ABET Evaluation

Materials Science & Engineering

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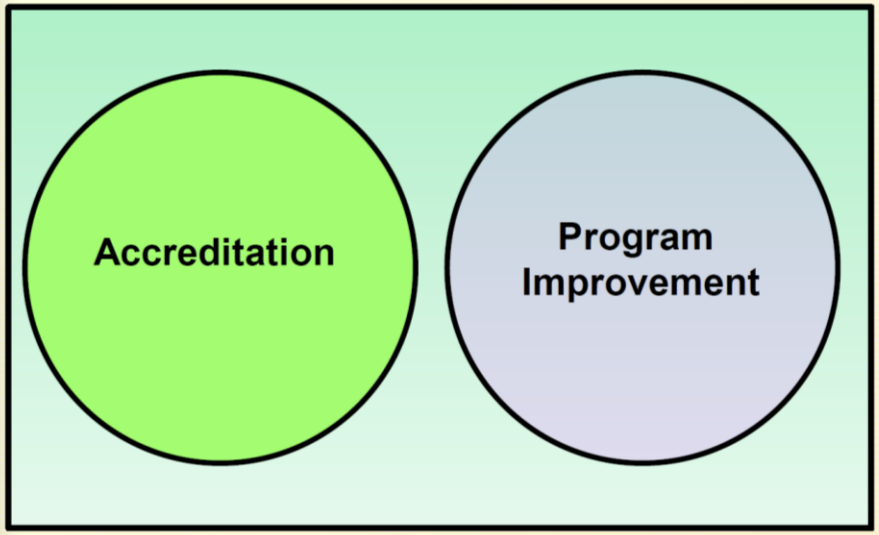
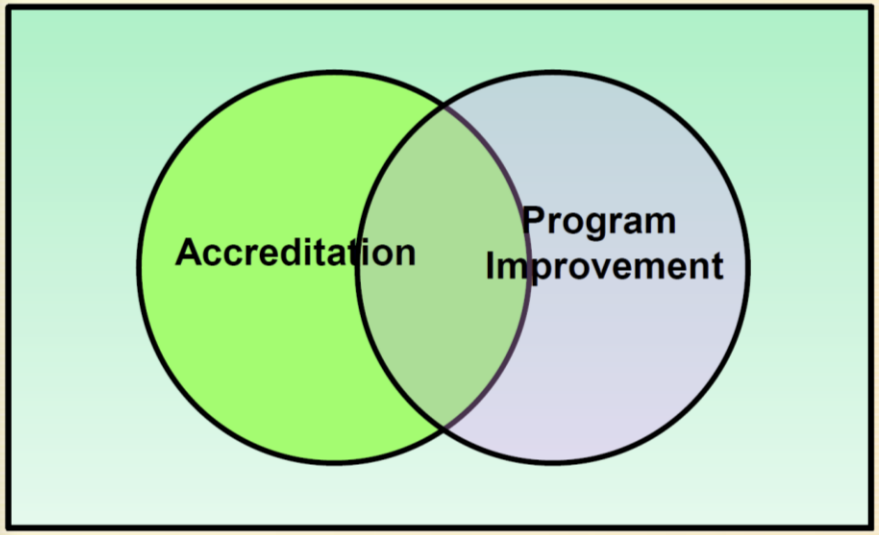
Purpose of this Presentation

The purpose of this document is to remind the faculty what must be done for the 2021-2022 Assessment of Student Outcomes, which is part of our ABET continuous improvement process.

Departmental Objectives relevant to ABET





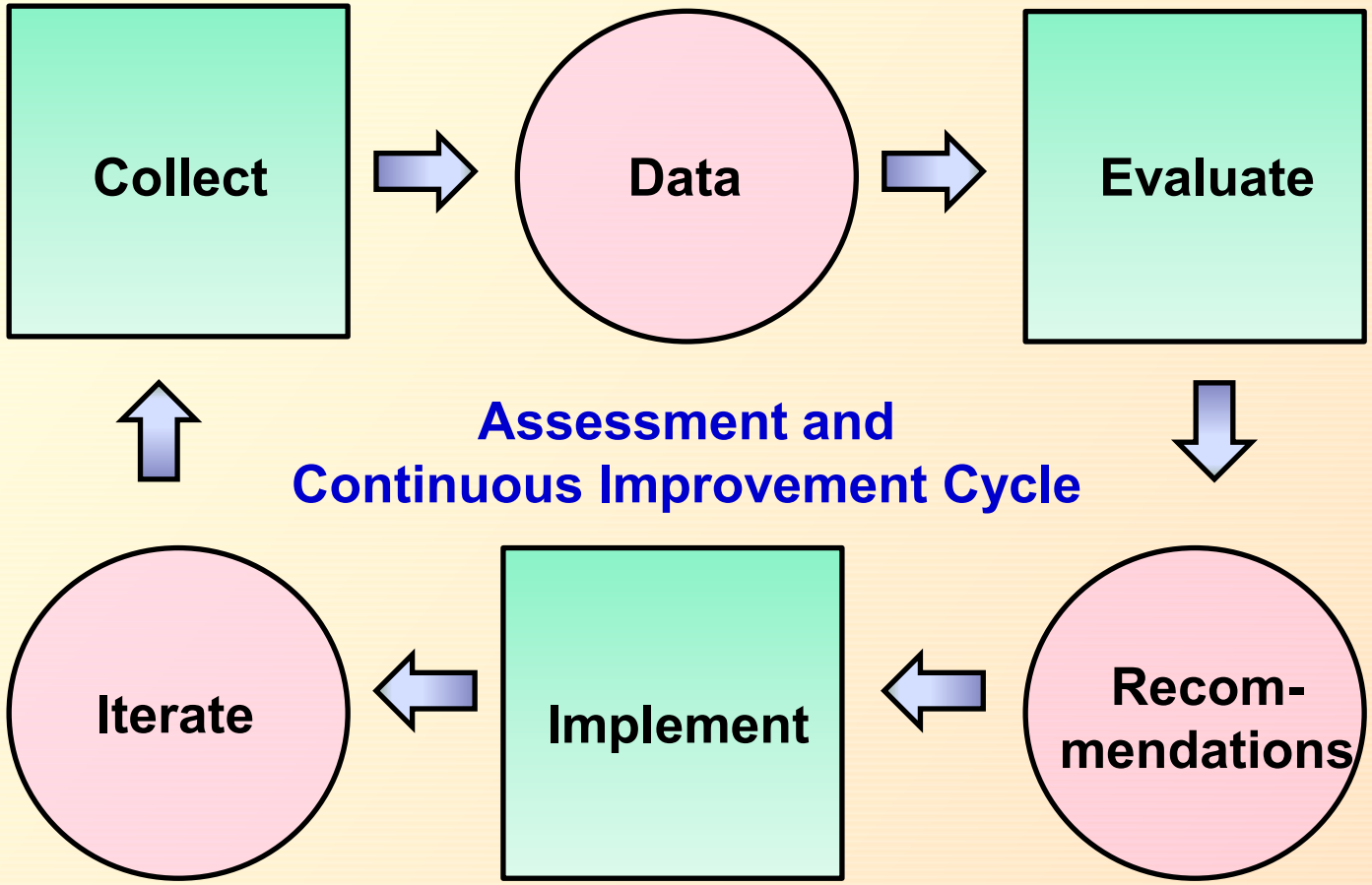
Both objectives are practically useful.

- We want to be part of an accredited MSE program.
- We want to improve the MSE program.

Many see the accreditation element as a necessary bureaucratic obstacle rather than a means of improvement.

The goal is maximize the overlap of these two elements in the ABET process.

Continuous Improvement (Criterion 4)



Assess Student Outcomes every three years.
Last done in 2018-2019, so it is time again this year.

Previous Student Outcomes (Criterion 3)

from ABET revised to 7 outcomes

a) an ability to apply knowledge of mathematics, science, and engineering
b) an ability to design and conduct experiments, as well as to analyze and interpret data
c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d) an ability to function on multidisciplinary teams
e) an ability to identify, formulate, and solve engineering problems
f) an understanding of professional and ethical responsibility
g) an ability to communicate effectively
h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i) a recognition of the need for, and an ability to engage in life-long learning
j) a knowledge of contemporary issues
k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

revised

from UT MSE

l) an understanding of the effect of composition, synthesis, and processing methods on structure and properties, and in turn the performance in service of all classes of materials (metals, ceramics, polymers)
m) an ability to apply statistical and computational methods for data analysis and solution of problems in materials systems
n) an ability to integrate knowledge of processing, structure, properties, and performance to solve materials selection and design problems

deleted

Current Student Outcomes (Criterion 3)

from ABET

The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program.

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (**SCI/MATH**)
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors (**DESIGN**)
3. an ability to communicate effectively with a range of audiences (**COMM**)
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts (**PROF**)
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives (**TEAM**)
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions (**LAB**)
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies. (**LIFE**)

Student Outcomes Mapping (Criterion 3)

Current Language EAC Criteria effective 2017-18 and 2018-19 Cycles	New Language Approved by the EAD October 20, 2017 Applicable beginning in the 2019-20 cycle
Criterion 3. Student Outcomes The program must have documented student outcomes that prepare graduates to attain the program educational objectives. Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.	**Criterion 3. Student Outcomes** The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program.
(a) an ability to apply knowledge of mathematics, science, and engineering (e) an ability to identify, formulate, and solve engineering problems	1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
(d) an ability to function on multidisciplinary teams	5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
(f) an understanding of professional and ethical responsibility (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (j) a knowledge of contemporary issues	4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
(g) an ability to communicate effectively	3. an ability to communicate effectively with a range of audiences
(i) a recognition of the need for, and an ability to engage in life-long learning	7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	Implied in 1, 2, and 6

Previous Mapping Student Outcomes to Courses

only core courses

only MSE students

every outcome twice

Course\Outcome	a	b	c	d	e	f	g	h	i	j	k	l	m	n
101						X		X	X	X				
201	X				X							X		
210	X	X	X	X	X		X				X	X	X	
250	X				X						X			
260	X				X	X	X				X	X		
290						X		X	X	X				
300	X	X	X	X	X		X				X	X	X	
301	X						X				X		X	
302	X	X		X	X		X				X	X	X	
304	X	X	X	X	X		X				X	X	X	
320	X				X						X	X		
340	X				X				X			X		X
350	X				X		X					X	X	X
360	X				X				X			X		
370	X	X	X								X	X	X	X
390	X				X							X		
405	X	X			X		X				X	X	X	
480	X		X	X	X		X				X		X	X
489	X	X	X	X	X	X	X							X
Total	17	7	6	6	15	4	10	2	4	2	11	13	9	5

Table taken from 2017 UTK MSE ABET Self Study Report.

Red indicates that course/objective pair to be assessed in 2018-2019.

Current Mapping Student Outcomes to Courses

only core courses

only MSE students

every outcome twice

		SCI/MATH	DESIGN	COMM	PROF	TEAM	LAB	LIFE
Topic	Course\Outcome	1	2	3	4	5	6	7
Materials Chemistry	110/117	X						
Impact of Materials on Soc.	120/127	X			X			
Intro to MSE	201/207	X						
Intro to MSE Lab	210	X	X	X		X	X	
Professional Dev. Seminar	220			X_o	X			X
Kinetics & Transport	250	X						
Thermodynamics	260	X		X	X			
Principles of Materials Lab I	300	X	X	X		X	X	
Statistics & Numerics	301	X		X				
Mechanical Behavior	302	X		X		X	X	
Principles of Materials Lab II	304	X	X	X_w		X	X	
Polymers	340/347	X					X	X
Electronic, Optical & Magnetic Materials	350/357	X		X				
Ceramics	360/367	X					X	X
Metals	390/397	X					X	
Materials Selection	480	X	X	X		X		
Capstone Senior Design	489	X	X	X_o, X_w	X	X	X	
	Total	16	5	10	4	6	8	3

Red indicates that course/outcome pair is to be assessed in 2021-2022.
Blue indicates that course/outcome pair is new.
Purple indicated course/outcome pair is both red and blue.

Faculty Assessment of Student Outcomes Organized by Outcome (2021-2022)

	student outcome summary	course 1	course 2
1	SCI/MATH	260 (thermo)	301 (statistics & numerics)
2	DESIGN	480 (materials selection)	489 (senior design)
3	COMM (ORAL)	290 (professional develop)	489 (senior design)
3	COMM (WRITTEN)	304 (principles mater. lab II)	489 (senior design)
4	PROF	120 (materials & society)	290 (professional develop)
5	TEAM	210 (Intro to MSE Lab)	300 (principles mater. lab I)
6	LAB	210 (Intro to MSE Lab)	300 (principles mater. lab I)
7	LIFE	290 (professional develop)	

Table A.1. Faculty Assessment of Student Outcomes Organized by Outcome

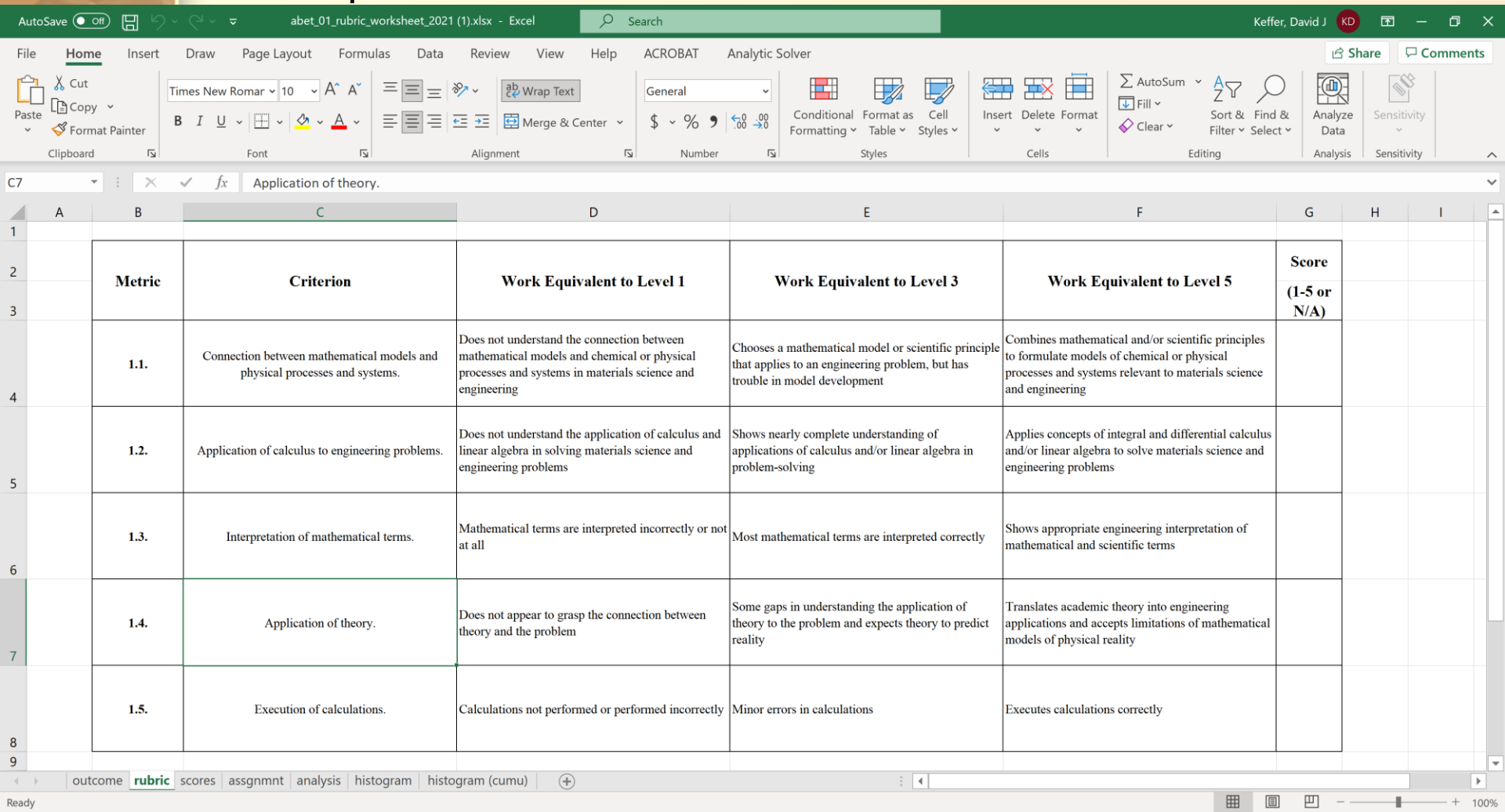
Faculty Assessment of Student Outcomes Organized by Semester (2021-2022) and Responsible Faculty Member

semester	course	outcome 1	outcome 2	outcome 3	responsible faculty member
Fall, 2021	201/7 (intro course)	-	-	-	multiple faculty
Fall, 2021	210 (intro to MSE lab)	5	6	-	**Lass**
Fall, 2021	300 (principles mater. lab I)	5	6	-	**Kocak**
Fall, 2021	301 (statistics and numerics)	1	-	-	**Keffer**
Fall, 2021	340/7 (polymers)	-	-	-	Rios
Fall, 2021	360/7 (ceramics)	-	-	-	Rawn
Fall, 2021	480 (materials selection)	2	-	-	**Rack** & multiple team advisors
Spring, 2022	110/7 (materials chemistry)	-	-	-	Mandrus
Spring, 2022	120/7 (materials & society)	4	-	-	**Gilbert**
Spring, 2022	220 (professional develop)	3(oral)	4	7	**Choo**
Spring, 2022	250 (kinetics & transport)	-	-	-	Xu
Spring, 2022	260 (thermo)	1	-	-	**Zhuravleva**
Spring, 2022	302 (mechanical behavior)	-	-	-	Liaw
Spring, 2022	304 (principles mater. lab II)	3(writ)	-	-	**Kocak**
Spring, 2022	350/7 (electronic materials)	-	-	-	~~Hu~~ (sabbatical, sub TBD)
Spring, 2022	390/7 (metallic materials)	-	-	-	Gao
Spring, 2022	489 (senior design)	2	3(oral)	3(writ)	**Rack** & multiple team advisors

Table A.2. Faculty Assessment of Student Outcomes Organized by Semester (2021-2022) and Responsible Faculty Member

Rubrics

Example Rubric for outcome 1



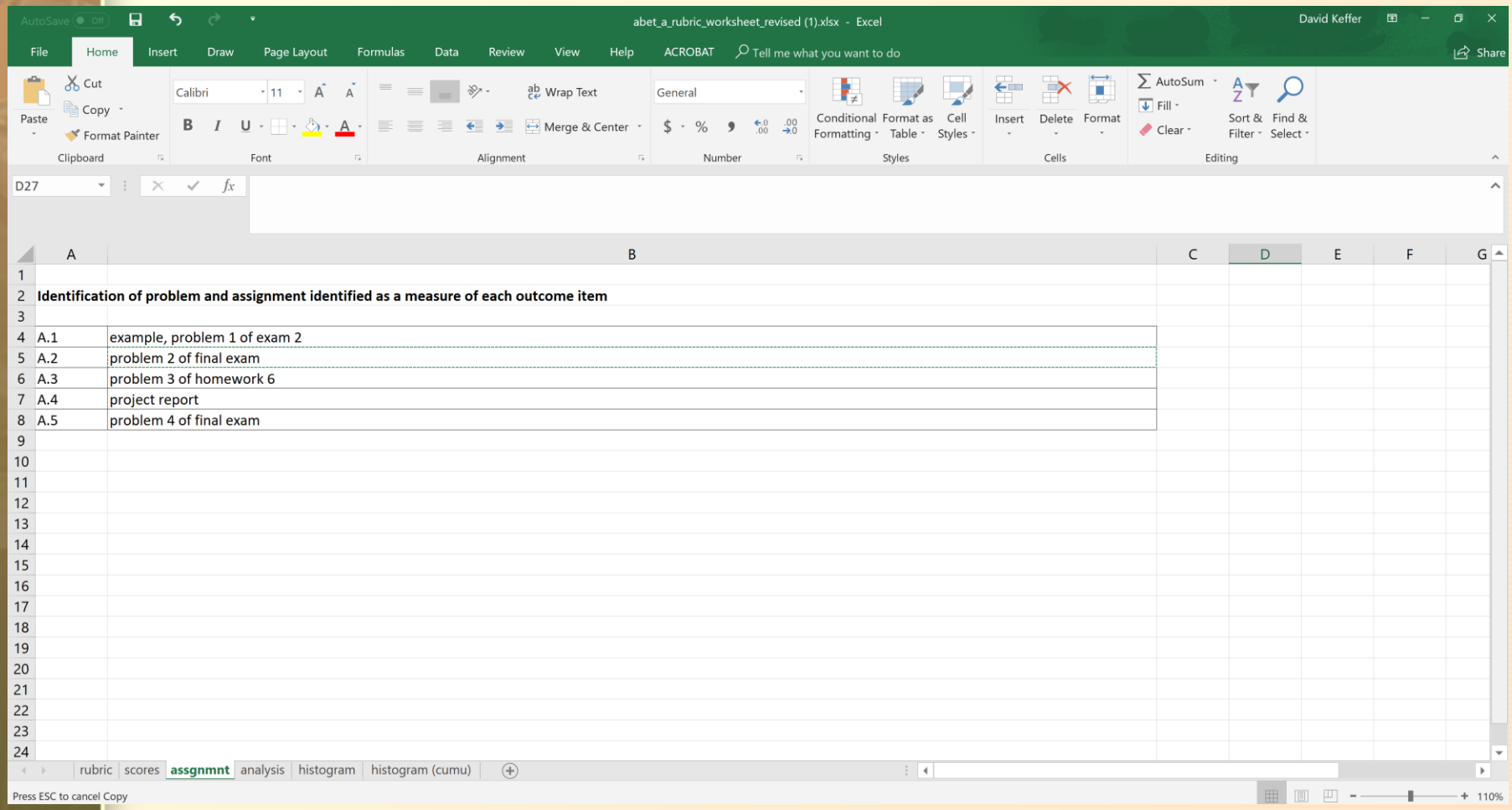
Metric	Criterion	Work Equivalent to Level 1	Work Equivalent to Level 3	Work Equivalent to Level 5	Score (1-5 or N/A)
1.1.	Connection between mathematical models and physical processes and systems.	Does not understand the connection between mathematical models and chemical or physical processes and systems in materials science and engineering	Chooses a mathematical model or scientific principle that applies to an engineering problem, but has trouble in model development	Combines mathematical and/or scientific principles to formulate models of chemical or physical processes and systems relevant to materials science and engineering	
1.2.	Application of calculus to engineering problems.	Does not understand the application of calculus and linear algebra in solving materials science and engineering problems	Shows nearly complete understanding of applications of calculus and/or linear algebra in problem-solving	Applies concepts of integral and differential calculus and/or linear algebra to solve materials science and engineering problems	
1.3.	Interpretation of mathematical terms.	Mathematical terms are interpreted incorrectly or not at all	Most mathematical terms are interpreted correctly	Shows appropriate engineering interpretation of mathematical and scientific terms	
1.4.	Application of theory.	Does not appear to grasp the connection between theory and the problem	Some gaps in understanding the application of theory to the problem and expects theory to predict reality	Translates academic theory into engineering applications and accepts limitations of mathematical models of physical reality	
1.5.	Execution of calculations.	Calculations not performed or performed incorrectly	Minor errors in calculations	Executes calculations correctly	

Rubrics online as excel spreadsheets

http://utkstair.org/clausius/docs/abet_mse_2023/

Rubrics

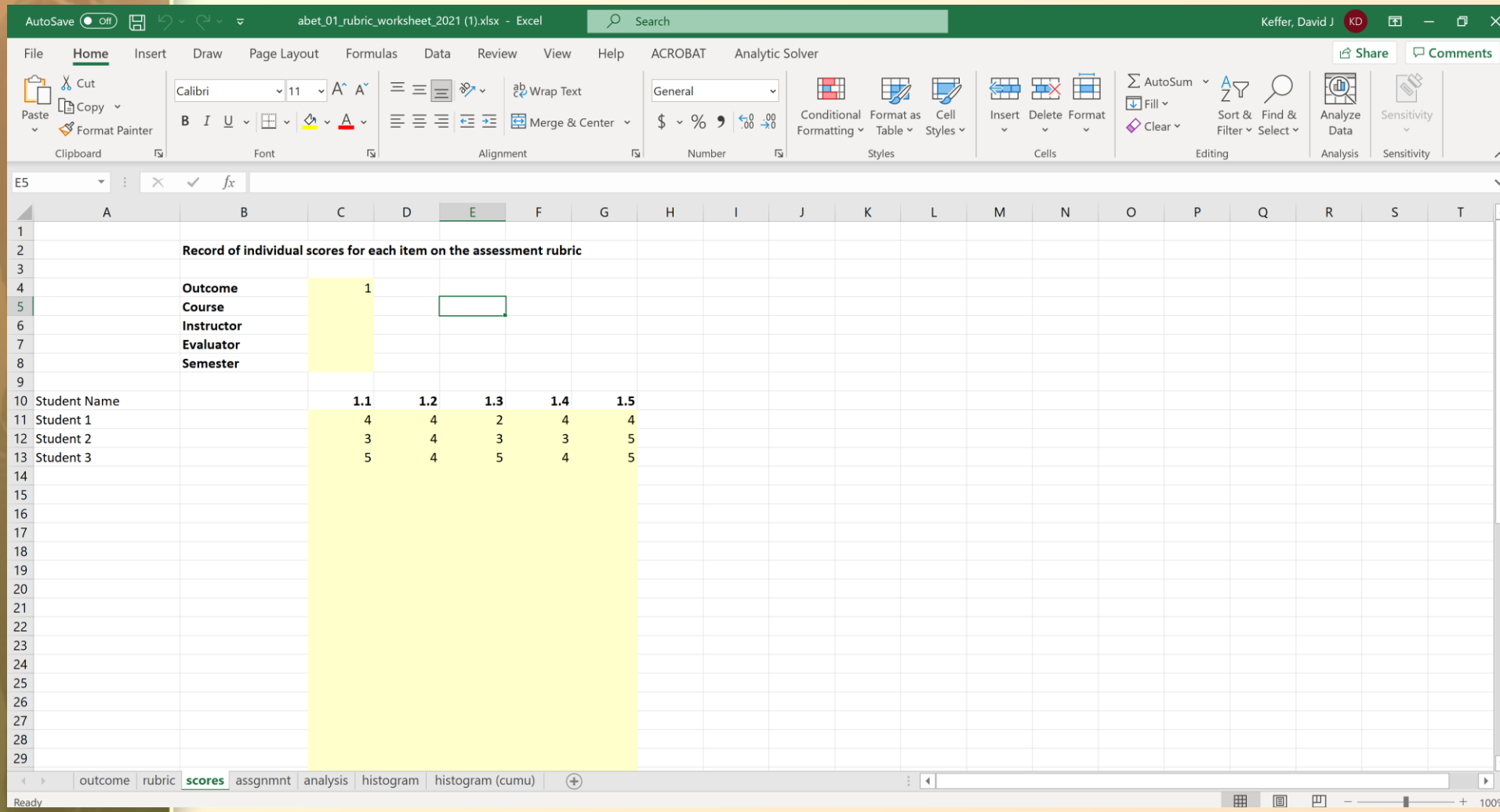
Identify a problem to assess each metric for a given outcome



At the beginning of the semester, identify problems.
"assgnmnt" tab in excel spreadsheet to record problem id.

Two things must be provided by faculty

During semester, record student scores for each metric.



"scores" tab in excel spreadsheet to scores.

grading scale: F = 1, D = 2, C = 3, B = 4, A = 5 (Integers only!)

What must be turned in by faculty

Excel Spreadsheet
- Identifies problem used to evaluate metric.
- Score for each student on each metric.

Send electronic copy of spreadsheet to Keffer. If assignment statements are electronic, send electronic copy of those to Keffer as well.

Please no paper copies of rubrics!

Deadline for spreadsheets and assignments are the day student grades are due. (Otherwise they will be lost.)

We must collect student work this year! (Preferably electronic.)
For our next ABET visit (Fall, 2023), we will need student work from this most recent assessment.

What do we do with the data?

Summary of Results for Data Collection:

The following summary reports the results of the data collection, evaluation and assessment based on the offering of MSE 301 in the fall semester of 2018. The average and standard deviation for each criterion are listed in **Table F.m.1**. The histogram is provided in **F.m.1**.

	M.1	M.2	M.3	M.4	M.5	M.6
average	4.70	3.75	4.20	4.20	3.40	4.35
standard deviation	0.90	1.34	1.29	1.29	1.36	0.91

Table F.m.1. Average and standard deviation of scores.

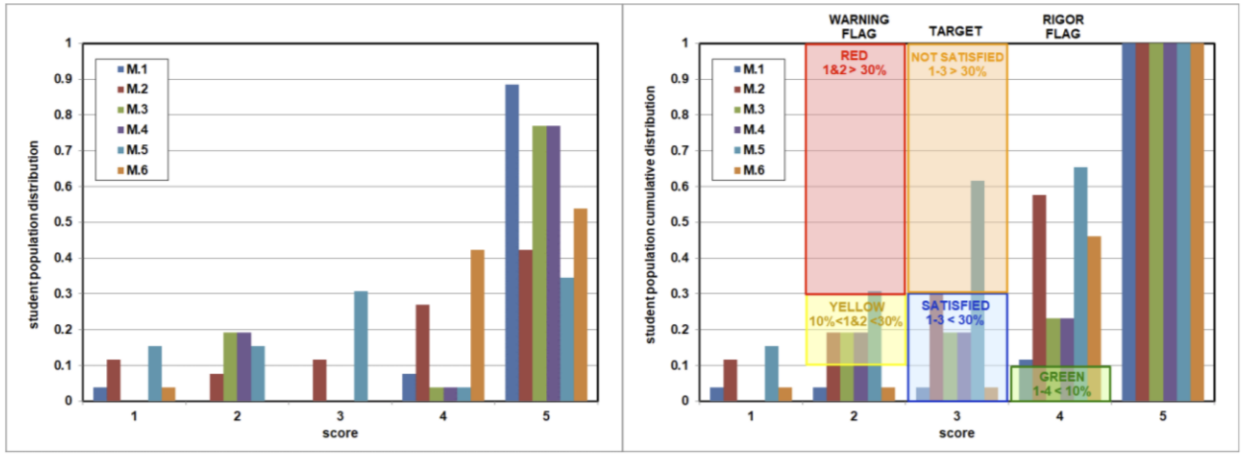


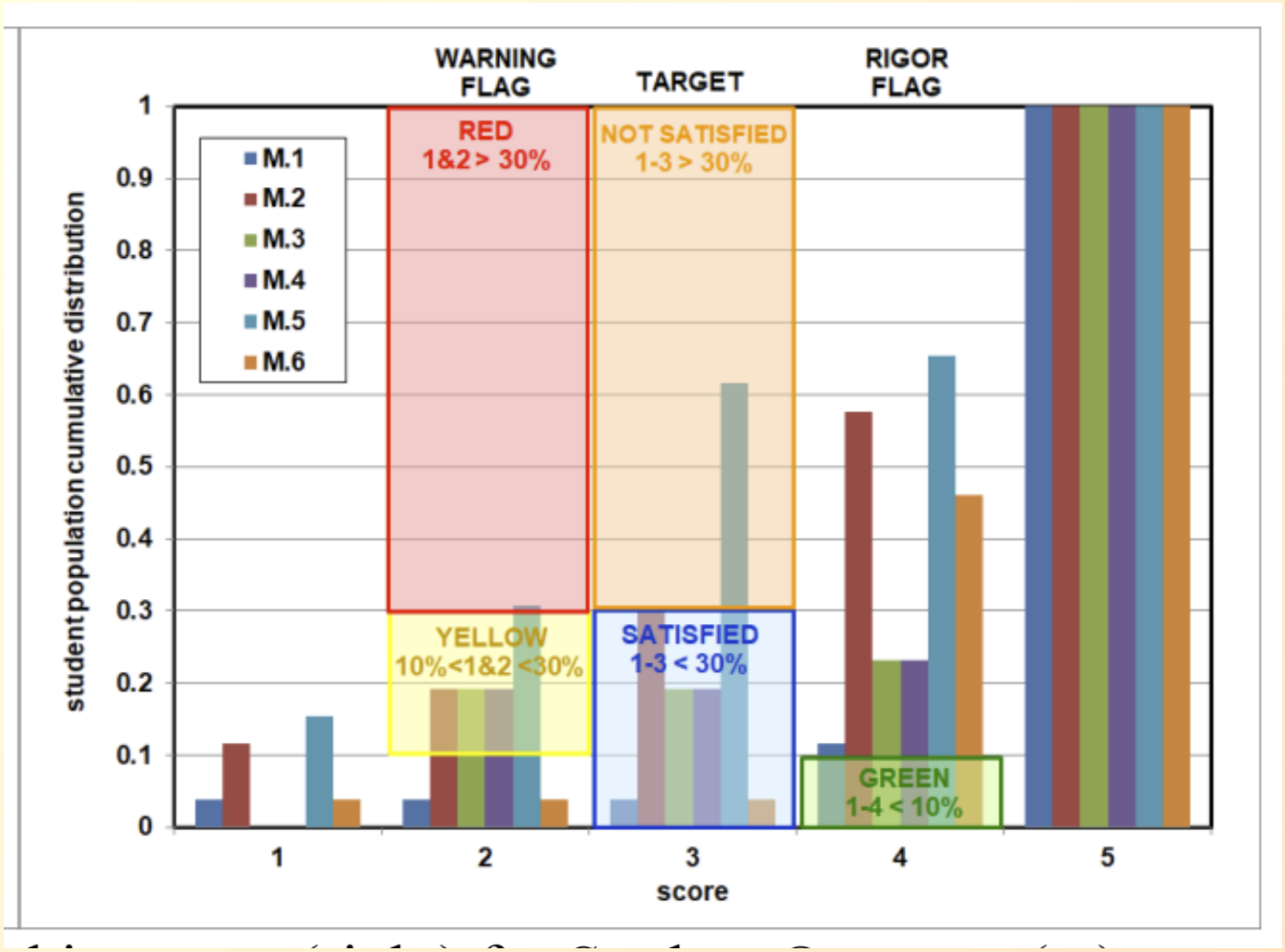
Figure F.m.1. Histogram (left) and cumulative histogram (right) for Student Outcome (m).

Summative Assessment of Student Outcome:

The cumulative distribution function in **Figure F.m.1** provides a clear visualization of the data collected and the evaluation performed from which an assessment can be made. Five of the six criteria (M.1 through M.5) are satisfied by more than 70% of the student population achieving a score of 4 or 5 (or equivalently less than 30% of the student population achieving a score of 1 to 3). One criterion (M.5, "solve a system of nonlinear ODEs") failed significantly.

Excel spreadsheet generates histograms. Keffer compiles the report.

What do we do with the data?



Review and discuss data at faculty meeting.
Make data-enabled changes to our curriculum.

Questions?

Rubrics and this presentation stored online at

http://utkstair.org/clausius/docs/abet_mse_2023/