by Craig Rusbult - Session 1, 9:45-10:45, Mon, Sep 22.

Building Bridges between Engineering and Science to Improve NGSS Practices [+ motivation, transfers]

The **wide scope** of Design Thinking — used for Engineering (broadly defined) and Science, whenever critical evaluation guides creativity in iterative problem-solving Cycles of Design — lets us build two useful **educational bridges** (life/school, engineering/science), helping students improve their Engineering-and-Science Practices, motivations to learn, transfers of learning.

A web-version of this page has links, colors, and more:
designprocessineducation.com/design-thinking/stem.htm

The Wide Scope of Design → Bridges and Benefits:
We use a process of design for **almost everything we do**, when we design a **product**, **activity**, **strategy**, or **theory**. This wide scope lets us build two kinds of Edu-Bridges:

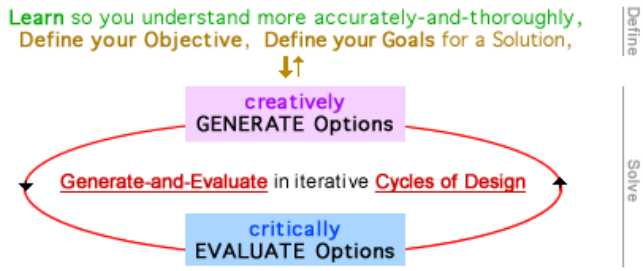
• **MOTIVATION-Bridges** between Life and School:
The simplicity of **D**esign **T**hinking (see Diagram A) — when we Define a Problem, then try to Solve the Problem by Generating-and-Evaluating Ideas in Cycles of Design — lets us show students how they **have used** DT in their past life, so they can confidently think "I have used DT for design-in-life, so I can use DT for design-in-school"; and they **will use** DT in their future life, so improving DT-skills *in school* will help them achieve their personal goals *for life*. Their confidence + motivation → educational equity.

• **TRANSFER-Bridges** between Engineering and Science:
In Diagram B, 3 elements (Predictions, Observations, Goals) are compared in 3 ways, 2 used for General Design (this includes Engineering) and 1 used for Science-Design.
In Design-Inquiry for General Design (e.g. Engineering) you use Quality Checks for main objective (with quality of a Solution-Option defined by Goals) AND Reality Checks by asking "do Predictions (from Mental Experiment, using Explanatory Theory-Based Model + If-Then Logic) match Observations (from Physical Experiment)?" By using this science-question, Engineering-DT and Science-DT occur in the same activity, in 3 comparisons of the 3 elements.
Transfers-of-Skills (including most NGSS Practices, and more) occur because similar DT-skills are used for Inquiry Activities in all subject areas, so we expect a transfering of valuable DT-skills between areas.

In Diagram C, Critical Evaluation (in Quality Checks) stimulates-and-guides Creative Generation when you ask "revise Option?" in a Design Cycle, or "revise Model?" in a Science Cycle (using Reality Checks), with critical-and-creative **Guided Generation** of Ideas-for-Options.

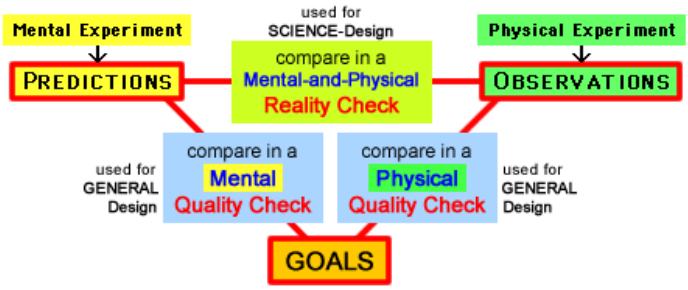
In Diagram D, Cycles of Plan-and-Monitor (similar to SRL Cycles for Self-Regulated Learning) help you Learn More from Experience, to develop-and-use a wide variety of metacognitive Thinking Strategies. (and other kinds of strategies, or activities or products, or science-models)

A - Simplicity: You use Design Thinking whenever you **Define Problem** (Learn, Define Objectives + Goals), **Solve this Problem** (Generate-and-Evaluate Ideas):



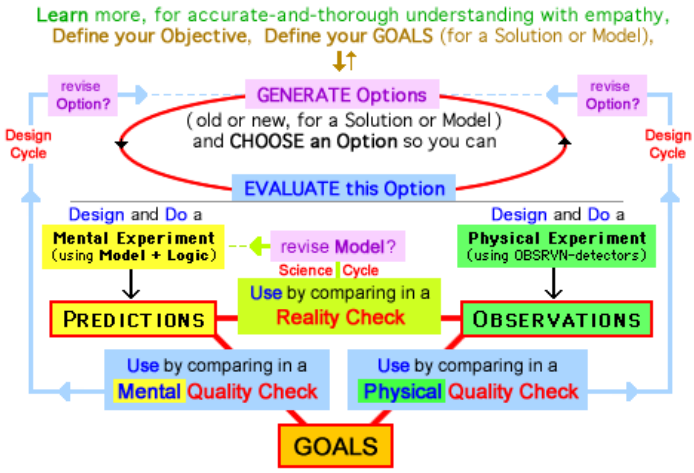
- -

B - 3 Elements (P, O, G) are used in 3 Comparisons:



- -

C - Design Cycles and Science Cycle:



- -

D - Plan (mentally Ideate) and **Monitor** (physically Test):