# Ongoing Design of a Case-Based E-Learning System Promoting Engineering Students' Personal Epistemology and Real-World Problem Solving Abilities: A Formative Evaluation

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## Background

**Epistemic Positions in Problem Solving**
Personal epistemic position is an important factor that influences the performance of solving ill-defined, real-world problems (Schraw, Dunkle, & Bendixen, 1995; Perry, 1970/1999; King & Kitchener, 1994; Kuhn, 1991). Recent empirical studies (e.g., Schraw et al., 1995; King & Kitchener, 1994) have indicated that students' personal epistemology plays a critical role in solving unclearly defined, complex problems.

**Sophomore Students' Epistemic Positions**
According to Perry's epistemic development scheme (Perry, 1968/1999; Moore, 2002), most second-year college students are in the process of moving from dualism (black-and-white type of thinking) to the multiplicity stage by acknowledging uncertainty and accepting multiple opinions (Choi & Lee, 2009). In King and Kitchener's (1994) reflective judgment model with three major stages including pre-reflective, quasi-reflective, and reflective thinking, second-year college students usually are placed in the later stage of pre-reflective thinking (believing that knowledge is certain) and are about to move to the early stage of quasi-reflective thinking (acknowledging uncertainty in problems and knowledge). Their way of approaching problems and learning from individual experience is significantly different between these epistemological stages.

## Goal

To facilitate second-year college students' epistemic growth to the multiplicity level or early contextual relativism level through an innovative case-based learning module for engineering design problems.

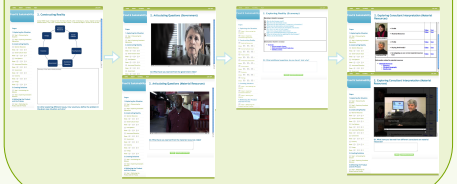
## Four Learning Phases for Engineering Case-Based E-Learning System

### Phase I: Exploring the Situation

Students are introduced to a real-world case problem and then build their initial ideas about problems and solutions. The goal of this stage is for them to realize the limitations of their thinking and to consider engineering design as a process instead of a product.

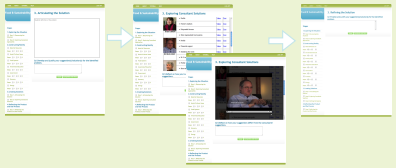
### Phase II: Constructing Reality

Students are exposed to rich contexts of the problem situation and navigate necessary information to revise their understanding of the problem.



### Phase III: Creating Solutions

Students are exposed to multiple perspectives from different experts and then will build their own solutions.



### Phase IV: Reflecting on the product & the process

Students are asked to reflect on the process of problem solving and on the problem and solutions.

## Formative Evaluation

- A two-week implementation in a sophomore course entitled Introduction to Environmental Engineering and Sustainability
- A total of 12 students

**Pretest** (1) Epistemological belief survey
(2) Pretest scenario problem solving

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**Implementation** Case-based E-Learning System

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**Posttest** (1) Epistemological belief survey
(2) Posttest scenario problem solving
(3) Perceived learning experience survey

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**Results**
(1) No significant changes in epistemic position
(2) No significant improvements in problem solving

## Further Recommendations

- More time should be given to the students for the case-learning activities. Three or four weeks may be more realistic in order to maximize the current learning resources for the intended learning.
- In-class discussions for the case learning should be combined with the independent e-learning activities. Many students suggested that having in-class discussion would help their learning with the e-learning module.
- The last few weeks of the semester should be avoided for these heavy learning activities unless this activity is assigned as part of a final project. Instead, earlier in the semester would be more appropriate.
- The second phase of the interface should be reconsidered and the technical error should be fixed.