Report from the Quantitative Literacy Professional Learning Community (PLC) 2016-17

Prepared by the QL PLC (Breeann Flesch, Chair; Sue Monahan, Administrative Support)

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What is Quantitative Literacy?

Quantitative Literacy (QL) is "a 'habit of mind' competency, and comfort in working with numerical data. Individuals with strong QL skills possess the ability to reason and solve quantitative problems from a wide array of authentic contexts and everyday life situations. They understand and can create sophisticated arguments supported by quantitative evidence and they can clearly communicate those arguments in a variety of formats (using words, tables, graphs, mathematical equations, algorithms, etc., as appropriate)" (American Association of Colleges & Universities).

QL encompasses six features:

- Interpretation – Ability to explain information in mathematical forms (e.g., equations, graphs, diagrams, tables, words)
- Representation – Ability to convert relevant information into various mathematical forms (e.g., equations, graphs, diagrams, tables, words)
- Calculation
- Application/Analysis – Ability to make judgments and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limitations of this analysis
- Assumptions – Ability to make and evaluate important assumptions in estimation, modeling and data analysis
- Communication – Expressing quantitative evidence in support of the argument or purpose of the work (in terms of what evidence is and how it is formatted, presented, and contextualized)

What is a PLC?

A professional learning community (PLC) is an interdisciplinary group of educators who come together around a common interest in strengthening teaching and learning in a particular area. WOU's university-wide assessment efforts are organized around PLC's that focus on each of our ULO's.

Table 1: QL PLC members

Educator	Department	Role on PLC
Breeann Flesch	Mathematics	Chair
Kendall Rosales	Mathematics	Member
Matt Nabity	Mathematics	Member
Ethan McMahan	Psychology	Member
John Leadley	Economics	Member
Vivian Djokotoe	Criminal Justice	Member
Kristin Latham	Biology	Member
Melinda Shimizu	Earth Science	Member

Bob Hautala	Exercise Science	Member
Dan Clark	Center for Academic Innovation	Contributing supporter
Sue Monahan	Provost's Office	Contributing supporter

What were the goals of the PLC?

The QL PLC convened with three goals in mind:

- *Alignment and assessment*: Examine the level of WOU undergraduate quantitative literacy by collaboratively reviewing student work in courses aligned with the Quantitative Literacy outcome. In its first consideration of our curriculum and its support of QL, the PLC considered these broad questions:
    - What opportunities do we provide WOU students to demonstrate quantitative literacy and its component parts?
    - What level of achievement do faculty who teach quantitative literacy courses expect of students?
    - Do students meet faculty expectations?

- *Curricular innovation and collaboration*: As an interdisciplinary group, develop, pilot and assess a new college mathematics course to satisfy BS requirements and serve students in natural sciences, social sciences and pre-professional fields who will not take calculus.

- *PLC Process Design and Refinement*: Pilot the PLC process for the assessment of undergraduate learning outcomes.

What process did the PLC use to achieve its goals?

The PLC met approximately once per month from July 2016 through June 2017.

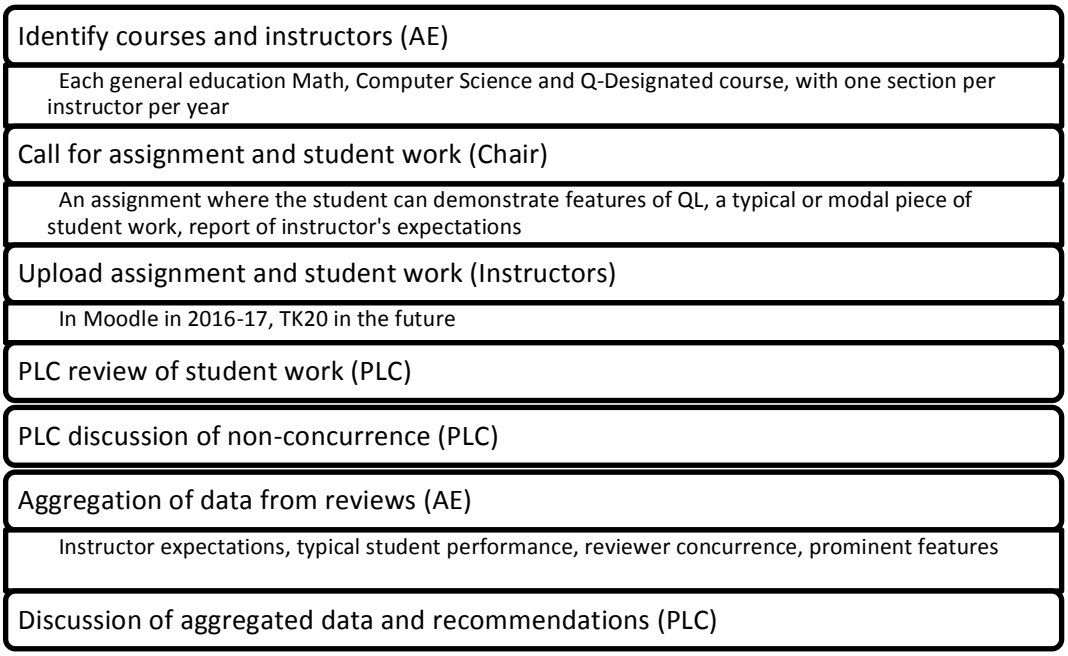
- The group pursued "alignment and assessment" by collecting and reviewing a sample of student work from each section of general education math, computer science and Q-designated courses. Review of student work was collaborative: Multiple members of the PLC reviewed each piece of work, scored the student's level of achievement and its alignment with the expectations instructors reported, and discussed any problematic cases. The review of student work resulted in robust conversations about each aspect of quantitative literacy and what it looks like in student work across a variety of disciplines.

- The group pursued "curricular innovation and collaboration" by advising Dr. Breeann Flesch as she designed and piloted a new course, "Applied College

Mathematics" (MTH 110), to satisfy the BS Mathematics requirement. The course was designed to serve the quantitative literacy needs of students in the natural sciences, social sciences and pre-professional fields who will continue on to study statistics rather than calculus.

- The group pursued "PLC process design and refinement" through regular assessment of PLC processes, feedback from members, and adjustments to processes. Through recursive feedback, the group (1) developed a process of reviewing a "typical" piece of student work (identified by the instructor) alongside the instructor's report of expectations, (2) refined a scoring sheet with course information that facilitated review, and (3) developed a mechanism for collecting student work from faculty. (See Figure 1 for summary of current PLC process.)

Figure 1: Current State of the PLC review process (Who is responsible)



Quantitative Literacy at WOU

Expectations of Students

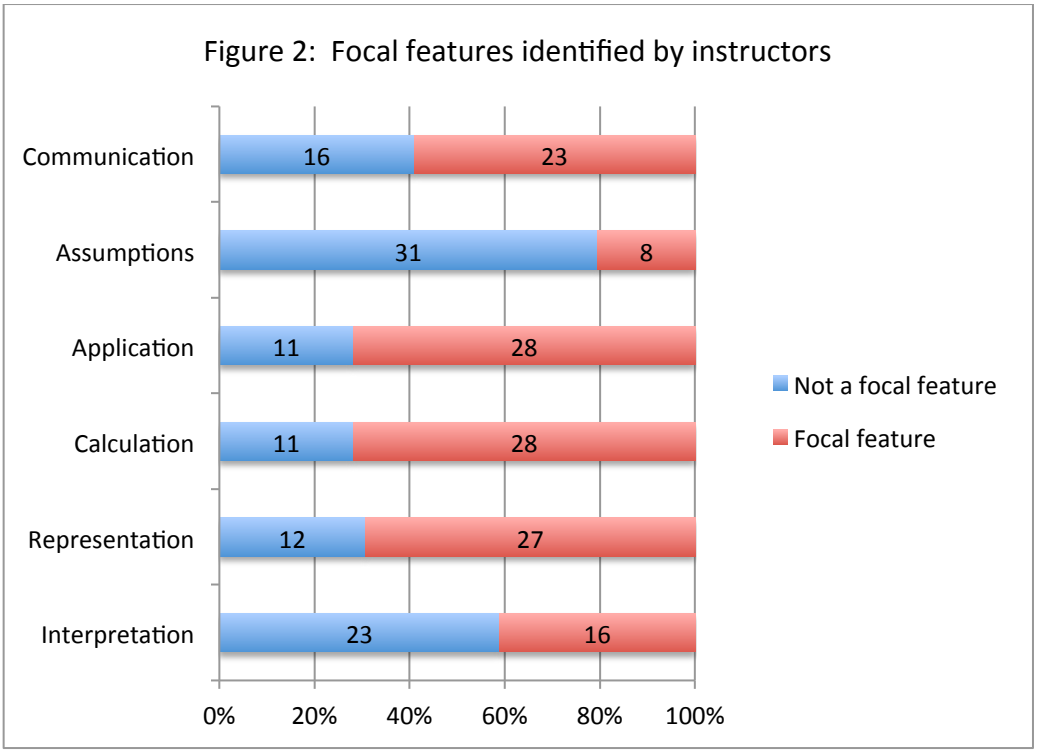
WOU has identified QL as a focal Undergraduate Learning Outcome (ULO). In 2015-16, in a project led by a mathematics faculty member, WOU's faculty identified desired levels of achievement in QL for our students, by degree. Those targets are summarized in Table 2 below.

Table 2: Faculty consensus on expected level of performance for features of QL

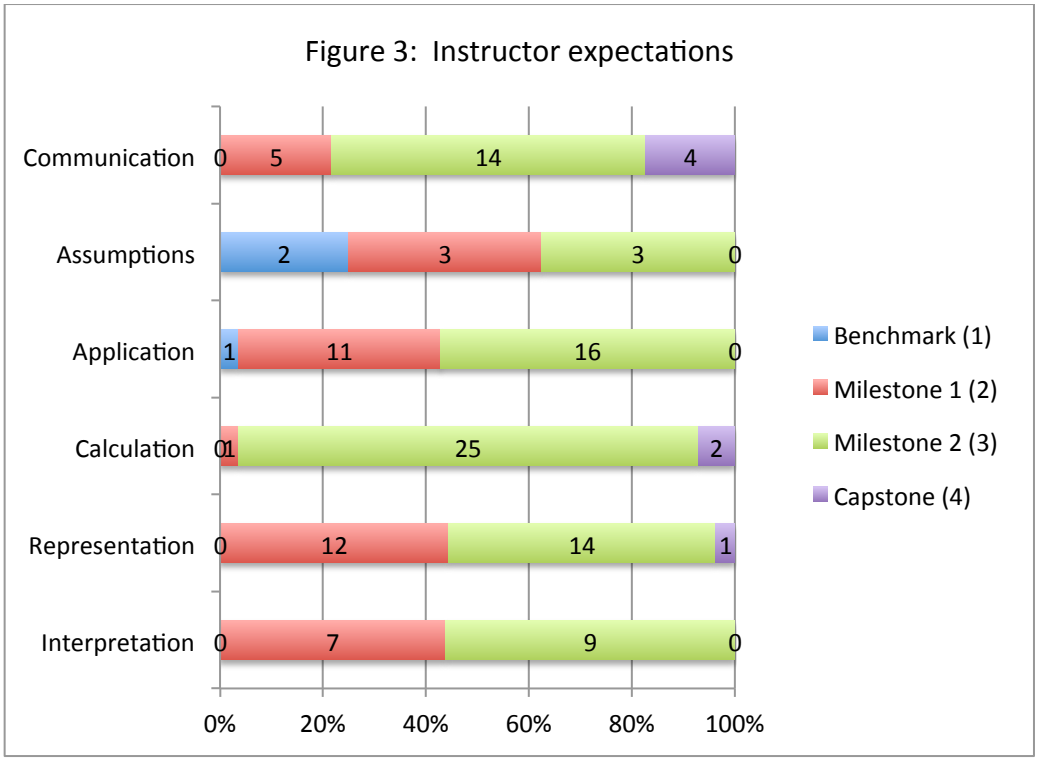
	BA	BS
Interpretation	3: Provides accurate explanations of information presented in mathematical forms. *For instance, accurately explains the trend data shown in a graph.*	4: Provides accurate explanations of information presented in mathematical forms. Makes appropriate inferences based on that information. *For example, accurately explains the trend data shown in a graph and makes reasonable predictions regarding what the data suggest about future events.*
Representation	2: Completes conversion of information but resulting mathematical portrayal is only partially appropriate or accurate.	3: Competently converts relevant information into an appropriate and desired mathematical portrayal.
Calculation	3: Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem.	3: Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem.
Application/Analysis	2: Uses the quantitative analysis of data as the basis for workmanlike (without inspiration or nuance, ordinary) judgments, drawing plausible conclusions from this work.	3: Uses the quantitative analysis of data as the basis for competent judgments, drawing reasonable and appropriately qualified conclusions from this work.
Assumptions	2: Explicitly describes assumptions.	3: Explicitly describes assumptions and provides compelling rationale for why assumptions are appropriate.
Communication	3: Uses quantitative information in connection with the argument or purpose of the work, though data may be presented in a less than completely effective format or some parts of the explication may be uneven.	3: Uses quantitative information in connection with the argument or purpose of the work, though data may be presented in a less than completely effective format or some parts of the explication may be uneven.

In total, the group had time to review 39 assignments. We included one piece of student work from each course from which we received submissions, but in the case of multiple instructors using a common assignment, we typically only reviewed work from one instructor.

Focal features of QL: We found that a typical assignment allowed students to demonstrate between two and four features of quantitative literacy. Please note that the group did not expect any one assignment to cover all features of quantitative literacy: Early in our PLC process we piloted review with sample assignments from PLC members' courses, and it became clear that it was the rare assignment that could effectively cover all aspects of Quantitative Literacy. Figure 2 summarizes the frequency with which *instructors* identified each feature as a focal feature of the assignment; this tells us what instructors believe students are being given the opportunity to demonstrate. Assumptions and interpretation were *least* likely to be identified as focal features by instructors.



Instructor expectations: We asked instructors to share with us *their* expectations of student performance on the assignment. Findings are summarized in Figure 3. Instructors had the highest expectations regarding "calculation" and "communication". With the exception of "assumptions", at least 50% of instructors who identified a feature as focal expected students to have achieved at level three or higher.



As noted earlier, in 2015-16 WOU faculty came to consensus on expected levels of achievement in Quantitative Literacy among WOU students upon graduation. To examine the concurrence between those expectations and the expectations of individual instructors, we examined the 300-400 level courses in disciplines (Q-designated and/or QL focused courses) and computed the *mean* instructor expectation for each feature. We selected these courses because they are designed to be taken later in a student's academic program, closer to the time of graduation.

Based on this, we found that instructor expectations in our upper division Q-designated courses in the disciplines align with campus-wide faculty expectations for BS students upon graduation for the following features: Representation, Calculation, Application/Analysis, Assumptions (see Table 3). On average, however, instructor expectations for Interpretation and Communication fall below the more general faculty expectations. Please note that assignments did not typically address *all* of the features of Quantitative Literacy. As a result, this data reflects those features where students had an opportunity to demonstrate the skill. Each assignment also left some skills un-assessed.

Table 3: Faculty consensus on target vs. instructor's stated expectations (n=12)

	BS	Mean expectation in 300-400 level courses in disciplines
Interpretation	4: Provides accurate explanations of information presented in mathematical forms. Makes appropriate inferences based on that information. *For example, accurately explains the trend data shown in a graph and makes reasonable predictions regarding what the data suggest about future events.*	2.6
Representation	3: Competently converts relevant information into an appropriate and desired mathematical portrayal.	3
Calculation	3: Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem.	3
Application/Analysis	3: Uses the quantitative analysis of data as the basis for competent judgments, drawing reasonable and appropriately qualified conclusions from this work.	3
Assumptions	3: Explicitly describes assumptions and provides compelling rationale for why assumptions are appropriate.	3
Communication	3: Uses quantitative information in connection with the argument or purpose of the work, though data may be presented in a less than completely effective format or some parts of the explication may be uneven.	2.5

Student achievement relative to instructor expectations: In approximately two-thirds of the assignments, instructors reported that students met or exceeded their expectations (see Table 4). Because of the way we collected this information at the beginning of our process, we are unable to say *where* students most commonly fell short. We have fixed this flaw in our data collection and review process, and should be able to collect and analyze this data going forward.

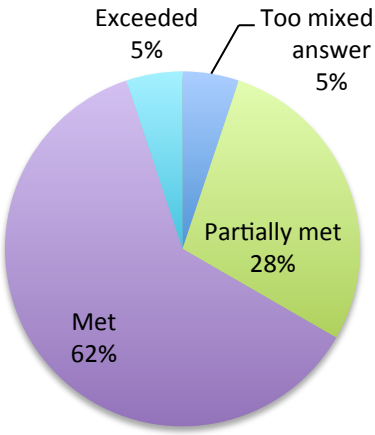
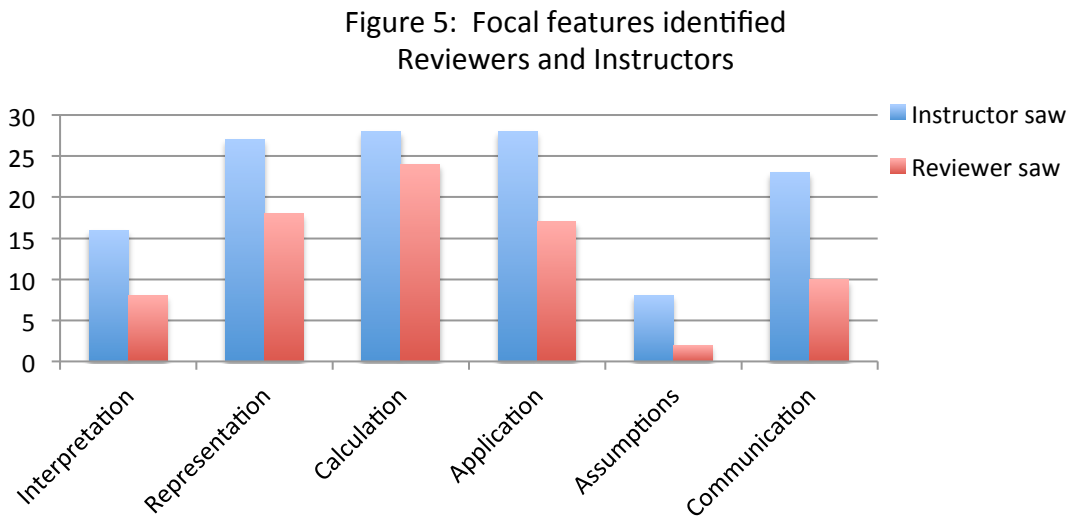


Figure 4: Student performance, relative to instructor expectations

Reviewer concurrence with instructors: Instructors and reviewers were asked to identify the most prominent features of the assignments. Reviewers were more likely to follow the instruction to identify just the two most prominent features, while instructors sometimes identified more. In all, however, we found fairly strong concurrence between instructors and reviewers about the features of QL that students had the opportunity to demonstrate.



Recommendations related to Quantitative Literacy for the General Education Committee, the Assessment Facilitation Steering Committee and the broader WOU community

- The strongest examples of quantitative literacy were deeply rooted in real world examples. We encourage providing students with even more opportunities to connect quantitative literacy with meaningful contexts.

- We encourage further development of high quality disciplinary courses where students have the opportunity to demonstrate quantitative literacy. The assignments and student work in Q-designated courses were impressive examples of quantitative literacy applied to real world contexts.

- More focus in QL-courses on assumptions, interpretation and communication may be warranted given the paucity of examples of assumptions in assignments and student work, and the divergence between overall WOU faculty expectations regarding Quantitative Literacy and individual instructor expectations of students.

- We suggest that the Mathematics Department review the pre-requisite structure for MTH 111 and MTH 243. Most Q-designated courses drew more heavily on material from MTH 243 rather MTH 111. We wonder if it might be possible to encourage more students to take MTH 243 or to take it *earlier* (perhaps by reconsidering having MTH 111 as a pre-requisite for MTH 243)

Recommendations related to PLC Process for Assessment of ULO's

- We found a process where instructors submit *one* assignment with *one* piece of typical student work, along with a report of the instructor's expectations, to be sufficient. That said, when multiple features of QL were in an assignment, it was sometimes hard to identify a single piece of student work; in those cases, typical work on a feature, from multiple students, worked better.

- In the future, it would be helpful to have instructors indicate, on the student work, the features they believe are prominent. This allows the PLC to more easily see from the perspective of the instructor.

- Once a PLC has a good sense of a skill and its components, it is recommended that they communicate with instructors about expectations for assignments (e.g., how many features of the skill are expected to be covered by the assignment).

- We recommend retaining a process for “opting out” of review, when the material to be reviewed is too far outside the expertise of the reviewer for the reviewer to feel comfortable reviewing.

- We found the process of focusing discussion on assignments where there was confusion or a lack of concurrence to be a productive use of time.

- The process of submitting the work electronically worked well for submitters and reviewers. Moving to electronic review of the work would facilitate data aggregation and reporting, however.