Employing Multifaceted Teaching and Learning Components to Foster CEAB Graduate Attribute Development

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David and Joan Lynch School of Engineering Safety and Risk Management

1) Background: Motivation for Blended Learning
2) Course Format Changes: Multifaceted Blended Learning
3) Resource Allocation: Personnel and Time
4) Targeted CEAB Graduate Attributes and Learning Outcomes
5) Student Performance on Exams, Team Project and GAs
6) Outcomes and Next Steps

1) The Background Story

1989: The Engineering Safety and Risk Management Program was established at the University of Alberta.

- Offered a full multi-disciplinary engineering safety and risk management (ESRM) course to undergraduate students
- Unique to Canada

2015: The David and Joan Lynch School of Engineering Safety and Risk Management was formed at the U of A

- Two courses: ENGG404 Leadership in Risk Management and ENGG406 Methodologies in Engineering Safety
- ENGG404 has evolved to become a benchmark and mandatory course for all undergraduate engineering curriculums
- Created graduate level version of ENGG404
- The School remains unique in Canada and much of North America for delivering ESRM education to engineers.

ENGG404 “Leadership in Risk Management”:

Objective:

- To develop core competencies and proficiencies in the leadership principles and practices towards organizational effectiveness for successful risk management.

ENGG406 “Methodologies in Engineering Safety”

Objective:

- To develop core competencies and proficiencies in the risk review methodologies and tools as widely practiced in industry.

ENGG406 is a technical elective. Although it was NOT ear-marked to implement multifaceted teaching and learning, improvements made in ENGG404 were tested in or leveraged to ENGG406 in order to accelerate effective implementation.

ENGG404 Perspective:

A Look Back - Prior to 2015:

- Mandatory for Senior Mining and Petroleum Engineers
- Elective for all others
- Total Enrollment hovered around 150 students
- One term per year
- Numerous guest speakers on campus once per year
- Traditional didactic lectures and seminars

ENGG404 Expansion and Challenge:

Expansion - 2016 and After:

- Became mandatory for all engineering students
- Significant enrollment increase:
  - 1100 students per academic year (3 terms)
- Phase-in with ramp-up over ~3 years
- Change in student demographic:
  - Senior level only to a mix of some 2nd year to 5th year
  - co-op and traditional, all engineering fields

Challenge: How do we maintain, even strive to improve the content and delivery of ENGG404? Answer …

2) Course Format Changes:

Summer 2016

ENGG 404:
Multifaceted Blended Learning Development

Fall 2016

ENGG404 Implementation

Assisted by the Center for Teaching and Learning at the University of Alberta

Blended learning: “[T]he organic integration of thoughtfully selected and complementary face-to-face and online approaches and technologies”

(Garrison & Vaughan, 2008, p.148).

- Enhanced learning environment through complementary, connected, face-to-face instructional strategies and online approaches
- May include a reduction in the face-to-face contact time
- We took a different approach – turn “sit and listen” time into a scaffolded (or supported) working time with access to members of the instructional team

What is Blended Learning?

In general:

- Improved engagement and student learning experience [1]
- Allows for more guided practice of skills normally practiced individually outside of class time [2]
- For universities, it can compensate for limited classroom space and resources despite increasing enrollment

Why use Blended Learning?

Specifically for ENGG404:

- Started as logistics solution:
  - manage guest speakers for multiple classes of the course, with increasing frequency of the course.

- Evolved to delivering content to support and “guide learning” in the team project seminars

- Evolved to solidify the requirements for course mapping:
  - Canadian Engineering Accreditation Board Graduate Attributes
  - Course-, Chapter-, and Module-level Learning Outcomes

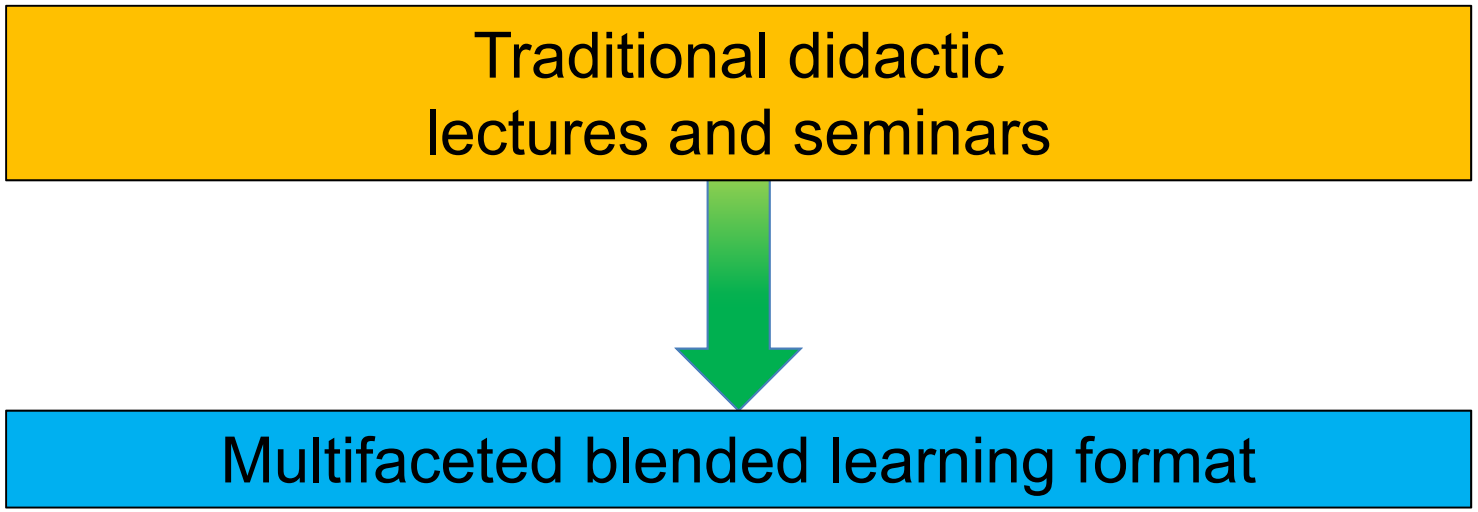
ENGG404 Challenge:

- Sustain the model of a team project, a case study into a real and major industrial loss incident, as a significant part of the course.
- Tailor the course to meet the needs of all engineering fields of study and the levels / years.
- Integrate Blended Learning Techniques and Active Learning Exercises into the course content and delivery
- Evolve to use the available on-line resources for delivering content and assessing students

ENGG404 Course Time:

- 3 hours lecture / week + 1.5 hour seminar / week

ENGG404 Delivery:



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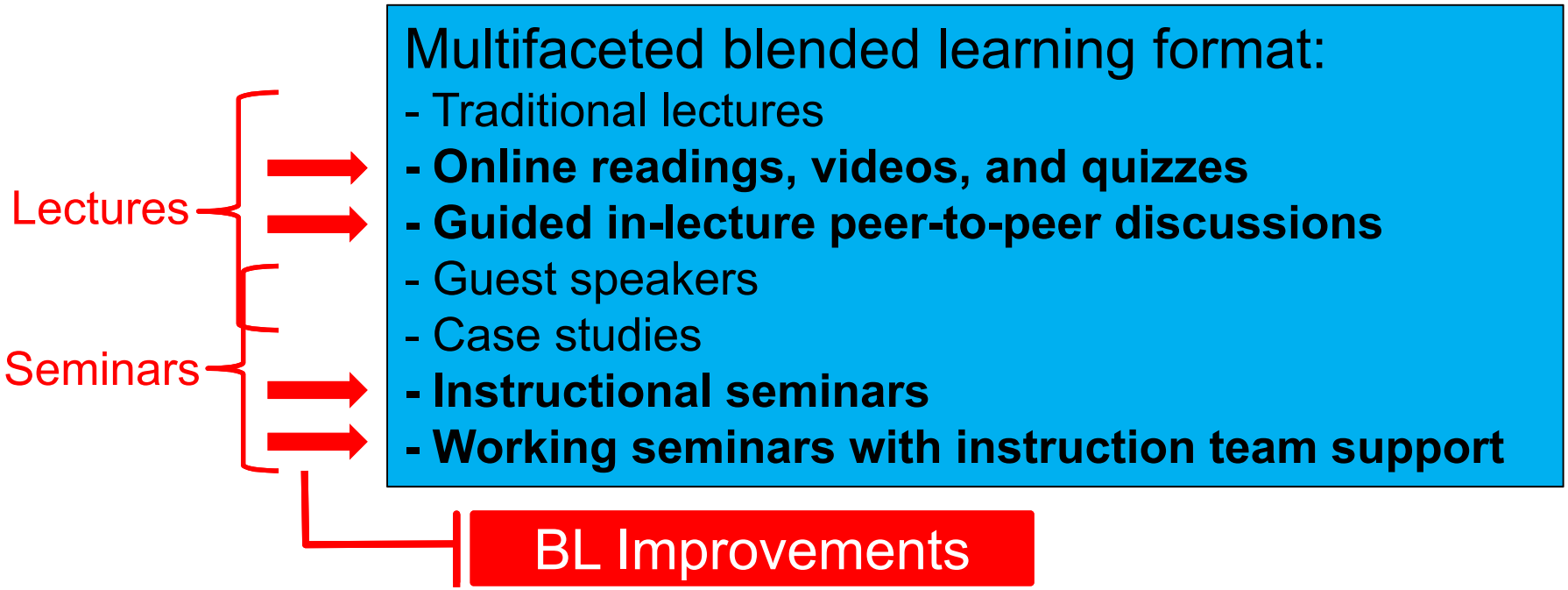


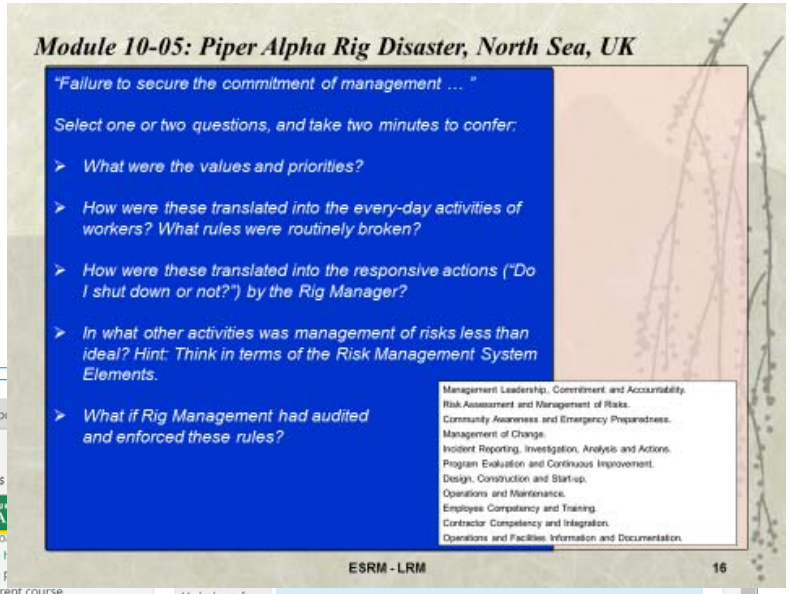
Piper-Alpha, North Sea, UK Video: Case Study of this Loss Incident:

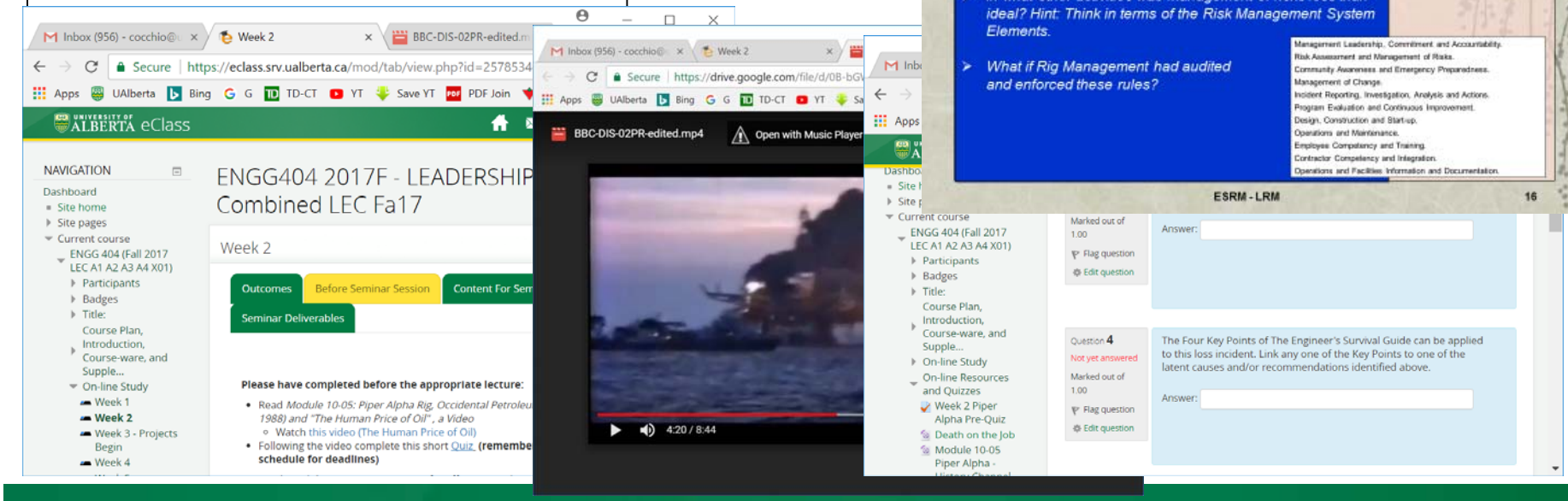
Module 10-05: Piper Alpha Rig Disaster, North Sea, UK

Video: Piper Alpha DVD, by BBC
Students view on eClass the five segments of the full-length (54 minutes) video, condensed to 8:44 m:ss:
01:44 - 02:05 Piper Alpha Capacity
06:02 - 10:10 Spiral to Disaster, the incident begins (in class)
13:15 – 14:58 "Don't Shut Down" (in class)
18:00 – 19:19 "Can we shut down now?"
20:25 – 21:20 "Ask him (if we can shutdown)!"

Access eClass to view these brief snippets in class:
02:25 - 02:55
03:35 - 03:45
05:20 - 06:25

Professor's comments on segments in the clip:
- *Degraded PTW*
- *Need to analyse risks properly*
- *Conflict between production and safety*
- *Almost always poor (risk) management*
- *Learn the lessons from these events*





Exam Question for the Case Study of a Loss Incident: Piper-Alpha, North Sea, UK

Preview question: Module 1-06: The Engineer's Survival Guide and Module 10-05: The Piper Alpha Loss Incident

Question **1**

Not yet answered

Marked out of 11.00

Module 1-06: The Engineer's Survival Guide and Module 10-05: The Piper Alpha Loss Incident

(11 marks total for all correct responses)

Recall the Piper Alpha Case Study, where an initial gas release escalated to the catastrophic failure of the asset. Choose any one of the Four Key Points of the Engineer's Survival Guide and explain how you would have applied this point in the ongoing operations of Piper Alpha prior to the occurrence of the catastrophic incident. Phrase your responses to answer:

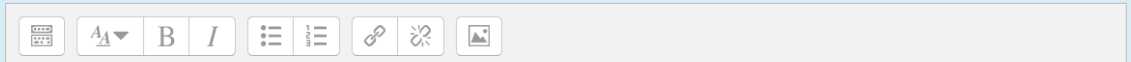
a) What was the situation? (2 marks)

b) What was the issue or concern with that situation? (3 marks)

c) What Key Point was met or was violated? State the Key Point. (1 mark)

d) What would you have done in that situation? (3 marks)

e) What would have been the probable outcome had you done it? (2 marks)



a) What was the situation?

b) What was the issue or concern with that situation?

c) What Key Point was met or was violated?

Previous Seminar Format

Previously Covered Course Content

Lecture material

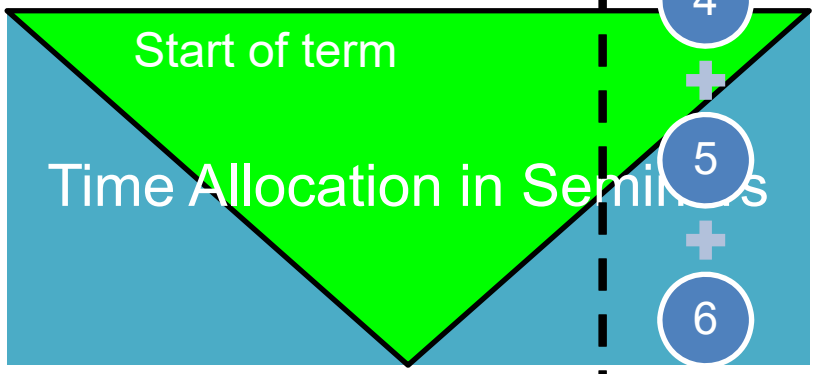
Individual online learning

Provide instructions on a section of the team project

Demonstrate an example of the work to be completed

Teams have the option to work in a provided space

Instruction Team is present to answer questions and provide guidance



1

2

3

4

5

6

7

:

Loss Incident Report

New Seminar Format

3) Resource Allocation

22	ENGG404 Time and Resource Allocation Per Term (to nearest 0.25 hr, ~57 hours total)								
Year	Metric	For Each **Lecture** Section (3 total)			For Each **Seminar** Section (3 total, various sizes)				
		Total Lecture Time	Blended Learning		Maximum Allowable Mandatory Seminar Time (per Calendar)	Mandatory Instruction Seminar Time	Voluntary Working Time with Instruction Team Present	Out-of-class Requested Meeting Time with Prof.	Out-of-class Team Project Time (est.)
			On-line Assigned Study Time	Guided Peer-to-Peer Discussion Sessions (est.)					
2015	Time	41 hrs	0 hrs	3.5-4.5 hrs	16.25 hrs	13 hrs	0 hrs	10-20 hrs	10-30 hrs / team
	People	1 prof.	None	1 prof.	1 prof.	1 prof.	None	1 prof.	None
2016	Time	41 hrs	2.5 hrs	7-9.5 hrs	16.25 hrs	11.75 hrs	13.5 hrs	< 10 hrs	5-10 hrs / team
	People	1 prof.	None	1 prof.	*1 prof. 1-2 TA's	*1 prof. 1-2 TA's	*1 prof. 1-2 TA's	1 prof.	None

* 1, 2 or 3 instruction team members available per seminar depending on seminar size; 1 member per 10 to 15 teams.

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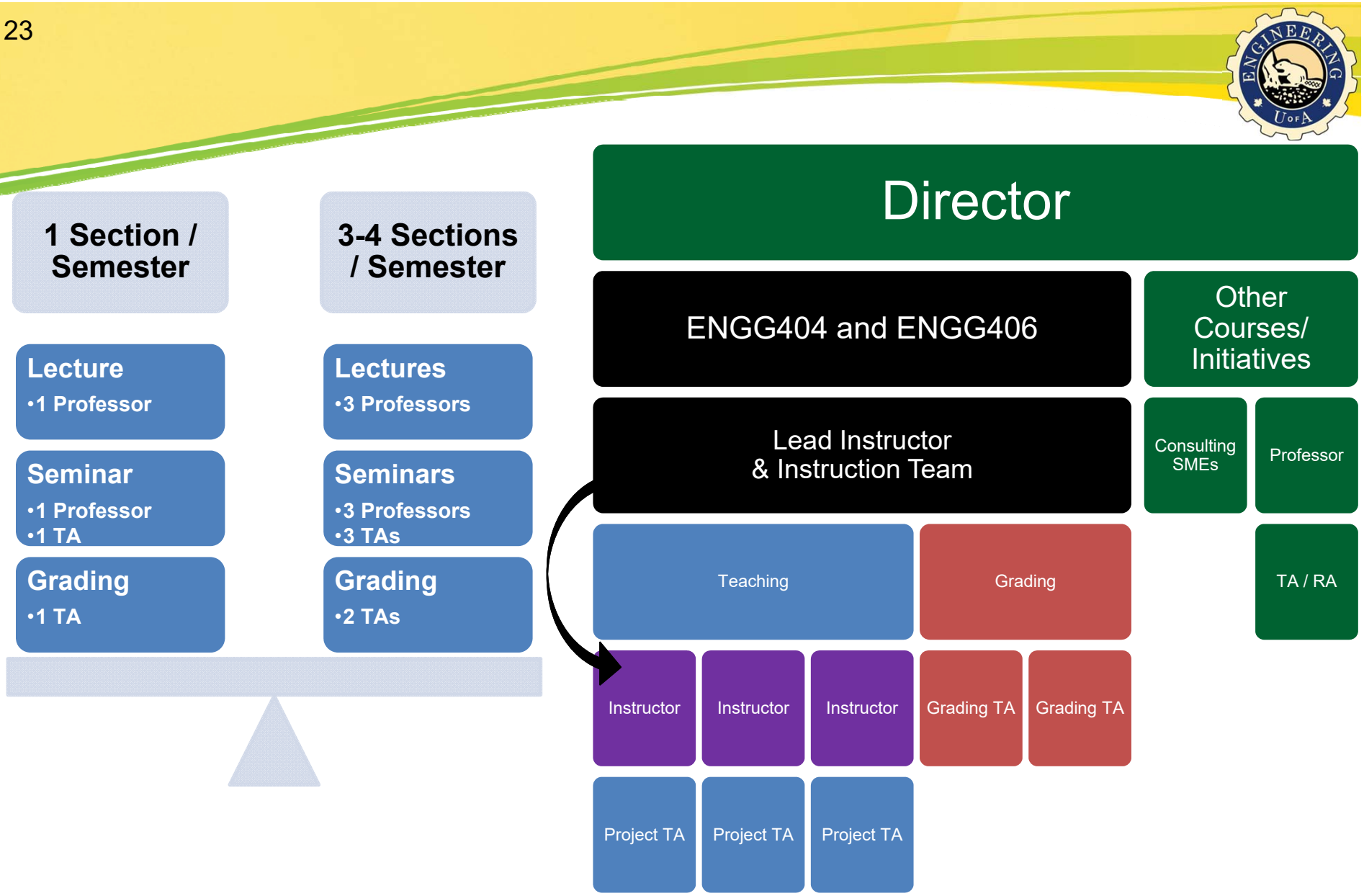
Resource Allocation Analysis



Instruction Team

4) Targeted CEAB Graduate Attributes and Learning Outcomes

CEAB GA	CEAB Definition
Professionalism	An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest.
Ethics and equity	An ability to apply professional ethics, accountability, and equity.
Life-long learning	An ability to identify and to address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge.
Individual and team work	An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.

CEAB, *2016 Accreditation Criteria and Procedures: Revised February 2017*. [3]

Targeted CEAB Graduate Attributes

CEAB Graduate Attributes:

- **Professionalism**
- **Ethics and Equity**
- Life-long Learning
- Individual Work, Team Work, and Team Leadership

Learning Outcomes:

- 10 Course-level
- ~30 Chapter-level
- ~250 Module-level

ENGG404 Course Level Learning Outcomes:

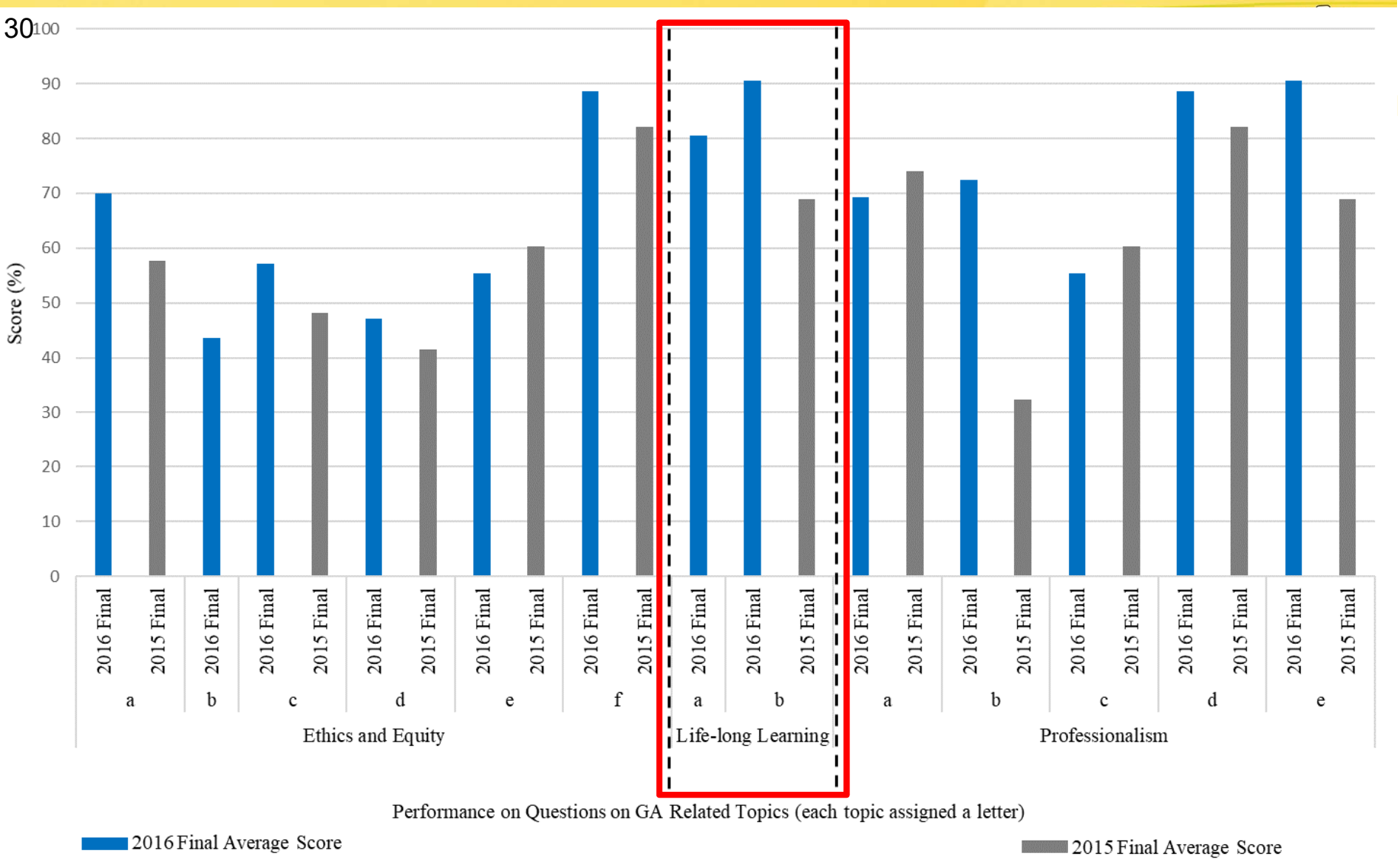
- Safety Culture
- Safety Leadership
- Risk Assessment Tools
- Incident Investigation, Root Cause Analysis, and Manage Actions Work Process
- Individual Work, Team Work, and Team Leadership
- **Professionalism**
- **Ethics and Equity**

5) Student Performance

Student Performance - Professionalism

ENGG404 senior student performance

Year	2015	2016
Teams	47	61
Format	Traditional	Blended
Assessment (Avg. ± St. Dev.)		
Assignment 1 Grade	73.1 ± 15.4	71.0 ± 16.1
Assignment 2 Grade	72.8 ± 19.3	74.1 ± 13.9
Midterm Exam Grade	76.6 ± 13.0	74.9 ± 9.3
Final Exam Grade	62.1 ± 9.8	69.0 ± 8.4
Team Project Technical Report	83.0 ± 9.2	80.7 ± 5.1



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Student Performance on Specific GA Exam Questions

Category	Contributing to the Teams' Work	Interacting with Teammates	Keeping the Team on Track	Expecting Quality	Having Relevant Knowledge, Skills, and Abilities
CATME Score Average ± St. Dev. (Out of 5)	4.2 ± 0.75	4.28 ± 0.62	4.12 ± 0.80	4.22 ± 0.66	4.32 ± 0.64
% of Students Scoring > Minimum Performance of a Successful Team Member (3/5)	94.9%	96.6%	90.7%	96.2%	95.8%

Comprehensive Assessment of Team Member Effectiveness (CATME)

- Online tool, 5 categories, self- and peer-assessment

CATME [4 – 6]

Student Performance – Ind. & Team Work

6) Outcomes and Next Steps

ENGG404 Improvement Outcomes:

Blended Learning improves student competencies while:

- Improving the quality of the course delivery
- Improving the quality of the student experience
- Accommodating significantly increased enrollment

The blended learning project:

- Improved our means to measure student competencies
- Requires in-advance development of course material

ENGG404 Improvement Outcomes:

Solidified and linked learning outcomes with

- CEAB Graduate Attributes,
- Content in course-ware and lectures,
- Assessment methods and marking rubrics for all term work.

ENGG404 Improvement Opportunities:

- Create a series of on-line “mini-documentaries”:
  - Demonstrate industry principles and practices, aligned to learning outcomes
- Create a series of on-line “virtual tours”
  - multiple versions relevant to different fields of study
  - Interactive: viewer “moves through” an area to select different items for more information
- Integrate more “In-class Peer-to-Peer” discussions

ENGG404 Outreach Opportunities:

- Publish a text-book: “Leadership in Risk Management”

- ENGG404 Blended Learning Version:
  - Transportable, Adaptable

- Transfer Learning to Other Learning-Institutions.
  - Create a “Turn-key” Course complete with Instructor’s Manual (lecture presentations, assessment methods)

ESRM Growth and Outreach Opportunities:

- One or more under-graduate courses with specialized risk management topics e.g. geotechnical, environmental assessment

- One or more graduate-level courses, and permanent offering of ENGG404 Graduate-level version

- Expand Learning to Industry:
  - Seminar and certificate-level courses

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Acknowledgements & References

David and Joan Lynch
School Of Engineering Safety and Risk Management

Thank You!

Questions?

PCL CONSTRUCTION

CAPITAL ENGINEERING

MAGNA

ConocoPhillips Canada

WORK SAFE ALBERTA

BIRD CONSTRUCTION COMPANY

Casman Construction Group of Companies

Shell

ACM Facility Safety

Alberta Health Services

ATHABASCA OIL CORPORATION

ATKINS

LEADING ORG SOLUTIONS

DOW

FINNING CAT

IRVING

TITANIUM CORPORATION

NOVA Chemicals

SCANIMETRICS

TERRACON GEOTECHNIQUE

WCB Workers' Compensation Board Alberta

GoSafetyPro

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How:

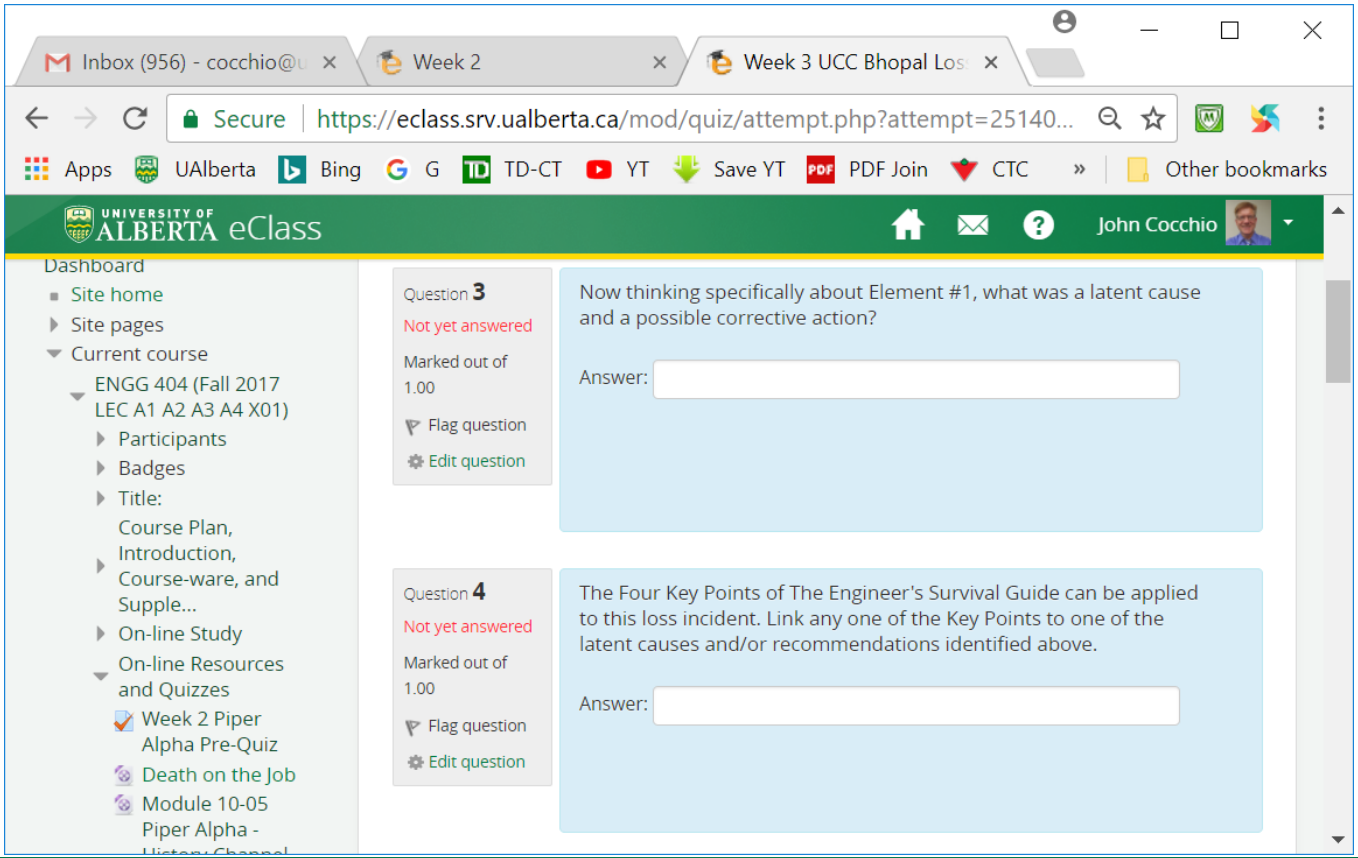
- Integrated seminars: combined instruction and guided learning opportunities for the team project.
- Teams formed on basis of program/plan/year: loss incident is specific, work with peers.
- Active Learning Exercises “Please confer!” in lectures.
- On-line videos or assigned reading c/w quizzes.
- On-line submission and marking of all term work.
- On-line administration of mid-term and final exams.
- Growth of the ESRM Instruction Team – depth and breadth in the fields of study.

Piper-Alpha, North Sea, UK
Learning Outcomes for this Module, a Case Study:

The student should be able to:

- Summarize the cause & effect of this event, how an event can escalate, and the underlying value of investigating and analyzing loss incidents.
- Describe the benefits of a Safety and Risk Management Program.
- Critique of management leadership (or lack thereof) in an industrial facility / operation.
- Argue in favour of the need for management leadership, commitment, and accountability at all levels, and the underlying values for what drives those needs.
- Apply the Engineer's Survival Guide

On-line Quiz:
Chemical Release; UCIL Pesticide Plant; Bhopal, India.



In-class "Peer-to-Peer" Active Learning Exercise: Piper-Alpha, North Sea, UK