

# **From the Ground Up: A Decision Aid for Outcomes-Based Assessment – Introduction and Use**

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UNIVERSITY OF  
**WATERLOO**

# Outline

## 1. Context

Department of Management Sciences, accreditation, outcomes-based assessment (OBA), graduate attributes.

## 2. Process

Bottom-up approach, closing the loop, continual improvement.

## 3. OBA Tool

Customized Excel workbook, data collection, analysis.

## 4. Insights & Discussion

Enhanced course profiles, faculty buy-in, next steps.

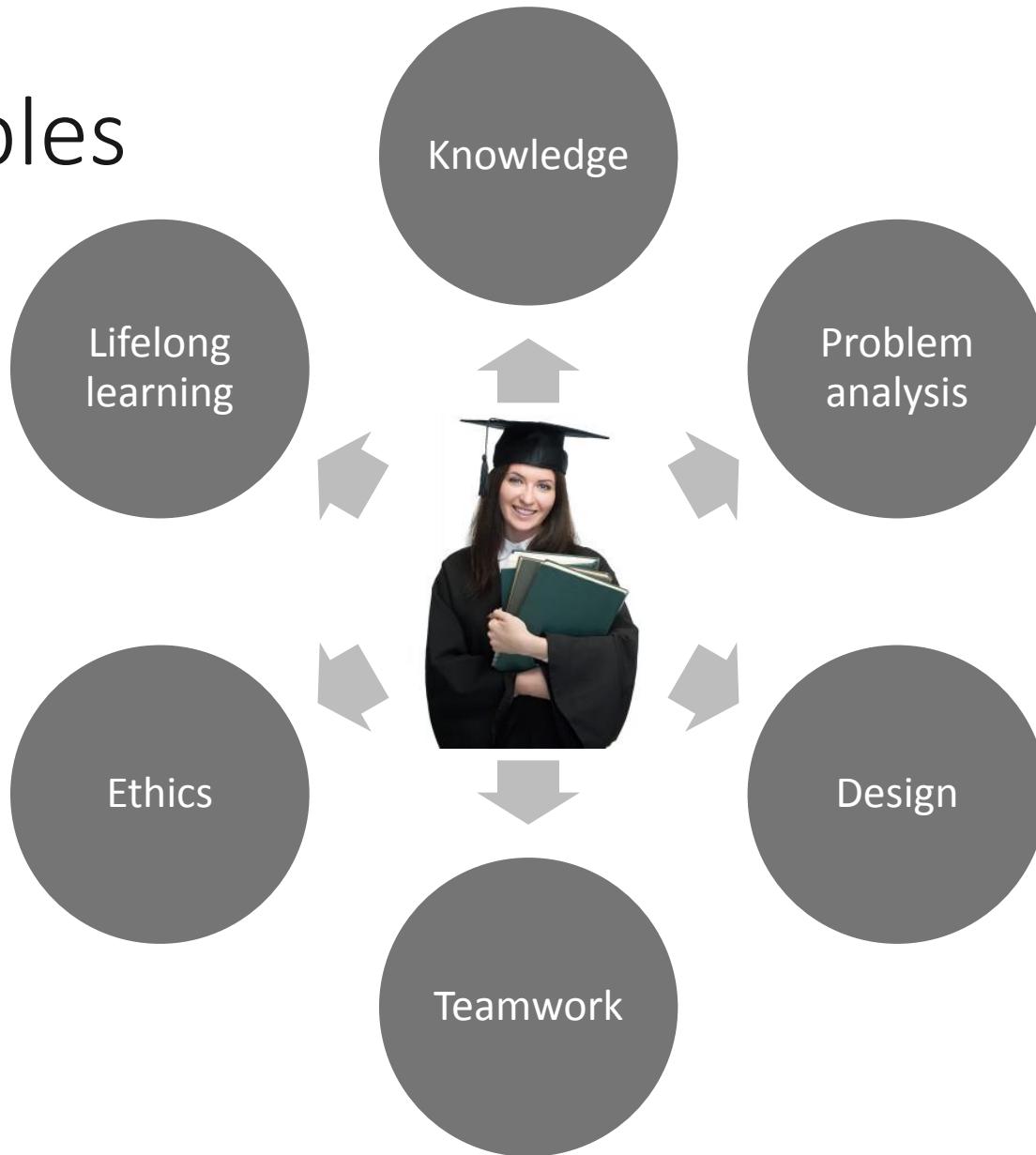


# Context

As mandated by the Canadian Engineering Accreditation Board (CEAB), engineering programs must demonstrate that graduates of its programs possess 12 **graduate attributes** by the time of graduation.



# Examples

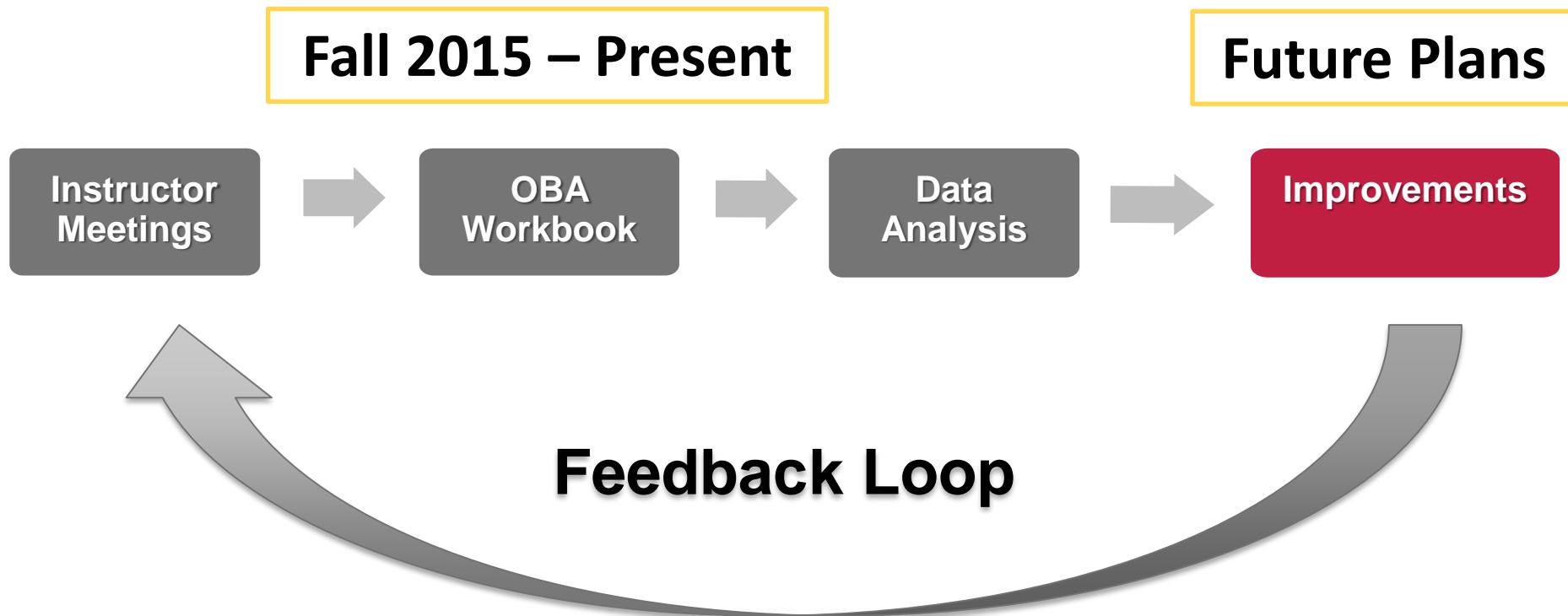


# Context

Established in 2007, the **Management Engineering** program at UW is 1 of 13 programs within the Faculty of Engineering and has an average enrolment of 300 students per year.



# Outcomes-Based Assessment (OBA)



# OBA Tool

A decision aid to measure students' performance in a course/activity was developed using **Excel** with VBA programming.



# OBA Tool: Indicators

A	B
1 Update Percentages	
2 Attribute	Indicator
3	
4 Knowledge Base	
5	<b>Recognize</b> the key elements of object-oriented programming using Java
6	<b>Describe</b> the main components of decision analysis
7 Problem Analysis	
8	<b>Model</b> an optimization problem to replicate a practical situation
9	<b>Critically evaluate</b> solutions, including performing "reality checks" on design problems and solutions
10 Investigation	
11	<b>Implement</b> data processing techniques to gather necessary information for critiquing an organizational environment
12	<b>Recognize and address</b> uncertainty
13	<b>Diagnose</b> search quality problems and suggest areas of engine improvement for future experiments
14 Design	
15	<b>Apply</b> analytical techniques to design and improve methods and processes
16	<b>Design and conduct</b> an experiment to test a proposed system change
17	<b>Generate</b> a diverse set of candidate engineering design solutions
18	<b>Build</b> relevant models that provide valuable insights for operational and/or strategic decision making
19 Use of Engineering Tools	
20	<b>Implement</b> optimization approaches in real-life applications using different mathematical software (e.g. Matlab, Cplex, Gurobi, Lindo, Excel solver)



# OBA Tool: Sample Indicators

## Knowledge Base

- **Recognize** the key elements of object-oriented programming using Java

## Economics and Project Management

- **Assess** risks and uncertainties associated with engineering economic decisions



# OBA Tool: Indicator Weights

A	B	C
1 Update Percentages		
2 Attribute	Indicator	Indicator Weight
3		
4 Knowledge Base		
5	Recognize the key elements of object-oriented programming using Java	0.5
6	Describe the main components of decision analysis	0.5
7 Problem Analysis		
8	Model an optimization problem to replicate a practical situation	0.5
9	Critically evaluate solutions, including performing "reality checks" on design problems and solutions	0.5
10 Investigation		
11	Implement data processing techniques to gather necessary information for critiquing an organizational environment	0.33
12	Recognize and address uncertainty	0.33
13	Diagnose search quality problems and suggest areas of engine improvement for future experiments	0.34
14 Design		
15	Apply analytical techniques to design and improve methods and processes	0.25
16	Design and conduct an experiment to test a proposed system change	0.25
17	Generate a diverse set of candidate engineering design solutions	0.25
18	Build relevant models that provide valuable insights for operational and/or strategic decision making	0.25
19 Use of Engineering Tools		
20	Implement optimization approaches in real-life applications using different mathematical software (e.g. Matlab, Cplex, Gurobi, Lindo, Excel solver)	0.5
<span>◀ ▶</span> Assessment Documentation <span>Master Marks +</span>		



# OBA Tool: Attributes

A	B
1 Update Percentages	
2 Attribute	Indicator
4 Knowledge Base	
5	<b>Recognize</b> the key elements of object-oriented programming using Java
6	<b>Describe</b> the main components of decision analysis
7 Problem Analysis	
8	<b>Model</b> an optimization problem to replicate a practical situation
9	<b>Critically evaluate</b> solutions, including performing "reality checks" on design problems and solutions
10 Investigation	
11	<b>Implement</b> data processing techniques to gather necessary information for critiquing an organizational environment
12	<b>Recognize and address</b> uncertainty
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19 Use of Engineering Tools	
20	<b>Implement</b> optimization approaches in real-life applications using different mathematical software (e.g. Matlab, Cplex, Gurobi, Lindo, Excel solver)



# OBA Tool: Assessment Documentation

A	
1	This sheet has no functional purpose except to provide a place to keep track of what the assessments are and what the codes mean.
2	
3	<b>SAMPLE 101</b>
4	
5	In SAMPLE 101, students were evaluated according to their performance on assignments, quizzes, a project, a mid-term, and a final exam.
6	
7	<b>1. Assignments - 10%</b>
8	A1 - Assignment 1: write and debug Processing and Java code
9	A2 - Assignment 2: solve problems and work with user input and files
10	
11	<b>2. Quizzes - 20%</b>
12	Q1-a - Quiz 1, Question a: operations analysis
13	Q1-b - Quiz 1, Question b: motion study and work design
14	Q2-c - Quiz 2, Question c: time study
15	Q2-d - Quiz 2, Question d: layout design and material handling
16	
17	<b>3. Project - 30%</b>
18	P1 - Part 1: analyze a prototype information system using a case study
19	P2 - Part 2: design an information system based upon foundations of application development
20	P3 - Part 3: write a final report detailing the progress of the project
21	
22	<b>4. Mid-term Exam - 10%</b>
23	M1-a - Mid-term 1, Section a: simple harmonic motions
24	M1-b - Mid-term 2, Section b: waves and sounds
25	
26	<b>5. Final Exam - 30%</b>
27	F-a - Final, Section a: supply chain management
28	F-b - Final, Section b: push and pull systems
29	F-c - Final, Section c: aggregate planning
30	
31	



# OBA Tool: Assessment Map

Indicator	Indicator Weight	Percentage Of Students					Assessments													
		<60	60-70	70-80	80-90	>90	A1	A2	Q1-a	Q1-b	Q2-c	Q2-d	P1	P2	P3	M1-a	M2-a	F-a		
Recognize the key elements of object-oriented programming using Java	0.5						X						X			X		X		
Describe the main components of decision analysis	0.5							X	X					X			X		X	
Model an optimization problem to replicate a practical situation	0.5														X					
Critically evaluate solutions, including performing "reality checks" on design problems and solutions	0.5									X	X							X		
Implement data processing techniques to gather necessary information for critiquing an organizational environment	0.33									X		X							X	
Recognize and address uncertainty	0.33												X				X	X	X	
Diagnose search quality problems and suggest areas of engine improvement for future experiments	0.34													X						
Apply analytical techniques to design and improve methods and processes	0.25													X						
Design and conduct an experiment to test a proposed system change	0.25														X	X				
Generate a diverse set of candidate engineering design solutions	0.25									X							X			
Build relevant models that provide valuable insights for operational and/or strategic decision making	0.25																	X		
Implement optimization approaches in real-life applications using different mathematical software (e.g. Matlab, Cplex, Gurobi, Lindo, Excel solver)	0.5									X	X		X		X			X	X	

Master Marks +



Department of Management Sciences, Faculty of Engineering

# OBA Tool: 'Out of' & 'Final Contribution'

A	B	C	D	E	F	G	H
1	A1	A2	Q1-a	Q1-b	Q2-c	Q2-d	P1
2	Out Of	5	100	100	100	50	40
3	Final Contribution	5	5	5	5	5	10
4							
5	178386962	3	15	83	55	20	8
6	827856103	4	56	93	9	28	22
7	173962955	5	61	26	19	21	19
8	180251227	4	32	64	79	13	31
9	661730366	0	30	40	88	2	27
10	909592826	2	40	42	63	18	1
11	174873873	3	4	42	83	11	17
12	251612646	0	11	60	55	28	9
13	766620588	4	51	25	58	20	19
14	937152483	2	26	28	96	0	24
15	402867633	5	86	95	30	6	4
16	424882727	3	58	74	78	31	14
17	375556239	4	5	67	21	7	24
18	916695216	0	13	60	69	9	27
19	943006656	0	94	72	27	34	6
20	370602115	1	81	11	64	7	17
21	977985985	3	43	50	46	2	9
22	942741605	2	95	78	15	4	14
23	273014137	1	36	43	75	5	4
24	875449684	2	90	88	12	4	2
25	605936397	5	47	28	38	32	9
26	643168673	3	74	6	90	7	7
27	524634804	1	19	78	30	8	2
28	747957558	2	21	16	65	23	19
29	916695216	1	91	69	34	9	1
30	943006656	2	88	75	19	32	1
31	370602115	2	80	48	23	15	30



# OBA Tool: Student IDs\*

	A	B	C	D	E	F	G	H
1		A1	A2	Q1-a	Q1-b	Q2-c	Q2-d	P1
2	Out Of		5	100	100	100	50	40
3	Final Contribution		5	5	5	5	5	10
4								
5	178386962	3	15	83	55	20	8	15
6	827856103	4	56	93	9	28	22	56
7	173962955	5	61	26	19	21	19	61
8	180251227	4	32	64	79	13	31	32
9	661730366	0	30	40	88	2	27	30
10	909592826	2	40	42	63	18	1	40
11	174873873	3	4	42	83	11	17	4
12	251612646	0	11	60	55	28	9	11
13	766620588	4	51	25	58	20	19	51
14	937152483	2	26	28	96	0	24	26
15	402867633	5	86	95	30	6	4	86
16	424882727	3	58	74	78	31	14	58
17	375556239	4	5	67	21	7	24	5
18	916695216	0	13	60	69	9	27	13
19	943006656	0	94	72	27	34	6	94
20	370602115	1	81	11	64	7	17	81
21	977985985	3	43	50	46	2	9	43
22	942741605	2	95	78	15	4	14	95
23	273014137	1	36	43	75	5	4	36
24	875449684	2	90	88	12	4	2	90
25	605936397	5	47	28	38	32	9	47

\*The student IDs are made up and not representative of any real data.



# OBA Tool: Results & Analysis

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
	Update Percentages			Indicator Weight	Percentage Of Students					Assessments											
					<60	60-70	70-80	80-90	>90	A1	A2	Q1-a	Q1-b	Q2-c	Q2-d	P1	P2	P3	M1-a	M2-a	F-a
1	Maths	Indicator																			
2	Knowledge Base																				
3																					
4	Knowledge Base																				
5		Recognize the key elements of object-oriented programming using Java		0.5		0.69	0.09	0.11	0.11	0.00											
6		Describe the main components of decision analysis		0.5		0.63	0.14	0.14	0.09	0.00	X										
7	Problem Analysis					0.69	0.09	0.03	0.14	0.06		X									
8		Model an optimization problem to replicate a practical situation		0.5		0.69	0.09	0.20	0.03	0.00											
9		Critically evaluate solutions, including performing "reality checks" on design problems and solutions		0.5		0.69	0.03	0.06	0.14	0.09											
10	Investigation					0.69	0.23	0.06	0.03	0.00			X								
11		Implement data processing techniques to gather necessary information for critiquing an organizational environment		0.33		0.86	0.14	0.00	0.00	0.00											
12		Recognize and address uncertainty		0.33		0.74	0.11	0.06	0.09	0.00											
13		Diagnose search quality problems and suggest areas of engine improvement for future experiments		0.34		0.94	0.06	0.00	0.00	0.00											
14	Design					0.80	0.17	0.03	0.00	0.00											
15		Apply analytical techniques to design and improve methods and processes		0.25		0.89	0.03	0.06	0.03	0.00											
16		Design and conduct an experiment to test a proposed system change		0.25		0.80	0.17	0.03	0.00	0.00											
17		Generate a diverse set of candidate engineering design solutions		0.25		0.69	0.03	0.06	0.14	0.09											
18		Build relevant models that provide valuable insights for operational and/or strategic decision making		0.25		0.69	0.03	0.06	0.14	0.09		X									
19	Use of Engineering Tools					0.80	0.17	0.03	0.00	0.00											
20		Implement optimization approaches in real-life applications using different mathematical software (e.g. Matlab, Cplex, Gurobi, Lindo, Excel solver)		0.5		0.89	0.11	0.00	0.00	0.00											



# OBA Tool: Sample Analysis

## Knowledge Base

- Recognize the key elements of object-oriented programming using Java

## Percentage of Students

<60	60-70	70-80	80-90	>90
0.09	0.28	0.40	0.18	0.05



# Insights

- Gained a good understanding of each course based on their content and assessment methods
- Discovered what attributes are not frequently evaluated in the program
- Built connection with instructors and made OBA as part of teaching duties
- Need a tool for data harvesting and analytics about students' and program's performance



# Discussion

- How to promote and cultivate a participatory culture within the Department?
- How to address deficiencies and conduct meaningful analysis of data?
- How to learn from similar or different assessment processes in other programs/institutions?



# Thank You!

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