The World Ender – A Problem Based Learning Packet. C. Runyon[1], C. Hall[1], M. Royle[2], R. Nettles[3], Coombs[1], J. Minafra[4] [1]College of Charleston, [2]Stall High School, [3]S2tem Centers, [4]SSERVI, NASA Ames

Introduction: Through *The World Ender* curriculum packet middle school students investigate collisions and research impact events, asteroids, regolith, and meteorites. The World Ender Curriculum packet incorporates effective and engaging pedagogical strategies, such as problem-based learning (PBL), design thinking, and document-based questioning, using authentic data and current news articles. This PBL forum provides students an opportunity to apply their knowledge, curiosity, creativity, and problem-solving abilities to relevant problems that have the potential to improve the way we explore the solar system. The unit focuses on design thinking, which serves as an effective means of emphasizing real-world situations in a classroom setting. Students use content knowledge while also incorporating numerous 21st century skills.

The packet: The *World Ender* includes multiple lessons covering both the Physical Sciences as well as Earth and Space sciences, Art and Social Studies. A large part of the effort has the students focusing on an engineering design challenge in which they must develop a process for redirecting an asteroid. Their selected path may or may not include harvesting or mining the asteroid. Students work collaboratively in teams to research and build a knowledge base, inquire and investigate phenomena that are relevant to the challenge and its criteria. Throughout the nine-week effort the students learn to think critically while working to solve the consequences of the potential Earth impact. The scenario developed uses multiple resources including current and historic video clips, interactive apps, news feeds, NASA resources, online and hard copies of scientific articles and more and is based on the Next Generation Science Standards (NGSS). Teachers are provided with an in-depth guide to facilitating the engineering design process.

As the students investigate collisions they read about historic impact events, concepts for redirecting and mining asteroids, and play games to learn about accretion using apps to solve Newton's Laws. In addition, students develop and conduct experiments and share information with team members. Once students have grasped Newton's 1st and 2nd Laws they will explore Earth's gravity, relative size and distance and research space, orbits and galaxies before building a model that will inform their team's solution to redirecting the *"World Ender"* asteroid. Extension activities incorporated into the storyline guide the students should they choose to mine the asteroid before redirecting it. The collection of activities ensures student understanding of the difference(s) between properties and changes, both physical and chemical, and provide extensive exploration of density, porosity and magnetism. Throughout the process, students are collecting and analyzing data using a variety of Vernier instruments including: albedo, IR, magnetism, go-motion, photo-gates and spectroscopy.

Teacher and student assessment from initial and ongoing classroom testing of these activities indicates the students are highly engaged and are excited about creating their final models.