Q-core Assessment Report

Course: M 273Q, Multivariable Calculus
Section assessed: M 273-003
Semester: Spring 2017
Instructor(s) and/or supervisor: Christina Hayes and Jaroslaw Kwapisz
Assessment done by (2 faculty members): Christina Hayes and Jaroslaw Kwapisz

Number of students in the course: 769 students in 21 sections took M 273 in AY 2016-2017. One section of these 21 was chosen as a representative sample.
Number of students assessed (at least 6): 34

Problems on the final exam were used to determine if the learning outcomes were demonstrated at an acceptable or unacceptable level. The description of the signature problem is listed below next to each learning outcome.

Learning Outcome 1: *Interpret and draw inferences from mathematical or statistical models represented as formulas, graphs, or tables*.
Problem 2 on the final exam. Two contour maps are shown. One is for a function whose graph is a cone. The other is for the function whose graph is a paraboloid. Students are asked to identify which of the two is the contour map of the cone.

- Total number of assignments assessed: 34
- Number of student assignments demonstrating the learning outcome at an acceptable level, as defined in the *Q-core Rationale and Assessment Plan* : 32
- Proportion of assignments rated as "acceptable": 32/34

- Is this over the specified threshold of 2/3?

- Yes, 94% of the students were successful in identifying the contour map of the cone. The material in multivariable calculus is heavily tied to geometry in 3D. It is very reassuring that such a high percentage of students is correctly able to read and interpret graphs.

- Comments and ideas for improving the process of assessment: Nearly all students were able to identify the contour map of the cone. This shows an ability to understand what shape in 3D corresponds to its 2D contour map. In terms of multivariable calculus assessment it is more interesting to see how many students are then able to take that knowledge and use it to critically problem solve. For future assessment of understanding of the method of Lagrange multipliers, for example, one could write a problem that ties contour maps to solving Euler-Lagrange equations, so that it is seen as less algorithmic by the students.

Learning Outcome 2: *Represent mathematical or statistical information numerically and visually.*
Problem 3 on the final exam. Students are told that a solid object occupies a region inside a given cone, but between two given spheres. (One could imagine a "circular" chunk of rind only of a watermelon). They are asked to rewrite a triple integral over the described region in the spherical coordinate system.

- Total number of assignments assessed: 34

- Number of assignments demonstrating the learning outcome at an acceptable level, as defined in the *Q-core Rationale and Assessment Plan* : 32
- Proportion of assignments rated as "acceptable": 32/34

- Is this over the specified threshold of 2/3? Yes, 94%

- Comments and ideas for better aligning the course or the assignments with the Q-core rationale: The course is most definitely aligned with the Q-core rationale as almost all problems in multivariable calculus require relating visual and numerical representations of mathematical problems.

- Comments and ideas for improving the process of assessment:

Learning Outcome 3: *Employ quantitative methods such as arithmetic, algebra, geometry, or statistical inference to solve problems*

Problem 11 on the final exam. Students are given a vector field and asked to use the Divergence Theorem to evaluate its surface integral over a region. To do so, students are given a solid and must identify the surface of the solid and then correctly apply the theorem.

- Total number of assignments assessed: 34

- Number of assignments demonstrating the learning outcome at an acceptable level, as defined in the *Q-core Rationale and Assessment Plan* : 26

- Proportion of assignments rated as "acceptable": 26/34

- Is this over the specified threshold of 2/3? Yes, 77%

- Comments and ideas for better aligning the course or the assignments with the Q-core rationale: Multivariable Calculus is a course very much aligned with the Q-core rationale. Students who did not perform at the "acceptable" level were generally able to calculate divergence, but confused/transposed the dimensions of the box with the correct axes, or were not able to relate the flux to a triple integral at all. The 77% acceptable performance score (lower than the other percentages in this report) is likely a reflection of the level of difficulty of the question. The Divergence Theorem belongs to the notoriously difficult part of the material covered at the tail end of the course. That 77% of students were able to use the theorem at an acceptable level is not only acceptable, but a result we are quite pleased with.