Contextual Assessment of Student Learning Through Reflection on Doing

Janet K. Allen
John and Mary Moore Chair and Professor
Systems Realization Laboratory
University of Oklahoma
Norman, Oklahoma, USA
janet.allen@ou.edu
+1 405-555-3960

Farrokh Mistree
L. A. Comp Chair and Professor
Systems Realization Laboratory
University of Oklahoma
Norman, Oklahoma, USA
farrokh.mistree@ou.edu
+1 405-306-7309
Thoughts for Reflection

“We are currently preparing students for jobs that don’t exist using technologies that haven’t been invented in order to solve problems we don’t even know are problems yet.”

Former Secretary of Education Richard Riley

“Rather than focusing on specific technologies or specific problems, we need to equip students with those concepts that are common to all problems, all technologies, all skills, ranging from workplace engineering to ethics to entrepreneurship.”


“It is not the strongest of the species that survive, nor the most intelligent but ones most responsive to change.”

Charles Darwin

Janet K. Allen and Farrokh Mistree
Key Competency: The ability to adapt rapidly to changing circumstances, technologies, and paradigms in the presence of uncertainty.

Our Challenge: Empower our “junior engineers” to develop the key competency by engaging in learning through reflecting on doing.

Hypothesis: Empower students to learn how to develop five non-technical career sustaining competencies by adopting several Threshold Concepts.

Janet K. Allen and Farrokh Mistree
Threshold Concepts
1. Question for the semester
2. Kolb’s experiential learning
3. MadLibs and Learning Statements
4. Mental Models: Competencies and Learning Objectives
5. Bloom’s taxonomy
6. Learning community / organization
7. Journaling
8. Sustainability / dilemma triangle
9. Observe, Reflect and Articulate (ORA) construct
10. ADT - Requirements list / Gap Analysis / SWOT / De Bono / Causal Loops
11. ADT - Decision Support Problems
12. Method for identifying dilemmas
13. Method for managing dilemmas
14. Self grading – SLE and A0EOS
15. Verification and validation

Themes for Lectures
1. Competencies and learning objectives
2. Learning community
3. Sustainability
4. Dilemmas
5. Attention directing tools
6. A0, A0EOS and SLE
7. Decision making
8. Answering the Q4S
9. Verification and validation
10. Digitized World: Industry 4.0


Imagine that you are an engineer with social conscience collaborating with social entrepreneurs in India to create a value network as required by the Question for the Semester.

What are the characteristics and features of a cloud-based ecosystem (that includes the internet of things) to promote sustainable development that improves the quality of life of villagers in off-grid villages in India and motivates the villagers to take care of and promote the environment (ecology, education, healthcare, sanitation, job opportunities, etc.) in environmentally sensitive areas that need to be electrified?

Your task is to internalize the Question for the Semester and collaboratively create a requirements list to foster sustainable development in off-grid villages in India and through the process develop career sustaining competencies by reflecting on doing.
Focus – Developing Career Sustaining Competencies

Learning through doing, reflecting and articulating

Competencies are the result of integrative learning experiences in which skills, abilities, and knowledge interact to form bundles that have currency in relation to the task for which they are assembled.

Develop career sustaining competencies through answering the Q4S

1. To continue learning through reflection and the associated creation and articulation of knowledge.
2. To speculate and identify gaps that foster innovation.
3. To ask questions, listen, reflect, and identify gaps and opportunities worthy of further investigation.
4. To make decisions using incomplete information, and
5. To think critically (deductive reasoning and inductive speculation) and identify a way forward.

Janet K. Allen and Farrokh Mistree
**TC2 - Kolb’s Experiential Learning**

Experiential learning is the process of learning through experience, and is more specifically defined as “learning through reflection on doing”. Experiential learning is distinct from rote (focus on memorization) or didactic (teaching from text books) learning, in which the learner plays a comparatively passive role. [1][https://en.wikipedia.org/wiki/Experiential_learning]

1. **Authentic Immersive Experience**
2. **Reflective Observation Take Aways**
3. **Abstract Conceptualization Lessons learned Learning Statements**
4. **Integrate with what you know Semester Learning Essay**

**Notes**
- 1. Focus on doing in an authentic, immersive experience. Includes reading, solving a problem, building, testing, etc.
- 2. Reflect on immersive experience.
- 4. Either reinforce what you know (pattern) or augment what you know (new pattern).

Janet K. Allen and Farrokh Mistree
TC3 - Learning By Reflecting on Doing

Must be structured as a **triple Experience** followed by **Learning** followed by **Utility**

Must be a single sentence

<table>
<thead>
<tr>
<th>Experience x</th>
<th>Learning y</th>
<th>Value / Utility z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through x (From x, By doing x, ...)</td>
<td>I learned y</td>
<td></td>
</tr>
<tr>
<td>I did not consider x initially</td>
<td>I realized y</td>
<td>Value / utility z</td>
</tr>
<tr>
<td>I thought (expected) x before / initially</td>
<td>I found out y</td>
<td>in future of</td>
</tr>
<tr>
<td></td>
<td>I discovered y</td>
<td>learning y</td>
</tr>
<tr>
<td></td>
<td>I became conscious of y</td>
<td></td>
</tr>
</tbody>
</table>

Examples of Learning Statements

**Through X I learned Y** which will help me do xx in Assignment yy.

**From Lecture N, I found out Y** which is valuable because ????.

Learning Statements allow you to contextualize your learning in the context of an experience or set of experiences and allows you to relate the learning to value in the future. Learning typically embodies insight / new knowledge that is foundational to innovation.

Janet K. Allen and Farrokh Mistree
Examples from 2017

Through comparing SWOT in AME5303 and soccer, I learned how to map the relationships between systems entities using systems dynamics and evaluate their relationship by doing reality check, with the value of creating and developing Competencies 3 and 5. Reza Alizadeh

By introspecting on my learnings in AME5303, I discovered that the course was developed to help transition us from being a tool user to a tool maker and I have decided to excel in being a tool maker, the value of which lies in the quality of my life. Bhagyashree Waghule

I thought that this class would provide me with steps to build my career sustaining competencies, but I realized that I need an authentic immersive experience and reflect on it in order to build my competencies, which adds value to L1, L2, L5, C1, C2, C3, and C5 that my experience is a tool to obtain a starting point for innovation and produce an environment of discussion and speculation. Emmanuel De Leon

After listening to Lecture 13, I gained insight to why using a systems perspective is important, with value in being able to utilize this method in the future when answering the Q4S. Nick Loupe

Janet K. Allen and Farrokh Mistree
A mental model is an explanation of someone's thought process about how something works in the real world. It is a representation of the surrounding world, the relationships between its various parts and a person's intuitive perception about his or her own acts and their consequences. Mental models can help shape behaviour and set an approach to solving problems (similar to a personal algorithm) and doing tasks.

A mental model is a kind of internal symbol or representation of external reality, hypothesized to play a major role in cognition, reasoning and decision-making. Kenneth Craik suggested in 1943 that the mind constructs "small-scale models" of reality that it uses to anticipate events.

A mental model is a cognitive tool to contextualize the problem.

Your mental model for this course embodies the relationship between competencies and learning objectives.

Janet K. Allen and Farrokh Mistree
Table 1. The assigned values to relationship between learning objectives and competencies.

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Gentle</th>
<th>Fair</th>
<th>Ok</th>
<th>Great</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assigned values</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

As shown in Table 1, with Gentle relationship, which has the lowest value of relationship between competency and learning objective, I demonstrate a weak relationship between the competency and learning objective. Etc., etc.
### TC7 - Journaling – Recording Progress

Emmanuel De Leon, 2017

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>Value</th>
<th>Learning Objective</th>
<th>Competency</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 Aug 17</td>
<td>QD3- What do I need to do to get the most out of this course?</td>
<td>1</td>
<td>L1, L3, L4</td>
<td>C1, C3, C4, C5</td>
</tr>
</tbody>
</table>

**Observe**

The willingness to be open to other learning/teaching styles and active participation is key in order to get the most out of the class.

**Reflect**

How is this class different from other classes I have taken in the past?

**Articulate**

I did not consider my learning style to be important in this course initially, but I found out that by learning my learning style I can actively participate in class by taking notes and asking questions to get the most out of this class, which adds value to L1, L3, L4, C1, C3, C4, and C5 in that it will allow me to compare available resources and critique information to help me justify future decisions.

**Evaluate**

This value is 1 because I benefited from hearing about what I have to do in the course to succeed and get the most out of it.
The table presented shows how I utilized and progressed with developing my competencies based off the exercises and assignments completed for AME5303. Overall, it shows that I have developed competency C5 in my ability to assess and think critically. My least progressed competencies are C2 and C4, and I have worked hard throughout the semester to develop them, however the data shows otherwise. Although the data shows this shortcoming, I know I have developed my abilities to identify gaps and make decisions using incomplete information by completing Assignments 1 and 2, as well as helping develop the solution for the Q4S. However, I recognize that these are two competencies that I must continue to improve outside the course and in my professional engineering career.

Janet K. Allen and Farrokh Mistree
The graph provided shows a clear imbalance of the development of each competency, with the progress most on the development of competency C5. Visually, my ability to equally develop each competency is unlikely for me. By visually inspecting my progress in developing my competencies, I realize that I may not have the skills to clearly focus on developing one competency over the other. This may be the case for me since I resort to doing what is comfortable for me to accomplish, rather than challenging myself to shift my thinking. Therefore, this is a skill I will also have to develop in my professional career.
Exercises and Assignments

Exercise 1 – Learning Styles
Exercise 2 – Mental Model
Exercise 3 – Journaling
Assignment 0 – Mental Model
Exercise 4 – Understanding the Q4S using the Sustainability Triangle
Exercise 5 – Deep Reading / Critical Evaluation to Identify Gaps
Assignment 1 – Frame the Q4S (Team)
Exercise 6 – System Dynamics – Causal Loop Development (Team)
Assignment 2 – Answer the Q4S (Team)
Exercise 7 – Outline of Semester Learning Essay

A0EOS – Self-Assessment of Work Done During the Semester
SLE – Self-Assessment of Development of Competencies

Janet K. Allen and Farrokh Mistree
AME4163 – Principles of Engineering Design

Salient Features
1. Design, Build, Text, Post-Mortem
2. 180 Undergraduates
3. 12000 Learning Statements
4. Data scraping and text mining
5. Results in the form of Wordels and Dendrons
Key Publications


To get copies of student submissions please contact farrokh.mistree@ou.edu

Janet K. Allen and Farrokh Mistree
Dialog - Learning Community

**Key Competency:** The ability to adapt to changing circumstances, technologies, and paradigms.

**Our Challenge:** Empower our “junior engineers” to develop the key competency by engaging in learning through reflecting on doing.

**Key Outcomes**

1. An authentic, immersive course aimed at empowering students to learn how to continue developing career sustaining competencies.

2. A framework to assess what students have learned as a result of reflecting on authentic, immersive experiences.

Janet K. Allen and Farrokh Mistree