UCI University of California, Irvine

Changing Grading Relationships through Specifications Grading

Renée Link
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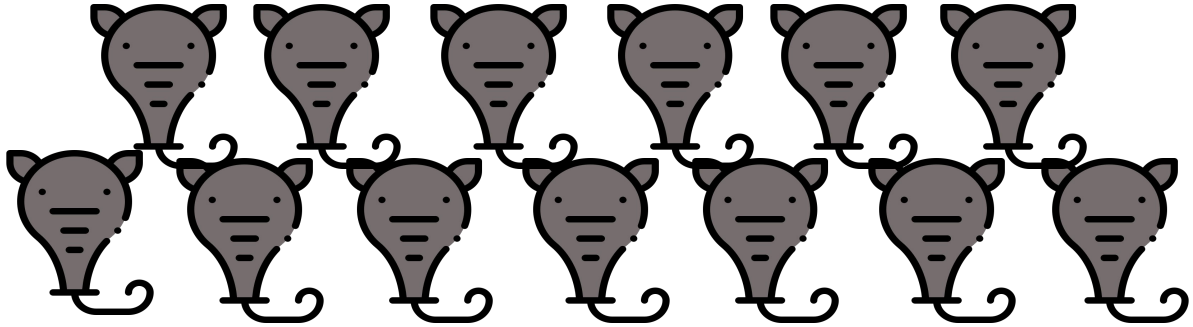
What I Teach

ME

= 1 head TA or stockroom manager

= 6 graduate TAs



= 100 students

Baby anteater by Freepik from Flaticon

Acknowledgements First

Dr. Kate McKnelly
(Emory)

Dr. Will Howitz
(GA Tech)

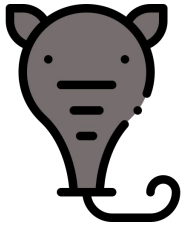
TEA TEACHING EXPERIMENT ACADEMY

BREWING LEARNING CONFIDENCE IN STEM

UCI Chemistry
Colleagues
Dr. Kieron Burke

Buster & Apollo

Chem 51L TAs &
Students



UCI Chemistry

Grading — The Necessary (?) Evil

"I definitely decided to pursue a career that involves teaching because I really love grading and assigning letter grades."
-- No one, ever

Grading does not motivate students

Norm-referenced grading (curving) forces competition

Norm-referenced grading (curving) can push out students from marginalized groups

Points-based grading leads to focus on points instead of learning

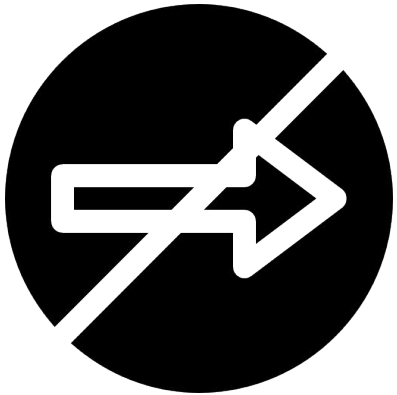
Grade is bestowed by instructor instead of earned

Schinske, J.; Tanner, K. *CBE Life Sciences* **2014**, *13*, 159-166.

Teaching Philosophy / Grading Practice

What I Said I Valued

- Learning is collaborative
- Mistakes lead to learning
- Growth mindset
- Transparency



What Grading System Said

- Compete for grades
- No room for mistakes
- No opportunities to show improvement
- Never know where you stand

Icon by Freepik from Flaticon

"Hello my name is" by maybeemily is licensed with CC BY-NC-SA 2.0.

Grade-Related Interactions

Excerpts from thousands of emails I have received from students (and you probably have, too):

I worked very hard in this class and I do not feel my grade reflects the effort I put in.

I'm only a few points away from the next grade. Can you round my grade up? Can I do some extra credit?

My answer was at least partially correct, so I think I deserve more points for this. I need more points so that I can have a higher grade for med school.

It's not fair that I have more points than my friend in a different section but they have a higher grade.

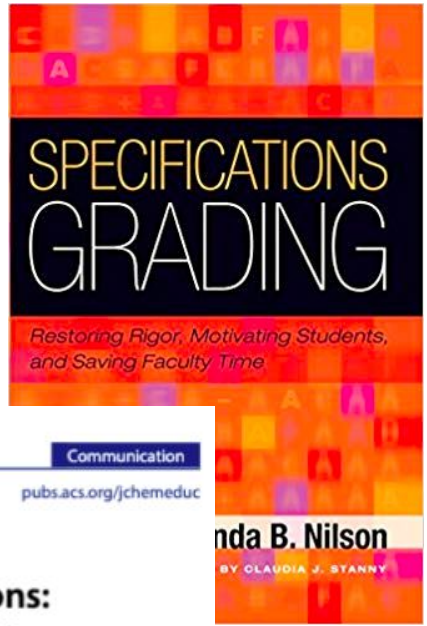
We have conditioned students to treat grades and points this way.

Down the Grading Rabbit Hole

Contract Grading

Mastery Learning

Standards-Based Grading



JOURNAL OF CHEMICAL EDUCATION
Communication
pubs.acs.org/jchemeduc

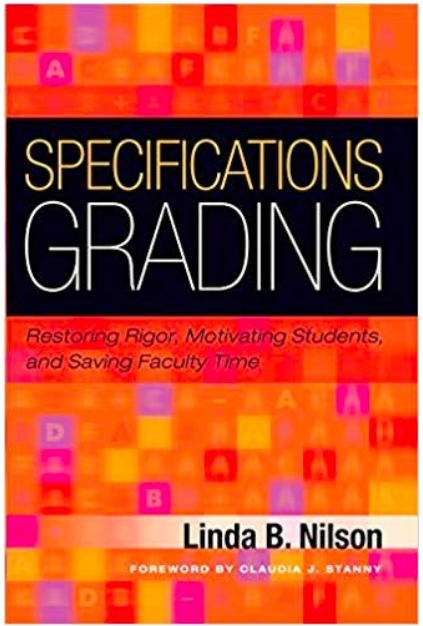
ConfChem Conference on Select 2016 BCCE Presentations: Specifications Grading in the Flipped Organic Classroom

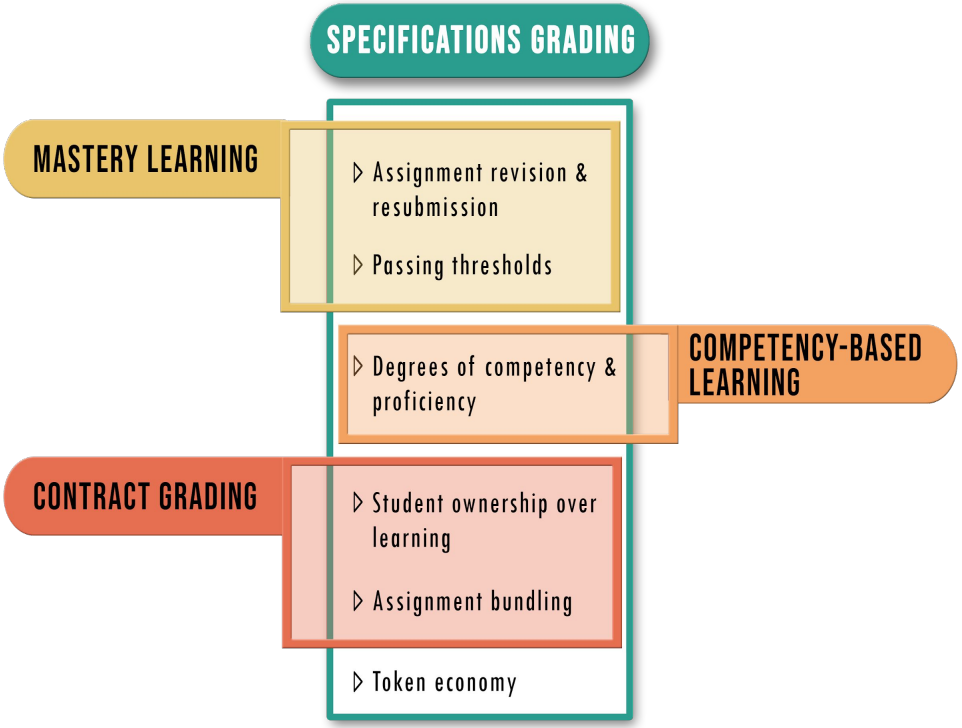
Joshua Ring*

School of Natural Sciences, Lenoir-Rhyne University, Hickory, North Carolina 28601, United States

Ring, J., *J. Chem. Educ.* **2017**, *94*, 2005-2006.

What is specifications grading? How is it done?



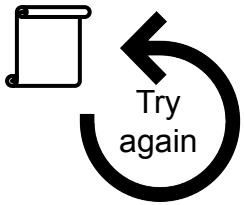


Nilson, L. B.; Stanny, C. J. *Specifications Grading: Restoring Rigor, Motivating Students, and Saving Faculty Time*; Stylus Publishing: Sterling, VA, 2014

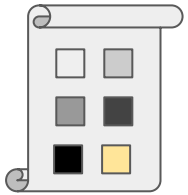
Howitz, W. J.; McKnelly, K. J.; Link, R. D. *J. Chem. Educ.* **2021**, *98* (2), 385-394.

Components of Specifications Grading

Revise/Resubmit/Reassess



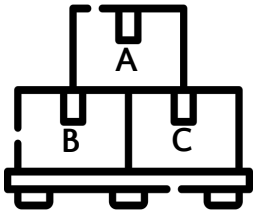
Rubrics (Specifications)



Buy-In

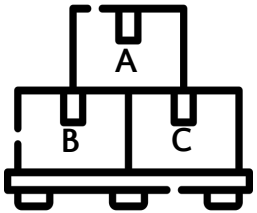
Token Economy

Grade Bundles

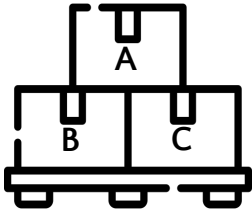


Icon by DinosoftLabs, Freepik, & Flaticon.

Grade Bundles



Common Grade Bundle Configurations



Core & Advanced Objectives

- Course objectives divided
- Pass all essential objectives for passing grade
- More general objectives = higher grade

Objectives Organized by Modules

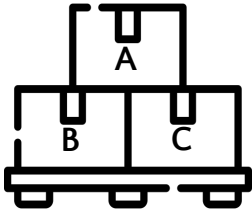
- Objectives organized into module “bins”
- 1 or more essential modules
- Higher grades = pass more modules

All Equal Objectives

- Course objectives may be divided
- More objectives = higher grade

Tsoi, M. Y.; et. al. *Georgia J. Sci.* **2019**, *77* (2), 10.

Core & Advanced Objectives



Organic Chemistry I (Ring)

A:	Pass 6 EOs + 15-16 GOs
A- :	Pass 6 EOs + 14 GOs
B+:	Pass 6 EOs + 13 GOs
B:	Pass 6 EOs + 11-12 GOs
B-:	Pass 6 EOs + 10 GOs
C+:	Pass 6 EOs + 9 GOs
C:	Pass 6 EOs + 7-8 GOs
C-:	Pass 6 EOs + 6 GOs
D+:	Pass 6 EOs + 5 GOs
D:	Pass 6 EOs + 3-4 GOs
D-:	Pass 6 EOs + 2 GOs
F:	Pass less than 6 Eos and/or 2 GOs

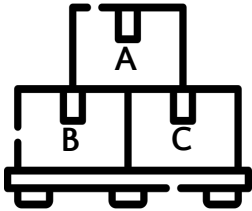
Discrete Math (Carlisle)

Table 2. Grade benchmarks in Disco

Course grade	A	B
Worksheets	Pass all but 1	Pass all but 2
Problems: Core	Pass all 6	Pass all 6
Problems: Adv.	Pass 5	Pass 3
Final exam (%)	85	75
Course grade	**C**	**D**
Worksheets	Pass all but 3	Pass all but 4
Problems: Core	Pass all 6	Pass 5
Problems: Adv.	Pass 1	Pass 0
Final exam (%)	65	55

Ring, J., *J. Chem. Educ.* **2017**, *94*, 2005-2006.
Carlisle, S. *Problems, Resources, and Issues in Mathematics Undergraduate Studies* **2020**, *30* (8-10), 926–951.

Core & Advanced Objectives



Thermodynamics (Mendez)

Table 1: Course Grade Requirements

	D	C	B	A
Quizzes	Earn passing scores (E or M) on 15 core learning targets.	Earn passing scores (E or M) on all 18 core learning targets.	Earn passing scores (E or M) on all 18 core learning targets PLUS 7 additional learning targets.	Earn passing scores (E or M) on all 18 core learning targets PLUS 14 additional learning targets.
Quiz "E" Scores	None required.	None required.	Earn "E" scores on 18 learning targets.	Earn "E" scores on 25 learning targets.
Design Project	None required.	Earn passing score (E or M) on report. No presentation required.	Earn passing scores (E or M) on report AND presentation.	Earn passing scores (E or M) on report AND presentation. Earn "E" score on report OR presentation.
Pre-Class Work	Pass 7 pre-class assignments.	Pass 8 pre-class assignments.	Pass 10 pre-class assignments.	Pass 11 pre-class assignments.

Organic Chemistry I (Link)

A
- ❑ Pass 7/8 HLO Quizzes
- ❑ Pass 8/8 ELO Quizzes
- ❑ Pass 8/8 ELO ReQuizzes

B
- ❑ Pass 4/8 HLO Quizzes
- ❑ Pass 8/8 ELO Quizzes
- ❑ Pass 8/8 ELO ReQuizzes

C
- ❑ Pass 8/8 ELO Quizzes
- ❑ Pass 8/8 ELO ReQuizzes

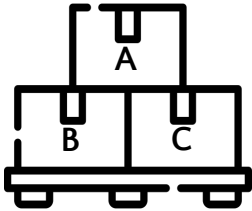
D
- ❑ Pass 4/8 ELO Quizzes & ReQuizzes (any combo)

Plus (+)*
- ❑ Sapling total ≥ 80%
- ❑ Group activities ≥ 10/15
- ❑ Weekly reflections/maps ≥ 4

Minus (-)
- ❑ Sapling total ≤ 70%
- ❑ Group activities ≤ 8/15
- ❑ Weekly reflections/maps ≤ 2

Mendez, J. Standards-Based Specifications Grading in Thermodynamics. *In 2018 ASEE Annual Conference & Exposition*; 2018.

All Equal Objectives



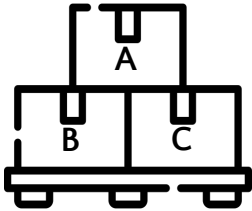
Thermodynamics (Mendez)

Table 2: Course Grade Requirements

To earn this grade:	Accomplish the following:
A	Earn passing scores on 15 quizzes, including at least 11 "E" scores, AND earn passing scores on project report and presentation.
B	Earn passing scores on 13 quizzes, including at least 7 "E" scores, AND earn passing scores on project report and presentation.
C	Earn passing scores on 11 quizzes (no "E" scores required), AND earn passing scores on project report and presentation.
D	Earn passing scores on 9 quizzes (no "E" scores required).

Mendez, J. Standards-Based Specifications Grading in a Hybrid Course. *In 2018 ASEE Annual Conference & Exposition*; 2018.

All Equal Objectives



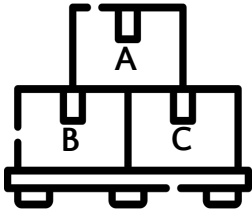
Differential Equations (Carlisle)

Table 1. Grade benchmarks in DE II

Course grade	A	B
Online homework (%)	85	80
Worksheets	Pass all but 1	Pass all but 2
Problems (of 20)	Pass 20	Pass 17
Projects	Pass 2	Pass 1
Final exam (%)	85	75
Course grade	**C**	**D**
Online homework (%)	75	70
Worksheets	Pass all but 3	Pass all but 4
Problems (of 20)	Pass 14	Pass 12
Projects	Pass 0	Pass 0
Final exam (%)	65	55

Carlisle, S. *Problems, Resources, and Issues in Mathematics Undergraduate Studies* **2020**, *30* (8-10), 926–951.

Objectives Organized by Module

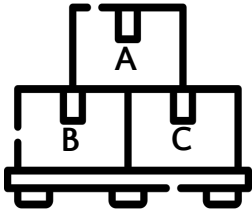


Calculus II (Tsoi, et. al.)

Course grade	Requirement
A	Pass essential module 1 and 5 general modules, student choice
B	Pass essential module 1 and 4 general modules, student choice
C	Pass essential module 1 and 3 general modules, student choice
D	Pass essential module 1 and 2 general modules, student choice
F	[Do not pass essential module 1] or [pass essential module 1 and (1 or none of the general modules, student choice]

Tsoi, M. Y.; et. al. *Georgia J. Sci.* **2019**, *77* (2), 10.

Common Specifications Grading Types



Core & Advanced Objectives

- Course objectives divided
- Pass all essential objectives for passing grade
- More general objectives = higher grade

Objectives Organized by Modules

- Objectives organized into module "bins"
- 1 or more essential modules
- Higher grades = pass more modules

All Equal Objectives

- Course objectives may be divided
- More objectives = higher grade

Equal Objectives with Repetition & Difficulty

- Course objectives met through multiple means
- More repetitions & higher-order assessments = higher grade

Tsoi, M. Y.; et. al. *Georgia J. Sci.* **2019**, *77* (2), 10.

Objectives with Repetition & Difficulty

Organic Chemistry Laboratory (Howitz)

A

- ❑ Pass 6/7 ELN assignments
- ❑ Pass 4/5 Post-Labs Reports
- ❑ Pass 3/3 Technique Video Assessments
- ❑ Pass Knowledge Check/Safety
- ❑ Pass Proficiency Exam at A level

B

- ❑ Pass 5/7 ELN assignments
- ❑ Pass 3/5 Post-Labs Reports
- ❑ Pass 2/3 Technique Video Assessments
- ❑ Pass Knowledge Check/Safety
- ❑ Pass Proficiency Exam at B level

C

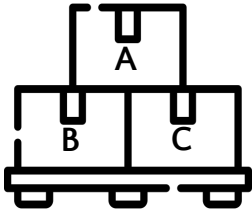
- ❑ Pass 4/7 ELN assignments
- ❑ Pass 1/5 Post-Labs Reports
- ❑ Pass 1/3 Technique Video Assessments
- ❑ Pass Knowledge Check/Safety

D

- ❑ Pass 3/7 ELN assignments

Course Grade Criteria
Online Pre-Lab Homework:
Pre-Lab Video Quizzes:
Lab Notebook:
Post-Lab Scaffolds:
Written Lab rt:
ecture ipation:
y Final :
- Lab niques:
ledge Check
ery Final:

Objectives with Repetition & Difficulty



Writing for Chemists (McKnelly)

MINIMUM To Earn C (fulfills the upper division writing requirement)

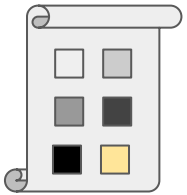
Small Writing Assignments (19 total): 12 hig
1000-Word Writing Assignments (4 total): 3 2
Presentations (5 total): 3 low-passes ▢ ▢ (
Presentation Participation: 3 Satisfactory Re
Lecture Participation: 2 Required ▢ ▢
Reading Completion (17 total): 13 completed
Complete/Incomplete Assignment Completi
Final Presentation: low-pass ▢
Final Paper: low-pass ▢

MINIMUM To Earn A-

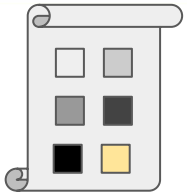
Small Writing Assignments (19 total): 17 high-passes ▢ + no unsatisfactory ▢
1000-Word Writing Assignments (4 total): 3 high-passes ▢ ▢ ▢ ▢ + 1 low-pass ▢
Presentations (5 total): 2 with high-passes ▢ ▢ + 2 low-passes ▢ ▢
Presentation Participation: 4 Satisfactory Required ▢ ▢ ▢ ▢
Lecture Participation: 5 Required ▢ ▢ ▢ ▢ ▢
Reading Completion (17 total): 16 completed ▢
Complete/Incomplete Assignment Completion (17 total): 15 completed ▢
Final Presentation: high-pass ▢
Final Paper: high-pass ▢

McKnelly, K. J.; Morris, M. A.; Mang, S. A. *J. Chem. Educ.* **2021**, *98* (4), 1201-1207.

Rubrics & Specifications



Assessment Specifications



Pass/No Pass

- Binary rubric items
- Passing threshold set
- Must meet minimum threshold to pass assessment
- No partial credit

High Pass/Low Pass/ No Pass

- Binary rubric items
- Two passing thresholds set
- Must meet minimum threshold to pass assessment at high or low levels
- No partial credit

Multi-level Rubrics/ Thresholds

- Rubrics may be binary or multi-level
- Assessments marked according to level met (E, M, R, N)

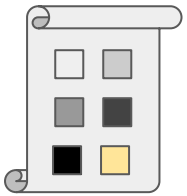
Points with Passing Threshold

- Traditional points-based rubric
- Minimum passing threshold for credit/desired letter grade
- Partial credit varies

Specifications Grading Requires Carefully Designed Rubrics...

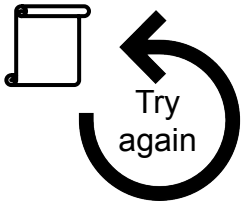
Criteria from Points-Based Rubric	Points
Theory (Full Credit): Student discusses fundamentals of column chromatography and relates the technique to TLC, noting similarities and differences and how a successful separation is achieved.	7

Criteria from Specifications Rubric	Satisfactory	Needs Revision
Theory 1a: Clearly describes the chemical principle(s) that govern how compounds are separated using column chromatography. Note: Be sure to include the importance of solvent choice.	▢	▢
Theory 1b: Clearly compares and contrasts column chromatography to TLC.	▢	▢
Theory 1c: Clearly describes what procedural steps must be taken to achieve a successful separation using column chromatography.	▢	▢
Theory 1d: Clearly explains how separation is monitored in real time, and how this allows the determination of whether the separation was successful or not.	▢	▢



Howitz, W. J.; McKnelly, K. J.; Link, R. D. *J. Chem. Educ.* **2021**, *98* (2), 385-394.

Revise/Resubmit/Reassess & Token Economy



Managing Retakes and Revisions with a Token Economy

Use tokens to incentive good habits

- Planning
- Study habits
- Metacognitive strategies

Tokens remove the need for instructor to judge student situations and requests.

Blackstone, B.; Oldmixon, E., J*ournal of Political Science Education* **2019**,*15* (2), 191−205.
McKnelly, K. J.; Howitz, W. J.; Thane, T. A.; Link, R. D. *Manuscript in review. Preprint on ChemRxiv. DOI: 10.26434/chemrxiv-2022-77wr7-v2*

Outcomes & Potential Benefits

Gains in Specific Assessments

Organic Chemistry (Ring)	Fall 2014, including partial credit (n=46)	Fall 2014, regraded without partial credit	Fall 2015, no partial credit given (n=35)
Final Exam Average	65.6%	41.4%	61.3%
Lewis/LA/CF	63.7%	28.5%	67.8%
Naming	71.9%	24.7%	61.0%
Resonance	67.8%	39.6%	63.5%
Acid-Base Explanations	68.3%	48.1%	50.5%
A + B → ?	61.9%	49.4%	62.0%
A + ? → C	61.0%	42.9%	72.5%

Ring, J. Specifications Grading in the Flipped Organic Classroom. In *Fall 2016 ConfChem: Select Presentations from CCCE Sponsored Symposia During the 2016 Biennial Conference on Chemical Education*; 2016. https://confchem.ccce.divched.org/2016FallConfChemP2

Gains in Specific Assessments

Discrete Math (Carlisle)

	Final Exam Mean	Final Exam Median
Term 1	74.5	73.83
Term 2	77.6	78.33
Term 3	83.67	86.67
Term 4	83.43	86
Term 5	83.46	85

Carlisle, S. *Problems, Resources, and Issues in Mathematics Undergraduate Studies* **2020**, *30* (8-10), 926–951.

Thermodynamics Hybrid (Mendez)

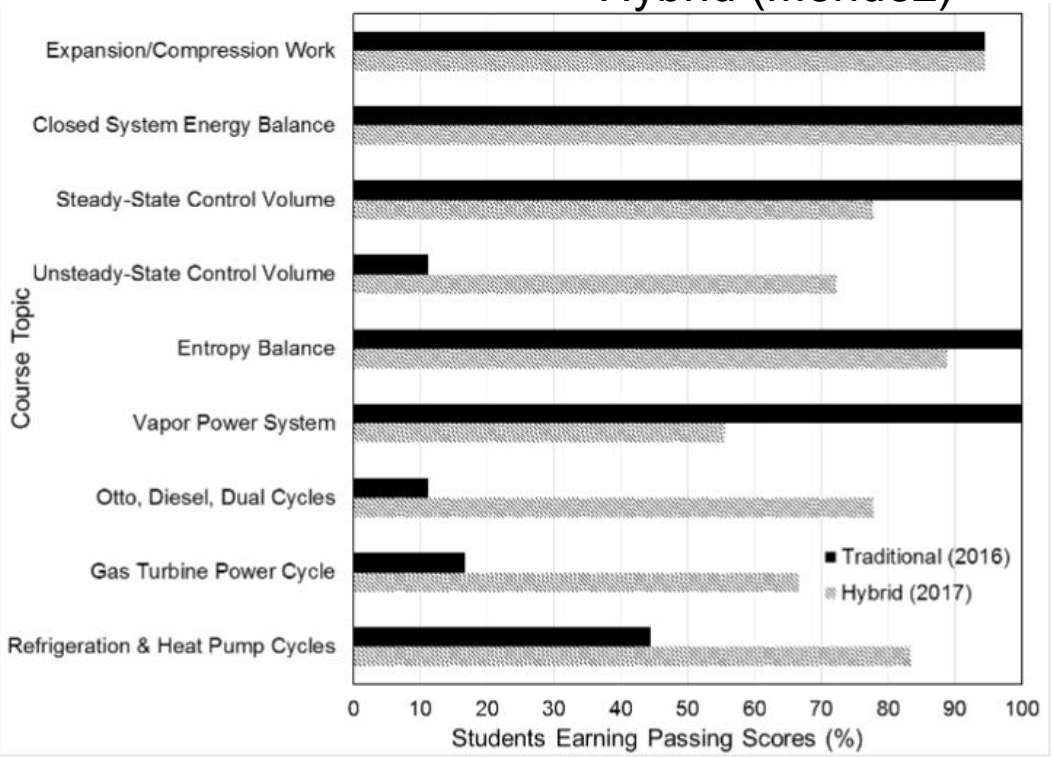


Figure 1. Student performance on course assessments in the traditional (solid bars) and hybrid (dashed bars) classes. In the hybrid class, these quizzes were proctored and took place in class.

Gains in Letter Grades

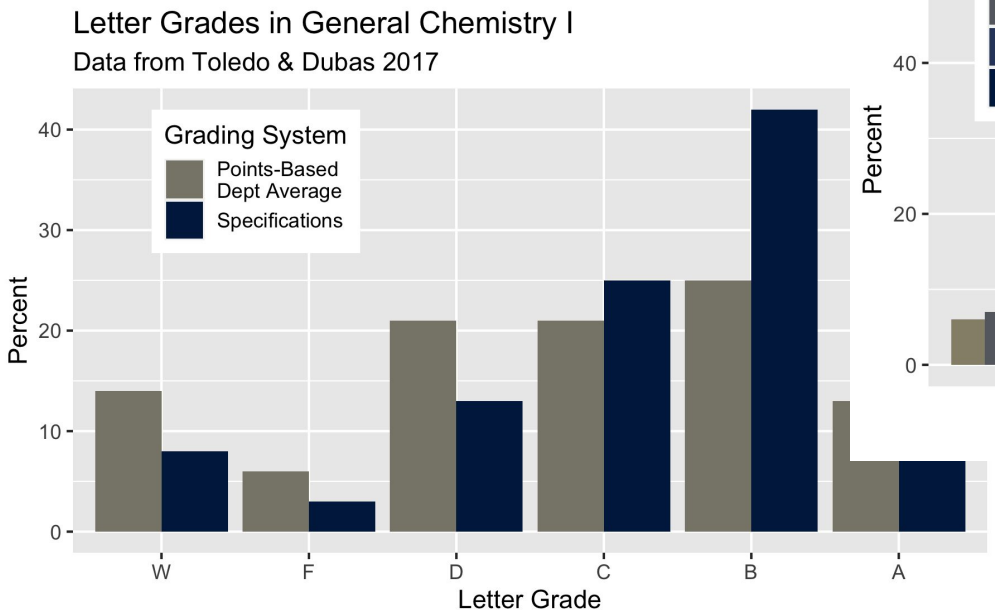
Discrete Math (Carlisle)

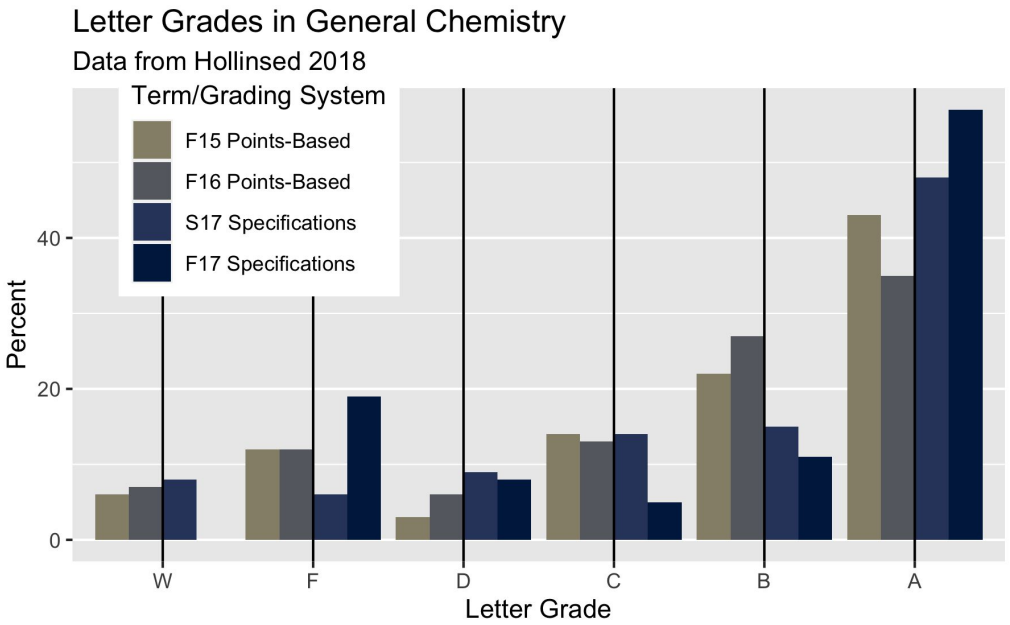
Table 3. Percentage of students with each course grade

Disco	Point system		Specs system		
Grade	Term 1 $n=24$	Term 2 $n=21$	Term 3 $n=19$	Term 4 $n=23$	Term 5 $n=21$
A	16.7	23.8	52.6	43.5	66.7
B+	20.8	19	15.8	21.7	9.5
B	25	28.6	5.3	8.7	0
C+	8.3	9.5	21	4.3	9.5
C	16.7	14.3	0	4.3	4.8
D+	0	4.8	0	4.3	0
D	8.3	0	0	0	4.8
F	4.2	0	5.3	13	4.8

Carlisle, S. *Problems, Resources, and Issues in Mathematics Undergraduate Studies* **2020**, *30* (8-10), 926–951.

Gains in Letter Grades

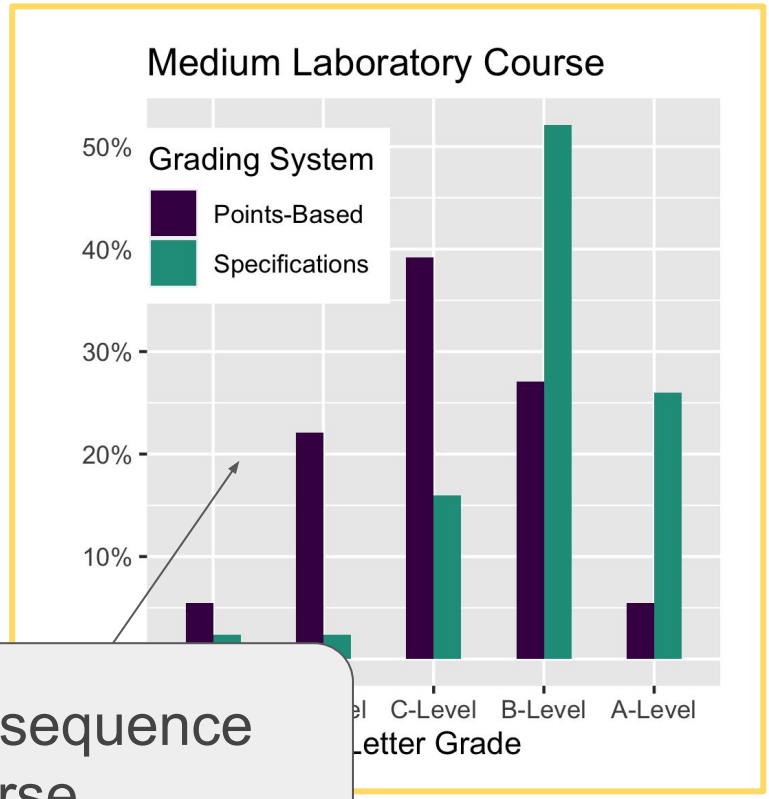


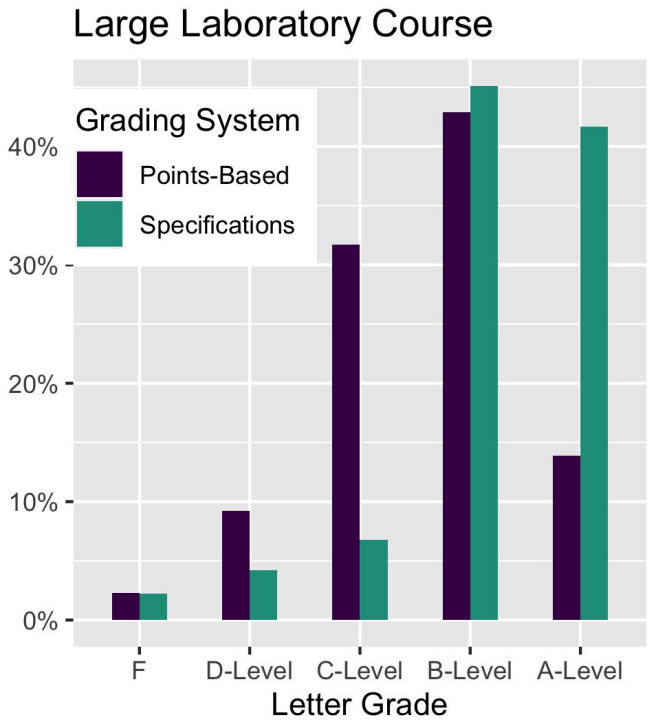


Toledo, S.; Dubas,J. M. J. *Chem. Educ.* **2017**,*94,* 1043-1050.

Hollinsed, W. C. Applying Innovations in Teaching to General Chemistry. In Increasing Retention of Under-Represented Students in STEM through Affective and Cognitive Interventions; ACS Symposium Series; 2018; Vol. 1301, pp 145–152.

Organic Chemistry Lab Grades





Off-sequence course

McKnelly, K. J.; Howitz, W. J.; Thane, T. A.; Link, R. D. *Manuscript in review. Preprint on ChemRxiv. DOI: 10.26434/chemrxiv-2022-77wr7-v2*

Relationship Shifts for Student & Instructors

Grading system matches teaching philosophy

Make mistakes and try again

Conversations are about content, not points

Peers are collaborators, not competitors

Positive Change

"...your class and the way it was structured alleviated the stress of an online lab course by a significant margin.... [the] grading scale; it's unlike anything I've personally encountered, and I think it focuses on what school is all about—learning, even if it's from mistakes. I think that our society has been brainwashed into expecting perfection, when really we should be aiming for a higher understanding of a subject from the mistakes we make and remember instead of the short-term comprehension that comes from doing something correctly the first try… I wish [it] would be implemented in other courses...

...I wasn't 'stupid' in your course—I felt more like I was growing and on my way to proficiency and understanding.." *Angelina Phu, UCI Student*

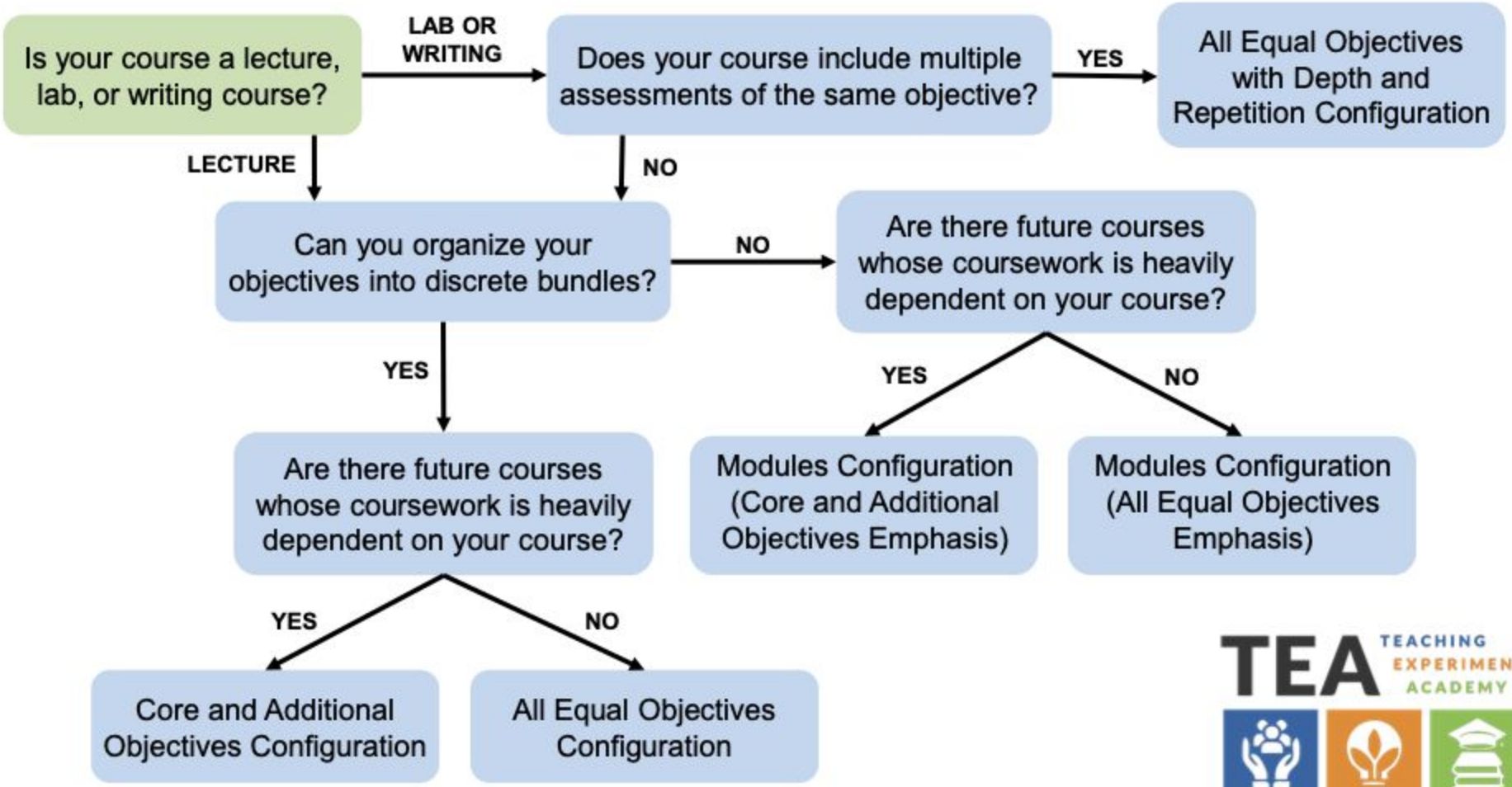
We Don’t Have to Grade the Way We Were Graded

Students appreciate transparent, non-competitive grading that allows for learning from mistakes

Learning and letter grade gains in supportive environment.

Specifications grading can work at scale.

Additional Slides That Might Help



TEA TEACHING EXPERIMENT ACADEMY

BREWING LEARNING CONFIDENCE IN STEM

Limited Time to Grade

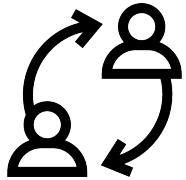
Approach Revision / Resubmission / Reassessment Strategically

Autograding (LMS)?

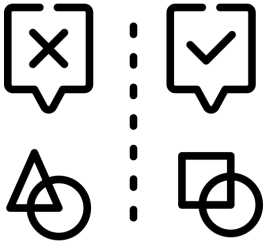
Complete / Incomplete?

✓ ✗

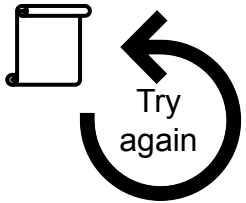
Peer- / Self-Grading?



Reassessed?



Revise/Resubmit?



Tokens?

Coins icon by DinosoftLabs. Other icons Freepik from Flaticon.

How Long Did TAs Spend Grading?

Comparison of self-reported TA grading time in a points-based course and specifications grading system (including revise & resubmit grading).

Median	5	5		7	7
StDev	0.46	0.83		0.91	0.96

Reference list for grading time in publications
https://bit.ly/3hqNZTB

Earn & Trade Token Examples

1 Token

- Revise and resubmit a “Needs Revision” post-lab within 72 hours after graded work is returned.
- 24 hour late pass
  - May use multiple tokens for additional 24 hour passed on a single assignment

2 Tokens

- Replace 1 Needs Revision on lab notebook assignment

3 Tokens

- Make-up lab (no reason needed)
- Buy out 1 student choice technique on exam

Extra may be earned for:

- Completing 3 surveys in the class
- Whole section 4 consecutive weeks of no waste/safety issues
- Metacognitive activities

Coin by Smashicons from Flaticon.

Managing Retakes and Revisions with a Token Economy

Student

Step 1. Submit reflection assignment.

Step 2. Earn 4 initial tokens.

Step 3. Track token balance through assignment “score” on LMS.

CANVAS

Step 4. Review token trade-in list.

Step 5. Fill out token trade-in Google form.

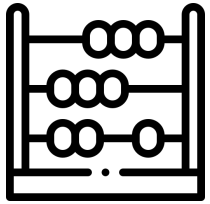
Google Forms

Step 6. Receive copy of their response.

Step 7. Forward copy to TA.

Instructor

Step 8. Subtracts tokens used from LMS token balance.

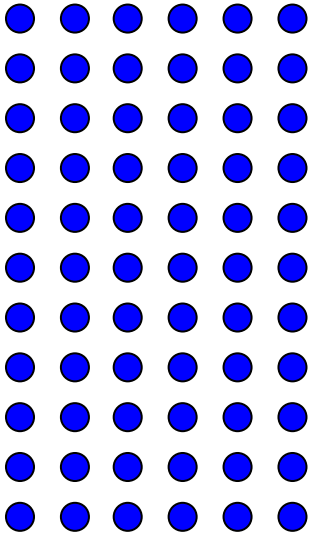


Coins icon by DinosoftLabs. Other icons Freepik from Flaticon.

Start with Student Learning Outcomes (SLOs)

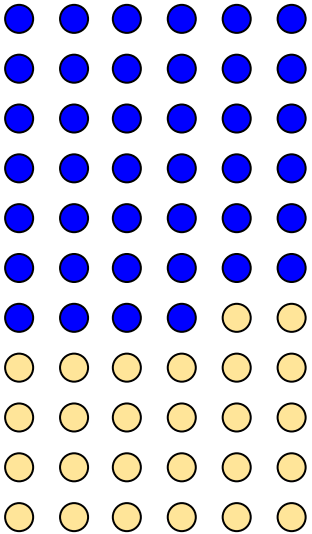
CC BY NC SA

Initial SLOs



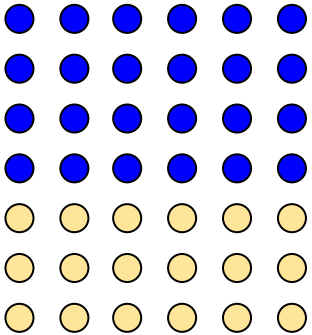
66 Total SLOs

Categorized SLOs

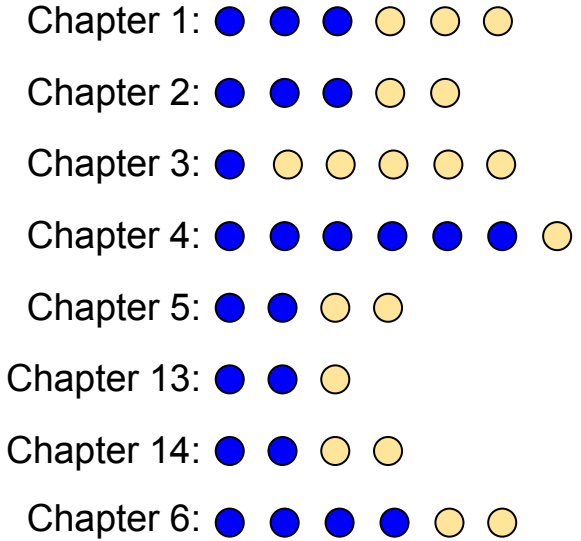


40 ELOs
&
26 HLOs

Consolidated SLOs



24 ELOs
&
18 HLOs



ELOs: essential LOs
HLOs: higher level LOs

Examples of Consolidated SLOs

cc BY NC SA

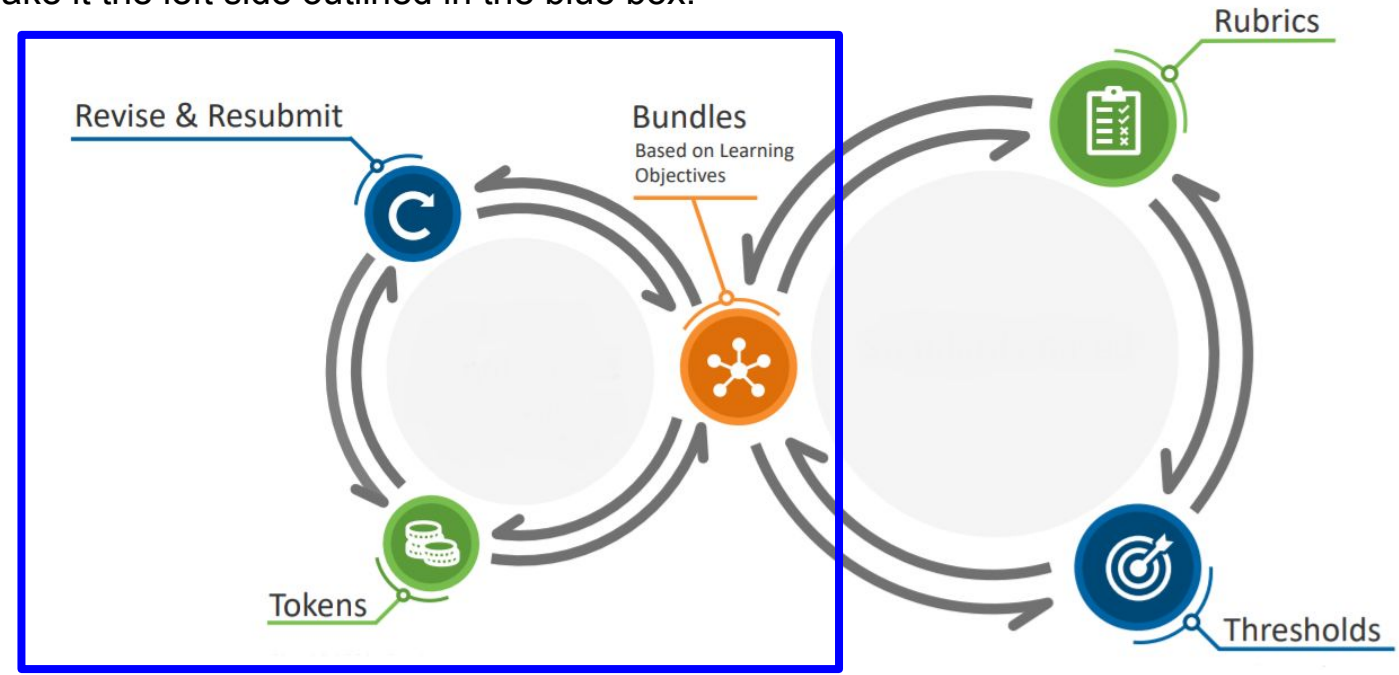
Initial SLOs	Consolidated SLOs
Identify acids and bases Determine relative acidity using pK_a Determine relative basicity using pK_a	Use structures and pK_a values to identify acids/bases.
Determine relative acidity using structure Determine relative basicity using structure	Use structure to determine relative acidity or basicity.

You probably have too many. Consolidate where you can.

- **ELOs:** essential LOs
- **HLOs:** higher level LOs

Relationships between the Elements of Specifications Grading

If you only incorporate parts of the system,
make it the left side outlined in the blue box!



A Few Specs Grading Examples Outside of STEM

- **POLITICAL SCIENCE:** Blackstone, B.; Oldmixon, E. Specifications Grading in Political Science. *Journal of Political Science Education* **2019**, *15* (2), 191–205.
- **COMMUNICATIONS:** Elkins, D. M. Grading to Learn: An Analysis of the Importance and Application of Specifications Grading in a Communication Course. *Kentucky Journal of Communication* **2016**, *35* (2), 2016.
- **PUBLIC ADMINISTRATION:** Jones, P. A. Implementing Specifications Grading in MPA Courses: A Potential Strategy for Better Work-Life Balance. *Journal of Public Affairs Education* **2020**, 1–17.
- **INFORMATION LITERACY:** Shields, K.; Denlinger, K.; Webb, M. Not Missing the Point (s): Applying Specifications Grading to Credit-Bearing Information Literacy Classes. In *The grounded instruction librarian : participating in the scholarship of teaching and learning*; Mallon, M. N., Hays, L., Bradley, C., Huisman, R., Belanger, J., Eds.; Association of College and Research Libraries: Chicago, IL, 2019.