Spatial Visualization (SV) is an important skill in which students can mentally rotate two-dimensional and three-dimensional objects. This skill is very important in STEM fields, more specifically in engineering. Spatial Visualization training is linked to higher retention rates in engineering. Having well-developed SV skills not only increases student success in STEM courses, but also in their future careers. For example, astronomers use SV skills to visualize the structure of the solar system and the motions of the planets, while radiologists use SV skills to interpret a medical x-ray.

Most departments at universities incorporate SV training into the freshman engineering curriculum through introductory engineering courses. At RIT, freshman biomedical engineering students are required to take BIME 181 Introduction to Biomedical Engineering. The course serves as an intro to the field of biomedical engineering and engineering methodology and how it relates to biomedical issues. The course also introduces students to important skills such as teamwork, research, and communication. In the fall of 2017, the course was restructured to introduce SV and design thinking skills to students. Prior to 2017, SV was not included in the curriculum of BIME181.

Once the course was restructured in 2017, post-tests were administered once the course ended to determine any improvement in SV skills due to the restructuring.

- Cohorts from 2017, 2018, 2019, and 2020 were exposed to SV skills.
- All test scores were recorded from 2015-2020.
- Scores in the analysis are representative of students who completed both the pre- and post-test as students who did not complete either a pre or post-test were omitted from this dataset.
- Data was statically analyzed (averages, standard deviations, ANOVA, and t-tests) to determine if there was significance.
- Any improvements in overall cohort performance was determined through learning gains.
- Learning gain is a way to measure student’s learning between the beginning and end of a course.
- The formula to calculate the learning gain is:

\[
\text{Learning Gains} = \frac{\text{post score} - \text{pre score}}{30 - \text{pre score}}
\]

where 30 was the highest score possible on the PSVT:R.

- Student motivations for completing the PSVT:R were also considered based on cohort.

### RESULTS

#### Table 1: Results of statistical analysis from the 6 cohorts

<table>
<thead>
<tr>
<th>Cohort</th>
<th># of students</th>
<th>Average Pre-Score</th>
<th>Standard Deviation of Pre-Score</th>
<th>Average Post-Score</th>
<th>Standard Deviation of Post-Score</th>
<th>Learning Gains</th>
<th>ANOVA pre-score p-value</th>
<th>ANOVA post-score p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>73</td>
<td>21.9</td>
<td>5.01</td>
<td>21.5</td>
<td>4.72</td>
<td></td>
<td>0.794</td>
<td>0.0064</td>
</tr>
<tr>
<td>2016</td>
<td>51</td>
<td>21.5</td>
<td>4.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>44</td>
<td>21.3</td>
<td>3.99</td>
<td>25.1</td>
<td>3.02</td>
<td>0.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>59</td>
<td>21.4</td>
<td>4.90</td>
<td>21.8</td>
<td>5.25</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>53</td>
<td>22.5</td>
<td>4.43</td>
<td>23.3</td>
<td>4.04</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>73</td>
<td>21.4</td>
<td>5.17</td>
<td>22.9</td>
<td>5.1</td>
<td>0.17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Based on the average pre-scores of the cohorts, it can be determined that the incoming freshman start on similar levels of each other.
- The post-scores were only collected from 2017-2020.

### CONCLUSION

The 2017 cohort pre-score was 21.3 and the post-score was 25.1. The 2019 cohort was split into two groups. One group had two class sessions covering Spatial Visualization (2) topics. Their pre-score was 22.3 and the post-score was 23.02. The other group was only exposed to SV topics once. Their average pre-score was 22.89 and their average post-score was 23.89. The group exposed to SV topics twice is comparable to the fall 2017 cohort, as they both spent the same amount of time in class covering SV topics. However, the 2019 cohort had a higher learning gains than the 2019 cohort. In 2017, the PSVT:R score impacted the final course grade. In 2019, students that had less exposure to SV topics had higher learning gains.

### REFERENCES