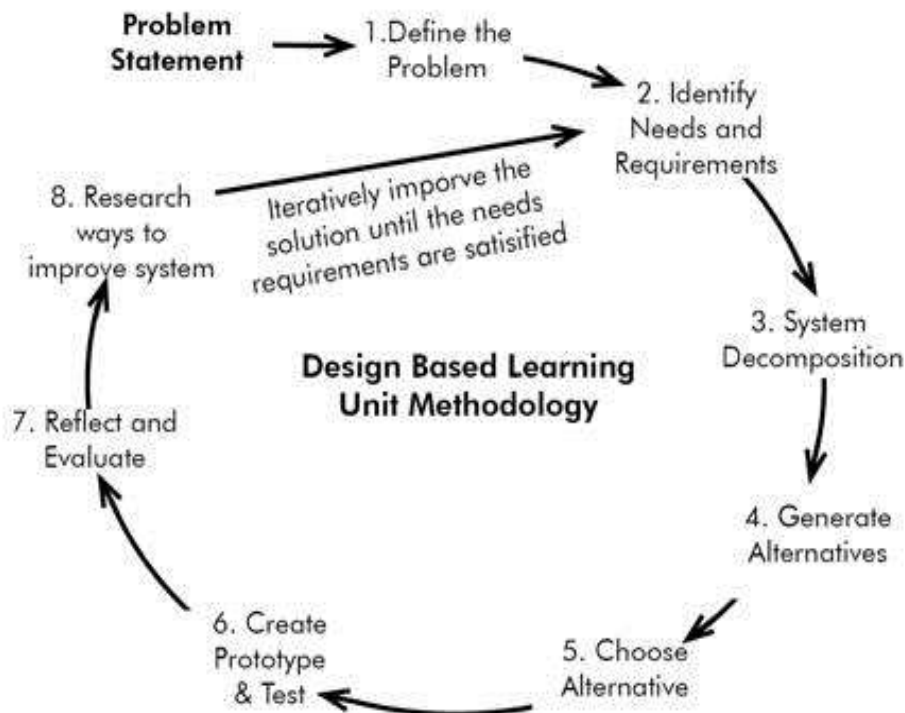


# Design Based Learning Units (DBLs)

According to the Standards for Technological Literacy published by the International Technology Education of Association, “All students need to develop an understanding of Engineering Design.” Design projects are being used to motivate and teach science and technology in elementary, middle, and high-school classrooms across America: they can serve to open doors to possible science or engineering careers. Over the last six years, the University of Pittsburgh’s Learning Research and Development Center (LRDC) has spent a considerable amount of effort researching and refining how to teach “engineering design”. They have developed a particular methodology called the Design-Based Learning Unit (DBL). The DBL is a well thought out design-project where the student develops a technological solution using limited resources. The DBL is carefully designed and orchestrated so that students feel that they have a lot of choice and freedom in their design, but the DBL is designed so that the student can only successfully solve the problem by applying the mathematical concept that the teacher intended to highlight. The DBL, a highly scripted but open-ended engineering design problem, has the dual benefit of being able to teach academic concepts in rich interactive environments as it develops the students’ problem solving, scientific inquiry skills, and engineering design competencies.

For the DBL to motivate students and teach core concepts effectively and efficiently across a variety of settings, the units must be developed in very particular ways. Just giving students a design challenge produces chaos. Telling students exactly what to do at every step produces boredom and little learning. A well designed DBL begins with an engineering design problem with clearly defined rubrics that define what a successful solution looks like, coupled with seemingly unlimited student choice about how they might solve the problem. The engineering design process systematizes the thinking and the learning issues that must be supported. Thus, students practice a real design process but also receive carefully designed lessons that foreground the STEM concepts the teacher has pre-determined important to teach. The figure below shows the typical macrostructure of a DBL unit. The DBL teaches systematic design process while motivating and supporting STEM learning.



The DBL provides a working, tested framework upon which Robot Algebra design problems are built. They provide a natural mode for teaching the topics which are inherent to robotics and technology and have proven success in the classroom over several years of research and refinement.

The fundamental elements of the engineering design process include:

- *Defining the problem, including thorough research enabling the formulation of well developed potential solutions*
- *Establishing clear objectives and criteria enabling the development of a requirements document*
- *Systems decomposition – break the problem down into granular modules*
- *The use of time management tools like PERT and Gantt Charts*
- *Ideation, brainstorming, and design reviews*
- *The development of working prototypes*
- *Iterative testing, evaluation, and improvement of the prototype*
- *Selecting the best solution based on established criteria*
- *Iterative improvement based on research and testing*

This methodology is valued in the workplace and needs to be taught to students.