAEP science assessment for Grades 4 and 8 are declining and are a reason for concern.

Recommendation

Despite a general trend of improvement on ISTEP+ and its high standing on TIMSS in 2003, Indiana's NAEP scores are slipping in science compared to other states. Indiana students demonstrated a decrease in student performance in 2005 and were behind three neighboring Midwestern states. Efforts underway to improve mathematics instruction in middle school and high school should be expanded to include science instruction. Science teachers must be trained to provide real-world learning opportunities to engage students with a relevant curriculum. Teachers must do a better job explaining their ideas, connecting scientific events, and guiding scientific investigations. In addition, by making sophisticated use of technology, science courses can provide visualizations of complex phenomena that help students connect school science to everyday situations.³¹ Indiana must also continue to examine its teacher recruitment and retention strategies to lessen the need for the issuance of emergency teacher licenses in mathematics and science at the secondary level and to ensure an adequate pool of highly qualified teachers in these subject areas.

Conclusion

Indiana students' rankings internationally also show above average performance.

According to the TIMSS, Indiana outperformed the national and international averages for Grade 4 mathematics, Grade 8 mathematics, Grade 4 science, and Grade 8 science. Grade 4 science scores are especially impressive, with Indiana students scoring among the world's elite countries.

Recommendation

Distance learning opportunities should be maximized in smaller school corporations that have limited financial and human resources to provide a full array of AP or dual credit courses. Ongoing data collection and analysis is necessary to monitor

student achievement progress in Indiana to make accurate comparisons nationally and internationally. This is especially true for the area of science, where not much data have been collected in comparison to the amount of data available for mathematics. In addition, it was noted that Grade 4 students fared better than Grade 8 students in both mathematics and science according to the TIMSS data. Therefore, further research and policy initiatives are needed between Grade 4 and Grade 8 to sustain high achievement outcomes.

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WEB RESOURCES

ISTEP+ Info Center

<http://ideanet.doe.state.in.us/istep/welcome.html>

National Assessment of Educational Progress (NAEP)

<http://nces.ed.gov/nationsreportcard/>

Trends in International Mathematics and Science Study (TIMSS)

<http://nces.ed.gov/TIMSS/>

TIMSS 2003 International Mathematics Report

<http://isc.bc.edu/timss2003i/mathD.html>

TIMSS 2003 International Science Report

<http://isc.bc.edu/timss2003i/scienceD.html>

Indiana Core 40 Info Center

<http://ideanet.doe.state.in.us/core40/welcome.html>

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