# Defining "Real World Engineering" Paradigms by Gender

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Recent trends in engineering education pedagogy support the use of "real world" problems and hands-on, inquiry-based and experiential learning to engage students at all levels and abilities. Clearly, educators are gaining understanding that problems found within engineering-focused disciplines traditionally relegated to undergraduate and graduate engineering education can be used to highlight relevance of more traditional primary and secondary academic subjects like mathematics, science, and social studies. The engineering challenge of creating a clean, safe water supply touches on a myriad of topics appropriate at various grade levels, for example: scientific concepts including states of matter, material chemical and physical properties, life science, and data collection; mathematical concepts involving scale comparing contaminant versus water quantity; social studies identifying anthropological issues regarding water need, use, and social responsibility; as well as the obviously related engineering concepts. This type of activity or project can be varied alternately to introduce or reinforce classroom content (or even in enrichment activities), according to classroom need or teacher intent.

However, are there parameters with which to define this idea of "real-world" for greatest educational benefit and student engagement for specific subpopulations present in the classroom? For instance, might a "real-world" engineering project that increases human knowledge, but does not directly affect people in any way, engage a different demographic group (in particular, by gender) than a project utilizing identical equipment, concepts, and skill mastery which does directly affect people? In specific, what is the effect of this type of differently defined "real-world" problem on students' levels of interest/engagement/attainment relative to otherwise identical engineering problems? Since, with younger students in particular, engagement may be a predictor for learning, teachers share a common goal of identifying how to effectively focus student interest.

With this in mind, determining specific contextual factors able to engage more effectively the target audience of single-gender or mixed gender populations within a particular classroom because of different human-impact perception might create opportunities to encourage learning effectively. For a particular set of desired skills or theoretical knowledge to be taught in the classroom, the utilization of specific types of human impact might be more useful for teachers seeking to maximize student interest and involvement based upon classroom demographics, particularly addressing and encouraging non-traditional students in engineering and technology at early ages.

Activity Description

For example, an activity to explore systematically and map an unknown environment can be given multiple contexts in order to engage different groups of students. This activity, modifiable for various ages and abilities can be formatted to require identical learning tools and develop similar theoretical understanding and skill development through a constructivist-based lesson. In this case, LEGO RCX built into the structure of a motorized vehicle and sensors can be combined with Robolab investigator programs to allow students to explore an unknown and obscured area, given several different contexts. These activities will be implemented as a part of a same grade-level, ability un-sorted, gender-neutral middle-school science classroom curriculum. Each activity will involve mapping a defined, hidden area with regard to temperature, light, and physical obstacles contained within a perimeter. Regardless of milieu, identical mapping protocol can be implemented by students in order to allow the creation of a map, or key, describing characteristics like temperature and presence of light or barriers in the area with respect to some translatable coordinate system.

During classroom implementation, observation and outcome of three identical activities involving these materials with frameworks differing in their direct impact on people will be discussed in establishing realistic, yet different contexts, particularly in terms of “real-world” applicability for students. In one classroom, the ‘real-world’ context for the activity will be an unmanned space probe landing on an unexplored planet, gaining relatively inapplicable knowledge for its own sake. A second group will perform an identical task within the context of mapping a local woodland area, a task with limited human application or impact. The final group will focus on a context involving developing an assistive device to enable an impaired person to map an unknown space, in order to safely and effectively manage independently.

## Assessment

The activity will contain multiple levels of attainment and engagement, which will be assessed observationally, with students in groups within the classroom. Student understanding of the use of indirect data, gathered by these materials to allow communication or description of an unknown area can be assessed by attainment for increasingly challenging activities. Individual students will be asked to discuss specific questions related to their interest to further define any relationship with respect to human-impact. Additionally, involvement and engagement by gender will be assessed observationally, particularly to determine inter-group dynamics based upon gender.

## Expected Engineering Paradigms by Gender

Clearly, “real-world” engineering projects that increase human knowledge with varying levels of direct societal impact should engage different demographic groups, particularly by gender. Within a project utilizing identical materials and developed goals, it is expected that female students will be increasingly interested in projects given frameworks with a high degree of personal application of knowledge. For instance, engineering and technology contexts assisting real people are expected to engage and encourage female students, who are traditionally less active with respect to this type of activity, particularly at the middle school level. Expected outcomes include increased attainment for female students and expanded leadership within mixed-gender groups. Additionally, it would be expected that the level of interest for male students would not decrease based upon the changed context—males would not necessarily show decreased involvement or engagement in project frameworks with greater human impact or application, particularly given otherwise gender-neutral backgrounds. Instead, usage of "real-world" contexts with direct application to society are expected to produce overall increases in student engagement, which should translate into greater understanding and attainment of educational material.

Effect on Curricula

If present, identification of factors defining "real-world" criteria able to engage different student populations may have positive impact in developing primary and secondary engineering and technology education across gender boundaries. In the long term, this utilization may alter the traditional demographics of engineering and technology students, by facilitating previously undeveloped interests. For example, modifying high-technology oriented activities with only limited societal impact to emphasize human interactions may be increasingly supportive of female students, who may seek greater ability to tangibly impact society than male counterparts.