Comparison of Pedagogical Approaches in a Pharmaceutical Calculations Course
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BACKGROUND
The need for pharmacy students to demonstrate competence in pharmaceutical calculations is clearly reflected in ACPE Standards 2016 Appendix 1; Area 2 of the NAPLEX competency statements; and section 2.7.3 of the PCOA content areas. Various pedagogical methods have been used to teach and assess this content area including live lecture and web-based instruction. These courses can also be traditionally scheduled or more self-directed in nature. Pharmaceutical calculations has been taught in standalone courses as well as integrated into other coursework. Importantly, assessment of calculation knowledge and skill should be longitudinal in nature as calculations is often taught early in the curriculum.

At the University of New Mexico, pharmaceutical calculations is taught as a stand alone course in the first semester. This course has been taught in three different ways with the goal of increasing the retention of the skill to accurately perform basic pharmaceutical calculations. Additionally, students are assessed in the spring semester of their P1, P2, and P3 year with a “Key Assessment” exam that they must pass with at least 80% in order to be allowed to progress to the IPPEs (after P1 and P2 years) or APPEs (after P3 year).

IMPLICATIONS
• Both short and long term retention of pharmaceutical calculation skills are important for a practicing pharmacist.
• The use of written exams (whether with online instruction or live lectures) promote the intermediate and longer-term retention of calculations skills
• The use of traditional live lectures (in combination with required homework) result in even higher performance both short-term and long-term.
• Colleges should consider the use of more traditional pedagogy to teach pharmacy students calculations

Table 1. Class performance (mean ± SD) on calculations Key Assessments

<table>
<thead>
<tr>
<th>Pedagogical Method</th>
<th>Immediate Retention (0 months)</th>
<th>Intermediate Retention (4 months)</th>
<th>Long-term Retention (16 months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online (n = 83)</td>
<td>88.9%±9.0%</td>
<td>82.1%±10.9%</td>
<td>78.3%±11.7%</td>
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<tr>
<td>Hybrid (n = 82)</td>
<td>89.8%±9.9%</td>
<td>88.8%±10.0%</td>
<td>86.1%±11.6%</td>
</tr>
<tr>
<td>Traditional (n = 82)</td>
<td>91.5%±6.5%</td>
<td>92.4%±8.4%</td>
<td>90.3%±7.4%</td>
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</table>

REFERENCES

METHODS
Over a three-year period, three different approaches were used in the instruction of a calculations course

**Online (n = 83):** No live lectures. Self-directed instruction provided by online PowerPoint modules. Assessment by 4 online exams with multiple attempts (high score counted) and a written final exam.

**Hybrid (n = 82):** No live lectures. Self-directed instruction provided by online PowerPoint modules. Assessment by 4 written exams and a written final exam.

**Traditional (n = 82):** Instruction provided by live lecture with required homework. Assessment by 4 written exams and a written final exam.

Students (N = 247) were assessed for their immediate (end of semester), intermediate (4 months) and long-term (16 months) retention using a 20 question written exam. Statistical analysis included an ANOVA with a Holm-Sidak multiple comparison procedure.

RESULTS
• There was no significant difference in immediate retention between the pedagogical methods.
• For intermediate retention, the students taught by both the hybrid and traditional methods demonstrated significantly (p<0.001) higher performance than the online method.
• The students taught by the traditional method also demonstrated significantly (p<0.05) higher performance than those taught by the hybrid method for intermediate retention.
• Similar results were found for long-term retention with traditional > hybrid > online.