The Effect of Homework Quantity on Student Outcome Quality as Determined by Average Final Course Grade in CHEM 121 Spring 2017-Fall 2019

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In Partial Fulfillment of

Accreditation Mandated Assessment
Institutionally Mandated Assessment
Annual Faculty Plan 2019-2020
Annual Faculty Self Evaluation 2019-2020

On

17 January 2019

A Rapid Communication

In the course of reviewing the previous six (6) semesters' (Spring 2017 through Fall 2019) worth of CHEM 121 student grades (i.e., course outcomes as measured by final average course grades), it was observed that, while each group of students was not statistically different from the other five (5) groups, or from the average, there was some sort of non-obvious pattern.
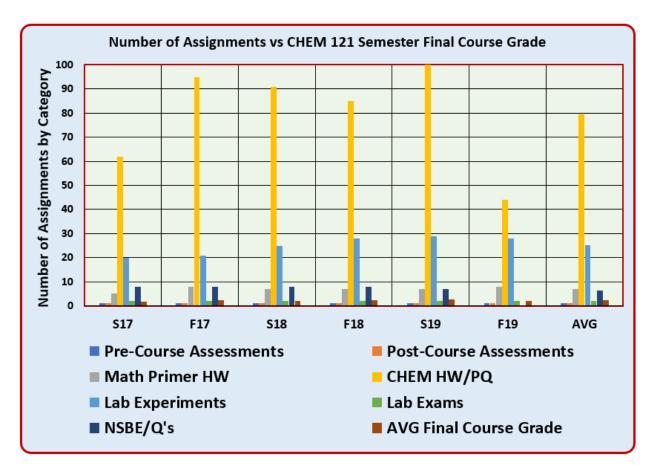
After considering all the possibilities, a number of potential criteria were qualitatively examined. The conceivable criteria included "flipped classes", "hybrid flipped classes", traditionally lectured courses, as well as length of course (8 weeks' accelerated and 16 weeks' traditional). In addition, the number of assignments, be they exams, worksheets, quizzes, lab experiments, were also taken into consideration.

"Flipped classes" were classes where students did the reading, did the homework and demonstrated their work on the board. All of the "flipped classes" were 16 weeks in duration.

"Hybrid flipped classes" were classes where some supplemental lecturing was provided to assist with student clarity, although the majority of the course remained "flipped". These "hybrid flipped classes" were 16 weeks in duration.
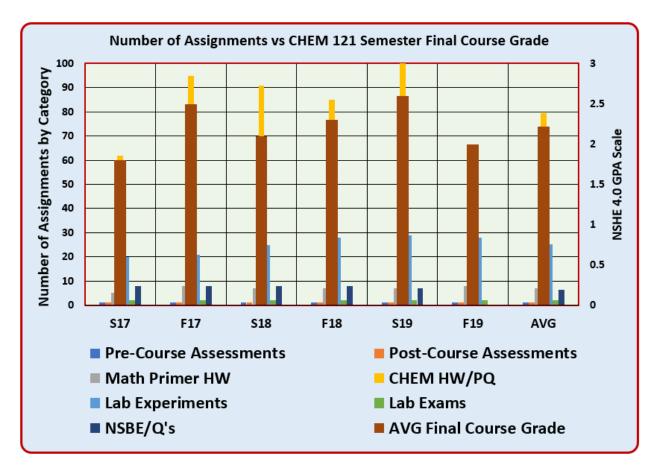
Traditionally lectured courses were accomplished per faculty-based lectures to students. At this time, the only section of CHEM 121 to be traditionally lectured in the group was offered in Fall 2019: at the time of this writing, CHEM 121 has been taught once (Fall 2019) using the accelerated, 8 week long, approach. Concurrently, the class consisted of re-structured lectures in an attempt to render the content in a more cohesive, flowing, more conducive-to-learning manner. The remaining five (5) semesters' CHEM 121 courses were taught over the traditional 16 weeks.

In Fall 2019, simply because CHEM 121 was being offered for the first time as an 8 week long course, the number of assignments were adjusted in an attempt to make the work "more reasonable" and palatable for a short-term course. As a result, the absolute numbers of assignments were manually obtained and plotted as below:
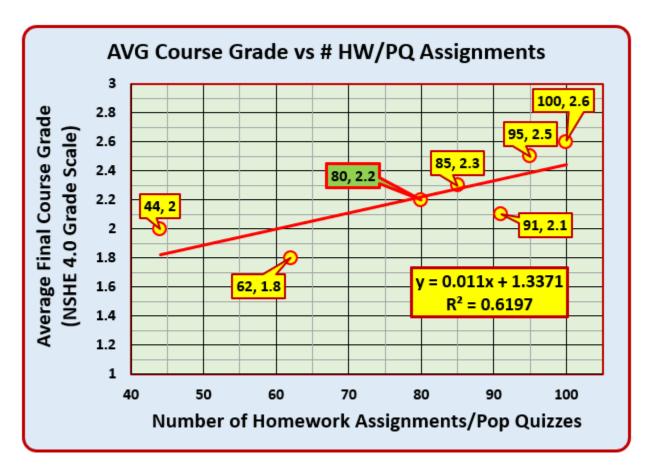

Clearly, in the image, above, the one item that stands out is the number of homework and pop quiz assignments (HW/PQ): they dominate the graphic. As a result of the HW/PQ domination, it was obvious that the data had to be presented differently. Because the Pre-/Post-course Assessments, Math Primer HW, Lab Experiments, Lab Exams and NSBE/Q's were, for all practical

purposes, constant, that suggested that the one parameter that could be useful to "isolate" is the average final course grade in CHEM 121 from each semester. This "isolation" is demonstrated, below:

With the exception of the data for F19, it's clear that students' average final grades followed the number of HW/PQ assignments in some manner. While it's obliterated, the number of F19 HW/PQ assignments still went the same direction as the average class grade (down).

As a result, the average final CHEM 121 course grades were plotted against the absolute numbers of HW/PQ assignments with the following results:

The call-out tags per each data point are in the order of **#HW/PQ Assignments**, **Average Final Course Grade** (using the NSHE 4.0 grading scale), e.g., **100, 2.6** means 100 HW/PQ assignments and an average final course grade of 2.6 (in reality, it's just shy of a B-).

While the data is presented as correlative, by far, this is the best correlation of assessment data that the author has obtained. Even if one ignored the R^2 value of 0.6197, it's quite clear from this data that, overall, the more homework that students have, the more likely they're studying more and learning the information better, on average. The call-out box outlined in red and filled with green is the average number of assignments (**80**) for students to hit an average final grade of almost a C+ (**2.2**).

While the biggest purpose/outcome of this study was to determine what to do in Spring 2020 with CHEM 121 regarding HW/PQ's, there were other outcomes, as well.

Outcome #1: F19 had the least number of assignments; when statistically compared to S17 (**62, 1.8**) the results (final average course grade) were no different. That's significant because F19 (**44, 2**) is the only 8 week data set available at this time. The remainder of data points are for 16-week courses, undifferentiated from "flipped courses" and "hybrid flipped courses".

Outcome #2: With the exception of the S19 class, all spring class average final grades are beneath the curve; S19 and every Fall section are above the curve. F17 and S19 have the highest overall average final grades and have the most amount of HW/PQ assignments.

Outcome #3: The final outcome is that, based on the data, in S20, the number of HW/PQ assignments will be increased to aid in/with student learning. Given the shorter class time (8 weeks), the increase will have to be carefully and wisely implemented.

Flesch-Kincaid 13.0; Flesch RE 43.7