The “Can You Hear Me Now?” activity was taught during the first week of the 2017 UCLA REU program. Over the course of two days, 13 upper-level college students used the concept of signal over background to design a cellphone tower grid that met requirements they had previously set. The concept of signal-to-noise ratios, and a conceptual understanding of what it means to have a certain level of signal over the background, is vital for scientists and engineers. It is only through a deep understanding of this concept that scientists can say with any certainty how good their data and results are. While many students have had a course that discusses signal-to-noise ratios, few students get a feel for what the different levels actually mean.

Learners worked with the practice “designing solutions within requirements” to define specific requirements their cellphone grid must meet, and then designed a grid that met those requirements. In engineering, science, and life, designing a solution within requirements is fundamental. From things as simple as going to the grocery store with a budget and trying to buy dinner for the week, to things as complicated as making sure a telescope actually does what it was intended to do, the practice of designing solutions within requirements is extremely important. The benefit of this practice is that students get hands-on experience of what scientists do everyday. Scientists and engineers must not only define their own requirements, but they must design a solution around them. The learners got the opportunity to chose for themselves what their cellphone grid must do, and then design the grid.

Learners were given a map of the Los Angeles area and the knowledge that we had a simulator that would take antenna positions and a level of signal over background, and generate a signal coverage map, including the percentage of area and percentage of population covered at that level of signal over background. There was also the option of using a population growth model, and attempting to fit a grid that worked now and in the future using the population growth model map. From there, learners could set for themselves any requirements that could be answered by the simulator.

The culminating assessment task consisted of multiple parts. Learners filled out a worksheet with the questions 1. What was the original question you set out to answer? 2. State your design specifications (requirements you needed to meet). 3. Explain how your cell phone tower grid uses signal over background to provide a solution to the requirements set by the company. 4. Were there any additional constraints you applied or found? 5. Did you make a tradeoff at some point? 6. Were there any drawbacks to your design? 7. Is there anything you wish you could have changed about your design? Then, learners made posters to highlight their design. They completed a jigsaw poster session that allowed them to experience a real-life poster session, where they had to individually answer questions on their project and justify their solution, how it met their requirements, and explain any tradeoffs made in the design. This encouraged each team member to take ownership of his or her project. Knowing that they would be asked questions, without a group to fall back on, requires each individual to be active in the project design.

From the learners, we collected the worksheets, the answers to our questions on their posters, and the posters themselves. This allowed us many opportunities to score them according to our rubrics. Three points were allowed maximum for each of three categories on our content rubric. A significant number of the 13 scored students scored higher than 5 points, indicating an understanding of the content we intended. Many students probably would have scored higher, but we found that one of the categories on

our rubric was not something we asked about, nor something the learners discussed. Instead, many discussed a different feature of their design that demonstrated their knowledge of the content, but was not something that was on our rubric.

We also scored our learners on their practice. Learners were scored on a range of 0-3, again for 3 categories. All of the learners scored 10 or higher, however, we again found a flaw in our rubric, where students with defined requirements, but not good requirements, scored highly, but missed a bit of the practice. One group in particular did not define strong enough requirements, but were very clear about what their requirements were and how their design met them, thus they scored highly on our rubric, but not on the practice itself.

As a group, our learners were very engaged in the activity, and, by our rubrics, developed a deeper conceptual understanding of signal over background. Every group was successful in defining requirements and designing a cellphone grid that met them. The variation in requirements and cell phone grids amongst the groups was extremely interesting to us. We had hoped in our design to allow for different learner paths and variations in goals based on prior knowledge, but I think even we were impressed with the different designs our learners developed.