**Engineering Design Process: Challenge-Based Learning** (Speakers: Mr. Jake Ohnmeis, Teacher, Goshen Middle School; and Mr. Rob Rapaport, Retired Engineer, Proctor and Gamble, CEEMS Resource Person; June 18, 2015, 1:00 pm–3:00 pm)

This session was given by Mr. Jake Ohnmeis, a current Goshen Middle School teacher and Rob Rapaport, a retired engineer for Proctor and Gamble on Thursday, June 18th, 2015 from 1-3 PM at the UC in Zimmer Hall, room 414. Mr. Ohnmeis received his bachelor’s degree from Miami University, where he studied Adolescent and Young Adulthood (**AYA**) mathematics with a minor in coaching. This is his second year at Goshen Middle School, teaching integrated math and Algebra 1. Mr. Rob Rapaport is a retired environmental engineer who worked in the field for over thirty years with industrial experience. During his career he worked with data dealing with mathematical models for predicting how consumer product chemicals affect surrounding water systems.

This session began with Mr. Ohnmeis passing out a piece of candy to every participant. One half of the participants received a choice of chocolate or mints, while the other half only received the option of a mint. Once everyone received a piece, he asked the participants to log onto <https://todaysmeet.com/challengebasedlearning>. He used the website to spark a discussion on how the participants felt about the free candy. Some people got a choice of chocolate or mints, while some did not get a choice, and only had mints. This connects to student choice, and in Figure I.64 Jake is explaining the importance of student choice (sense of control, sense of purpose, and sense of competence) Student choice is very much embedded into the challenge based learning project design.

The next portion of the session was a quick overview of the components of challenge based learning. Challenge based learning is an engaging collaborative learning experience, where students and teachers work together to propose solutions to real problems, and take action. The steps of challenge based learning are the hook, big idea, essential questions, the challenge, societal impacts, and guiding questions. The hook catches the attention of students and makes it relevant. The hook can be presented in many forms, such as a video or a hands-on activity. The big idea is of importance on a local or global scale and works to meet the academic standards required to be taught. The essential question can be generated from the big idea and reflects the interest of the students. The challenge is brainstormed by students or teachers, and asks the students to create a specific solution. The guiding questions are developed by the students and that center around the “scientific concepts” of the big idea.



**Figure 1: Mr. Jake Ohnmeis Explains Role of Student Choice in CBL**

After the brief overview of the challenge based learning design, Mr. Ohnmeis introduced his project called “Stand Strong With Pythagoras.” In **Figure 1** Mr. Ohnmeis is introducing the project that he implemented in his classroom this past school year. He discussed the standards that he is expected to teach with the Pythagorean Theorem, and then asked the session participants to complete the hook. The hook was to work in groups to build a platform that is 8.5 inches tall and capable of holding as many reams of paper as possible. The constraints were materials and time. The materials provided were 3 sheets of paper, one poster board, one roll of tape, one coffee stirrer, and four sticks of gum. Participants had thirty minutes and the poster board must be the base and the top of the platform. In **Figures 2 and 3** one can see the progression of the platform construction. In the end, the most stable

Iplatform could hold over 13 reams of paper (as seen in **Figure 5**). The final portion of the hook was a whole group discussion of how do we all have the same materials but have different results?

After testing all the designs, Jake introduced his big idea for his challenge based project to the participants. “Geometry and Building Design During Natural Disasters” is the big idea that Jake implemented. Once the big idea is introduced, Jake encouraged having a discussion with students about buildings and how/why they are constructed a certain way. Pose the question: What can we do to minimize the damage? For the societal impact portion of the project, Jake asked his students to name some challenges that are present in our society today that are related to the Big Idea of Geometry and Building Design During Natural Disasters (school, city, state, country, world.)

Jake then elaborated on how to create an essential question (which have no right or wrong answer), and how to encourage students to create their own essential question. One method is to have the students brainstorm five questions that we could group’s platform. After thirty minutes, each group had a chance to test their platforms explore using or relating buildings/architecture and the math concept: Pythagorean Theorem. Then have groups share their questions, and then based on results, generate the ideas that find a common theme (which the teacher has already come up with). Therefore students feel as if they generate the challenge/question themselves, giving them that sense of empowerment. Then the instructor presents the challenge. For Jake’s project, his challenge was to create a three story building that would be structurally sound to withstand an earthquake using the Pythagorean Theorem. This challenged includes testing different stabilizing techniques that will enhance a building’s structure (triangle reinforcers). Jake then posed the following question for students to investigate: Which type of building is more stable in high frequency earthquakes? Low frequencies? After explaining the creating of essential questions, Jake discussed guiding questions. This is the processes of brainstorming questions that students will need to answer for the task at hand and the instructor also gives guiding questions after the discussion as well. Once the students have gone through these steps and created their design and/or solution, they are then asked to present their results and reflect on their work.

At the end of the presentation, teachers were able to ask questions of Jake. Questions included concerns on how he added in the content throughout the project, the assignment of groups/member roles, and any changes that he plans to make when he teaches this unit again.

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| **Figure 2: Mr. Jake Ohnmeis Introduces “Stand Strong With Pythagoras”** | **Figures 3: Group Preparing Materials to Build the Platform** |
| **Figure 4: Group Building the Platform** | **Figure 5: Testing the Platforms** |