Contextual Assessment of Student Learning Through Reflection on Doing

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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."

From The Jobs Revolution: Changing How America Works by Steve Gunderson, Roberts Jones, and Kathryn Scanland (2004)

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

Charles Darwin

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.

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

Ge X., Allen JK and Mistree F., 2018, "Career Sustaining Competencies for Managing Disruptions and Innovative Problem Solving in a Digitized World," IEEE International Conference on Advanced Learning Technologies, IIT Bombay, Mumbai, India. Paper ID 82.

Mistree, F., Panchal, J.H., Schaefer, D., Allen, J.K, Haroon, S., and Siddique, Z., 2013, "Personalized Engineering Education for the 21st Century." In Curriculum Models for the 21st Century. (M. Gosspar and D. Ifenthaler Eds.), Springer, pp. 91-112.

TC1 - Question for the Semester (Q4S) and Task

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 lists 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

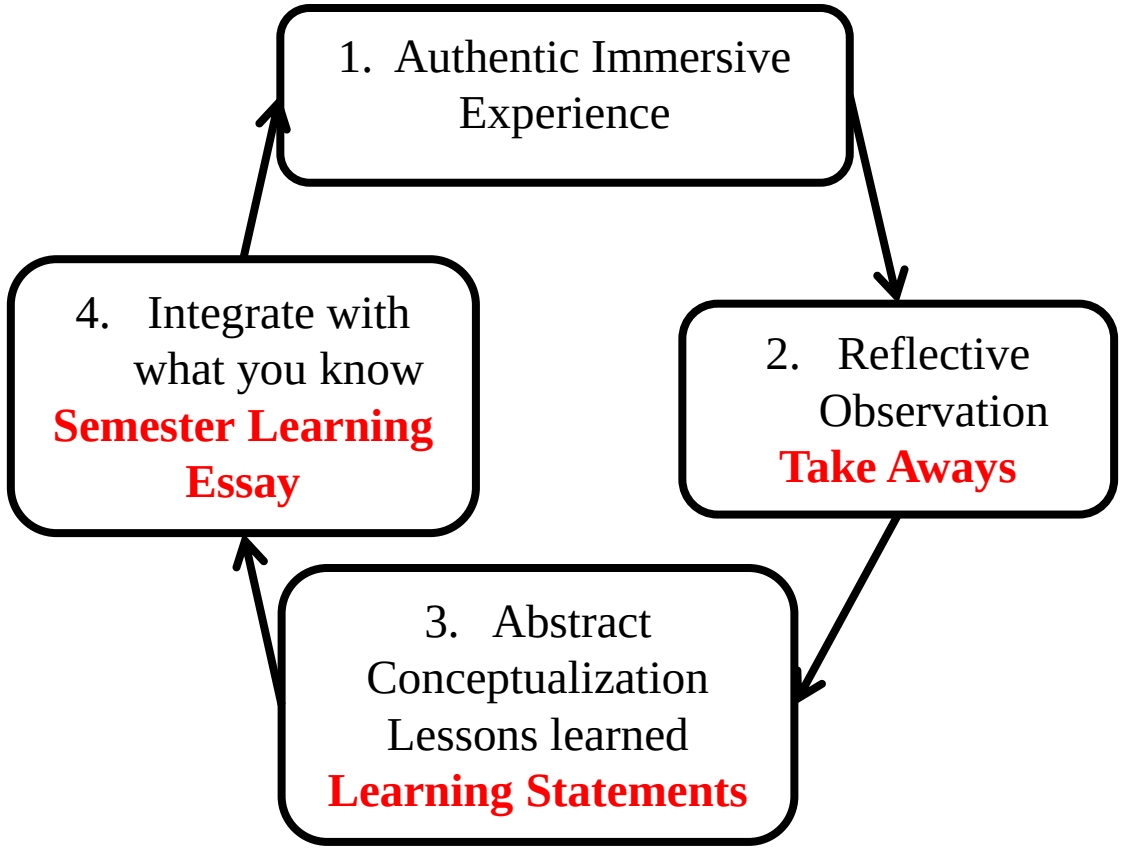
Develop career sustaining competencies through answering the Q4S

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.

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



Notes

1. Focus on doing in an authentic, immersive experience. Includes reading, solving a problem, building, testing, etc.
2. Reflect on immersive experience.
3. Through abstraction identify lessons learned.
4. Either reinforce what you know (pattern) or augment what you know (new pattern).

TC3 - Learning By Reflecting on Doing

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

Experience x	**Learning y**	**Value / Utility z**
Through **x** (From **x**, By doing **x**, …)	I learned **y**	
I did not consider **x** initially	I realized **y**	Value / utility **z**
I thought (expected) **x** before / initially	I found out **y**	in future of
	I discovered **y**	learning **y**
	I became conscious of **y**	

Value = Benefit/Time

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.

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*

TC4 - What is a Mental Model?

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.

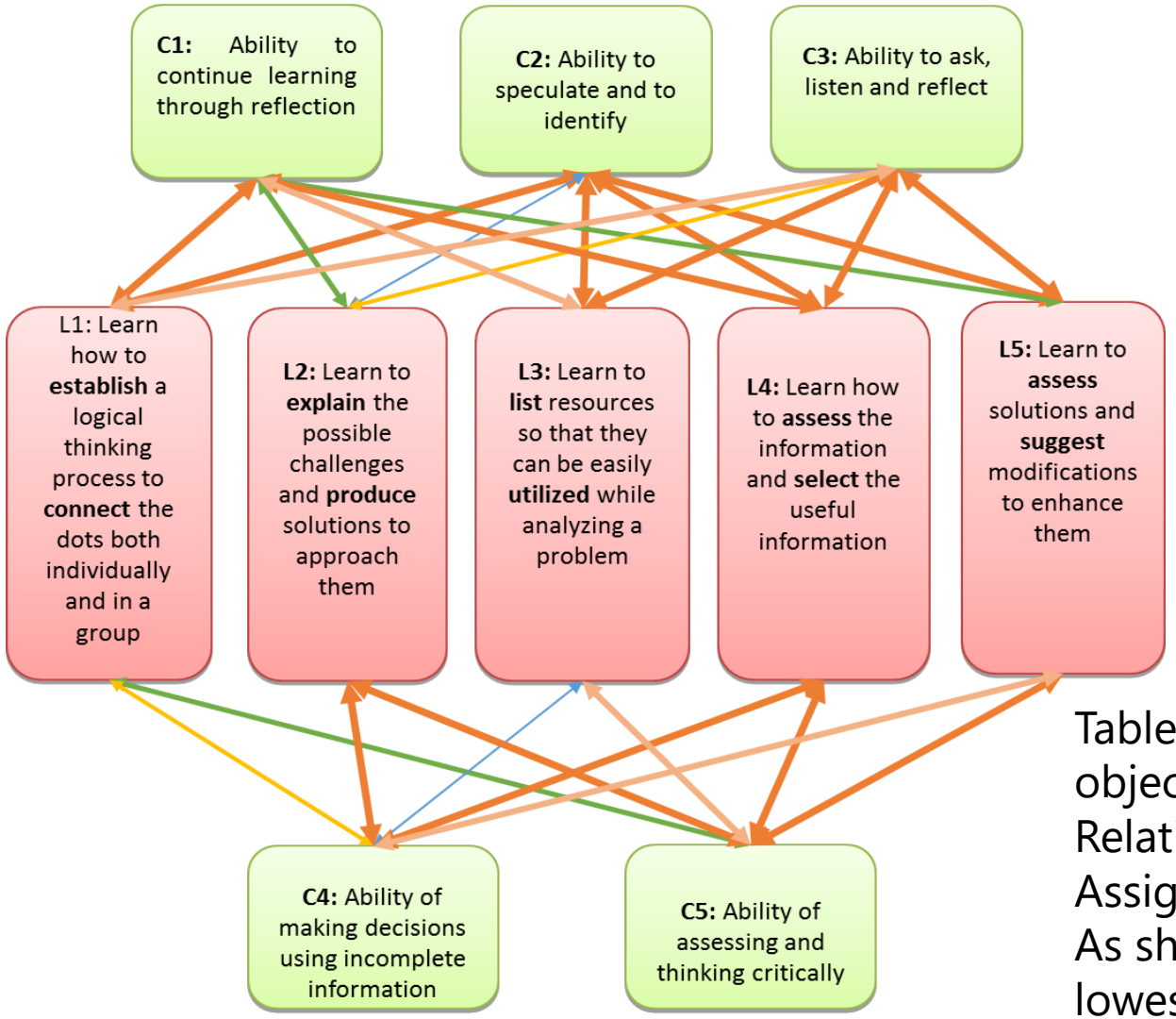
A *mental model* is a kind of internal symbol or representation of external reality, hypothesized to play a major role in cognition, reasoning and decision-making. Kenneth Craik suggested in 1943 that the mind constructs "small-scale models" of reality that it uses to anticipate events.

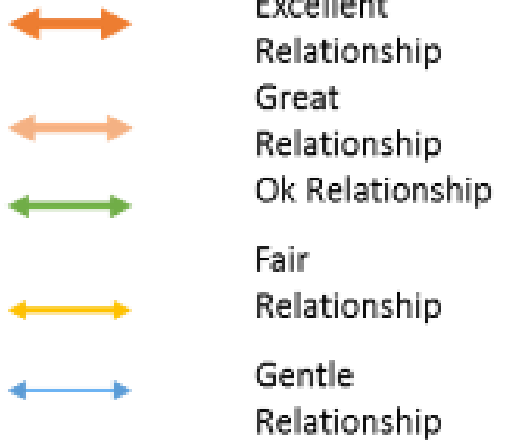
•https://en.wikipedia.org/wiki/Mental_model

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*.

TC4 - Mental Model – Reza Alizadeh's Learning Objectives and Competencies (2017)





Learning objective includes the word *learn* and *action / transformative* words from Bloom's Taxonomy.

Highlight the action words.

Table 1. The assigned values to relationship between learning objectives and competencies.

Relationship	Gentle	Fair	Ok	Great	Excellent
Assigned values	1	2	3	4	5

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

Date	Source	Value	Learning Objective	Competency
21 Aug 17	QD3- What do I need to do to get the most out of this course?	1	L1, L3, L4	C1, C3, C4, C5
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.			

TC7 - Journaling – Template for monitoring learning

Emmanuel De Leon, 2017

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 short coming, 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.

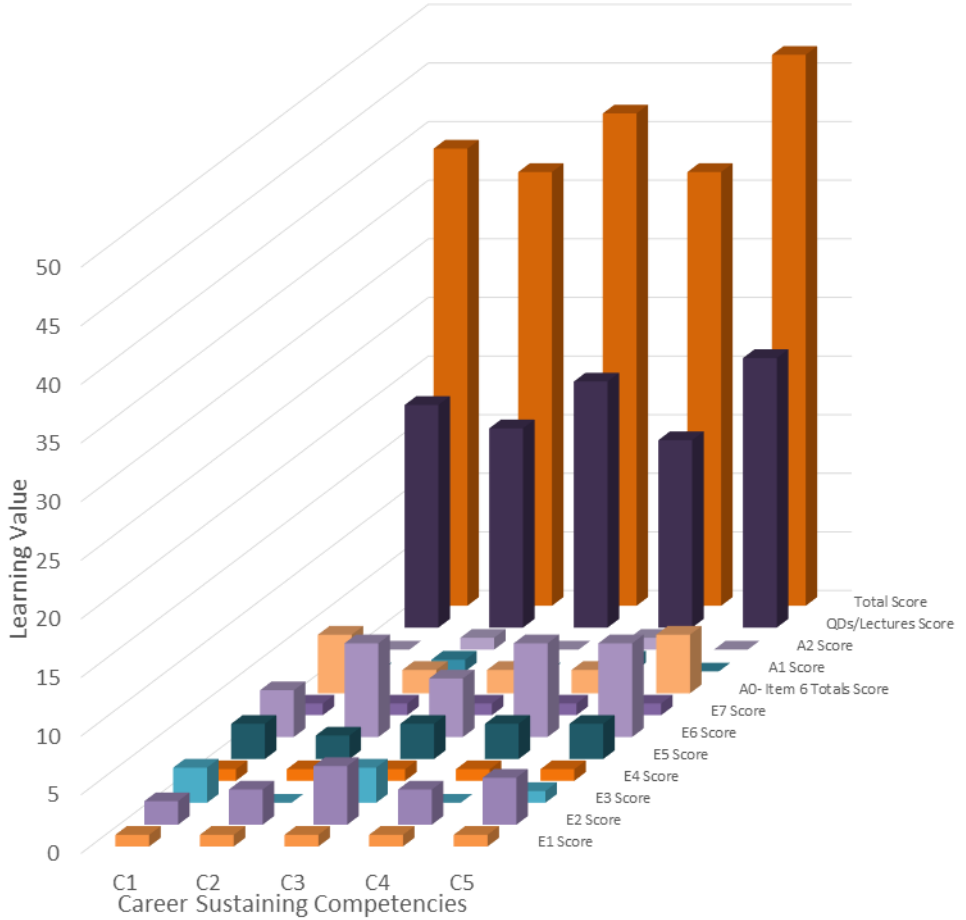
		Career Sustaining Competencies				
		C1	**C2**	**C3**	**C4**	**C5**
E1	Score	1	1	1	1	1
	%	2.22	2.50	2.22	2.50	2.22
E2	Score	2	3	5	3	4
	%	4.44	7.50	11.11	7.50	8.89
E3	Score	3	0	3	0	1
	%	6.67	0.00	6.67	0.00	2.22
E4	Score	1	1	1	1	1
	%	2.22	2.50	2.22	2.50	2.22
E5	Score	3	2	3	3	3
	%	6.67	5.00	6.67	7.50	6.67
E6	Score	4	8	5	8	8
	%	8.89	20.00	11.11	20.00	17.78
E7	Score	1	1	1	1	1
	%	2.22	2.50	2.22	2.50	2.22
A0- Item 6 Totals	Score	5	2	2	2	5
	%	11.11	5.00	4.44	5.00	11.11
A1	Score	0	1	0	1	0
	%	0.00	2.50	0.00	2.50	0.00
A2	Score	0	1	0	1	0
	%	0.00	2.50	0.00	2.50	0.00
QDs/Lectures	Score	19	17	21	16	23
	%	42.22	42.50	46.67	40.00	51.11
Total	**Score**	**39**	**37**	**42**	**37**	**47**
	%	**86.67**	**92.50**	**93.33**	**92.50**	**104.44**
Goal	**Score**	**45**	**40**	**45**	**40**	**45**

Transformation to numbers not shown

TC7 - Graphical Representation of Learning

Emmanuel De Leon, 2017

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

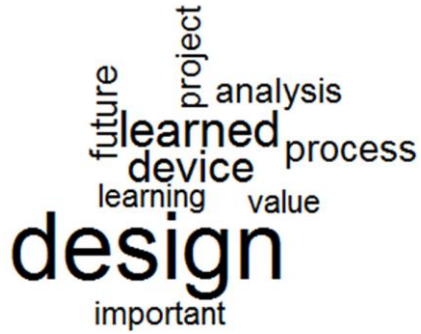
AME4163 – Principles of Engineering Design

Assignment	1	2	3	4	5	6
Description / POED	***Given:*** Story, Team Contract ***Provide:*** Problem Statement, POA, HOQ, Req. List, LS	***Given:*** Prob. Statement, HOQ, Req. List. ***Provide:*** Function Structure, Morph. Chart, 6 Configs., PMI, Failure, LS	***Given:*** Configurations, PMI, Failure ***Provide:*** Go/No-Go from 6 to 2, Bill of Materials, Recommendation, LS	***Given:*** Concept ***Provide:*** Geometry analysis, CAD model, refined Bill of Materials, Buildability, Report, LS	Post-mortem report	Semester Learning Essay
1a	×					
1b	×					
1c	×					
1d	×	×	×	×		
2a		×				
2b		×				
2c		×				
3a			×	×		
3b			×	×		
3c				×		
4a					×	
4b					×	
4c					×	
5a						×
5b	×	×	×	×	×	×
5c						×

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

Lectures



A5 – Post-Mortem

Janet K. Allen and Farrokh Mistree

Key Publications

1. Ge X., Allen JK and Mistree F., 2018, "Career Sustaining Competencies for Managing Disruptions and Innovative Problem Solving in a Digitized World," IEEE International Conference on Advanced Learning Technologies, IIT Bombay, Mumbai, India. Paper ID 82.
2. Autrey J.L., Sieber J., Siddique Z. and Mistree F., 2018, "Leveraging Self-Assessment to Encourage Reflection on Doing," International Journal of Engineering Education, Vol. 34, No. 2(B), pp. 708-722.
3. Ifenthaler, D, Siddique, Z. and Mistree, F., 2015, "Change of Attitudes, Self-Concept, and Team Dynamics in Engineering Education." In Emerging Technologies for STEAM Education. (Eds. X. Ge., D. Iffenthaler and M.J. Spector. Eds.), Springer, pp. 201-215
4. Mistree, F., Panchal, J.H., Schaefer, D., Allen, J.K, Haroon, S., and Siddique, Z., 2013, "Personalized Engineering Education for the 21st Century." In Curriculum Models for the 21st Century. (M. Gosspar and D. Ifenthaler Eds.), Springer, pp. 91-112.
5. Mistree, F., Panchal, J.H., and Schaefer, D., 2012, "Mass-Customization: From Personalized Products to Personalized Engineering Education." Chapter 9 in Supply Chain Management, (Crosnik, A and Xiong, Y. Eds.), INTECH Rijeka, Croatia, pp. 150- 174. ISBN 979-953-307-234-9.

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

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.