Engineering Education

UNIVERSITY OF TORONTO

The Long and Winding Road:

Finding our path as educators

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Ryerson 2018

Collaborative Specialization in Engineering Education

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Summary

- My Path
  - –Pedagogy
  - –Course design
- Our Path

2

My Path: Lessons Learnt

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- Pedagogy
  - Learning about learning
  - Active learning helps
- Course design
  - Tyranny of Content
  - Integrated learning experiences

3

Making Connections

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Lecturing for an Hour

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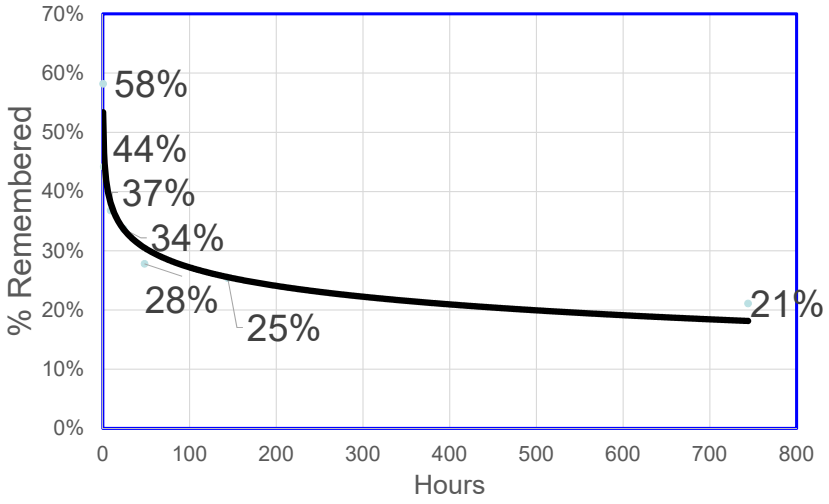

Adapted from Ebbinghaus Forgetting curve data

5

Iteration Helps and It Gets Easier

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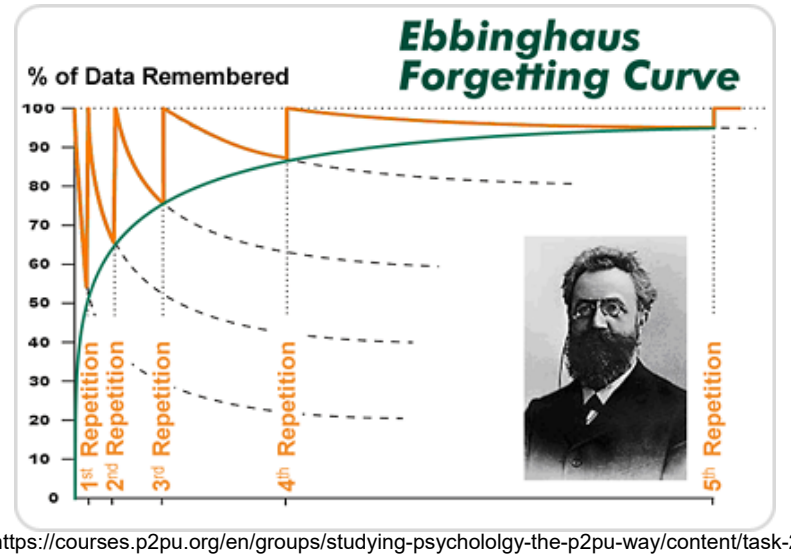

https://courses.p2pu.org/en/groups/studying-psychololgy-the-p2pu-way/content/task-21-the-ebbinghaus-forgetting-curve/

6

Assessment Helps

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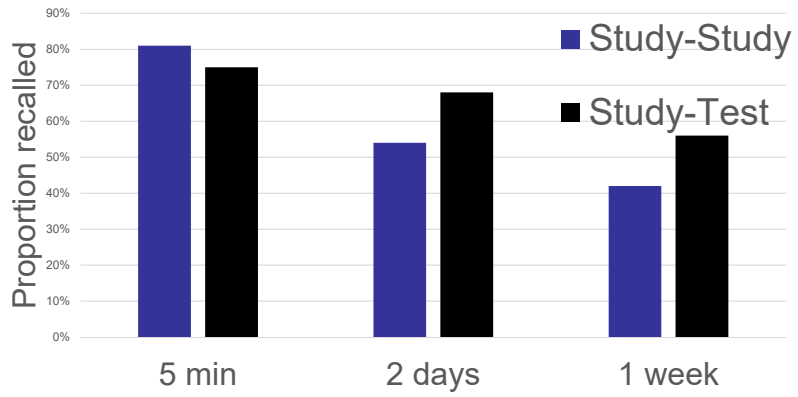

Adapted from Roediger and Karpicke. "The power of testing memory: Basic research and implications for educational practice." *Perspectives on Psychological Science* 1.3 (2006): 181-210.

7

Active Learning Helps

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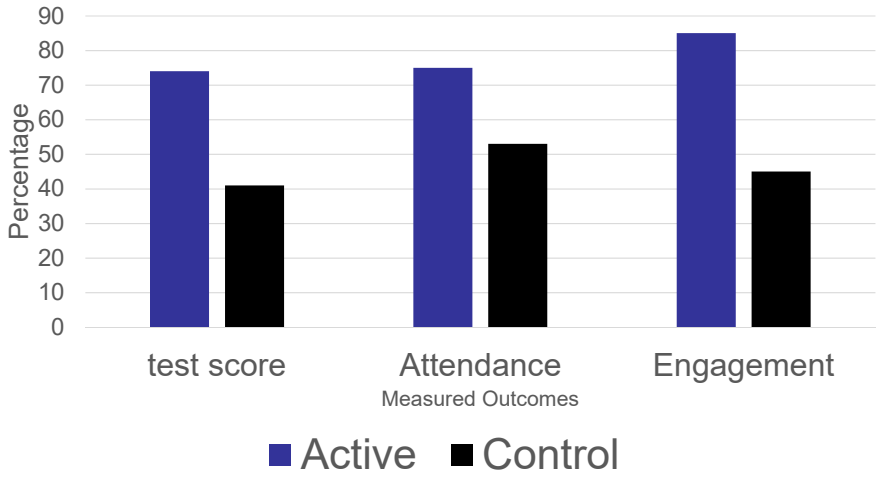

Adapted from Wieman C. Et al. "Improved Learning in a Large-Enrollment Physics Class Science 332 2011

8

Active Learning

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Cons

- Takes up instructional time
- Many students don't like it…initially
- Need to switch from sage to guide
- Reduces spontaneity?
- Doesn't work in large classes?

Pros

- Can be collaborative and individual
- Promotes engagement and reflections
- Supports forced recall
- Research evidence is mostly supportive[1]

1: Prince M Does Active Learning Work? A Review of the Research JEE 2004

9

Active Learning Strategies

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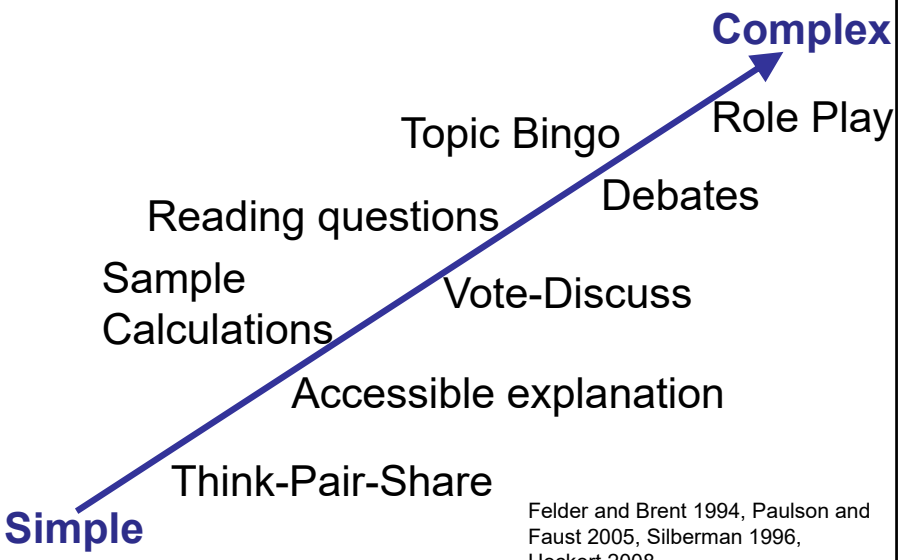

Felder and Brent 1994, Paulson and Faust 2005, Silberman 1996, Ueckert 2008,

Videos Help: Explaining Entropy

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11

Course Design: Tyranny of Content

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- **Outcomes**: What students will have learned, and retained
- **Assessment**: What students will do to demonstrate learning?
- **Instructional design**: Experiences I provide to enable this learning

Wiggins G “understanding by Design” 2nd Edition 1998

12

Triaging Course Content

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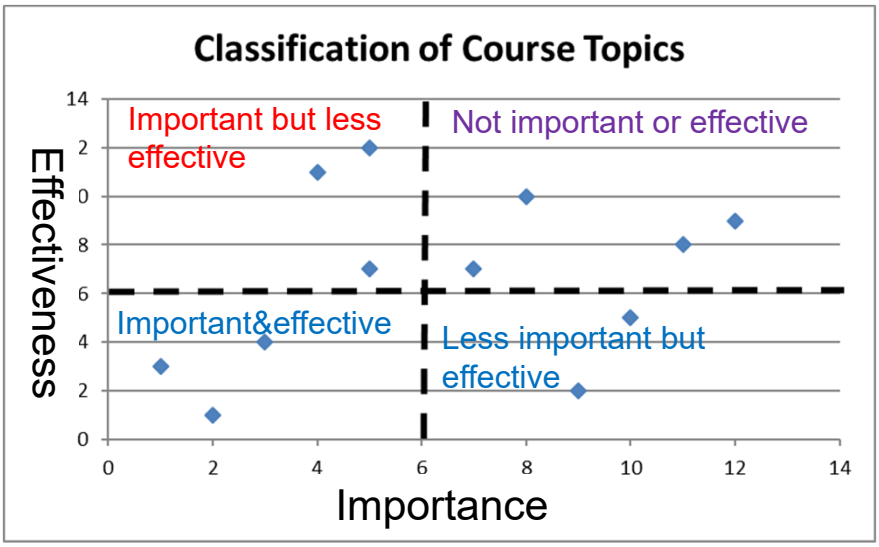

13

Holistic Learning Experiences

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- From acquisition based learning to participatory learning
- Move from individual learning to situated learning[1]
- From construction of knowledge to creation of identity
- Problem based with adequate scaffolding[2]

1: Wenger and Lave “Situated Learning” 1991
2: Kirschner, Sweller and Clark *Edu Psychol* 41(2) 75-86 2006

Integration and Mixing Helps

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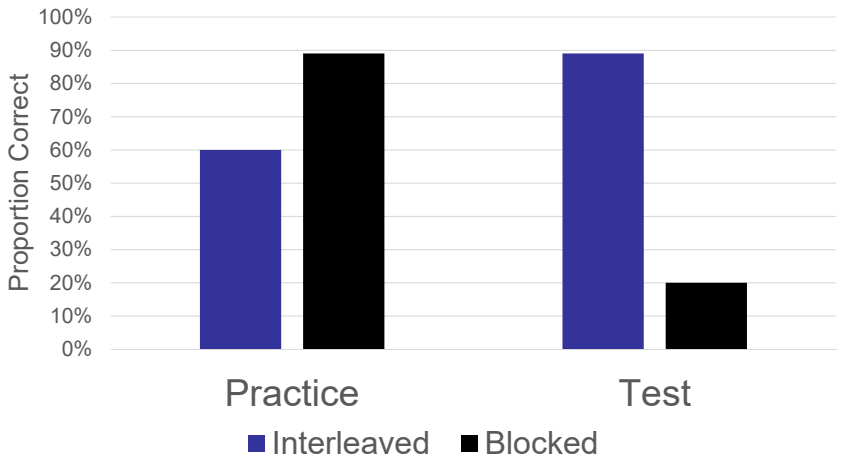

Adapted from Rohrer and Pashler *Educational Researcher*, Vol. 39, No. 5, pp. 406–412 (2010)

15

CHE230: Environmental Chemistry

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- Core technical course
- Instruction based on semi-inverted cooperative learning design
- Students in same teams of five for tutorials and a project
- Cooperative learning[1]
- Peer instructions to promote reflection[2]

1:Johnson,Johnson&Smith *J. Excel. College Teaching* 25(3&4) 2014
2: Roscoe and Chi *Instr Sci* (2008) 36:321–350 2005)

16

Role Play to Reality:
Environmental Consulting Design Project

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- Process
  - Students create their own environmental consulting company (Team of 5)
  - Bid on one of four RFPs
- Instructional design:
  - Iterative with multiple feedback stages
  - Integrate 8 of 12 accreditation attributes
  - Practice field

17

Projects 2018

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Sarnia's Chemical Valley

Portlands Soil Quality

Mine in Red Lake

Portlands Air Quality

18

Instructional Structure

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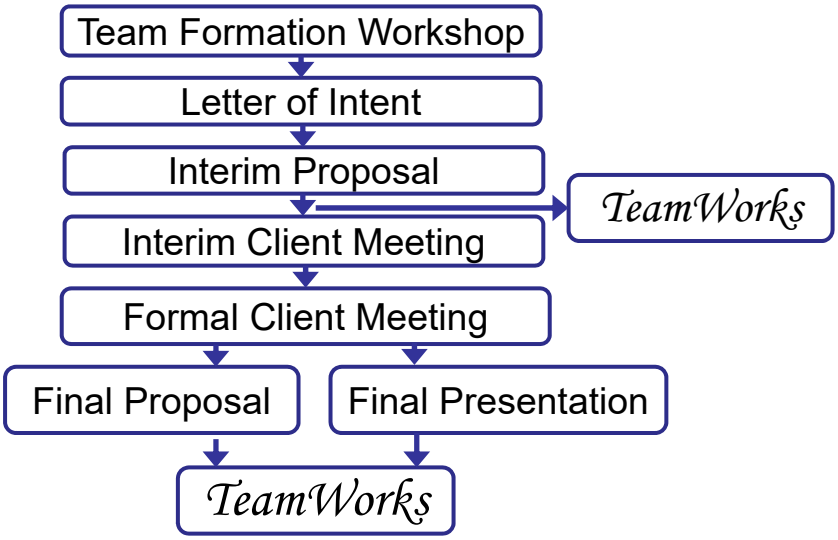

19

TeamWorks: Web Teaching Tool

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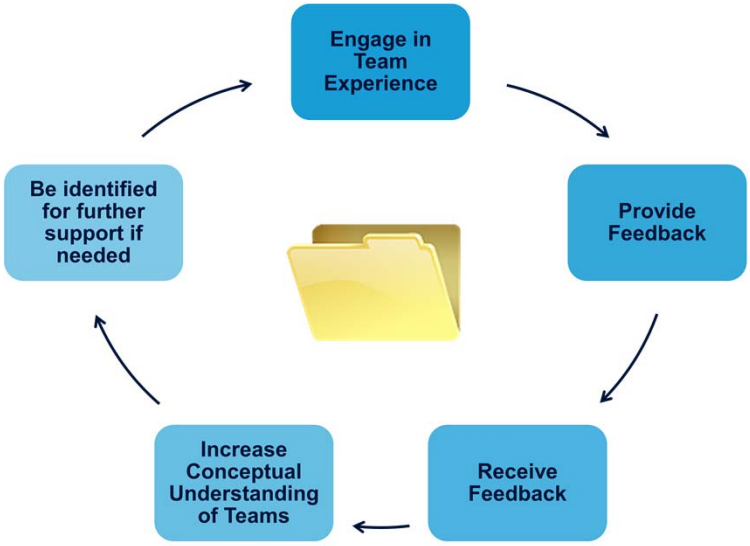

20

Team Leadership Styles

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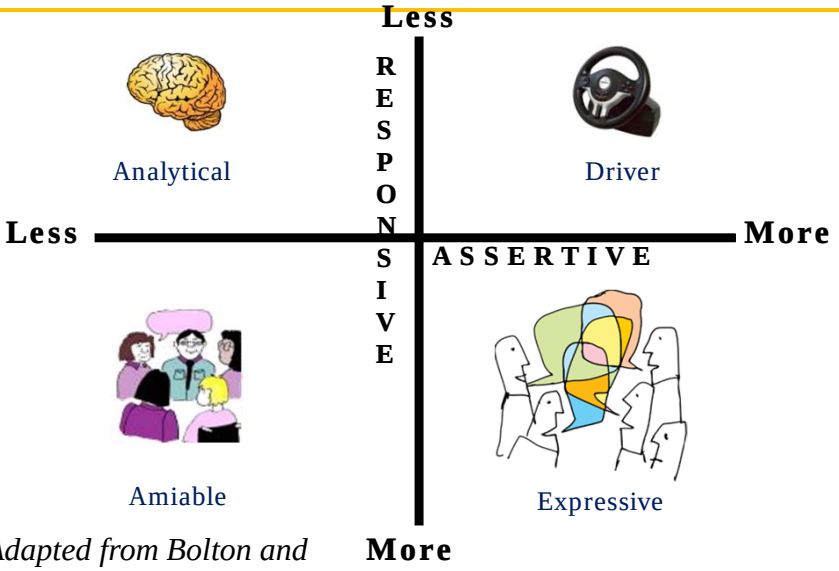

Adapted from Bolton and Bolton

21

Team Skills to Effective Teams

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Organisational Contributes by organising	Relational Contributes by building relationships	Communication Contributes through communication
Attend team meetings prepared	Listen and pay attention to team members	Exchange information in a timely manner
Do their fair share of the work	Seek-include input from members	Openly express ideas and opinions
Deliver their work on time	Show respect for other teammates	Promote productive discussion
Help to plan and organize workflow	Demonstrate accountability	Raise contentious issues in a constructive way

22

Formative Feedback

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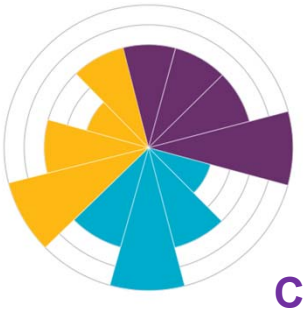
Self



Peer

Relational
Communication
Organisational

23

Lessons: Tools and Techniques

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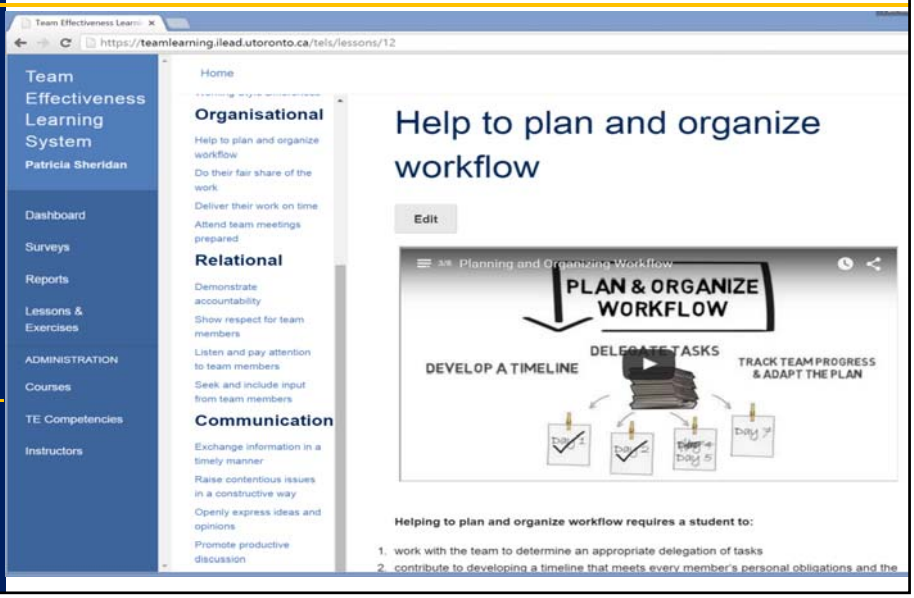
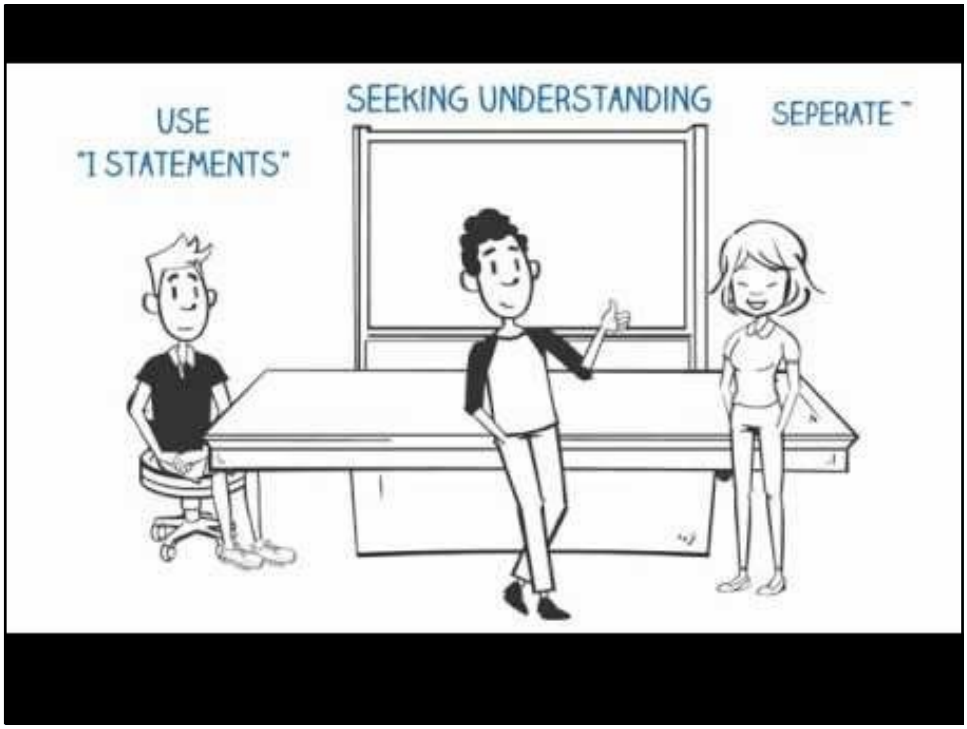


24



Instructor Feedback

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Team Effectiveness Learning System

Aidan Malone

Reports

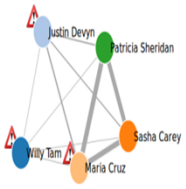
Lessons & Exercises

ADMINISTRATION

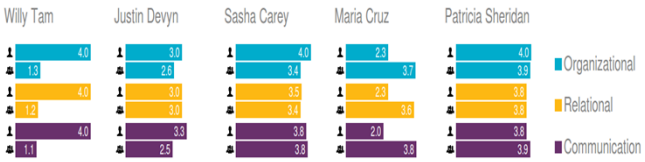
Courses

Sample Course

Group 1



Group Data



26

Our Path: Shifting Landscape

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- Society wants more broadly prepared students
- Higher vs. hire education
- The role of post-secondary education?
- New players are entering field

27

We are responding!

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http://people.uwplatt.edu/~turnern/assets/MedievalClassroomFullSz.jpg

28

Growing Expectations

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- Transdisciplinary competencies
- Emerging Practices
- Scholarship of engineering education

- The Engineer of 2020: Visions of Engineering in the New Century, National Academies Press 2004.
- Goldberg D.E. and Summerville, M "A Whole New Engineer," ThreeJoy Associates Inc. 2014
- Kamp A. "Engineering Education in a Rapidly Changing World Rethinking the Vision for Higher Engineering Education" TU Delft, Second Revised Edition, 2016
- Harrison A "Skills Competencies and Credentials" HEQCO 2017
- "Some Assembly Required "STEM Skills and Canada's Economic Productivity" CCA 2015

29

Institute for Studies in Transdisciplinary Engineering Education and Practice

Engineering Education

- Guide pedagogical development and teaching innovation;
- Integrate transdisciplinary competencies into instruction of engineering;
- Promote inter-departmental collaboration and curricular efficiency
- Better prepare our graduates for success and impact

ISTEP
Institute for Studies in Transdisciplinary Engineering Education and Practice

30

Summary

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- Education landscape is evolving
- Time to look more closely at
  - what we teach,
  - how we teach and
  - who we want to graduate
- Many opportunities
- Cultural shift remains a challenge

31