STEM Education: Establishing Engineering in Elementary Instruction
Supplemental Materials

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Shannon Hynes
Brent Whitlock

Advisor:
Professor Katherine Foo

Sponsor:
Massachusetts’s Audubon Society

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The Massachusetts Audubon Society is a non-profit organization dedicated to protecting Massachusetts parks and reservations for the benefit of wildlife, as well as to educate the public and use their support to positively impact the natural environment. Specifically, the organization focuses on protecting land conservations from development, educating and inspiring future generations to be passionate about land safekeeping and promoting Massachusetts protection efforts to both the general public and today’s policy makers.

A nonprofit organization based in Lincoln MA, Mass Audubon relies on donations and gifts from private and public sources. Their website suggests various methods of giving money including leaving money in your will and just simply donating. Because the organization systematically believes that anyone can help make a difference, it offers many different volunteer opportunities. Last year, over 14,000 people volunteer across Massachusetts to help them reach their goals.

Mass Audubon boasts more than 125,000 members and supporters including pivotal advocates on Beacon Hill. As an organization, they protect about 38,000 acres of land, earning them the title of the largest nature conservation nonprofit organization in Massachusetts with twenty nature centers visited by half a million visitors every year.

Leading the organization is a president along with the support of four vice presidents responsible for Operations, Philanthropy, Marketing and Communications, and Wildlife Sanctuaries. Additionally, three directors help manage all of the conservations and each conservation has its own director. Our most important contacts are Deborah Cary, the director of Wachusett Sanctuary and Kristin Steinmetz, the education coordinator.

Financially, their estimated total assets amounted to around $242 million in 2017. They get money from various sources: gifts, investment returns, bequests, government grants, program income, and membership dues.

Mass Audubon collaborated with the Berkshire Natural Resource Council and the town of Lenox to create a long-distance hiking trail up Lenox Mountain. They do some collaborations and work directly with other large conservation organizations.

For the Wachusett Sanctuary specifically, there are several different educational programs open to children of different age groups, from preschoolers to high school children. There are also involvement opportunities for homeschooled children, ensuring that they have a well-rounded education that involves conservation. The Massachusetts Audubon society is heavily invested in the conservation of Massachusetts wildlife and the education of young students; which will help them to understand the value of nature and how to properly protect it.

Appendix B:
### Stems Education: Establishing Engineering in Elementary Instruction

#### Combined Statement of Financial Position

June 30, 2017 and 2016

<table>
<thead>
<tr>
<th>Assets</th>
<th>2017 Unrestricted</th>
<th>Temporarily Restricted</th>
<th>Permanently Restricted</th>
<th>Total</th>
<th>2016 Unrestricted</th>
<th>Temporarily Restricted</th>
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<th>Total</th>
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<td><strong>Current Assets</strong></td>
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</tr>
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<td>Cash and cash equivalents</td>
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<td>$11,151,492</td>
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<td>$6,827,403</td>
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<td>Due to (from) Other Funds</td>
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<td>997,961</td>
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<td>1,988,437</td>
<td>1,988,422</td>
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<td>46,524,235</td>
<td>58,868,642</td>
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<td>-</td>
<td>40,000,070</td>
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<td>$252,419,961</td>
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<td><strong>Liabilities and Net Assets</strong></td>
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<td><strong>Current Liabilities</strong></td>
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<td>2,264,424</td>
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<tr>
<td><strong>Total current liabilities</strong></td>
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<td>3,934,826</td>
<td>6,206,524</td>
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<td><strong>Split Interest Agreements</strong></td>
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<td>liabilities, net of current</td>
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<td>Unrestricted</td>
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<td>Operating, property, equipment</td>
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<td>47,877,218</td>
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<td>-</td>
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<td>and fine arts funds</td>
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<td>198,913</td>
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<td>-</td>
<td>59,846,259</td>
<td>-</td>
<td>59,846,259</td>
<td>-</td>
<td>56,374,251</td>
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<td><strong>Permanently restricted</strong></td>
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<td>128,828,519</td>
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<td>-</td>
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<tr>
<td><strong>Total net assets</strong></td>
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<td>128,828,519</td>
<td>255,556,125</td>
<td>56,374,251</td>
<td>-</td>
<td>-</td>
<td>56,374,251</td>
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<tr>
<td>**Total liabilities and net</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>assets</td>
<td>$26,892,764</td>
<td>$59,828,192</td>
<td>$128,828,519</td>
<td>$255,556,125</td>
<td>$43,892,592</td>
<td>$30,972,591</td>
<td>$161,172,548</td>
<td>$252,419,961</td>
</tr>
</tbody>
</table>

The accompanying notes are an integral part of these combined statements.
| STEM Education: Establishing Engineering in Elementary Instruction |

**Massachusetts Audubon Society, Inc. and Wibbitz Wood Trust Fund**

**Financial Statements of Activities and Changes in Net Assets**

**For the Year Ended June 30, 2021 and 2020**

### 2021 Financial Statements

#### Public Support

<table>
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<tr>
<th>Unrestricted</th>
<th>Temporarily Restricted</th>
<th>Permanently Restricted</th>
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<th>Unrestricted</th>
<th>Temporarily Restricted</th>
<th>Permanently Restricted</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gifts, grants and bequests</td>
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<td>-</td>
<td>$8,441,256</td>
<td>$9,841,256</td>
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<td>2,776,300</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>Total unrestricted</td>
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<td>5,833,628</td>
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<td>11,217,458</td>
<td>11,617,458</td>
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<td>-</td>
<td>271,440</td>
<td>271,440</td>
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<td>271,440</td>
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<tr>
<td>Total grants</td>
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<td>6,105,068</td>
<td>-</td>
<td>11,790,338</td>
<td>11,888,908</td>
<td>-</td>
<td>23,679,246</td>
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<tr>
<td>Total contributions received</td>
<td>5,655,270</td>
<td>6,105,068</td>
<td>-</td>
<td>11,790,338</td>
<td>11,888,908</td>
<td>-</td>
<td>23,679,246</td>
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<tr>
<td>Total unrestricted &amp; contributions received</td>
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<td>6,086,116</td>
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<td>12,106,846</td>
<td>12,507,316</td>
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<td>Net assets released from program restrictions</td>
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#### Earned Revenue

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<th>Unrestricted</th>
<th>Temporarily Restricted</th>
<th>Permanently Restricted</th>
<th>Total</th>
</tr>
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<td>Program income</td>
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<td>10,216,383</td>
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<td>9,776,600</td>
<td>9,776,600</td>
<td>-</td>
<td>19,023,983</td>
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<td>Membership dues</td>
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<td>3,695,461</td>
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<tr>
<td>Other revenue</td>
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<td>-</td>
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<td>Total earned revenue</td>
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<td>13,472,061</td>
<td>9,776,600</td>
<td>-</td>
<td>23,248,661</td>
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#### Operating Expenses

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<th>Total</th>
<th>Unrestricted</th>
<th>Temporarily Restricted</th>
<th>Permanently Restricted</th>
<th>Total</th>
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<td>Program services</td>
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<td>23,133,384</td>
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<td>Administration and general</td>
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<td>-</td>
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<td>Development</td>
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<td>Changes in net assets from operations before depreciation</td>
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<td>8,461,053</td>
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<td>18,237,653</td>
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<td>Depreciation</td>
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<td>-</td>
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<tr>
<td>Changes in net assets from operations</td>
<td>1,905,883</td>
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<td>-</td>
<td>8,461,053</td>
<td>9,776,600</td>
<td>-</td>
<td>18,237,653</td>
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#### Non-Operating Revenue (Expenses)

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<th>Unrestricted</th>
<th>Temporarily Restricted</th>
<th>Permanently Restricted</th>
<th>Total</th>
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<td>Gain on sales of investments</td>
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<td>Change in value of split interest agreements</td>
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<td>(86,657)</td>
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<td>Contributions related to endowment</td>
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<tr>
<td>Write-off of capitalized marketing costs</td>
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<td>(3,441,887)</td>
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<td>-</td>
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<tr>
<td>Total non-operating revenue (expenses)</td>
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<td>(3,408,540)</td>
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<td>Net Assets, beginning of year</td>
<td>50,035,512</td>
<td>50,035,512</td>
<td>115,152,548</td>
<td>115,152,548</td>
<td>230,437,352</td>
<td>230,437,352</td>
<td>345,588,078</td>
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<tr>
<td>Transfer of funds designated for special projects</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Transfer of net assets</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
</tbody>
</table>

The accompanying notes are an integral part of these consolidated statements.
## MASSACHUSETTS AUDUBON SOCIETY, INC. AND WHETSTONE WOOD TRUST FUND

Combined Statements of Cash Flows  
For the Years Ended June 30, 2017 and 2016

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cash Flows from Operating Activities:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes in net assets</td>
<td>$12,836,058</td>
<td>$1,153,178</td>
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<tr>
<td>Adjustments to reconcile changes in net assets to net cash provided by (used in) operating activities:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>2,504,852</td>
<td>2,573,104</td>
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<tr>
<td>Bad debt – uncollectible pledges</td>
<td>35,196</td>
<td>147,695</td>
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<tr>
<td>Unrealized and realized (gains) losses on investments</td>
<td>(15,165,961)</td>
<td>4,286,784</td>
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<tr>
<td>Write-off of capitalized marketing costs</td>
<td>1,341,387</td>
<td>-</td>
</tr>
<tr>
<td>Capital grants</td>
<td>(2,976,347)</td>
<td>(3,175,385)</td>
</tr>
<tr>
<td>Endowment contributions</td>
<td>(1,707,036)</td>
<td>(502,378)</td>
</tr>
<tr>
<td>Changes in split-interest agreements</td>
<td>486,573</td>
<td>(770,055)</td>
</tr>
<tr>
<td>Forgiveness of long-term debt</td>
<td>-</td>
<td>(180,055)</td>
</tr>
<tr>
<td>Changes in operating assets and liabilities:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounts receivable</td>
<td>183,051</td>
<td>556,723</td>
</tr>
<tr>
<td>Pledges receivable</td>
<td>(226,255)</td>
<td>811,323</td>
</tr>
<tr>
<td>Inventory</td>
<td>14,018</td>
<td>(5,777)</td>
</tr>
<tr>
<td>Prepaid expenses</td>
<td>135,044</td>
<td>(193,169)</td>
</tr>
<tr>
<td>Accounts payable and accrued expenses</td>
<td>206,067</td>
<td>362,045</td>
</tr>
<tr>
<td>Amounts received in advance for future services</td>
<td>(2,212)</td>
<td>(233,300)</td>
</tr>
<tr>
<td><strong>Net cash provided by (used in) operating activities</strong></td>
<td>$(2,335,565)</td>
<td>$4,830,733</td>
</tr>
</tbody>
</table>

| **Cash Flows from Investing Activities:** |           |           |
| Purchase of property and equipment | (2,726,364) | (6,415,427) |
| Proceeds from sale of property and equipment | 965,626    | -         |
| Proceeds from sale of investments | 8,160,401 | 27,263,067 |
| Purchase of investments | (8,667,262) | (26,588,074) |
| Gift annuity contributions | 13,455     | 100,000   |
| Charitable remainder trusts contributions | -          | 584,674   |
| Payments to annuitants | (363,305) | (387,004) |
| **Net cash used in investing activities** | (2,617,449) | (5,442,764) |

| **Cash Flows from Financing Activities:** |           |           |
| Capital grants          | 2,976,347 | 3,175,385 |
| Endowment contributions | 1,710,536 | 503,378   |
| **Net cash provided by financing activities** | 4,686,883 | 3,678,763 |

| **Net Change in Cash and Cash Equivalents** |           |           |
| (266,131) | 3,066,732 |

| **Cash and Cash Equivalents:** |           |           |
| Beginning of year | 11,429,613 | 8,362,881 |
| End of year | **$11,163,482** | **$11,429,613** |

The accompanying notes are an integral part of these combined statements.
Appendix C:

**No Child Left Behind**

Differences in scoring can occasionally be something far from the educational program and a need for the government to step into our school systems to have set standards to meet regarding student progress, this is referred to as the No Child Left Behind (NCLB) law in Massachusetts. This law ensures that students who are not doing as well as their peers receive additional attention to stay with the material.

Despite differences at home, standardization attempts to put all students on an equal education background. Students from disadvantaged backgrounds are at an inherent educational disadvantage; standardized tests are no exception. While these students are at a disadvantage and have lower test scores, they are not necessarily less intelligent. These students require extra attention and focus at school, but it is difficult to make a program which compensates for any issues at home. Problems at home, make school extremely difficult and test scores reflect these problems, at times more than the student’s actual comprehension of the material. An example is a student who only eats at school and not at home, and then takes a standardized test where he cannot think because he/she is too hungry. Their low-test score is more of a function of how hungry they are and less of a function of how intelligent they are. On the other side of the spectrum, students who live in more opportune environments have readily available support sources through technology and books, as well as all basic necessities which makes their test scores a more accurate representation of intelligence and material comprehension.

One place where children from underprivileged backgrounds are specifically disadvantaged is access to an outdoor play area. Many low-income areas do not have suitable outdoor play areas. Lack of safe parks to play at, urban traffic patterns and supervision difficulties are just a few of the reasons children from low income areas have trouble getting outside and playing. Unfortunately, this outdoor play that some children lack access to is critical to their development. From confidence and responsibilities to creativity and physical shape, playing outside is key for developing children and people in general.

In an urban setting, our route is often dictated by sidewalks, crosswalks and walk signs. Our minds are held captive by advertisements, trucks blasting by and people bustling past us. Our attention, a slave to the busy urban landscape and fast paced tempo of the city. The passive tranquility of a more rural environment provides a rejuvenating juxtaposition to the urban prison. Both mind and body are free to choose their own path in a carefree manner. This sense of self determination and freedom, to do and think as we please, is critical for developing confidence and a sense of responsibility. The rugged, seemingly lawless terrain of a wooded path encourages children to explore beyond the beaten trail and truly choose their own direction.

When children “cut loose” outside, especially in a large setting, they improve their creativity from different kinds of stimulation. Getting out and running around is great for the mind and body. Many chemicals in the brain require a “reset”. Exercise helps with this “reset” and helps people sleep better which is also critical to a healthy mind. Physically, exercise is important for motor skill development, body development and weight control. Because of the limited opportunities to get out and play for underprivileged youth, recess in school is particularly important to students in low income areas.

Fortunately, most U.S. school systems allow an average of 27 minutes for recess, which allows kids especially from lower income homes to improve health, social development, and learning. Mandatory downtime away from education is important for students to remain focused and willingness to participate in class. Recess proves to be an important time for children to develop their creativeness and personable skills, but standardized testing stands in the way because
teachers feel the pressure of having to take away recess time for teaching and also serves as a tool for punishment to the students. This evidently hinders the students learning because: attention requires periodic novelty, that the brain needs downtime to recycle chemicals crucial for long-term memory formation, and that attention involves 90 to 110 minute cyclical patterns throughout the day (Jensen, 1998). In experimental studies, Pellegrini and Davis (1993) and Pellegrini, Huberty, and Jones (1995) found that elementary school children became progressively inattentive when recess was delayed, resulting in more active play when recess occurred.

In comparison to the U.S., other countries such as Finland spend an average of 75 minutes at recess and Japanese students get 10-15 minute breaks each hour in addition to a longer recess period. This begs the question of why do we continue to take away or shorten a valuable source that is intended as a mental break from academics but also serves to improve a child's development and interpersonal skills?
Appendix D:

**Issues Surround Standardized Testing**

The pressure of teaching to these tests have consumed educators and many feel as though their jobs are on the line if their students do not receive adequate test scores. Specifically, in the state of Massachusetts, there is a similar situation with the state standardized test being the Massachusetts Comprehensive Assessment System (MCAS). In the third grade MCAS only covers the knowledge of third graders in the English and Mathematics department. Although this seems like a great opportunity for educators to expand and elaborate Science lessons that are congruent with Massachusetts Curriculum Science Standards, this actually is a disadvantage for educators because MCAS only covers the retention of third graders in the English and Mathematics department. Therefore, educators spend less time teaching Science and more time teaching English and Mathematics. If a school system does poorly on MCAS, the state will become more involved in day to day operations and educators are often looked to be replaced. According to Bhattacharyya, teaching to the tests as these educators do, may result in higher test scores, but the overall level of student learning does not improve.\textsuperscript{22} With this reasonable concern for educators, presenting material that will be on MCAS becomes the main focus of educators ensuring that students will perform well and in turn the teachers will be seen as great educators. This drawback of too much emphasis on MCAS takes away from the students learning; current teaching methods of tedious multiple-choice assessments and lecturing is not as effective for student engagement and knowledge retention.\textsuperscript{7} There is simply no alternate solution at this time, because the state requires students to continue taking MCAS. Therefore, MCAS is simply an obstacle educators have to teach around.
Appendix E:

**Bloom’s Taxonomy**

This can be explained by Bloom’s Taxonomy. Bloom’s Taxonomy breaks learning ability into six levels. The most basic level of learning is knowledge, or simply just memorization of material. The next level is comprehension, which defends or explains what you have learned. Application builds off of this as the ability to change, compute, demonstrate, and relate it to a different situation. The Fourth level is analysis, which is the ability to breakdown, differentiate, and identify material. Fifth is synthesis, the ability to compile, create, and design material. Finally, Evaluation is the ability to appraise, conclude, criticize, interpret, and fully understand the material.\textsuperscript{27} Figure 6 is a visual reference for Bloom's Taxonomy. It is important for educators to recognize what level of learning the students are on, by having the basic levels of knowledge and comprehension the students simply memorize and explain the material that was presented by the instructor. The ultimate goal of teaching is for the students to evaluate and be able to use what they learn and apply this knowledge to something in the real world. Because of the pressures of standardized testing and NCLB Law, educators do not cover the material well enough and resort to having students learn through the bottom levels of Bloom’s Taxonomy pyramid.

![Bloom’s Taxonomy's 6 Levels of Learning](image)

Figure 6: Bloom’s Taxonomy
Appendix F:  

**Student Engagement is Important to a Student’s Success**

Engaging young students in education helps prepare them for the challenges they will face in the future. There are several different methods that get students to stay focused in school. Group assignments foster thoughtful discussions and help students engage each other.\(^{28}\) Throughout life there will be more opportunities to work as a group and by making sure that young students learn interpersonal skills early ensures that they will be more effective in the workforce. Engagement encourages students to be more willing to speak their minds to their teammates as opposed to the whole class or the teacher. In a collaborative environment there are no wrong answers, things can merely be more useful or less useful in a given solution. One teacher in the elementary school system described the experience as follows:

“In that kind of environment (group activities) when they work as a team, if they make a mistake they are not singled out, cooperatively they can come up with their own solution giving them more confidence to come up with a well thought out solution to the entire problem. If they are with another student, one student will listen to the other and often times will learn something, which helps prepare them for the future in school and in the workplace”.\(^{29}\)

This seems to be in direct connection with what Gallenstein says when describing how important it is to make a point to reward participation and encourage students to speak their mind even if they might be wrong.\(^{30}\) The best way to get students engaged in the material is to get them to the think about the material and be able to provide some feedback on the subject. Whether it is an answer to a problem or its concurrent with other students; group work makes this possible.
Congratulations! Count yourself lucky, you have been selected to take part in a WPI IQP Project that entails the creation of an expanded engineering curriculum to be used in conjunction with an elementary school field trip to Mass Audubon’s Wachusett Meadow Wildlife Sanctuary. In this project we will be working to educate teachers in the ways of presenting engineering to students as well as creating activities to supplement the elementary school’s current curriculum. You’re answers to our questions will be helpful in the development of our project, however your answers will remain anonymous. You also reserve the right to stop this interview at any time if you would like.

**Statement of Consent:** I have read the above information and have received answers to any questions I asked. I consent to take part in the study.

Your Signature _____________________________ Date _____________________________

Your Name (printed) __________________________________________________________

In addition to agreeing to participate, I also consent to having the interview script recorded.

Your Signature _____________________________ Date _____________________________

Signature of person obtaining consent _____________________________

Date _____________________________

Printed name of person obtaining consent _____________________________

Date _____________________________
Appendix H:

**Observation Form for Wachusett Sanctuary Visit**

**Activity:** Do Insects Freeze in Winter  
**Grade Levels in attendance:**  
**Educator’s Name:** Chris Eaton  
**Evaluator’s Name:**  
**Date:** 2/8/19  
**Start Time:** 1:00 PM  
**End Time:** 3:00 PM  

**Activity Evaluation:**
- Does the activity have an obvious goal or specific outcome?
- Does the activity provide enough background knowledge for the student to be able to do it?

**Participant Evaluation:**
- Are the students understanding the activity (comprehending the reason for doing it, and understanding the outcomes)?
- Are students interested in the activity, for example: engaged and asking questions?

**Educator Evaluations:**
- Does the educator seem excited about the activity?
- Does the educator have enough knowledge about the subject to answer any questions?

**Notes:**
-
Observation Form for Wachusett Sanctuary Visit

Activity: Do Insects Freeze in Winter

Grade Levels in attendance:

Educator’s Name: Chris Eaton
Evaluator’s Name: Matt/ Joey

Date: 2/8/19  Start Time: 1:00 PM  End Time: 3:00 PM

Activity Evaluation:

• Does the activity have an obvious goal or specific outcome?
  * Just a basic course in insects, providing background on identifying them and how they live.

• Does the activity provide enough background knowledge for the student to be able to do it?
  * Everything that the children needed to know was gone through at the beginning.
  * After knowledge was presented, a worksheet was presented after for deeper understanding.

Participant Evaluation:

• Are the students understanding the activity (comprehending the reason for doing it, and understanding the outcomes)?
  * Students were able to do worksheets and answer questions after the subject was taught so they were retaining and making connections.

• Are students interested in the activity, for example: engaged and asking questions?
  * Two students remained very engaged and 2 others struggled to stay on task during the lecture. No questions were asked by students.
  * Outside three kids were engaged in finding insects and they all really seemed to enjoy and wanted to continue doing it, but one student wasn’t really engaged or interested.

Educator Evaluations:

• Does the educator seem excited about the activity?
  * She was more than happy to teach the program, was very active with the students and got them involved with many activities.

• Does the educator have enough knowledge about the subject to answer any questions?
  * The instructor was extremely knowledgeable about the subject matter, answered all questions asked confidently

Notes:

• Went over basics of insects (characteristics) in the classroom area
• Activity to determine which are insects and which are not
• Showed real examples of insect specimens
• Modeling to create an insect of their own, cut out different parts of insects and then reassemble them in the correct way
• After program the instructor provides each homeschooled child's parent a packet with additional information for them to expand upon if desired.
• Students were given lots of objects to hold and look which made connections (ex. Students looked through Kaleidoscopes to understand how insects see)
Student Observation Form for Wachusett Sanctuary Implementation of Challenges

Activity: Redesign Animal Features
Grade Levels in attendance:

Educator’s Name:
Evaluator’s Name:

Date: Start Time: End Time:

Activity Evaluation:
- Was the activity appropriate for the time allocated?
- Does the activity provide enough background knowledge for the student to be able to do it? (they don't ask too many questions and have a clear idea of what needs to be done)
- Did the activity allow for equal opportunity for each student? (Based on different learning styles, every student was able to complete the activity in a timely manner)

Participant Evaluation:
- Are the students understanding the activity (comprehending the reason for doing it, and understanding the outcomes)?
- Are students interested in the activity, for example: engaged and asking questions?

Notes:
Semi-Structured Interview Questions:

1. What STEM (Science, Technology, Engineering, Mathematics) topics do you currently teach?

2. Which topics in STEM are you most comfortable teaching?

3. Do you feel comfortable teaching engineering? Why or why not?

4. In your experience, what kind of exposure to engineering do you have?

5. Do you think other teachers you have encountered including all age levels feel comfortable teaching engineering? Reasoning for this?

6. Do you think teaching engineering is important in early education? Why or why not?

7. Do you feel that STEM is valued in your school? Why or why not?

8. Has your school/district ever provided professional development in STEM or engineering?

9. Does your school dedicate resources such as time, money, activities to STEM or engineering? Please explain.
Student Observation Form at Clinton Elementary:
Educator’s Name: 
Grade Level: 3rd Grade 
Content Area: Static Electricity
Evaluator’s Name: 
Date: Time: Start: End:

TIME
• Did the activity take too long where the students were rushed and couldn’t finish experimenting?

• Was there enough explanation in the short introduction for the students to understand the procedure of the activity and then correctly conduct the activity.

ENGAGEMENT
• The students were emotionally ready to begin the activity upon our arrival to the classroom. An example of students not being emotionally ready are them not listening to directions or not being seated in their respected area.

• The students were attentive to the lesson statement and were prepared to begin experimenting. An example of this is students not speaking and facing myself (the instructor) as I am speaking.

• Students worked well in groups of four students (four including themselves). This entails the students share items with other group members, respect each other, communicate effectively with one another.

• The students enjoyed the activity and were truly interested and engaged in the challenge.

UNDERSTANDING
• Students made an educated guess on what the balloon would pick up based on a reasonable assumption. An example of this reasonable assumption can be that the eraser is too heavy and the paper is much lighter.

• Students were able to make a connection to what the balloon would pick up after conducting the experiment.
The students showed a level of understanding of static electricity after watching the end of assessment lesson to the exercise. The students were able to understand simple real world application of static electricity and the actions that are caused by static electricity.
Appendix I:

**Student Observation Form:**
Educator’s Name: Mrs. Cravedi  
Grade Level: 3  
Content Area: Static Balloon Activity  
Evaluator’s Name: Shannon Hynes  
Date: 2/14/2019  
Start: 10:30  
End: 11:00

**TIME**
- Did the activity take too long where the students were rushed and couldn’t finish experimenting?

No, there was extra time so we did more experiments and took our time with explaining and trying them all.

- Was there enough explanation in the short introduction for the students to understand the procedure of the activity and then correctly conduct the activity.

Yes, they understood and were able to conduct and understand the experiment. They struggled not touching the items when they didn’t work but other than that they conducted the activity well.

**ENGAGEMENT**
- The students were emotionally ready to begin the activity upon our arrival to the classroom. An example of students not being emotionally ready are them not listening to directions or not being seated in their respected area.

The students were all ready and in their seats, they had to get up to get materials but only one student per group did that not all of them. Generally a very good listening class.

- The students were attentive to the lesson statement and were prepared to begin experimenting. An example of this is students not speaking and facing myself (the instructor) as I am speaking.

They listened well to instructions and answered questions when asked. They did a really good job of coming together when we needed to make check-points.

- Students worked well in groups of four students (four including themselves). This entails the students share items with other group members, respect each other, communicate effectively with one another.

Students did great working in groups, they all had their own paper which made it easier for them to make their own assumptions. Due to the extra time students were able all able to test it and all were able to be involved in the process.

- The students enjoyed the activity and were truly interested and engaged in the challenge.
The students loved the activity and loved the balloons especially. They really enjoyed rubbing it on each others heads. They were really interested in what the balloon could pick up and understood that it was generally more apt to pick up light things.

UNDERSTANDING

- Students made an educated guess on what the balloon would pick up based on a reasonable assumption. An example of this reasonable assumption can be that the eraser is too heavy and the paper is much lighter.

Students were able to make accurate assumptions on what would happen with the balloon based on the weight and general knowledge.

- Students were able to make a connection to what the balloon would pick up after conducting the experiment.

The students were able to understand a weak force. They were able to understand the static was only strong enough to pick up light small things.

- The students showed a level of understanding of static electricity after watching the end of assessment lesson to the exercise. The students were able to understand simple real-world application of static electricity and the actions that are caused by static electricity.

They were able to make connections to real world static like shocks on the door or the rug or hair. They understood that was static electricity.
Student Observation Form:
Educator’s Name: Mrs. Cravedi
Grade Level: 3rd Grade
Content Area: Static Electricity
Evaluator’s Name: Matthew Bressette
Date: 2/14/19 Time Start: 10:30 End: 11:00

TIME
- Did the activity take too long where the students were rushed and couldn’t finish experimenting?

- We finished the activity early, and had the students go around the room picking different objects however it was extremely structured and only one person from each group was allowed to move at a time.

- Was there enough explanation in the short introduction for the students to understand the procedure of the activity and then correctly conduct the activity.

- The students had a good idea of the activity based on the explanation given, however it did take a bit of micromanaging to get the students to fill out the sheet.

ENGAGEMENT
- The students were emotionally ready to begin the activity upon our arrival to the classroom. An example of students not being emotionally ready are them not listening to directions or not being seated in their respected area.
  - The class was extremely well behaved.
  - The teacher kept very good control of the entire group.

- The students were attentive to the lesson statement and were prepared to begin experimenting. An example of this is students not speaking and facing myself (the instructor) as I am speaking.
  - They seemed to be paying attention and they didn’t get to crazy with the balloons which was surprising to me.

- Students worked well in groups of four students (four including themselves). This entails the students share items with other group members, respect each other, communicate effectively with one another.
  - The students worked well in groups of four, occasionally one person was a bit left out but only for a few seconds. All of the students were respectful of the other opinions in their group.

- The students enjoyed the activity and were truly interested and engaged in the challenge.
• The students had a really good time and loved doing the activity.

UNDERSTANDING

• Students made an educated guess on what the balloon would pick up based on a reasonable assumption. An example of this reasonable assumption can be that the eraser is too heavy and the paper is much lighter.

• The students were able to make pretty accurate guesses that the popsicle stick and the eraser would not get picked up however a lot of the groups struggled with the paper clip. If the paper clip was a very small one it should have been picked up but if it was a bigger one then it probably wouldn't move.

• Students were able to make a connection to what the balloon would pick up after conducting the experiment.

• Students made great observations trying out different things to pick up around the room like pieces of string, rice and laminated name tags.

• The students showed a level of understanding of static electricity after watching the end of assessment lesson to the exercise. The students were able to understand simple real world application of static electricity and the actions that are caused by static electricity.

• They understood the actions caused by static electricity, I tied it straight into static shocks.
Student Observation Form:
Educator’s Name: Mrs. Picariello
Grade Level: 3
Content Area: Static Balloon Activity
Evaluator’s Name: Shannon Hynes
Date: 2/14/2019 Start: 11:00 End: 11:30

TIME
• Did the activity take too long where the students were rushed and couldn’t finish experimenting?
Extra time so we did more experiments and took our time with explaining and trying them all. Had too much time honestly and panicked to do more thanks.

• Was there enough explanation in the short introduction for the students to understand the procedure of the activity and then correctly conduct the activity.
They struggled not touching the items when they didn’t work, they were able to do the project but took a little longer to go through and grasp what was happening.

ENGAGEMENT
• The students were emotionally ready to begin the activity upon our arrival to the classroom. An example of students not being emotionally ready are them not listening to directions or not being seated in their respected area.
The students were not really ready and were quite rowdy, they were given materials as I explained so didn't really listen.

• The students were attentive to the lesson statement and were prepared to begin experimenting. An example of this is students not speaking and facing myself (the instructor) as I am speaking.
They came together to make checkpoints but not all understood the checkpoints. Listened to me occasionally not always.

• Students worked well in groups of four students (four including themselves). This entails the students share items with other group members, respect each other, communicate effectively with one another.
Students did okay working in groups, they had one paper which made them discuss a lot which theory they wanted to go with which allowed them to really think. The students enjoyed the activity and were truly interested and engaged in the challenge.
The students loved the activity and loved the balloons especially. They really enjoyed rubbing it on each others heads. They were really interested in what the balloon could pick up and understood that it was generally more apt to pick up light things.

UNDERSTANDING
• Students made an educated guess on what the balloon would pick up based on a reasonable assumption. An example of this reasonable assumption can be that the eraser is too heavy and the paper is much lighter.
Students were able to make pretty accurate assumptions on what would happen with the balloon based on the weight and general knowledge. They mostly knew but a lot thought the paper clip and popsicle stick would work cause they are decently light.

- Students were able to make a connection to what the balloon would pick up after conducting the experiment. The students kind of understood the weak force. They were able to see the static was only strong enough to pick up light small things but didn’t quite understand it was the balloons force.

- The students showed a level of understanding of static electricity after watching the end of assessment lesson to the exercise. The students were able to understand simple real world application of static electricity and the actions that are caused by static electricity. They were able to make connections to real world static like shocks on the door or the rug or hair. They understood that was static electricity but didn't really make a static connection with that to the balloon.
**Student Observation Form:**
Educator’s Name: Mrs. Andrade  
Grade Level: 3rd grade  
Content Area: Static Electricity  
Evaluator’s Name: Matthew Bressette  
Date: 2/14/19  
Time Start: 11:00  
End: 11:30

**TIME**
- Did the activity take too long where the students were rushed and couldn’t finish experimenting?

- The activity was a bit short so we added an additional step where the kids would go around the room and try different objects to see what the balloon would pick up.

- Was there enough explanation in the short introduction for the students to understand the procedure of the activity and then correctly conduct the activity.

- The introduction went pretty well, the students understood that each person would get on object to test.

**ENGAGEMENT**
- The students were emotionally ready to begin the activity upon our arrival to the classroom. An example of students not being emotionally ready are them not listening to directions or not being seated in their respected area.

- The students responded very will to the 5 up cue.
- The students were very attentive when I was giving the explanation for the activity.

- The students were attentive to the lesson statement and were prepared to begin experimenting. An example of this is students not speaking and facing myself (the instructor) as I am speaking.

- The students did surprisingly well with handling the balloons and very rarely used them for their unintended use.

- Students worked well in groups of four students (four including themselves). This entails the students share items with other group members, respect each other, communicate effectively with one another.

- The students worked very well in groups of 4 even when they had to share only one worksheet.

- The students enjoyed the activity and were truly interested and engaged in the challenge.

- The students were very excited to do the activity
They were very engaged when testing out the different objects. The entire group was watching to see if the object moved.

UNDERSTANDING

- Students made an educated guess on what the balloon would pick up based on a reasonable assumption. An example of this reasonable assumption can be that the eraser is too heavy and the paper is much lighter.

- A lot of the students figured out that the balloon would only pick up the smaller lighter objects.

- Students were able to make a connection to what the balloon would pick up after conducting the experiment.

- The students were around the room as a group testing various objects and they had a pretty good idea of what would work and what wouldn’t based on the initial activity at their desks.

- The students showed a level of understanding of static electricity after watching the end of assessment lesson to the exercise. The students were able to understand simple real world application of static electricity and the actions that are caused by static electricity.

- After explanation they understood that static shocks happen for the same reason that the balloon would attract things.
Student Observation Form:
Educator’s Name: Mrs. Moore  
Grade Level: 3  
Content Area: Static Electricity  
Evaluator’s Name: Joe Terwilliger  
Date: 2/14/2019  
Time: 30  
Start: 10:00  
End: 10:30

TIME

- Did the activity take too long where the students were rushed and couldn’t finish experimenting?

The timing was just about right. I had time to answer questions and get side-tracked about topics the children found interesting but also did not have a lot of unused time at the end of the lesson. This was mainly because the activity could be broken down into simple steps and then time could be budgeted for each step in an organized way.

- Was there enough explanation in the short introduction for the students to understand the procedure of the activity and then correctly conduct the activity.

There was enough time to explain the activity to the students in a way that they could understand. Static electricity is a little bit complicated, but the students were able to understand the basic concept of making a prediction and then testing that prediction.

ENGAGEMENT

- The students were emotionally ready to begin the activity upon our arrival to the classroom. An example of students not being emotionally ready are them not listening to directions or not being seated in their respected area.

The students were extremely emotionally ready to begin the activity because the teacher gave them “a talk” before I entered the room. Additionally, the teacher informed me that her class was the best in the 3rd grade and that I should have no problems at all. She was right.

- The students were attentive to the lesson statement and were prepared to begin experimenting. An example of this is students not speaking and facing myself (the instructor) as I am speaking.

The students were attentive for the most part. Students were mainly interested asking and answering questions, and then playing with the balloon. The students were also most interested in the objects that were picked up (paper) as opposed to the ones which were not.

- Students worked well in groups of four students (four including themselves). This entails the students share items with other group members, respect each other, communicate effectively with one another.

The students worked relatively well in groups. I noticed that if I asked the group member writing to “be the leader” and personally see to it that the sheet got filled out, but still taking teammate considerations in mind, they took a pride in the work and also helped the distracted students stay focused. There were also groups with a notably distracting individual which made it difficult for anybody in the group to stay focused.
• The students enjoyed the activity and were truly interested and engaged in the challenge.

The students were very interested in playing with the balloons. They essentially rubbed their head with the balloon and then played with each other's hair for as long as we would let them. They were very disinterested in the writing aspect of the project, but they loved playing with static electricity in general. It was really good that one group member was willing to sit down and stay focused. Some other students even started trying to shock each other by rubbing their feet on the ground or balloon on their head. Lastly, they were interested in static electricity just because I was interested in it. Basically anything I talked about in an animated way retained their attention.

UNDERSTANDING

• Students made an educated guess on what the balloon would pick up based on a reasonable assumption. An example of this reasonable assumption can be that the eraser is too heavy and the paper is much lighter.

Many of the students got it right, some of them guessed all yes or all no and some of them had seemingly random guesses. Because they are in 3rd grade, they did not get a particularly specific understanding of the mechanics of static electricity so understanding why one material might work over another was extremely challenging and did not generally happen.

• Students were able to make a connection to what the balloon would pick up after conducting the experiment.

Students were not able to make connections to what picked up the balloon after conducting the experiment. Some of them understood that size was important and some of the students thought it was mainly a function of how long they rubbed the balloon on their head.

• The students showed a level of understanding of static electricity after watching the end of assessment lesson to the exercise. The students were able to understand simple real world application of static electricity and the actions that are caused by static electricity. The students understood the lesson as far as I was willing to explain it. Static electricity is complicated for 3rd graders so I did not get too deep into the explanation, but most students seemed to understand. Additionally, after the exercise, I asked a few questions referencing things they should have learned in the beginning and many of them were ready to answer. The students seemed to fully grasp all of the examples of static electricity, including: lightening, sparks in your blankets at night, shocking your friend while running on the carpet and of course, the frizzy hair.
**Student Observation Form:**
Educator’s Name: Mrs. Clouatre  
Grade Level: 3  
Content Area: Static Electricity  
Evaluator’s Name: Joe Terwilliger  
Date: 2/14/2019  
Time: 30  
Start: 10:30  
End: 11:00

**TIME**
- Did the activity take too long where the students were rushed and couldn’t finish experimenting?

The timing was fine even though I was late. I skipped the video at the end and explained the content myself to save a little bit of time and was able to get back on track easily. The students were not rushed, only kept on track with the task.

- Was there enough explanation in the short introduction for the students to understand the procedure of the activity and then correctly conduct the activity?

There was plenty of time to explain the procedure but I made the mistake of immediately handing out the balloons. Once the students got the balloons, they did not want to make predictions and just started testing immediately. On the bright side, most of the students were talking and thinking about the results of the experiment while they were rubbing the balloon on their head. Additionally, if a student did not see the result they expected, they usually ran the experiment themselves.

**ENGAGEMENT**
- The students were emotionally ready to begin the activity upon our arrival to the classroom. An example of students not being emotionally ready are them not listening to directions or not being seated in their respected area.

Students were completely ready for the activity because they had also been given a “talk” before started and their teacher was sitting in the back monitoring the kids closely. At the end they got a little jumpy because recess was next.

- The students were attentive to the lesson statement and were prepared to begin experimenting. An example of this is students not speaking and facing myself (the instructor) as I am speaking.

The students were partially attentive. Obviously there is always room for improvement, but for the most part the students were great. One of the greatest problems was students who were physically farther back in the classroom. Additionally, there was a huge range of attention span within the class; keeping an eye on the easily distracted students while giving attention to the person sitting down and writing seemed really beneficial.

- Students worked well in groups of four students (four including themselves). This entails the students share items with other group members, respect each other, communicate effectively with one another.

The group of four seemed best. We had one group of five, and two of them seemed to distract themselves while the other three worked on the project. In the group of four, all of the students tended to do the same thing. If they were getting distracted, it was easy to address the group and
get them back on track. Additionally, the person doing the writing usually kept pushing the
group to continue moving forward.

- The students enjoyed the activity and were truly interested and engaged in the challenge.

Students really did seem to enjoy the activity. They were engaged and excited to learn the
material and also see what it was that I was so interested about. Most of them were more
interested in playing with the balloon than actually filling out the sheet, but a few of them were
very interested in doing a good job as a group. Because I refereed to the person writing
everything down (often on the quiet side) as the “smart group leader,” they took a personal pride
in getting the rest of their teammates on the right track. To my surprise, they were great about
incorporating other group members ideas and did not just do it all themselves.

UNDERSTANDING

- Students made an educated guess on what the balloon would pick up based on a
reasonable assumption. An example of this reasonable assumption can be that the eraser
is too heavy and the paper is much lighter.

Some students made the exact right predictions, some predicted all yes or all no, and the rest had
seemingly random predictions. I do not think the students put any real thought into why they
picked each object, just used their best general intuition.

- Students were able to make a connection to what the balloon would pick up after
conducting the experiment.

Students were not able to make connections to what picked up the balloon after conducting the
experiment. Some of them understood that size was important and some of the students thought
it was mainly a function of how long they rubbed the balloon on their head.

- The students showed a level of understanding of static electricity after watching the end
of assessment lesson to the exercise. The students were able to understand simple real
world application of static electricity and the actions that are caused by static electricity.

The students understood the lesson as far as I was willing to explain it. Static electricity is
complicated for 3rd graders so I did not get too deep into the explanation, but most students
seemed to understand. Additionally, after the exercise, I asked a few questions referencing
things they should have learned in the beginning and many of them were ready to answer. The
students seemed to fully grasp all of the examples of static electricity, including: lightening,
sparks in your blankets at night, shocking your friend while running on the carpet and of course,
the frizzy hair.
Student Observation Form:
Educator’s Name: Mrs. Plump
Grade Level: 3
Content Area: Static Electricity
Evaluator’s Name: Brent Whitlock
Date: 2/14/2019    Time: 30    Start: 10:30    End: 11:00

TIME

- Did the activity take too long where the students were rushed and couldn’t finish experimenting?

No, after the students conducted the activity, there was plenty of time to give the real-world application of static electricity that extends past the end of the assessment video. Students moved at a fast but efficient pace. I spent about eight minutes trying to organize the groups with the teacher because desks were not pushed together and organized for this activity.

- Was there enough explanation in the short introduction for the students to understand the procedure of the activity and then correctly conduct the activity.

The introduction at the beginning explained the scope of the activity, the students were well prepared which was evident by the quality of work that they produced.

ENGAGEMENT

- The students were emotionally ready to begin the activity upon our arrival to the classroom. An example of students not being emotionally ready are them not listening to directions or not being seated in their respected area.

Yes the class was sitting in their respected areas and attentive as I walked in. Students were then placed into groups where they did so with ease. Students were eager to do the activity and cooperated very well with instruction.

- The students were attentive to the lesson statement and were prepared to begin experimenting. An example of this is students not speaking and facing myself (the instructor) as I am speaking.

The students were not talking as I was introducing the activity to the students. They were facing me as I was instructing and began working right away after I passed out the balloons to begin the activity.

- Students worked well in groups of four students (four including themselves). This entails the students share items with other group members, respect each other, communicate effectively with one another.

The students worked very well in groups of four students. The students shared the balloon and each tested one item which followed the directions. Students made guesses together to why the paper was able to stick to the balloon but not the other items. There was one group of five students and this group struggled more so than the other groups. In this group, it seemed that two
out of the five students seemed to be playing with the balloon more so than the project which resulted in that group taking longer to finish. This may because the group size was too big.

- The students enjoyed the activity and were truly interested and engaged in the challenge.

The students had a very fun time. As soon as the students saw the balloons, this brought excitement for them to be playing with them. Students wanted to keep them as well so it seemed to be a great age group to introduce this kind of activity. The students seemed thrilled to have someone new in their classroom, especially a younger adult. The students tended to be more active.

**UNDERSTANDING**

- Students made an educated guess on what the balloon would pick up based on a reasonable assumption. An example of this reasonable assumption can be that the eraser is too heavy and the paper is much lighter.

The students discussed with each other which material would stick based off of the first part of the activity. I heard discussions of the size of the object, weight, and length could influence which item could be picked up which was great.

- Students were able to make a connection to what the balloon would pick up after conducting the experiment.

After the activity the students made the assumption that because the paper was lighter, so the balloon was able to pick it up. They did not previously know the charges at this point.

- The students showed a level of understanding of static electricity after watching the end of assessment lesson to the exercise. The students were able to understand simple real-world application of static electricity and the actions that are caused by static electricity.

Once watching the end of the assessment video, the class openly engaged in a discussion on the charges. Students first started saying the paper was able to be picked up by static electricity, then I stated well why does the static electricity happen. The next student states that it is the charges, and then I further say what do the charges have to be in order for this attraction. The third student then says there needs to be a positive and negative charge. By me continuing to ask further questions, the students were able to develop this thought process.
Student Observation Form:
Educator’s Name: Ms. Zinkus
Grade Level: 3
Content Area: Static Electricity
Evaluator’s Name: Brent Whitlock
Date: 2/14/2019
Time: 30
Start: 11:00
End: 11:30

TIME
• Did the activity take too long where the students were rushed and couldn’t finish experimenting?

The activity was exactly thirty minutes. The teacher and I had issues trying to set up the projector which led to taking a minute or two for the students to reorganize and gather around a small laptop screen to watch the end of assessment video. Multiple times I had to tell the students to quiet down for the next plans of the activity.

• Was there enough explanation in the short introduction for the students to understand the procedure of the activity and then correctly conduct the activity.

The introduction was thorough enough for the students to begin working and know what they should be doing.

ENGAGEMENT
• The students were emotionally ready to begin the activity upon our arrival to the classroom. An example of students not being emotionally ready are them not listening to directions or not being seated in their respected area.

The students were all sitting together when I walked in, they were quiet and eager. It took some time to break the students up into groups and respected areas.

• The students were attentive to the lesson statement and were prepared to begin experimenting. An example of this is students not speaking and facing myself (the instructor) as I am speaking.

The students were less attentive because they seemed to want to play with balloons. Students asked a lot of questions that were not very pertinent to the activity at hand. This seemed to interrupt others and cohesiveness of the activity for the students in general.

• Students worked well in groups of four students (four including themselves). This entails the students share items with other group members, respect each other, communicate effectively with one another.

These group of students struggled to work together and share. There were a few groups with students not participating with group dynamic not meshing. This was also Valentines Day so some students may be upset or distracted. The work environment was very loud because the
students were very excited to be working with balloons and when they received positive results with the paper sticking to the balloon.

- The students enjoyed the activity and were truly interested and engaged in the challenge.

The students were excited about working with new resources such as balloons. The students really enjoyed the hands-on learning experience.

**UNDERSTANDING**

- Students made an educated guess on what the balloon would pick up based on a reasonable assumption. An example of this reasonable assumption can be that the eraser is too heavy, and the paper is much lighter.

Most groups struggled to explain what they believe the balloon would pick up.

- Students were able to make a connection to what the balloon would pick up after conducting the experiment.

Some students did not quite understand why this was, they did not make the connection of static electricity until I showed the end of assessment video.

- The students showed a level of understanding of static electricity after watching the end of assessment lesson to the exercise. The students were able to understand simple real-world application of static electricity and the actions that are caused by static electricity.

After showing the video I explained what happened because of time for the students to understand the concept of static electricity. Students made a similar connection to the lesson topic that they are currently on with magnets. Magnets attract opposites and so do charges. The students then asked a series of questions about the applications of static electricity and made connections to rubbing your feet on the carpet and touching the door knob, going down the slide and zapping yourself, or touching something with a different charge and zapping yourself. This class seemed like it was behind my previous class I demonstrated too, but slowly started making the connection to static electricity in other applications beyond this activity.
Balloon Challenge

Name: __________________________
Date: __________________________

Directions:
1. Will the static filled balloon make these things move?

<table>
<thead>
<tr>
<th>Objects</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td></td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>NO</td>
<td></td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

2. Get a balloon from your teacher and rub it on your head very fast for 15 seconds without popping it. Repeat this for each object.

3. Hold the static filled balloon about 1 to 2 inches over the pile of materials and record what happens below.

4. After you see what happened to that object, explain why that object moved or did not move.
Fill in observations here.

<table>
<thead>
<tr>
<th>Objects</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stick to balloon</td>
<td>-move slightly to</td>
<td>center and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>almost stick</td>
<td>stay still, no</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>movement</td>
</tr>
</tbody>
</table>

What did the pile do...
- Stick to balloon
- Move slightly to center and almost stick
- Stay still, no movement

I think it worked because paper contains the materials and is light enough to be attracted by static electricity.

I think it works because it is light enough.

The same.
Balloon Challenge

Name: __________________________
Date: __________________________

Directions:
1. Will the static filled balloon make these things move?

<table>
<thead>
<tr>
<th>Objects</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Get a balloon from your teacher and rub it on your head very fast for 15 seconds without popping it. Repeat this for each object.

3. Hold the static filled balloon about 1 to 2 inches over the pile of materials and record what happens below.

4. After you see what happened to that object, explain why that object moved or did not move.
<table>
<thead>
<tr>
<th>Objects</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paper clip</td>
<td>Paper</td>
<td></td>
</tr>
</tbody>
</table>

**What did the pile do...**
- Stick to balloon
- Move slightly to center and almost stick
- Stay still, no movement

<table>
<thead>
<tr>
<th></th>
<th>NO</th>
<th>YES</th>
<th>NO</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>The paper clip did not move much</td>
<td>The paper clip did not move much</td>
<td>The paper clip did not move much</td>
<td>The paper clip did not move much</td>
<td>Because its too heavy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>G</th>
<th>F</th>
<th>K</th>
<th>A</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comb</td>
<td>Balloon</td>
<td>That par can</td>
<td>I love Valentine's Day</td>
<td>I am going to rub my feet on the floor</td>
</tr>
<tr>
<td>= Balloon</td>
<td></td>
<td>Dance</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Balloon Challenge

Name: \\
Date: \\

Directions:
1. Will the static filled balloon make these things move?

<table>
<thead>
<tr>
<th>Objects</th>
<th>![Paperclip]</th>
<th>![Paper]</th>
<th>![Stick]</th>
<th>![Eraser]</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>NO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Get a balloon from your teacher and rub it on your head very fast for 15 seconds without popping it. Repeat this for each object.

3. Hold the static filled balloon about 1 to 2 inches over the pile of materials and record what happens below.

4. After you see what happened to that object, explain why that object moved or did not move.
Fill in observations here.

<table>
<thead>
<tr>
<th>Objects</th>
<th>Paperclip</th>
<th>Paper</th>
<th>Marker</th>
<th>Eraser</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>What did the pile do...</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stick to balloon</td>
<td>Did <em>not</em> stick</td>
<td>Sticked</td>
<td>Did <em>not</em> stick</td>
<td>Did <em>not</em> stick</td>
</tr>
<tr>
<td>Move slightly to center and almost stick</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stay still, no movement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It worked because it is made of sticky paper.

No, that's wrong.
Student Observation Form for Wachusett Sanctuary Implementation of Challenges

Activity: Redesign Animal Features (Predator vs Prey)
Grade Levels in attendance: 5 yo to 9 yo
Educator’s Name: Jenn Riley
Evaluator’s Name: Matthew Bressette
Date: 2/20/19  Start Time: 1:00 PM  End Time: 1:45 PM

Activity Evaluation:
- Was the activity appropriate for the time allocated?
- The activity did take the desired amount of time.
- Does the activity provide enough background knowledge for the student to be able to do it? (they don’t ask too many questions and have a clear idea of what needs to be done)
- The kids were extremely knowledgeable about the subject before we started the activity. This allowed us to ask our own questions of the students and have learn from each other.
- Did the activity allow for equal opportunity for each student? (Based on different learning styles, every student was able to complete the activity in a timely manner)
- The younger students struggled a bit with the writing portions of the activity.

Participant Evaluation:
- Are the students understanding the activity (comprehending the reason for doing it, and understanding the outcomes)?
- The kids understood the activity, and did a great job however, some students went a little too far by adding lasers or giving the animal a helium tank to fly.
- Are students interested in the activity, for example: engaged and asking questions?
- The kids didn’t really ask that many questions of their own, but they were more than happy to talk about the adaptations they made.
- The kids seem very engaged in the activity and always willing and ready to contribute.

Notes:
- One of the students knew the difference between poison and venom.
- Some of the interesting adaptations included: a poisonous bite, claws for a rabbit to be able to climb a tree, and additional reproducibility for coyotes.
Student Observation Form for Wachusett Sanctuary Implementation of Challenges

Activity: Redesign Animal Features (Predator vs Prey)
Grade Levels in attendance: 5 yo to 9 yo
Educator’s Name: Jenn Riley
Evaluator’s Name: Brent Whitlock
Date: 2/20/19 Start Time: 1:00 PM End Time: 1:45 PM

Activity Evaluation:

• Was the activity appropriate for the time allocated?
The forty five minute period was plenty of time for the students to understand each animal and to illustrate as freely as they would like.

• Does the activity provide enough background knowledge for the student to be able to do it? (They don't ask too many questions and have a clear idea of what needs to be done)
The students were provided a paper with each animal that they were asked to redesign. The students collaborated with one another to have further opinions on each animal for their own redesign.

• Did the activity allow for equal opportunity for each student? (Based on different learning styles, every student was able to complete the activity in a timely manner)
Yes the activity allowed for equal opportunity because the activity was kept simple for all ages. Students asked many questions and were even providing further information on each animal to help others that may not know as much or if the instructors did not cover this additional information.

Participant Evaluation:

• Are the students understanding the activity (comprehending the reason for doing it, and understanding the outcomes)?
Most students already knew a great deal about these animals or other similar predators or prey because of the activities they have learned prior to ours at Wachusett Meadow. This was great for the students to brainstorm ideas. Specific examples the students gave were the correlation of coyotes being good predators because of their speed and strong legs that allow for long duration hunts. Another older student of the age of nine made a comment that bears are actually omnivores and that mother grizzly bears eat mostly grass. I noticed that the younger students were more eager to participate and kept simple one redesign application, while older students made thorough more descriptive redesign changes that are higher level thinking such as limbs growing back and venomous bite. Majority of the students were able to figure out which is a predator and which is the prey animal.

• Are students interested in the activity, for example: engaged and asking questions?
Students were very interested in the predators especially. Students were engaged and asking questions prior. Once starting the activity, students wanted to just illustrate rather than listing the animals strengths prior to drawing. Younger students typically struggled with the writing portions.

Notes:
Student Observation Form for Wachusett Sanctuary Implementation of Challenges

Activity: Redesign Animal Features (predators vs prey)
Grade Levels in attendance: 5yr-9yr

Educator’s Name: Jenn Riley
Evaluator’s Name: Joey Terwilliger
Date: 2/20  Start Time: 12:30  End Time: 2:00

Activity Evaluation:
- Was the activity appropriate for the time allocated?
  Yes, the activity could be done either quickly or slowly. For us, it was about as long as the activity could have gone.
- Does the activity provide enough background knowledge for the student to be able to do it? (they don’t ask too many questions and have a clear idea of what needs to be done)
  The activity provided enough background knowledge but the students added to the lesson themselves to make it significantly more substantial.
- Did the activity allow for equal opportunity for each student? (Based on different learning styles, every student was able to complete the activity in a timely manner)
  The activity did provide equal opportunity for each student; despite the age range, all students were engaged with one minor exception. A significantly older boy seemed a little disinterested, probably because he thought the exercise was below him.

Participant Evaluation:
- Are the students understanding the activity (comprehending the reason for doing it, and understanding the outcomes)?
  The students understood the activity in their own capacity. Some of the younger students adapted the animals with mechanical features; but all of the students understood the idea of an animal having a job and needing to be designed to do that job.
- Are students interested in the activity, for example: engaged and asking questions?
  The students were extremely interested in the activity and asked questions the entire time.

Notes:
A younger student struggled to sit still especially while people were presenting, and kept scribbling over his work. After a few new worksheets, he drew a bunny with a laser turret on it’s back and illustrated the ensuing turmoil.
Student Observation Form for Wachusett Sanctuary Implementation of Challenges

Activity: Redesign Animal Features (predators vs prey)

Grade Levels in attendance: 5yr-9yr

Educator’s Name: Jenn Riley
Evaluator’s Name: Shannon

Date: 2/20/2019                      Start Time: 1:00                      End Time:1:45

Activity Evaluation:

• Was the activity appropriate for the time allocated?
  Yes, the students were able to do the whole worksheet and color in their animals in the time allocated. They even go to present their improved animals at the end to the class with the extra time.

• Does the activity provide enough background knowledge for the student to be able to do it? (they don't ask too many questions and have a clear idea of what needs to be done)
  Yes they understood all the knowledge and even had some had prior knowledge going into it. They had more things to contribute than to ask questions about.

• Did the activity allow for equal opportunity for each student? (Based on different learning styles, every student was able to complete the activity in a timely manner)
  They were all able to do the activity, some had better ideas and understood the idea of the project a little better than others, usually due to the age difference.

Participant Evaluation:

• Are the students understanding the activity (comprehending the reason for doing it, and understanding the outcomes)?
  They all understood the activity, some more than others. A lot of them made crazy changes so maybe specifying they need to change an animal trait not add laser eyes would be beneficial

• Are students interested in the activity, for example: engaged and asking questions?
  The students were definitely interested and participated a ton when asked questions and gave a lot of good information when we were talking about the animals.

Notes:

• Super interested when talking about the animals, we also passed fur and paws around which helped them get a better understanding of the animal
• Knew a lot about the animals, some kids more than others but they all understood which was a predator and which was prey
• Understood omnivores and explained how predators eat not only prey but plants too
• Some kids were too young to write but understood the concepts, some knew a ton about the animals and made really good connections between the prey and predators enough to really make genuine changes to the animals
• Some students were really thinking about the animals flaws and were able to produce features as solutions for an animals lifestyle
Appendix J:  

**Semi Structured Teacher Interview (early)**

Interviewee: Carolyn Bressette - Spencer East Brookfield Elementary School Teacher  
Time and Place of Interview: 11/23/18 19 Lakeshore Drive Fiskdale MA, 01518

Question: What kind of role does MCAS play in day to day teaching of class?

Answer: You have to address what the MCAS is going to assess. You are driven by the MCAS on how to teach even though the state says not to, but everyone does it because you want the students to know what they are being assessed on.

Question: What are some standard techniques for keeping 3rd grade students engaged in material?

Answer: Find what motivates the student. Have a lot of hands on activities that make them accountable for their own work. They need to monitor their own work and feel a sense of accomplishment.

Question: Do you have any tips for creating a curriculum in a way that helps students stay engaged?(keep it broad)

Answer: Hold them accountable of what they learning, recording sheets on what they are learning is helpful. Recording answers (making tallies) to track their responses. Work as teams not as individuals. Environments should be able to be reconfigured to change throughout the day keeping things on the fly. Correlate to real world problems.

Question: Has there been a noticeable shift towards STEM education in recent years? And if so what was the impact of it?

Answer: yes, they(the teachers) try to incorporate the lessons to have science and technology in them. Most public schools have the technology now that supports that kind of learning. Society is driving this, all the states are pushing this agenda not just massachusetts. The nation as a whole is dictating that it must be incorporated because we are falling behind compared to other countries.

Question: In what ways if at all does STEM education differ from standard math and english?

Answer: Usually in the standard way of teaching, we were saying this is the answer just dictating what they are learning. The new STEM pursuit allow them to experiment on their own and come up with a solution to the problem, they are learning on their own.

Question: How receptive would 3rd grade students be to hands on design challenges?

Answer: very receptive, they should investigate, collaborate and be creative

Question: Do you see any problems with current education curriculums at a 3rd grade level? And if so please describe
Answer: The kinds are not allowed to make mistakes. In the STEM theory you are allowed to make mistakes and come up with different solutions, in the standard way of teaching this is not normal. The benefit of the STEM theory is that they will come up will several solutions in different ways that will enhance their learning experience, helping them think outside the box.

Question: What happens if a school is doing poorly on MCAS testing?

Answer: The state will come in and help the school address their needs, they will assist them in coming up with a solution that will help the students learn better.

Additional Notes: I think the kids are more receptive to learning that way(STEM), keeps them excited about learning. That kind of environment(STEM) if they work as a team, if they make a mistake they are not singled out, cooperatively they can come up with a solution giving them more confidence to come up with a solution. If they are with another student, one student will listen to the other and often times will learn something, which helps prepare them for the future in school and in the workplace, that’s something that I see when I work with the students.
Semi-Structured Teacher Interview

**Interviewee:** Andrew Wood (Teacher in Newton public schools for over a decade teaching 3rd grade, now teaches at a school in VT)

**Interviewers:** Brent Whitlock

**Date:** 2/13 at 9 AM-10 AM

**Understanding Engineering**

1. What STEM (Science, Technology, Engineering, Mathematics) topics do you currently teach?

For many years he taught 6th grade. Now teaches 4th and 5th grade in VT. Background in placed based teaching of history and science to create curriculum. Integrated curriculum is very much like STEM because it uses outside knowledge of nature given where they live. He was Math and Science teacher in Newton. Every topic he tried integrating engineering and science activities. Math is the hardest to integrate because it is harder to use outside sources. They teach how to tap trees, building water filters, and building desks for the classrooms in VT.

2. Which topics in STEM are you most comfortable teaching?

Science and Math because of his experience.

3. Do you feel comfortable teaching engineering? Why or why not?

Comfortable to teach because of his experience over time. He enjoys the activities and its dynamic of changing.

4. In your experience, what kind of exposure to engineering do you have?

Integrated engineering in his curriculum because of his use of projects. Has no experience in engineering when it comes to higher level of education. Previously it was never in his background.

5. Do you think other teachers you have encountered including all age levels feel comfortable teaching engineering? Reasoning for this?

Three types of teachers: Jump on projects, neutral, resistors. People spend a lot of time getting the resistors to join the movement. If you were a camp counselor or have engineering in your background from college they will be on board. Old school teachers may be against this new style of teaching because the students may be difficult to control, loud noises, and materials everywhere; therefore it would be overwhelming for them. Teachers who pursue teaching elementary or middle school would most likely not take a class with engineering lessons or engineering integrated in the classroom. Engineering is an intimidating term, people may not be able to scale that term down for a 3rd grader. Teachers don't have a good sense of what that looks like for a 3rd grader.

6. Do you think teaching engineering is important in early education? Why or why not?

Absolutely. His definition of engineering is higher level Bloom's taxonomy, designing, collecting data, prototyping. Depending on the demographic not all kids will be ready for advanced activities because of intellectual development, emotional instability, and at home lifestyle.

7. Do you feel that STEM is valued in your school? Why or why not?
Varies from principle to principle and district. In Newton the principles were hands off and administrators changed fairly frequently. Parents were supportive and typically well educated backgrounds being from MIT and other higher level education. The principle in VT is very supportive of STEM because they want to develop the curriculum around the area and lifestyle they live.

8. Has your school/district ever provided professional development in STEM or engineering?

They have a STEM teacher in VT that serves as an additional helper. In any school, teachers vary on development of what a teacher can handle with messiness of projects and hands on learning.

9. Does your school dedicate resources such as time, money, activities to STEM or engineering? Please explain.

VT is very supportive of STEM. Supportive of bringing in local outside sources into the school to learn about water quality services and building desalination filters and water filtration devices. Hiring half time staff teacher dedicated to supporting STEM in the classroom for the following year that will serve as putting on activities for the students and restructuring the curriculum to cater to STEM learning.

Notes:

Good start to Mystery Science, the kids like it, but unconnected to the experience to the rest of the school. Kids learn over time and meaning, one day is not enough to build meaning over time. There is a missed opportunity there. Fun isolated lesson.

Replace the playground mulch material. This serves as an opportunity to give a lesson activity. Lessons on testing the bark or tire instead of using mulch in playground area. There are benefits of using these materials instead. Kids to fall safely onto these materials.

Push for going to Mass Audubon 3 times a year to get a better feel and continue learning.

Debunk for teachers that it is just not science and mathematics. Engineering is *state definition* but engineering is also kids rubbing balloons on their heads. They are naturally engineers.
**Semi-Structured Teacher Interview**

Understanding Engineering

**Interviewee:** Andrew Wood (Teacher in Newton public schools for over a decade teaching 3rd grade, now teaches at a school in VT)

**Interviewers:** Matthew Bressette

**Date:** 2/13 at 9 AM-10 AM

1. **What STEM (Science, Technology, Engineering, Mathematics) topics do you currently teach?**

Focus on integrated curriculum, that brings all of different subjects together. Math is more difficult to integrate. They have built desks, made maple syrup and built water purifiers with his 4th and 5th grade classes.

2. **Which topics in STEM are you most comfortable teaching?**

Taught science and Math in Newton but has incorporated all of STEAM

3. **Do you feel comfortable teaching engineering? Why or why not?**

He embraces the mess that comes along with engineering

4. **In your experience, what kind of exposure to engineering do you have?**

No previous experience with engineering in education

5. **Do you think other teachers you have encountered including all age levels feel comfortable teaching engineering? Reasoning for this?**

This all depends on the teacher, some are gung-ho and willing to get after it and others are more neutral while the old school teachers will resist any changes. In the elementary levels the teachers have very little experience with engineering, in middle school is rare, and in high school can be found among math and science teachers.

6. **Do you think teaching engineering is important in early education? Why or why not?**

He thinks engineering is important in early education. He believes that engineering is linked to bloom's taxonomy, and then to higher level thinking skills.

7. **Do you feel that STEM is valued in your school? Why or why not?**

This varies from principal to principle. In Newton the principles were pretty hands off and were not the most supportive of STEM. Families were very supportive, and admin was more neutral. In his Vermont school the principle is 100% behind any efforts that he makes to include new STEM material in his classroom.
8. Has your school/district ever provided professional development in STEM or engineering?
Yes, to STEM related material (science and math) not to engineering directly though. Cross curricular activities in STEM yes.

9. Does your school dedicate resources such as time, money, activities to STEM or engineering? Please explain.
For the upcoming school year they are hiring a part time STEM/Place Based support person who will be able to help the teachers plan out curriculums and maybe even conduct certain activities in the teachers elementary classrooms.

Notes:
- Something to note is that not all students are ready for those higher-level thinking activities and the development of the skills associated with them.
- “Schools are more focused on standardized testing instead of messy engineering projects.”
- Teachers sometimes walk in a room with messy engineering projects and cannot handle it. He on the other hand thinks of it as a good day when his classroom is a mess with paint everywhere and materials out because it means the children were getting involved and having a fun engaging experience.
- David Sobel, Antioch university
- Mystery science is a good starting point
  - Seems unconnected to the rest of the student experience
  - Students learn over time by connecting and building meaning.
- Could do an activity on the safety bark used in the playground. Could test out different things like bark, rubber, cork. Kids dropping things from the top to see how high they bounce.
- Think about what they do before they go on the field trip.
- Push for 3-4 visits to the sanctuary repeat exposure. Can get a grant to pay for busses.
- Engineering can be an intimidating term for teachers. They often times cannot think about what engineering would look like with third grade students.
- Feel as though social studies and science are tacked on at the end of the week instead of focused on.
- In our presentation to the teachers make sure that we debunk the idea that engineering is just high-level mathematics done by adults. Say engineering is also kids with balloons rubbing them on their heads.
Semi-Structured Teacher Interview

Interviewee: Carolyn Bressette, Elementary Teacher at East Brookfield Elementary

Date: 2/17 at 11 AM - 11:30 AM

Interviewer: Matthew Bressette

1. What STEM (Science, Technology, Engineering, Mathematics) topics do you currently teach?
   • She doesn’t teach them particularly but she does spend time in the inclusion classroom of teachers who do.

2. Which topics in STEM are you most comfortable teaching?
   • Comfortable teaching science, Math and engineering.

3. Do you feel comfortable teaching engineering? Why or why not?
   • Yes, It’s something that can be applied to real life and therefore it is a concrete skill. It’s important that they have access to something that is concrete.

4. In your experience, what kind of exposure to engineering do you have?
   • No professional development towards engineering (had to gain some exposure by going online to different website).
   • Also married to a Civil Engineer

5. Do you think other teachers you have encountered including all age levels feel comfortable teaching engineering? Reasoning for this?
   • Yes, it starts in preK with lego blocks and foam blocks.
   • They haven't been given professional development on engineering but they focused on reading and math in their own education and don't incorporate science as much as they should.

6. Do you think teaching engineering is important in early education? Why or why not?
   • Yes, applications are in real life, everyday practices

7. Do you feel that STEM is valued in your school? Why or why not?
   • Yes, it’s on the rise. There is one elementary teacher assigned to teaching science in all the grades. Her focus is mainly science and they also have another one that only focuses on teaching math not all of the subjects. It allows the teacher to better understand what the students need to learn and can build on it every year instead of just have the same students for one year.
8. Has your school/district ever provided professional development in STEM or engineering?

- No professional development. Next year they are supposed to be getting Math but now they only focus on reading. Because something like 80% of elementary kids can’t read (research) in the district. The bilingual kids struggle to do this specifically second English language learners.

9. Does your school dedicate resources such as time, money, activities to STEM or engineering? Please explain.

- No, not much of anything.

Notes:

- Focus more on reading than STEM
- They do teach them that engineers build things, like legos the engineers would build a wall and then you could blind someone and put them through a maze to test it out. (they also have little ladybug robots to go around and solve a problem).
Semi-Structured Teacher Interview

Teacher: Kathy Chalupka
Grade: 3rd
School: Swanson Road Intermediate School, Auburn MA
Interviewer: Shannon Hynes
Date: 2/17/2019

Understanding Engineering

1. What STEM (Science, Technology, Engineering, Mathematics) topics do you currently teach?
   - Science just changes this year by national core standards, so STEM gets brought in with that so auburn has aligned with the COMMON CORE, used mystery science prior, they use the person program which is a lot of projects.
   - Common core is less exploring and more projects, mystery science was more exploratory, usually projects near holidays
   - Example Halloween, they make parachute for spiders, come up with how long it will take for candy to dissolve in liquids
   - Used to do a lot of mystery science
   - Always taught math and science so new component is making experiments
   - Moved away from mystery science for MCAS reasons

2. Which topics in STEM are you most comfortable teaching?
   - Obviously not an expert in any of them but generally they’ve been pushing it more in school, so they are all becoming more comfortable.

3. Do you feel comfortable teaching engineering? Why or why not?
   - Wasn’t part of training, mostly through experience.
   - Teachers need more training

4. In your experience, what kind of exposure to engineering do you have?
   - Never clearly taught but has learn to teach it through experience and different programs

5. Do you think other teachers you have encountered including all age levels feel comfortable teaching engineering? Reasoning for this?

6. Do you think teaching engineering is important in early education? Why or why not?
   - Early ages is great to start, super important to learn failure at a young age
   - Younger the better
   - Design process and learning from failure and growing with that

7. Do you feel that STEM is valued in your school? Why or why not?
• STEM isn't overlooked, definitely being pushed way more now than before, definitely growing and will be more in the next few years
• Also becoming woven into their testing / engineering
• MCAS in 5th grade is now becoming way more engineering

8. Has your school/district ever provided professional development in STEM or engineering?
• Nothing has been to her knowledge, most
• She’s been part of the science committee, so they go to Boston science museum and talk about curriculum.

9. Does your school dedicate resources such as time, money, activities to STEM or engineering? Please explain.

NOTES:
Appendix K:

Understanding the Dimensions of the STE Frameworks

1) Start with the Standard(s).

2) Break down the standard:
   a. What is it asking the students to do? (Practice)
   b. What concept is it asking the students to know? (Core Idea) Consider what vocabulary
      the students need to know to understand this concept.
      Core idea:
      Vocabulary:
   c. Is there any relationship to other scientific phenomena? (Crosscutting Concepts)

3) What are some of the outcomes you would expect to see?

Need more information?
Google: NGSS Evidence Statements and search for the standard
## STEM Education Quality Framework

<table>
<thead>
<tr>
<th>STEM Learning Quality Component</th>
<th>Not Evident</th>
<th>Emerging</th>
<th>Accomplished</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The learning experience has little or no potential for student engagement given the prior knowledge and/or skill level of the targeted class.</td>
<td>The learning experience has potential for engaging some of the students in the targeted class given their prior knowledge and experience. For example, the task may be appropriate for some students, while being too challenging, or not challenging enough for others.</td>
<td>The learning experience has potential for engaging most of the students in an academically homogeneous class, or is differentiated to meet the needs of subgroups of diverse learners in the targeted class.</td>
<td>The learning experience, in addition to being appropriately leveled or differentiated to provide students with the opportunity for academic success, is designed to challenge the minds and stimulate the imaginations of learners with diverse histories of academic success.</td>
</tr>
<tr>
<td><strong>1. Potential for Engaging Students of Diverse Academic Backgrounds</strong></td>
<td>Quality STEM learning experiences are designed to engage the minds and imaginations of students of diverse academic backgrounds.</td>
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<tr>
<td><strong>2. Degree of STEM Integration</strong></td>
<td>Quality STEM learning experiences are carefully designed to help students integrate knowledge and skills from Science, Technology, Engineering or Mathematics.</td>
<td>The learning experience requires students to complete task(s) that integrate knowledge and/or skills from two of the STEM disciplines. Or, the teacher describes or prompts discussion of the relationships between and among two or more of the STEM Disciplines.</td>
<td>The learning experience requires students to complete task(s) that integrate knowledge and/or skills from three of the STEM disciplines. For example, students use a graphing calculator to apply a mathematics formula to a science data set.</td>
<td>The learning experience is carefully designed to help students integrate knowledge and skills from Science, Technology, Engineering and Mathematics. For example, science students design and test water filtration devices. Calculate their comparative efficiencies, and display the data using computer software.</td>
</tr>
<tr>
<td><strong>3. Connections to Non-STEM Disciplines</strong></td>
<td>Quality STEM learning experiences help students connect STEM knowledge and skills with academic standards from other disciplines.</td>
<td>The learning experience provides no opportunities for students to make connections between their STEM learning and non-STEM disciplines. For example, Language Arts, Social Studies, Art, etc.).</td>
<td>The learning experience requires students to connect STEM learning with knowledge and/or skills from at least one non-STEM discipline. For example, researching the economic and environmental impacts of alternative energy sources.</td>
<td>The learning experience requires students to connect STEM learning with one or more non-STEM disciplines, and includes instructional support for quality performance in the non-STEM discipline. For example, providing students with information about quality technical writing.</td>
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<tr>
<td><strong>4. Integrity of the Academic Content</strong></td>
<td>The academic content for the learning experience is inaccurate or is not anchored to the relevant academic content standards.</td>
<td>The academic content for the learning experience is accurately presented and appropriately anchored to at least one academic content standard for each content area represented.</td>
<td>The academic content for the learning experience is accurately portrayed and appropriately anchored to more than one academic content standard for each content area represented. Or, the learning experiences are anchored to one content standard in each targeted discipline that is difficult to teach, or hard to learn.</td>
<td>The academic content for the learning experience is accurately portrayed, tied to multiple content standards, and focused on helping students acquire deep understanding of a “big idea” or “foundational skill” critical to their future learning in the targeted discipline(s).</td>
</tr>
<tr>
<td><strong>5. Quality of the Cognitive Task</strong></td>
<td>The cognitive task is simplistic, too easily solved, and does not require students to employ higher-order thinking skills.</td>
<td>The cognitive task requires students to employ higher order thinking skills in addressing a project or problem with the procedures prescribed by the teacher.</td>
<td>The cognitive task requires students to employ higher order thinking skills in addressing a teacher-defined project or problem where students are responsible for designing the procedures to complete the assigned task(s).</td>
<td>The cognitive task requires students to select and employ the higher-order thinking skills necessary to frame the problem, design the procedures, develop strategies to complete the project, or to generate one or more possible solutions to the problem. (For example, in PBL this is frequently referred to as presenting students with an ill-structured problem).</td>
</tr>
<tr>
<td><strong>6. Connections to STEM Careers</strong></td>
<td>The learning experience provides no opportunity for students to explore STEM careers that are related to the STEM learning experience taking place in the classroom.</td>
<td>The learning experience engages students in work that occurs in one or more STEM careers, but does not explicitly help students make the connection between their classroom work and work in the STEM career field.</td>
<td>The learning experience engages students in work that occurs in one or more STEM careers and the teacher intentionally helps students see the relationship between their classroom work and the work carried out by STEM professionals.</td>
<td>The learning experience requires students to complete tasks in a simulated or real STEM work environment in which they are working like STEM professionals. In addition, the experience includes an activity intentionally designed to help students explore the relevant STEM careers and their educational requirements.</td>
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</table>
## 7. Individual Accountability in a Collaborative Culture

Quality STEM learning experiences often require students to work and learn independently and in collaboration with others using effective interpersonal skills.

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<tr>
<td>Students are not required to work or learn in collaboration with other students.</td>
<td>Students are encouraged or required to work in teams, but the collaborative work is informal in nature with little or no attention given to individual accountability.</td>
<td>Students are required to work in formally structured teams with specific methods for measuring team and individual accountability for the targeted learning outcomes.</td>
<td>Students are required to work in formally structured teams that have clearly defined expectations for individual and team accountability, including an intentional instructional focus on helping students develop the interpersonal skills valued in real-world work environments such as respect for diverse perspectives, active listening, checking for shared understanding, etc.</td>
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## 8. Nature of Assessment(s)

Quality STEM learning experiences require students to demonstrate knowledge and skill, in part, through performance-based tasks.

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<tr>
<td>The assessment plan is limited in scope and designed to test primarily for retention using traditional measures such as pencil and paper tests and quizzes.</td>
<td>The assessment plan includes more than one form of assessment, with at least one assessment that requires students to demonstrate knowledge or skill through the completion of a performance-based task.</td>
<td>The assessment plan includes multiple forms of assessment with at least one assessment that is performance-based and anchored to a rubric. The assessment however, is not an authentic representation of the real world of work outside of school.</td>
<td>The assessment plans includes one or more rubric-based, performance assessments that require students to demonstrate knowledge and/or skill in completing authentic tasks that model performances in the real world of work outside of school.</td>
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<tr>
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<tr>
<td>9. Application of the Engineering Design Process</td>
<td>The learning experience includes no requirement that students develop thinking skills required in the engineering design process.</td>
<td>The learning experience helps students develop or refine thinking skills that are part of the engineering design process without explicitly referencing the engineering design process.</td>
<td>The learning experience explicitly references the engineering design process and requires students to demonstrate thinking skills across multiple steps in the engineering design process.</td>
<td>The learning experience, in addition to explicitly referencing engineering design, requires students to demonstrate thinking skills in employing all steps of the engineering design process including opportunities to experience the recursive nature of the process.</td>
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<tr>
<td>Quality STEM learning experiences require students to demonstrate knowledge and skills fundamental to the engineering design process (e.g., brainstorming, researching, creating, testing, improving, etc.).</td>
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<tr>
<td>10. Quality of Technology Integration</td>
<td>The learning experience includes no opportunities for technology integration and makes no references to the many roles technology plays in the STEM fields.</td>
<td>The learning experience includes one or more technology tools or resources which are employed or demonstrated only by the teacher.</td>
<td>The learning experience engages students in effectively employing at least one technology tool or resource selected by the teacher.</td>
<td>The learning experience requires students to select and effectively employ multiple technology tools and resources to enhance their capacity to complete tasks, solve problems or manage projects.</td>
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<tr>
<td>Quality STEM learning experiences provide students with hands-on experience in using multiple technologies. (Examples: computer hardware and software, calculators, probes, scales, microscopes, rulers and hand lenses to name just a few.)</td>
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</table>
A Framework for Quality STEM Education

For more information, including professional development on the Quality STEM Education Framework please contact margy.stevens@mcesc.org or james.rowley@notes.udayton.edu.

Background

The Framework for Quality STEM Education and its accompanying rubrics were developed by the Dayton (Ohio) Regional STEM Center in collaboration with Dr. James Rowley of the University of Dayton’s School of Education and Allied Professions. The STEM curriculum development work being done at the Dayton Regional STEM Center is anchored to the quality framework. In addition, the framework plays a critical role in the professional development of STEM teachers and fellows working to advance the quality of STEM education in their respective schools, universities and STEM workplaces.

For information about professional development opportunities for teachers and school administrators based on the Framework for Quality STEM Education, contact Margy Stevens, Director of the Dayton Regional STEM Center at margy.stevens@mcesc.org.

The Purpose of a STEM Education Quality Rubric

The purpose of the quality framework is to support on-going communication between and among STEM stakeholders by creating a common framework for conceptualizing, and a common language for communicating about STEM teaching and learning. In this capacity it can support educational leaders in making informed decisions about the allocation of resources, especially with regard to the planning and delivery of professional development. Finally, at the micro-level, the framework and rubrics can guide teachers in designing quality STEM learning experiences and provide a valuable tool for reflection and self-assessment. Perhaps most importantly, it can serve as the common ground where both teachers and STEM professionals can anchor their collaborative work as they endeavor to build the bridges from classrooms to STEM careers.

An Overview of Key Components

Before presenting the list of ten elements that constitute the Stem Education Quality Framework, the following additional points are important to consider.

- A quality STEM learning experience is not a function of time. A quality STEM experience might take the form of a one class period activity, a three-week unit of instruction, or a semester-long project.

- The absence of one or more STEM quality elements does not mean the experience is not a quality STEM learning experience. In some cases, an element may be purposefully excluded or does not apply. Collectively considered, the elements should have a ceiling effect of helping STEM stakeholders develop a deeper and broader vision of quality STEM Education.
### STEM Education Quality Components

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<tr>
<th>#</th>
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<td>Potential for Student Engagement</td>
<td>Quality STEM learning experiences are designed to engage the minds and imaginations of students of diverse academic backgrounds.</td>
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<td>2</td>
<td>Degree of STEM Integration</td>
<td>Quality STEM learning experiences are carefully designed to help students integrate knowledge and skills from Science, Technology, Engineering and Mathematics.</td>
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<td>3</td>
<td>Connections to Non-STEM Disciplines</td>
<td>Quality STEM learning experiences help students connect STEM knowledge and skills with academic standards from other disciplines.</td>
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<td>4</td>
<td>Integrity of the Academic Content</td>
<td>Quality STEM learning experiences are content-accurate, anchored to the relevant content standards, and focused on the big ideas and foundational skills critical to future learning in the targeted discipline(s).</td>
</tr>
<tr>
<td>5</td>
<td>Quality of the Cognitive Task</td>
<td>Quality STEM learning experiences challenge students to develop higher order thinking skills through processes such as inquiry, problem-solving, and creative thinking.</td>
</tr>
<tr>
<td>6</td>
<td>Connections to STEM Careers</td>
<td>Quality STEM learning experiences place students in learning environments that help them to better understand and personally consider STEM careers.</td>
</tr>
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<td>7</td>
<td>Individual Accountability in a Collaborative Culture</td>
<td>Quality STEM learning experiences often require students to work and learn independently and in collaboration with others using effective interpersonal skills.</td>
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<td>10</td>
<td>Quality of Technology Integration</td>
<td>Quality STEM learning experiences provide students with hands-on experience in using multiple technologies. (Examples: computer hardware and software, calculators, probes, scales, microscopes, rulers and hand lenses to name just a few)</td>
</tr>
</tbody>
</table>
Appendix M:

References


