The Engineering Learning Process

from Three Perspectives: *Designer, Facilitator, and Learner*

Steps are mapped to the Learning Process Methodology (*in italics*)

Step 1

Purpose (*LPM Step 1: why*)

a. What is going to be learned?
b. Why is this knowledge important to the big picture of the course/discipline?
c. How does this knowledge connect with other related knowledge? *(LPM Step 2: orientation)*
d. Why is this knowledge relevant to the learner's life?

Step 2

What do we do to approach this learning (essential core) like a mathematician with the discovery and creativity to make it interesting, intriguing, and fun? (i.e., play with the engineering)

a. Find an interesting context relevant to the learner(s) (Who Gives a Darn?) *(Step 1 LPM)*
b. Make it discovery-oriented *(Step 2 LPM: orientation)*
c. Add creativity and new insights to the discoveries
d. Engage in learning that mirrors the Engineering mindset

Step 3

Expectations for the learning performance (*LPM Step 4: learning objectives & LPM Step 5: performance criteria)*

a. What are the learning objectives?
b. What are the expected performances, and associated tasks, that the learner must be able to do by the end of the learning experience?
c. What specific performance criteria are going to be used for measuring the quality of this performance?
d. The description of the expected level of performance should allow the learner or facilitator to determine the degree of success.

Step 4

What do you already know? (*LPM Step 3: pre-requisites*)

a. What previous life experiences can you bring forward to this new learning?
b. What previous knowledge of prior courses can you take advantage of?
c. What can you bring forward from the discovery exercise?
d. What can you look forward to in the current reading that you can utilize?
e. What you can look for and analyze in the presented models?

Step 5

Required engineering language (the precision of its terminology, symbolic representations and Engineering notation) (*LPM Step 6: Vocabulary*)

a. Identify previous Engineering language that is going to be used
b. Introduce new representations
c. Introduce new associated tool(s) and Engineering conventions
d. Introduce the terminology for each of the new engineering ideas/concepts

Step 6

Information needed before (reading assignment) and during the learning experience (*LPM Step 7: Information*)

a. Describes briefly the key concepts and big ideas
b. Identifies valuable internet sites or books for exploring and reading
c. Provides unique resources and expertise for the learning
    - Methodologies
        - Steps with discussion
        - Worked out example(s)
        - Opportunity for learner to try out their own example
    - Table of Tips or Insights in contextualizing
    - Common Errors with specific content
    - Visuals and diagrams representing unique perspective

Step 7

Learning resources *(LPM Step 7 Information and Resources)*

May include: Software tools, Manipulatives, Simulations, Learning Objects, Data sets

Step 8	Are you Ready? (*LPM Step 8: Plan*) a. Validate what is known after performing Engineering Learning Process Steps 1 – 6 b. Document this learning with answers to Exploratory Questions and/or reading quiz c. Document what is not known with a set of questions ready to be investigated in class d. Identify the key learning challenges contained within this knowledge e. Planning how the learner will meet the challenges; putting together a plan with specific steps
Step 9	Classroom activity a. Summarize and review Steps 1 – 7 of the LPM • Why *(LPM Step 1)* • Learning Objectives *(LPM Step 4)* • Performance and Criteria *(LPM Step 5)* • Critical Information for the activity *(LPM Step 7)* b. Plan *(LPM Step 8)* connects pre-activity of the experience to the classroom experience, including specific tasks such as sub-activities to increase understanding related to Critical Thinking Questions (see d, below) c. Models *(LPM Step 9)* d. Critical Thinking Questions (CTQ) *(LPM Step 10)*
Step 10	Demonstrate Your Understanding *(LPM Step 11)* • Start with familiar context • Move into a less familiar context • Challenge learner to transfer to an unfamiliar context • Limit the additional challenges to three with the focus on generalizing
Step 11	Hardest Problem: Generalizing the knowledge *(continuance of LPM Step 11)* a. Identify the variations that can be included in the problem that would complicate solving it b. Create a problem that challenges all these dimensions c. Think through to make sure that you can address all the dimensions even when they change d. Test the boundary conditions for validity e. Explore possible and appropriate contexts for use of this knowledge based upon valid contextual prompts, issues, and boundaries
Step 12	Making it Matter: Problem Solving *(LPM Step 12)* a. Explore situations that require the use of this knowledge along with previous knowledge b. Pick contexts or situations that are meaningful for the learner c. Set the level of challenge presented in the problem to require the use of the problem solving methodology but not so difficult that it would require research process d. Learner must identify meaningful contexts so they can own and solve relevant problems e. Focus on Step 9 of PSM to see how these problem solutions can be reused in new situations
Step 13	Identify and Correct the Errors *(LPM Step 13: a focus on content)* a. Assess the learning: knowing you know what you know b. Shift from nearly clear to crystal clear by finding out others' errors in thinking c. Validate learning by using at least one validation technique
Step 14	Learning to Learn Engineering *(LPM Step 13: focus on discipline process)* a. Target areas of Learning Engineering to reflect on b. Explore the Engineering Professionalism and Mindset connected with the content c. Identify ways to help the growth of the learner, i.e., improving learning skills connected with the Engineer Learner Profile
Step 15	Assess Learning Performance *(LPM Step 13: focus on the Engineering Learning Process)* • Use the target of the learning challenge (Performance and Criteria) for self-assessment of effectiveness and efficiency of learning performance • Recognize strengths produced and how they were produced • Identify improvements with specific action plans • Develop new understanding about Engineering learning process and learning performance