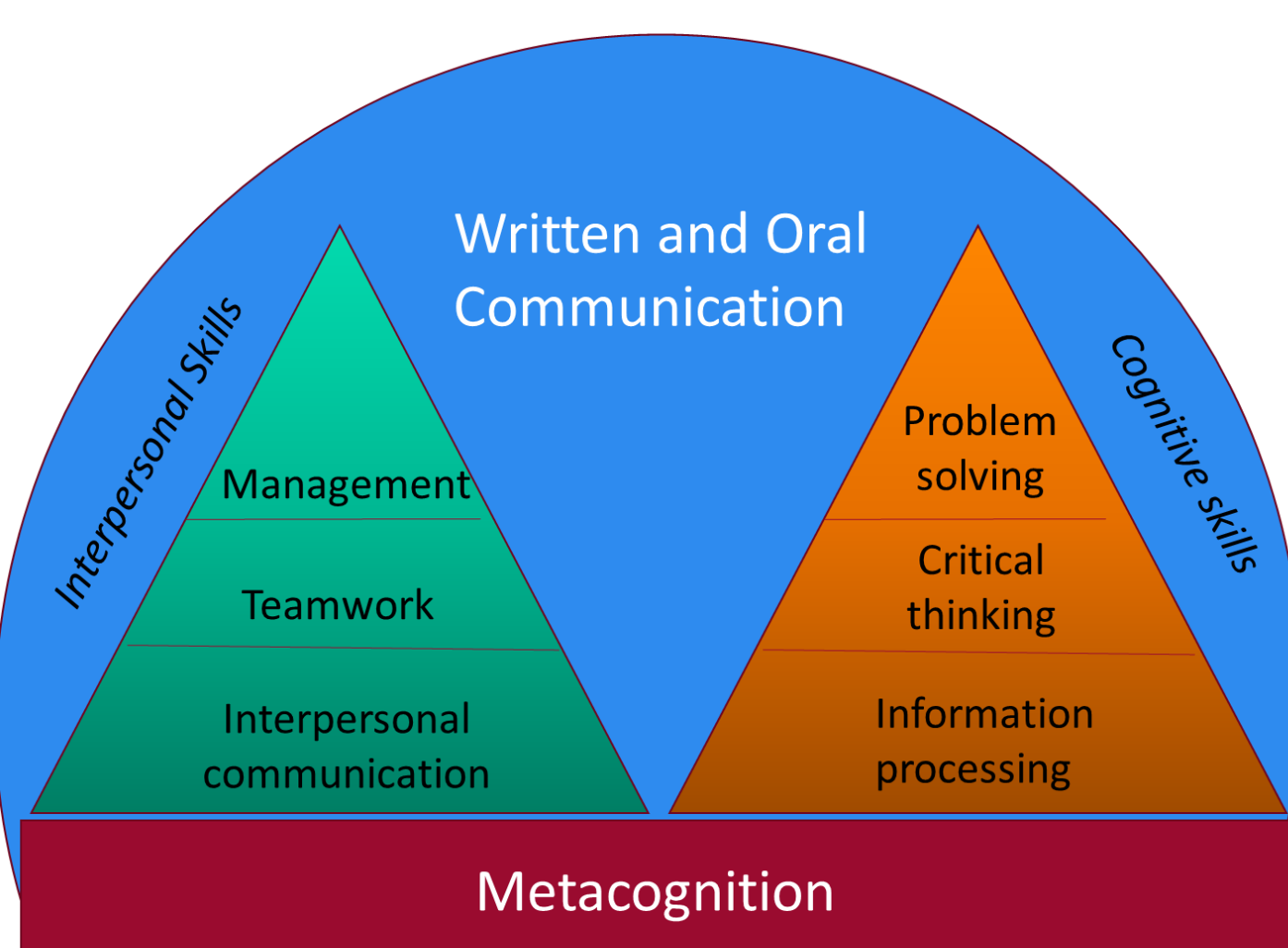
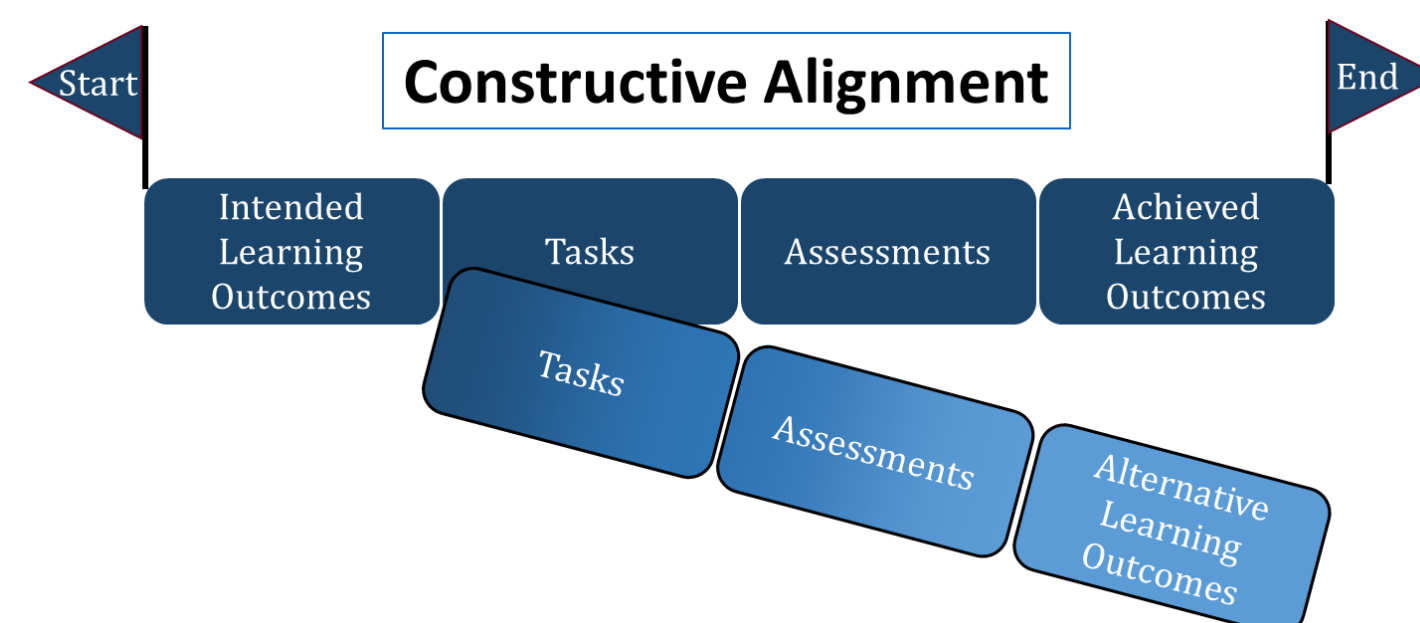




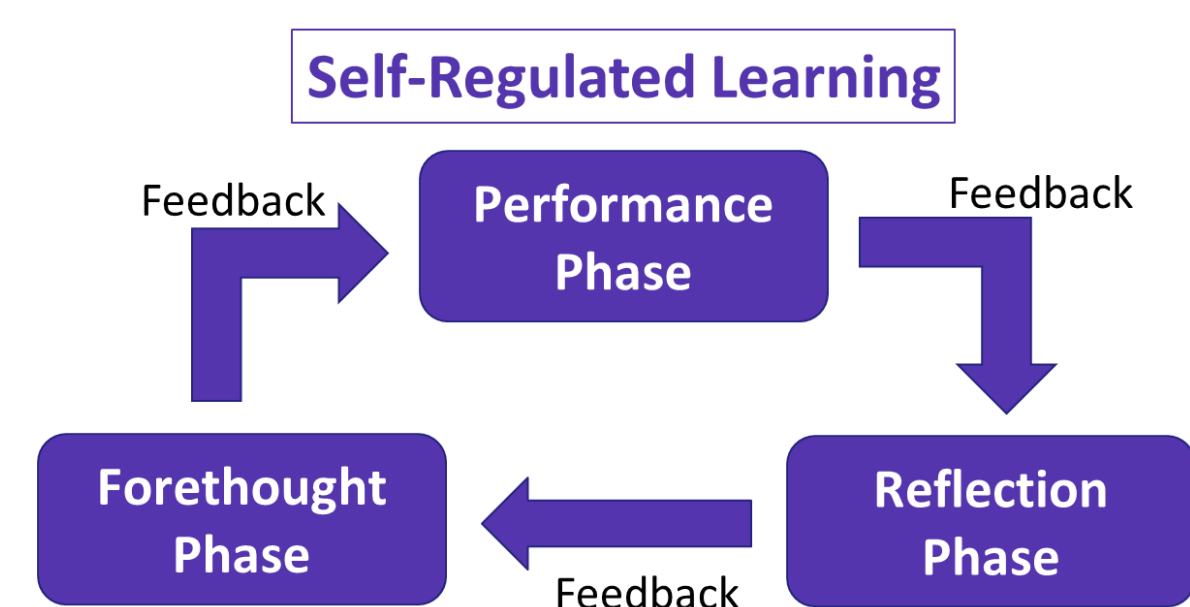
Assessing and Providing Feedback on Process Skills

Process skills like teamwork and problem solving are important skills for students to learn before entering the workplace. Process skills can be categorized as either interpersonal skills or cognitive skills as shown by the two peaks in the diagram below. When instructors want to begin facilitating the development of skills, and providing students with effective feedback that will lead to growth, it's helpful to start with the foundational skill along either the interpersonal skills tier, or the cognitive skills tier. Then, your learning and assessment strategies can progress to the next skill in the sequence. If we tell our students that we want them to develop process skills, we should assess these skills in our classrooms. The assessment and feedback methods used in this work were informed by the theories of constructive alignment and self-regulated learning.



If tasks and assessments do not align with the intended learning outcomes, then it is unlikely that the learning outcomes will be achieved.

*Biggs, J., Constructive alignment in university teaching. *HERDSA Review of Higher Education*, 2014, 1 (1), 5-22



Feedback is also a key component to improve performance and achieve outcomes.

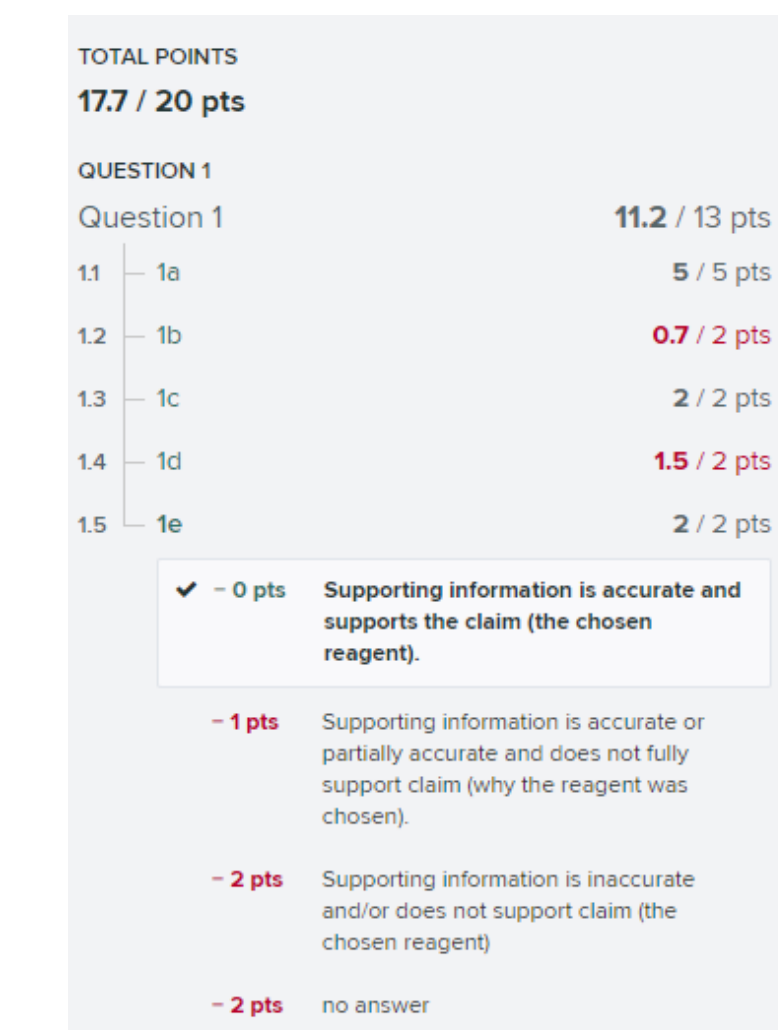
*Zimmerman, B. J. *Becoming a Self-Regulated Learner: An Overview, Theory into practice*, 2002, 41(2), 64-70.

Research Questions

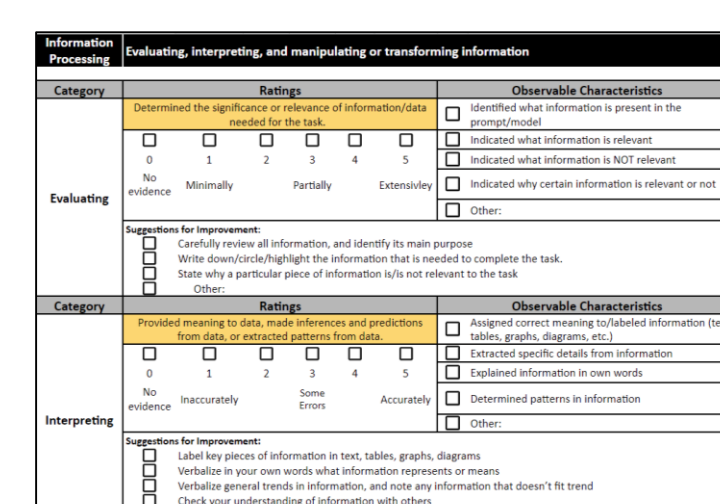
1. What are the most practical ways to provide students with feedback on process skills?
2. How can we encourage students to meaningfully reflect on their process skills?
3. How does feedback on process skills affect student learning gains?

Course Management Systems Used to Deliver Feedback and Collect Student Reflections

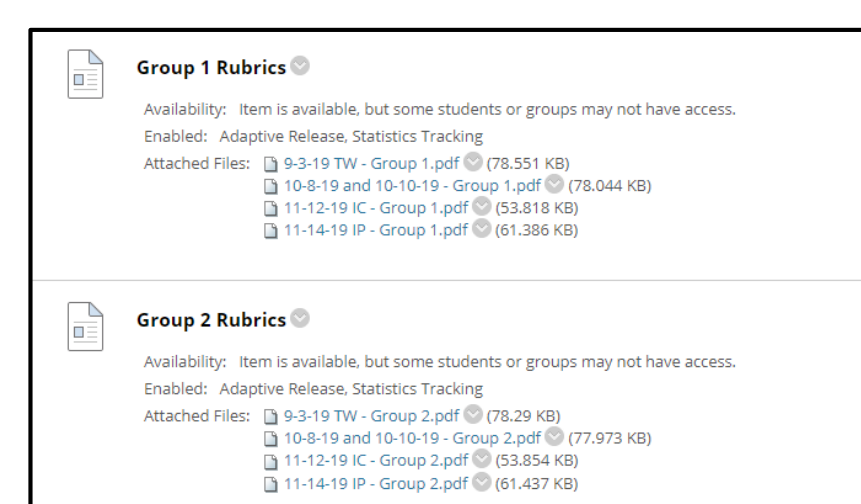
- Gradescope allowed us to connect process skills to course content



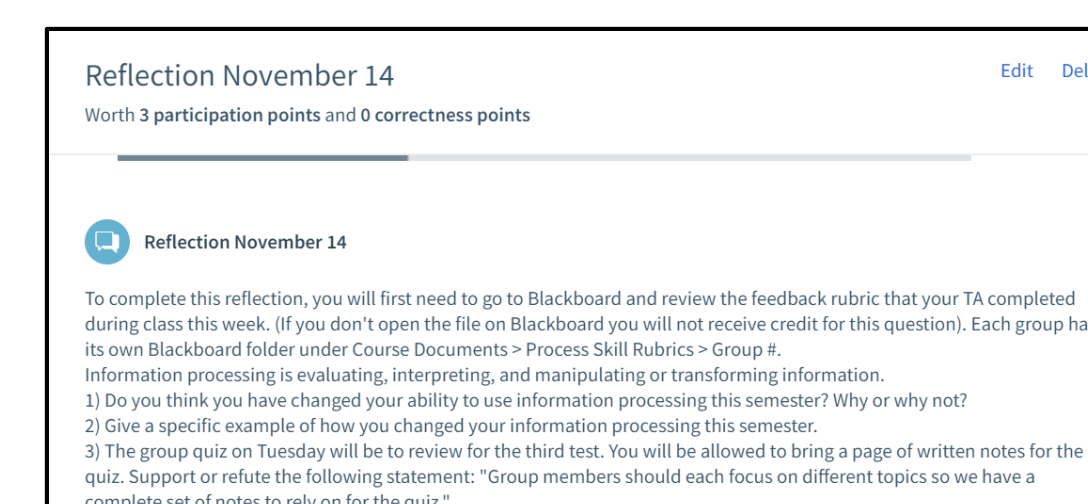
- Teaching assistants used Google Drive to fill out the rubrics
- PDF versions of the scored rubrics were uploaded to Blackboard, in order to track how often (or if) students viewed the rubrics
- Students submitted reflections about the rubrics and scoring of the rubrics on TopHat



TAs filled out rubrics on Google Drive



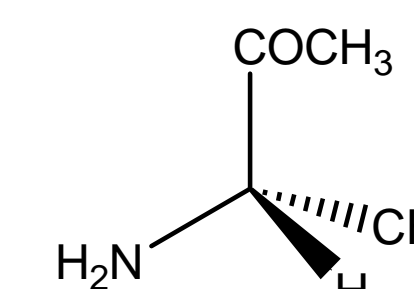
Students viewed the rubrics on Blackboard



Students reflected on the feedback on TopHat

Relating Process to Content During Class

Information Processing
Evaluate: what info is present
Interpret: what does it mean
Transform: convert to another form if necessary

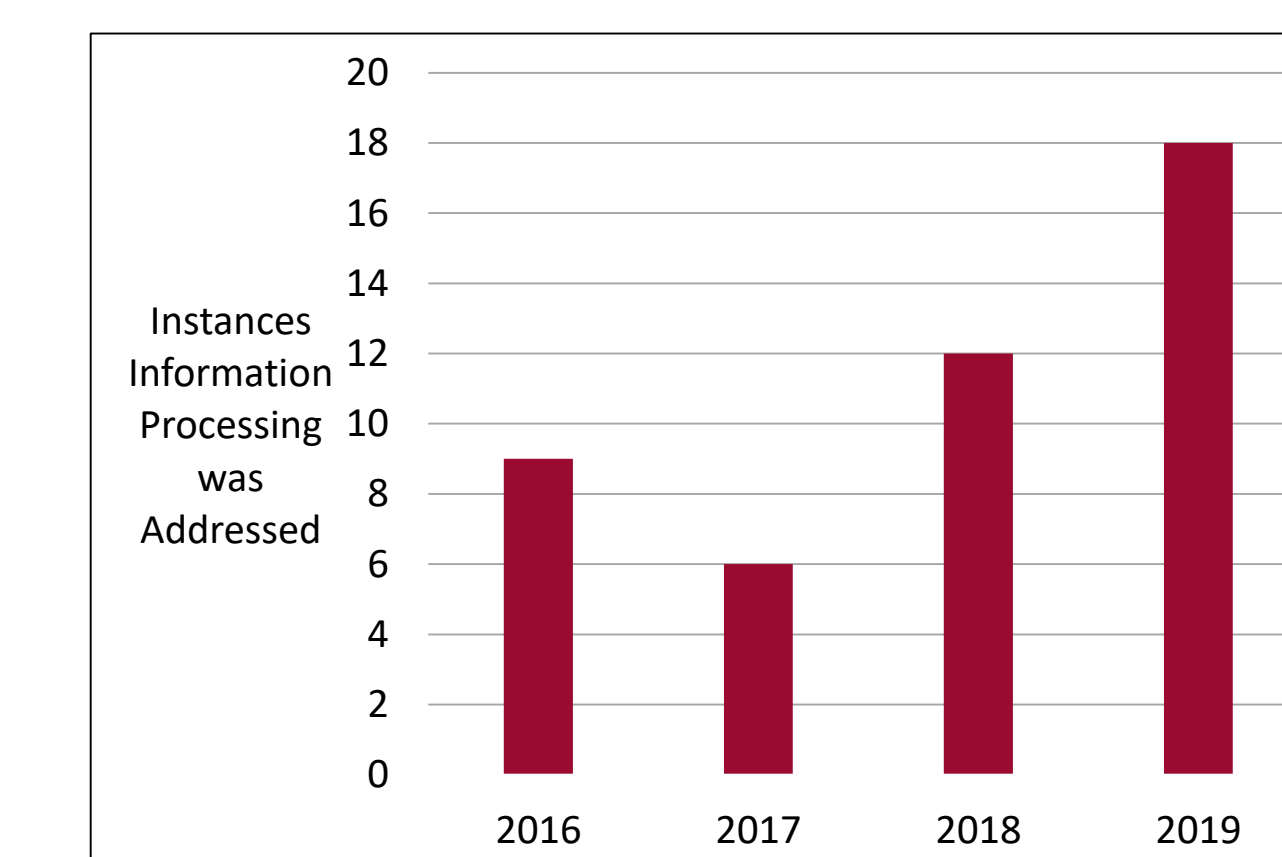
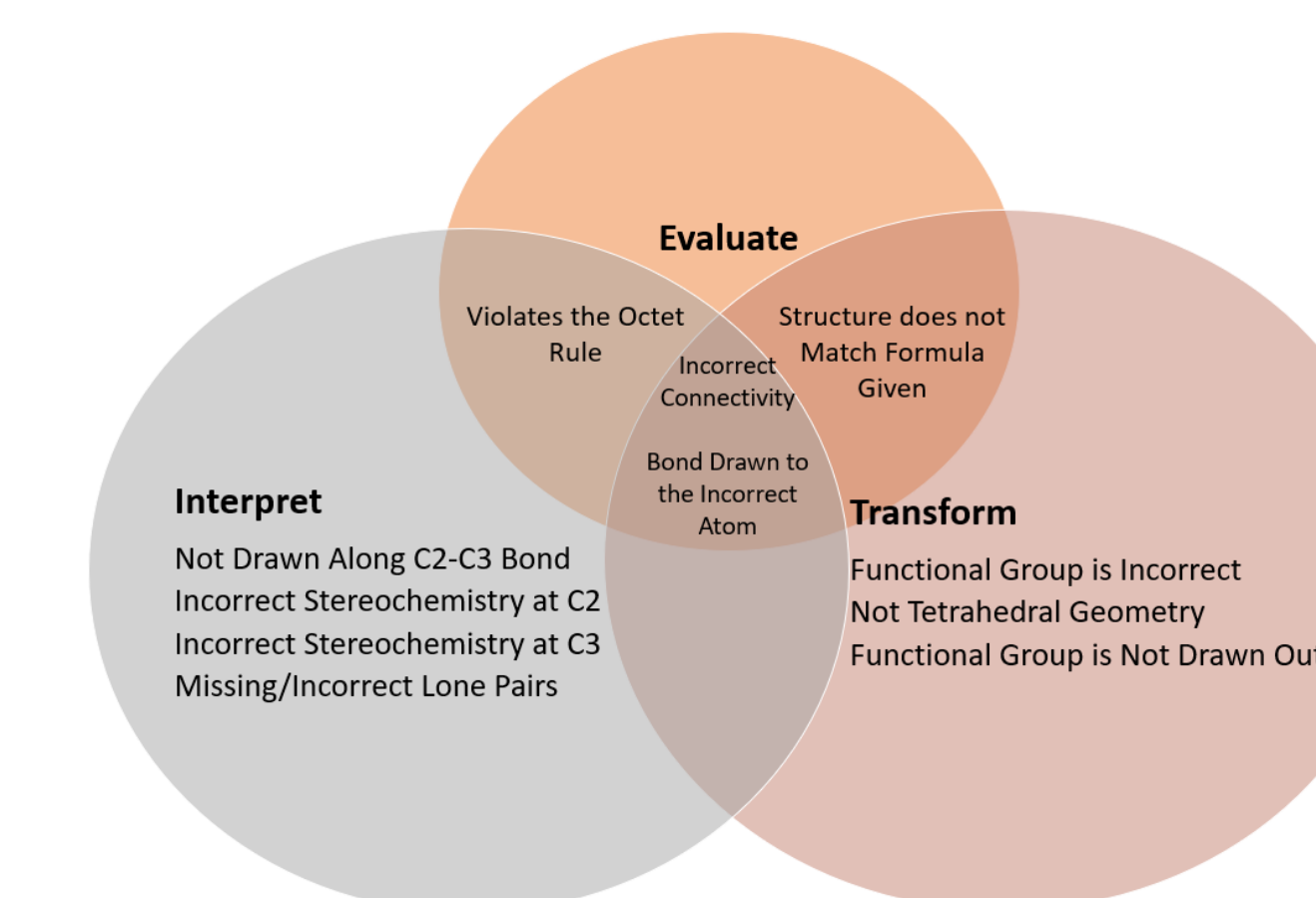


The instructor used terms from the information processing rubrics when doing a content example in class. The process of how the information was evaluated, interpreted and transformed was outlined when going over this example.

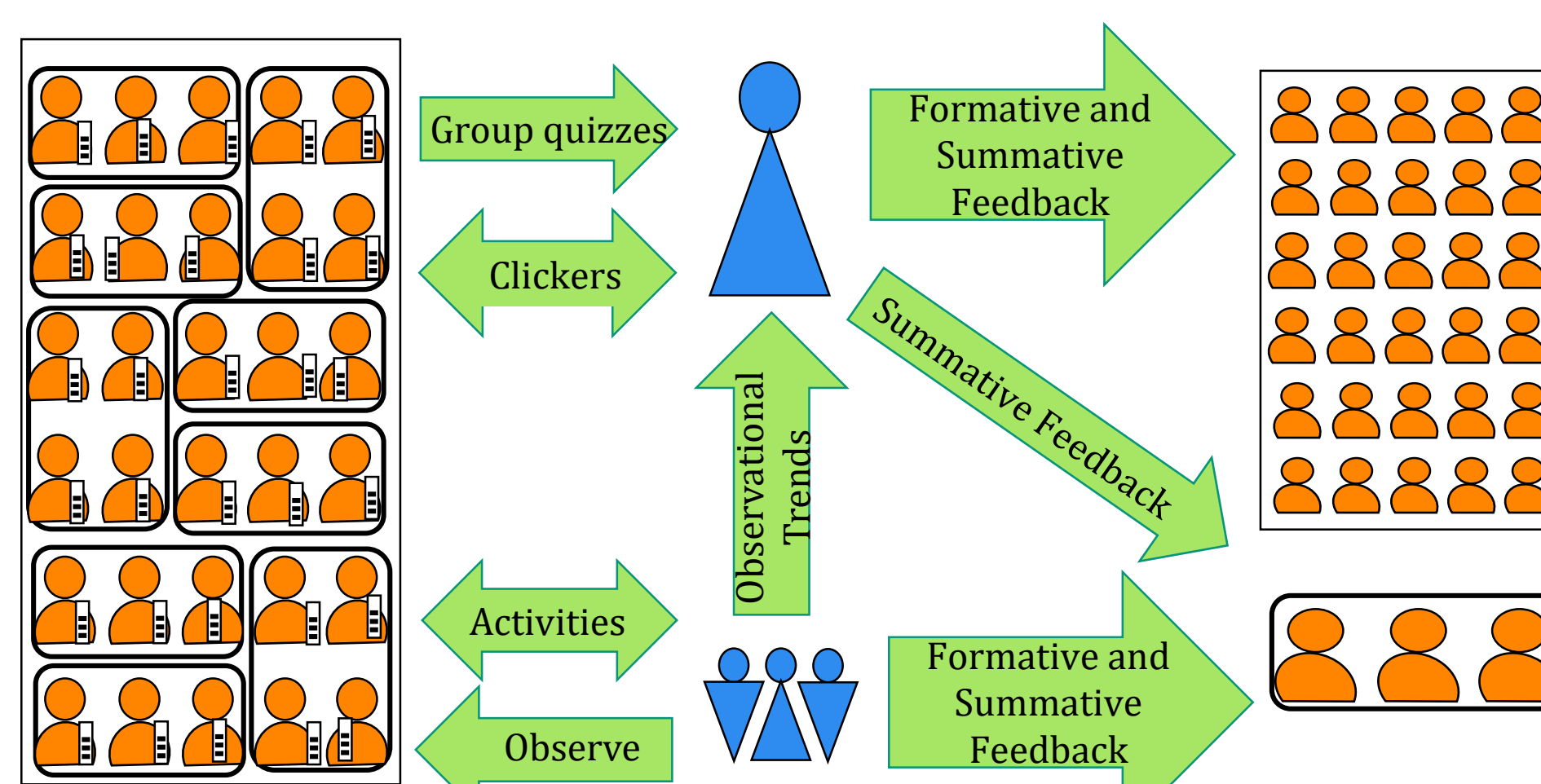
Data was collected on the errors students made on the problem below, given three times a semester.

1. (7 pts) Draw the 2R, 3R isomer of $\text{CH}_2(\text{OH})\text{CCH}_3\text{C}(\text{OH})\text{CN}$ in the following formats: (Note: the carbon on the CN group is numbered 1)

Errors were classified with respect to the three categories of information processing.



The Role of Teaching Assistants in Providing Feedback



Undergraduate teaching assistants (TAs) in a large class are critical in providing feedback to students both on content and process.

- TAs were assigned to 4-5 groups to facilitate learning and assess process skills.
- TAs interacted with their teams during POGIL activity work, clicker questions and group quizzes.
- TAs completed feedback rubrics during in-class team work.
- Overall the TAs were positive about the feedback rubrics, compared to the analytic rubrics as shown in the comments here.

"...for a lot of the more abstract concepts like IP and CT it helped to contextualize them by assigning certain behaviors to them." - TA Reflection

"The list of observed behaviors...became a great guide to introduce me to the style of learning and teamwork that I should be aiming for my students to exhibit during class." - TA Reflection

"I honestly enjoyed being able to just go back to the rubric after class though and write meaningful, non-rushed comments." - TA reflection

"...the suggestions for improvement definitely helped me better identify areas that each group was struggling with and formulate feedback that represented the goals of each process skill. With the original rubrics, I felt that I was making more general statements that weren't necessarily aligned with the specific skills being assessed" - TA Reflection

Acknowledgments

We thank our Primary Collaboration Team for valuable input during development of the feedback rubrics. Thanks also to students and TAs who allowed us to examine their work and reflections on using the rubrics and receiving feedback. Finally, we thank the National Science Foundation for the funding of this project.

IUSE Collaborative grant:
#1524965
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#1524399



Feedback Rubrics Developed to Give Explicit Feedback on Process Skills

This is an example of one category from the information processing rubric

Category	Ratings	Observable Characteristics
Manipulating or Transforming	Converted information/data from one form to another.	Converted relevant information into a different form.
	Converted information into an appropriate form.	Converted information into an appropriate form.
	Explained the process behind the transformation.	Explained the process behind the transformation.
	Other:	Other:

Observable characteristics provide the rater with easily identifiable behaviors that they can utilize to make an accurate rating.

Suggestions for improvement provide actionable feedback for students and guidance for more detailed, content relevant feedback.

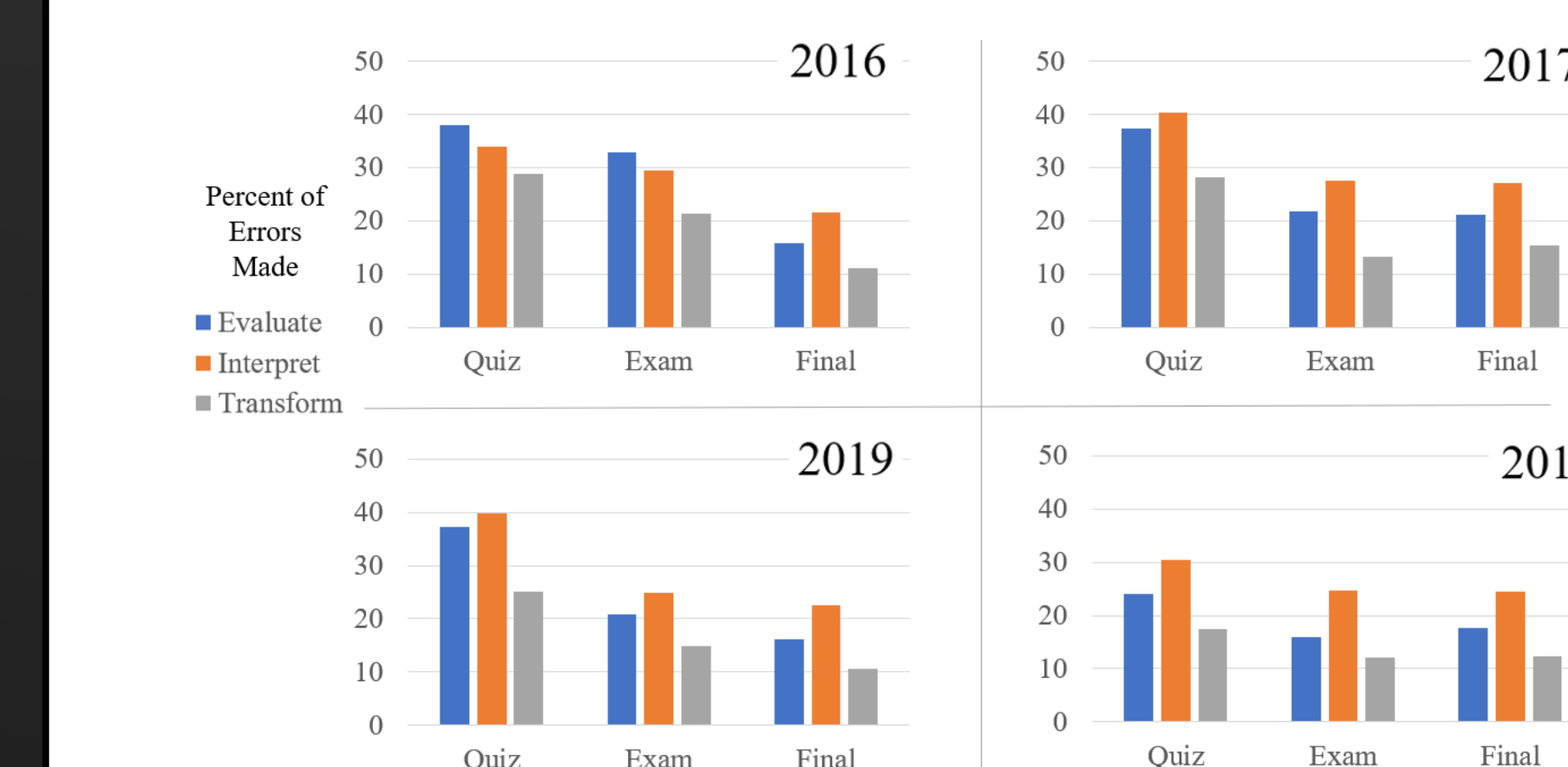
Comments section allows raters to provide more detailed feedback, often related to the specific task.

Setting and Methods to Provide Feedback

Organic Chemistry Classroom	
Instructor, Pedagogy	POGIL 15+ years experience
Institution	Urban, Public R1
Student demographic	STEM, pre-health, 2nd and 3rd years
Class size	180-240
Class time	Twice weekly for 75 min
Classroom Layout	Fixed tiered, lecture hall
Teaching Assistants	9-12 per semester
Clickers	3-6 times per class
Teams	Self assigned, fixed groups to 3-4 students

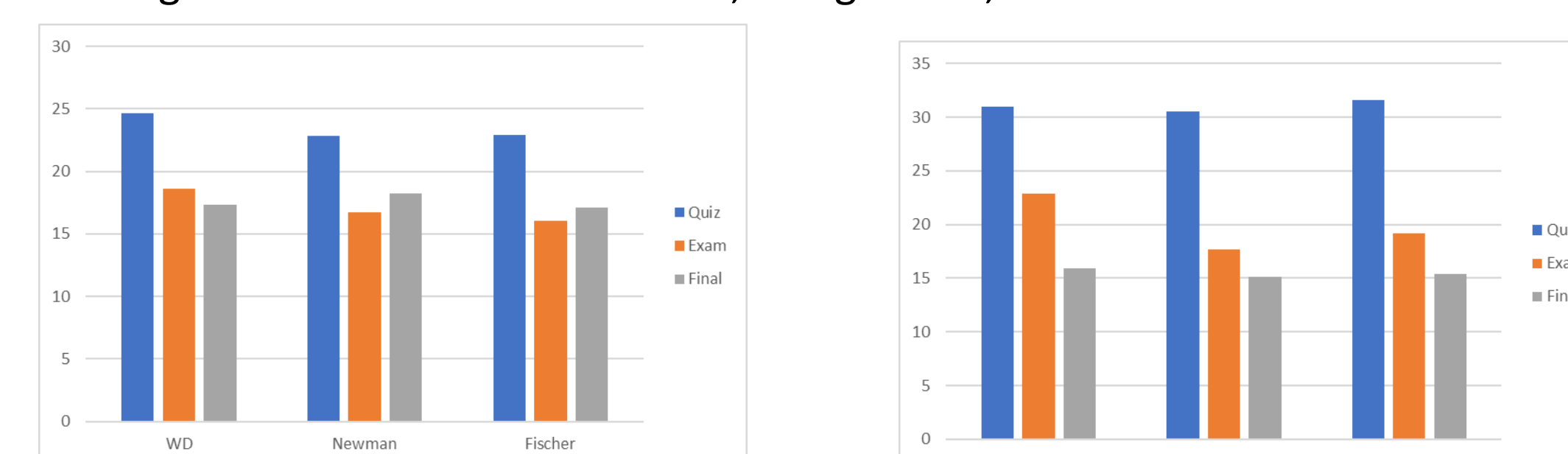
Targeted feedback is important for improvement in performance

- Explicit Feedback
 - Homework assignments (graded)
 - In-class questions
 - Quiz and exam scores
- Implicit feedback
 - Comments in class on what's important
 - Content covered in class and on assessments
 - Topics of student reflections



Type of errors based on information processing. Interpret errors are generally the most predominant.

Percentage of errors for each structure; wedge-dash, Newman and Fischer.



2018: Gradescope used for quiz only

2019: Gradescope used for quiz and exam and more implicit feedback in class provided

Improvement (decrease in number of errors) is greatest in 2019, when there was more attention to feedback.

Conclusions

- Feedback rubrics provide students with actionable items to improve their process skills.
- Feedback rubrics help TA easily identify behaviors associated with process skills.
- TA were instrumental in facilitating and giving feedback in the large classroom.
- Gradescope provides a means to give students feedback on both content and process.
- Interpret errors were the greatest on problems rich with information processing.
- With increased feedback the total number of errors decreased (2019).