How New Hampshire's Educators Can Stimulate Growth in Science

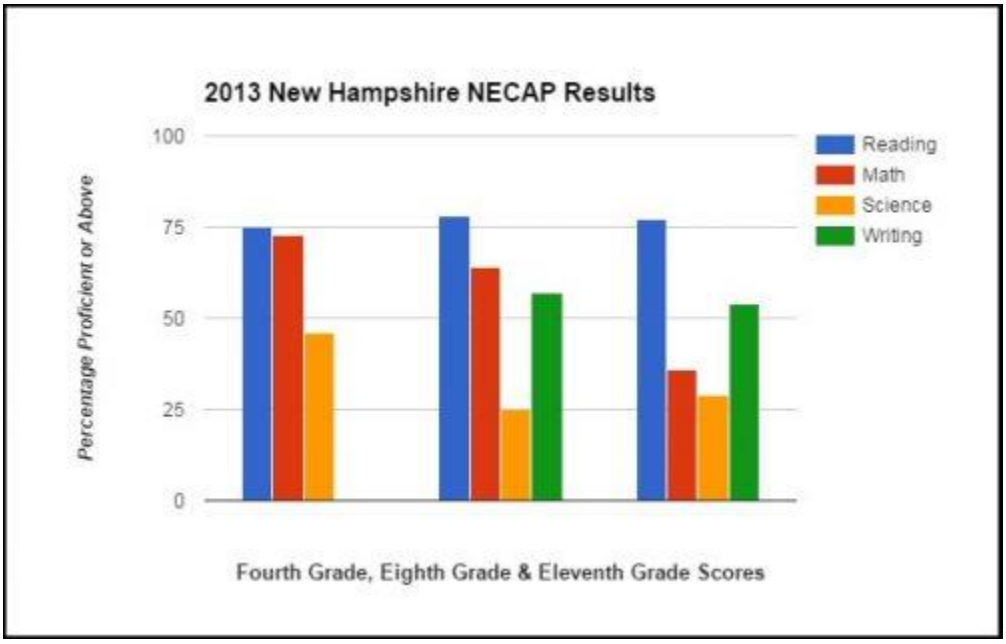
by Thom Smith

President Theodore Roosevelt is credited with saying, "Comparison is the thief of joy." When examining academic scores, this statement can be true or false depending on the type of comparison that is being made. In New Hampshire, educators can look at their students' test scores in comparison to the rest of the country and feel pretty good about the results. However, if our state's teachers analyze their students' performance in each subject area, they may become duly distressed, particularly with how the science data measures up to their students' reading, writing, and math scores.

Let's look on the bright side first. According to a 2011 *Live Science* article on the Science and Engineering Readiness Index (SERI), which focuses on how well schools are educating students in physics and calculus, New Hampshire ranked fourth in the nation (Tate, 2011). In a 2014 *Forbes* report on education, New Hampshire ranked 10th in the nation in overall academic proficiency (Crotty, 2014). Most recently, *Education Week* released its 2016 annual report card which grades states on their performance in three categories: chance for success, school finance, and a K–12 achievement index; New Hampshire received the sixth best ranking in the nation ("New Hampshire Earns a B-Minus," 2016). Comparing themselves to the rest of the United States, New Hampshire students, educators, and administrators can and should be proud of their accomplishments.

Now let's examine the statistics on an internal level and specifically on science performance. How do New Hampshire's students fare in science compared to other subject areas? It can be a challenging task to accurately make this comparison because of the recent adjustments made in state assessments. This comparison will be made using the most recent data from the New England Common Assessment Program (NECAP) for two reasons: (1) This assessment program provides tests and releases scores of reading, writing, math, and science assessments, allowing for an academic subject comparison. (2) The newer Smarter Balanced Assessment Consortium (SBAC) does not provide assessments for science and it would be faulty to compare academic scores from two different types of assessments.

The most recent year students across New Hampshire took the NECAP assessments in math, reading, writing, and science was in 2013. The 8th and 11th grade students participated in assessments in all four subjects. The 4th grade students participated in math, reading, and science assessments. In the fall of 2013, 8th grade students and 11th grade students scored noticeably lower in science than in math, reading, and writing. Fourth grade students scored noticeably lower in science than in math and reading. In fact, the science scores were so low in each grade level that more students were considered below proficient than above proficient. Lastly and discouragingly, only 1 percent of students in each grade level earned the "proficient with distinction" mark in science (New Hampshire Department of Education, 2013).



Considering this is just a snapshot of one year of assessment scores, we need to examine the NECAP science results from between the years of 2008-2015 to gain better insight into our how our state's students have been progressing in science. Science assessment data has

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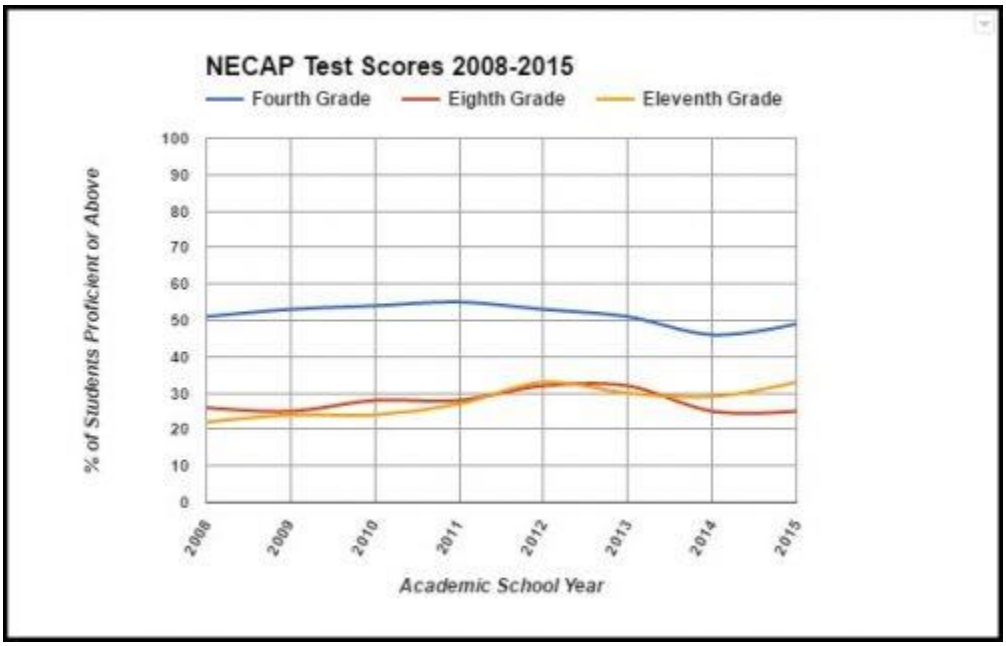
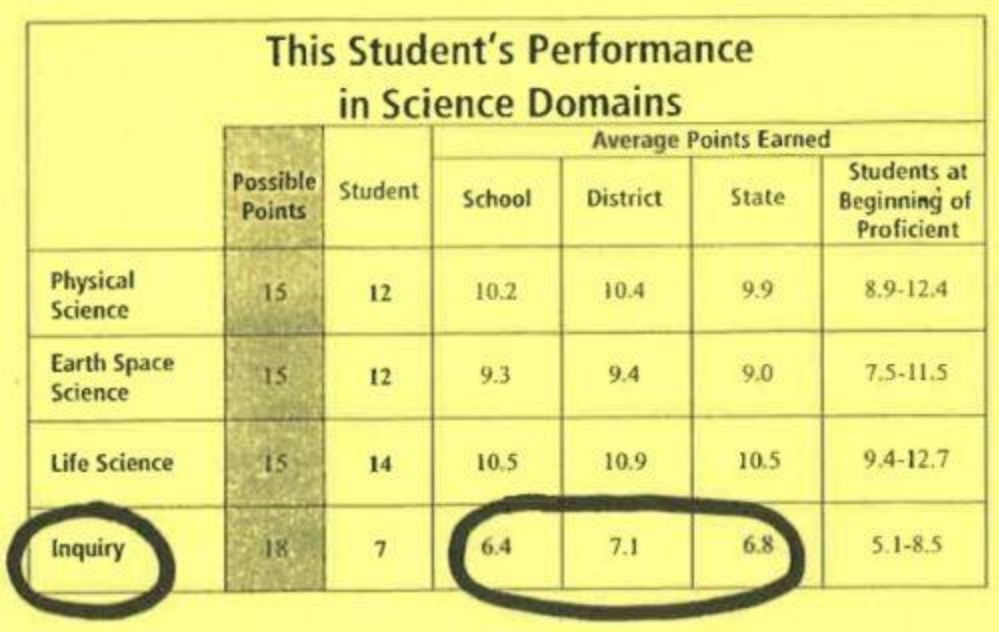
indicated that our state's 4th grade students have been hovering around 50 percent or above scoring proficiency since 2008. Eighth and 11th grade students have been lingering around 25 to 30 percent or above proficiency in science for the last several years. And every year in each grade level since 2008 the students achieving the "proficient with distinction" mark is 1 percent or less. Our state's science data indicates that there is certainly room for improvement and a need to divert from stagnation.



Before coming to conclusions on how New Hampshire educators and administrators can take steps to remedy the stagnancy of our students' science progress, one more pattern in the NECAP science scores deserves extreme attention. The NECAP science tests determine how students are faring in four specific domains: physical science, earth and space science, life science, and inquiry. Each grade level for every year since 2008 has performed significantly less in one of these domains than the others: inquiry. It is quite evident that our students—from elementary to high school—need assistance in improving their inquiry skills. Below is an image of one 4th grade student's 2014 NECAP science test scores indicating the disparity between the domain results.



This Student's Performance in Science Domains

	Possible Points	Student	Average Points Earned			
			School	District	State	Students at Beginning of Proficient
Physical Science	15	12	10.2	10.4	9.9	8.9-12.4
Earth Space Science	15	12	9.3	9.4	9.0	7.5-11.5
Life Science	15	14	10.5	10.9	10.5	9.4-12.7
Inquiry	18	7	6.4	7.1	6.8	5.1-8.5

So what can educators do to remedy this science stagnancy? What can we do to increase our students' performance in all science domains, particularly inquiry? We need to look at where science education begins: at the preschool and elementary levels of education.

If you ask search engines, "What is the most integral part of a bicycle?" the majority of articles that appear will agree that the frame is the most valuable component. A bicycle frame is the part of a bike that connects everything. The same could be said for the primary grades of education; they create the framework that connects every other level of education. If children have a preschool and elementary school experience that creates contortions and weaknesses in their learning framework, then it will be much more difficult for educators in higher levels of education to fit all the necessary learning skill pieces together. New Hampshire educators need to examine where the construction of our allegorical frames need to be adjusted so that the whole cycle of education can become a more productive and enjoyable ride for our students.

The construction of our framework of education does not begin with preschool or elementary school educators but with college professors and their education majors. For our students to improve in science, they need teachers who are prepared and comfortable with teaching science. There are two main ways postsecondary institutions can better prepare their student teachers to meet the science needs of their future students: (1) require more coursework dedicated to instructing students on the art of teaching science and (2) increase collaboration with public schools beyond the traditional student teaching experiences.

If you research the required coursework for early childhood and elementary education majors around the state, you will commonly find only one course that instructs students on how to teach science. Often, this course isn't solely dedicated to science either, but combined with one or two more subjects. Obviously, preschool and elementary student teachers need to be well versed in how to adequately instruct young children how to read, write, and be mathematically literate

because they are building foundational knowledge their students will need for the rest of their educational careers and lives. But isn't it equally important to build a foundational knowledge of how to effectively question, observe, plan, investigate, analyze, and make accurate conclusions?

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Students that have successful experiences in an academic subject in the primary grades will most certainly carry their strengths and enthusiasms for a subject on to middle school. But if students receive an insufficient education in any particular subject at a young age, it is likely they will continue to struggle in that subject as they move on to middle school and potentially may develop a dislike for that subject altogether. Unfortunately, young students have a high potential of struggling with the subject of science and losing interest in it. This is because science is the subject that the majority of elementary educators feel least prepared to teach.

The 2012 National Survey of Science and Mathematics Education asked over 7,000 teachers in schools across the US about their perceptions of their preparedness to teach each subject (Banilower et al., 2013). Over 80 percent of elementary school teachers indicated they feel very well prepared to teach language arts and 77 percent indicated the same about math. What was the percentage of elementary educators surveyed who perceived themselves to be very well prepared to teach science? Thirty-nine percent. And who holds the initial responsibility to assist teachers in being very well prepared to teach science? College professors. It is imperative that more specific coursework dedicated to the instruction of science be made available to early childhood and elementary education majors. Increasing the number of science credits required in order to graduate should also be strongly considered. A rise in science instruction training will undoubtedly result in the growth of student academic progress in science.

Communication and collaboration between collegiate education departments and public schools needs to increase as well. Public schools need to seek out opportunities to assist their local colleges and universities where there are needs, and colleges and universities need to seek out increased experiences for their student teachers in local schools. Public school districts should be reaching out to postsecondary schools to see how they can assist in the professional development of student teachers because those student teachers could be their future colleagues who will be responsible for teaching their students. Postsecondary institutions need to be brainstorming with local districts about how they can improve their programs in order to best prepare their students for the field of education so their students are well equipped to face the complexities of twenty-first century teaching.

One of the most effective ways student teachers can be prepared to meet the needs of their future students is to have the most experiences possible as lead teacher of a classroom. The New Hampshire Board of Medicine requires two years of postgraduate training in an accredited program for an individual to receive a physician's license (New Hampshire Board of Medicine,

2017). Unlike the health profession, the education profession does not require a certain amount of time for an individual to spend in the field before they can receive their teacher certification. The amount of time a student teacher spends instructing students is dependent upon the requirements set by a college's education department. The expansion of a student teacher's required time in the classroom and an increase in required science coursework, accompanied by school districts increasing their efforts to provide local education majors with relevant professional development opportunities, would certainly assist in achieving the goal of improving science education in our state (and in every academic subject).

Besides ramping up efforts to assist teachers in training, an endeavor to increase and improve science professional development for current educators needs to happen. At the elementary level, professional development varies from year to year, but the bulk of it often focuses on math, reading, technology, or relevant classroom management issues. This is not to say science professional development does not occur, but when most of your educators are generalists, not specialists, the direction of professional development is usually determined by what the school deems most valuable, such as what subjects are progress monitored most, or what the school dedicates a lot of resources toward or both. Also, if there is a chance for teachers to have a say in what professional development they receive, they will more often than not choose what is of great interest to them. If more teachers feel uncomfortable teaching science and they are opting to choose professional development opportunities in areas of strength, then the pattern of less-than-optimal science education will continue.

Referring back to the 2012 National Survey of Science and Mathematics Education, only 59 percent of elementary educators surveyed noted that they had received science professional development in the last three years (Banilower et al., 2013). This means the other 41 percent had not received training in science for more than four years. Fifteen percent noted they had never received professional development in science at all! Conversely, over 80 percent of both middle school and high school teachers indicated they had received training in science in the last three years, but this percentage was so high because most middle and high school educators teach science exclusively. Again, it must be emphasized that the foundation of science skills is being constructed at the preschool and elementary levels; therefore, early childhood and elementary school teachers need to be well trained in science instruction so we can provide our students with the best opportunity to succeed in science throughout their academic career.

The main method by which we can provide our students with a true taste, an authentic thirst, for science is by being able to provide them with objects to touch, gadgets to operate, and experiences within our world that are new.

New and experienced teachers, particularly preschool and primary grade teachers, need more training in science, but without the physical tools needed to effectively teach science, our students will still find themselves at a disadvantage. Philosopher Jean-Jacques Rousseau once said, "We should not teach children the sciences but give them a taste for them." The main method in which we can provide our young students with a true taste for science is by being able

to provide them with objects to touch, gadgets to operate, and hands-on experience within our world that are new.

At the primary stage of education, the academic focus is understandably to teach children how to read, write, and learn their math facts. The behavioral focus is to assist students in becoming kind, respectful, and effective citizens. Due to these necessary objectives, the larger portion of elementary school budgets is dedicated to providing teachers with the resources they need to effectively meet these objectives. This is not to imply school districts and schools do not allocate funds for science education, because they do, but more often than not the resources provided to early childhood educators in the subject of science are not sufficient.

There are a few ways we can ensure teachers have the necessary resources they need to give their students a "taste" of science. Educators need to take more initiative in researching, discovering, and utilizing the many resources they have available to them outside of the classroom. Administrators need to reexamine their budgets and find ways to increase classroom science budgets—not necessarily annually, but at least periodically. Lastly, science committees need to be formed and maintained to continuously brainstorm and act in ways they can enhance their schools' science resources.

There are many nonprofit organizations and local businesses willing to assist educators by providing their students with hands-on science experiences inside and outside classroom walls. Teachers need to tap into these resources that are often free or affordable. Budgets often allocate more funds for reading and mathematics than for any other subject area in primary schools. By slightly decreasing funds in one subject area periodically and increasing available science funds, school administrators can provide intermittent boosts to science resources in their schools. The formation and preservation of science committees in primary schools could be integral in searching for and finding valuable resources that improve science education in their schools.

Many elementary schools have math and reading specialists, and an increasing number of schools are adding technology specialists too. Since primary schools are full of generalists, particularly generalists who have more training in reading and math, they should be considering adding science and social studies specialists to advance these subject areas. The existence of a science specialist in an elementary school could help teachers and students tremendously.

Even if postsecondary educators ramp up their efforts to provide education majors with more coursework and training experiences, and preschools and elementary schools increase their science professional development and resources, none of this will matter if we cannot apply the necessary instruction our young students need in the classroom. Student teachers, new teachers, and experienced teachers alike need to be committed to applying inquiry-based learning into the classroom.

Why inquiry-based learning? Inquiry-based learning, in simple terms, is the process of sparking curiosity in students, allowing them to investigate their curiosity, and enabling them to discover knowledge through their own investigations. Inquiry-based learning is instructing students on the scientific method, but with one major difference: the students are not being told what to learn,

they are asking to learn and determining what needs to be learned. This does not mean teachers are not still in charge of the classroom, nor does it mean teachers are not educating their students in the necessary science content their students need. Inquiry-based learning is an instructional art—a creative process by which teachers determine intended learning objectives for their students, provide triggers that initiate authentic curiosity in their students, and supply their students with enough content knowledge, resources, and support to assist students in discovering the answers they are seeking and the processes by which they need to satisfy their curiosity.

Inquiry-based learning can be a challenge for educators, particularly educators of young children. Their students understandably have a limited knowledge of science content, and some can have a difficult time behaviorally in situations where they are given a lot of freedom to explore. Also, many educators of young children can have a difficult time relinquishing certain amounts of control to students because this can be perceived as a road to destruction—a messy, disorganized class. But we must not ignore our young students' vast amount of curiosity that is just waiting to be satisfied, and, when facilitated correctly, the fulfillment of this curiosity can assist in developing their science knowledge enormously. Increased training in inquiry-based learning will aid teachers in being more comfortable and prepared to incorporate this productive method of instruction in their classrooms.

During a recent interview, the new Director of Science Education in New Hampshire, Barbara Hopkins indicated, "Teachers are asking for professional development to implement the new NH College and Career-Ready Science Standards." She went on to explain that, "[t]he challenges will be to integrate the three-dimensional focus on content, science practices and cross-cutting concepts at all grade levels which challenge the traditional roles of students and teachers in the learning process." Many educators are eager to provide more effective science education for their students, but to do so, all science educators—from preschool teachers to postsecondary professors—need to be willing to adjust and enhance their roles.

Comparison can be the provider of joy and the encourager of perseverance simultaneously. By determining our areas of strength, we can use our prior successes to improve our instructional shortcomings. Hopkins explains how "science should be considered more of a verb instead of a noun." New Hampshire educators need to become more active than ever in determining how to upgrade our instructional dexterity. We need to transition from explaining science to our students to participating in science with them.

Thom Smith is a classroom teacher at Kearsarge Regional Elementary School in Bradford, New Hampshire.

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