

**Prior projects:** Prior to doing this project, students should have done these project:

- None

**Philosophy behind this project:**

This project is a handout that will be given on the first day of class to provide students with a set of guidelines for creating their own 3D graphs by hand. Students typically struggle with graphing functions, surfaces, and solids in 3D. These guidelines encourage students to do a rough sketch first, and then use different color pens and shading to help students make sense of their graphs. This will be especially useful throughout the semester to create the bounds for integration, and make sense of vector calculus. The handout also helps set expectations for the quality of graphs should be turning in for homework.

Having students create their own visuals for 3D graphs can also improve their spatial visualization ability. There is research suggesting that students' spatial visualization skills correlate with their success in calculus 1 and 2. We are currently doing research to assess if there is any correlation between students' spatial visualization skills and their success in calculus 3.

**Learning Goals:**

1. Review right-hand orientation for 3-space
2. Review of plotting points
3. Review of parallel
4. Review of intersection
5. Review of intercepts
6. Review of drawing plane, sphere, ellipse, parabola, and lines
7. Improve spatial visualization skills

**Implementation Notes:**

1. This handout is to be given on the first day of class. Students should be instructed to keep this with them at all times as a reference when drawing in 3-space. They will be using it throughout the first week in class.
2. Explain to students that they should refer to this handout for expectations of quality of graphs submitted for homework grading.
3. It should be worth mentioning that graphing in 3-space is a skill that needs development, and is not something that comes naturally for many.
4. Not every instructor will use the same axes setup given in the handout (some will encourage students to graph from a more natural isometric perspective). The expectation of high quality graphs should still be maintained.

**Wrap-Up:**

1. The wrap-up should be brief; focusing on that fact graphing in 3D is a skill that needs to be developed through practice.
2. Also mention that students will be expected to maintain high quality for their graphical representations. The better their graphs become, the easier it will make their life as the semester progresses.