A Survey and Analysis of College Students' Preinstructional Understanding of Planet Formation. M. N. Simon[1], C. D. Impey[2], and S. Buxner[2], [1]University of Arizona, Lunar and Planetary Laboratory (1629 E. University Blvd, Tucson, AZ 85721, msimon@lpl.arizona.edu), [2]University of Arizona, Department of Astronomy (cimpey@as.arizona.edu, buxner@email.arizona.edu).

Introduction: From an early age, students are taught about our "celestial address," the Solar System. The Solar System is one of the top-ten most frequently discussed topics in undergraduate introductory astronomy courses for non-majors, commonly referred to as "ASTRO 101" [1]. When this subject is taught, however, the lecturer typically gives a brief overview of each planet, and students are left to wonder how the Solar System formed to begin with. In order to effectively teach planet formation at the college level, it is necessary to address any preinstructional ideas or misconceptions students may have on how the Solar System came to exist. This topic is growing in importance and has become incredibly relevant to astrobiology due to the discovery of nearly 5,000 exoplanet candidates. The properties of these systems have shed light on critically important concepts such as snowlines, planetary migration, the habitable zone, and the architecture of planetary systems more generally. All of the concepts are more easily understood when students are able to properly grasp how solar systems form in the first place. This highly active research field has been slow to be properly represented in the astronomy classroom at the introductory undergraduate level.

To date, there has yet to be a study conducted that addresses the topic of planet formation at the college level with a large number of ASTR 101 students. In response, we presented students in eleven undergraduate 100 and 200-level astronomy courses for non-majors at the University of Arizona (approximately 900 students) with one of six short answer questions on the topic of planet formation. The questions were administered on the first day of the Fall 2016 and Spring 2017 semesters before any relevant material was taught. We follow a procedure similar to [2], and present an analysis of student responses to these student supplied response (SSR) questions. We use a post-hoc coding technique and will discuss any common trends, themes, and misconceptions that appear from the student responses. These responses will ultimately lend to the development of the Planet Formation Concept Inventory (PFCI) that will be used by ASTR 101 instructors to evaluate students' understanding of the topic at hand before and after it is taught in the course.

Preliminary Analysis: As a preliminary analysis, we coded the responses to the first and most general SSR question, "*Describe how the Solar System (planets) formed to the best of your ability. Include drawings when appropriate to help with your explanation."* For this particular question, we collected responses from 170 students, 164 of which were code-able. Thirty-nine of the students in this sample had taken a previous introductory astronomy course at the high school or college level. The most common theme amongst student responses was that ~45% of students believed the Solar System formed from the Big Bang. Other common themes that students attributed to planet formation included collisions and accretion, gravity, energy, explosions, and "stuff" in space (most commonly matter and debris). We grouped the student responses into one of three levels of understanding: novice, intermediate, and advanced. Novice responses included students who generally did not understand how the solar system formed at all or attributed solar system formation to the Big Bang (68% of responses). Intermediate student responses included those that combined incorrect timescales and concepts with correct concepts (24% of responses). For example, *"Our Solar System was formed due to an incredible explosion trillions of years ago. Over time, the stardust and rock collide and gravity makes them accumulate more matter over time until planets are made."* Finally, the most advanced responses included a more in depth understanding of planet formation – students mentioned disks, planets clearing their hill radii, and the distinction between terrestrial and gas giant planets (8% of responses). Of the 13 advanced responses, 9 were from students who had taken a previous astronomy course.

For this presentation, we will discuss findings from our entire dataset (all six SSR questions and approximately 900 student responses). Similar to the preliminary analysis, we will identify common themes and misconceptions from the entire sample, which will provide instructors with the topics and misconceptions that should be emphasized and addressed when teaching planet formation in "ASTRO 101" courses in the future.

References: [1] Slater, T. F., Adams, J. P., Brissenden, G., & Duncan, D. 2001, "What Topics are Taught in Introductory Astronomy Courses?" Phys. Teach., 39, 52. [2] Bailey, J. M., Prather, E. E., Johnson, B., & Slater, T. F. (2009), College Students Preinstructional Ideas About Stars and Star Formation, Astronomy Education Review, 8(1).