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Utilizing Feedback in On-Line Quizzes to Improve Student Learning and Retention

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Utilizing Feedback in On-Line Quizzes to Improve Student Learning and Retention

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ABSTRACT
Written feedback was provided for on-line multiple-choice quizzes in a chemistry survey course in order to determine if student learning would be improved. Students could view the feedback (consisting of a detailed explanation/numerical solution) along with their score immediately after completing the quiz and then could choose to attempt the quiz a second time (same concepts, but different questions) to improve their score, knowing that if they took the second attempt that was the score they would receive for their grade. Analysis from five class sections show that on average 43.4 +/- 3.0% of students chose to repeat the quiz, and showed an average score improvement of 15.0 +/- 2.0%.

BACKGROUND
Studies have shown that performance on assignments is a better predictor of long-term learning than exams. In a chemistry survey course it is important to correct student mistakes/ misconceptions early on because the fundamentals are used throughout the course (and subsequent courses). One of the most powerful tools to helping students learn is feedback. In order for feedback to be effective, it must be delivered in a timely fashion while the material is still fresh and relevant to the course. The feedback is designed to immediately tell the student where they went wrong, to further develop their understanding through explanation and then give them an opportunity to demonstrate they have learned the material.

SAMPLE QUESTION 1
You have a clear solution of sugar water at 95°C. You cool it to 10°C and the solution stays clear after shaking. Which of the following is true?
A) The solution at 95°C was saturated
B) The solution at 95°C was unsaturated
C) The solution at 10°C is super-saturated
D) The solution at 10°C must be saturated
Feedback: When cooled, the solubility of a solid generally decreases, so if the solution at 95°C was saturated, as it cooled then less of the solid would be able to dissolve and crystals would form as it cooled (this did not happen because the solution remained clear). Therefore, the solution at 95°C must have been unsaturated. The solution at 10°C could not be super-saturated because you shook it, no crystals formed. There is no way to tell without further experimentation whether the solution at 10°C is saturated (contains the maximum possible amount of dissolved solute) or unsaturated (contains less than the maximum).

SAMPLE QUESTION 2
The pressure on a 500.0 mL gas sample changes from 760. mm Hg to 800. mm Hg. What is the new volume assuming all other factors remain constant?
A) 425 mL
B) 475 mL
C) 525 mL
D) 595 mL
Feedback: Boyle’s Law relates the pressure and volume of a gas keeping temperature and amount of gas constant. Pressure and volume are inversely related; if one goes up, the other goes down. \( P_1V_1 = P_2V_2 \) where \( P_1 = 760 \text{ mm Hg}, \ V_1 = 500.0 \text{ mL} \), \( P_2 = 800 \text{ mm Hg} \) so \( V_2 = \frac{760 \text{ mm Hg} \times 500.0 \text{ mL}}{800 \text{ mm Hg}} = \frac{V_2}{800 \text{ mm Hg}} \); \( V_2 = 475 \text{ mL} \).

AVERAGE QUIZ SCORES

<table>
<thead>
<tr>
<th>% Improvement</th>
<th>Scores (of 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.01%</td>
<td>18</td>
</tr>
<tr>
<td>14.04%</td>
<td>17</td>
</tr>
<tr>
<td>14.08%</td>
<td>16</td>
</tr>
<tr>
<td>14.12%</td>
<td>15</td>
</tr>
</tbody>
</table>

2nd ATTEMPT SCORE ANALYSIS

<table>
<thead>
<tr>
<th>% of students who chose a second attempt</th>
<th>Better</th>
<th>Average</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>42.5%</td>
<td>46.7%</td>
<td>40.2%</td>
<td></td>
</tr>
<tr>
<td>45.7%</td>
<td>47.5%</td>
<td>43.4%</td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSIONS
Those students making the second attempt (on average 43.4% of students) are using the feedback as a learning tool. This is evidenced by the fact that on average the re-takers are able to increase their scores by 15% over their first attempt. This indicates students who are having trouble with the material are the ones repeating the quiz, and are using the feedback to correct their mistakes and misconceptions. It is interesting to note that the second attempt average is still lower than the average from students only taking one attempt by about 7%.

The majority of the re-takers (about 70%) see an improvement in their score, while about 10% show no change in score and 20% show a decrease in score from the first attempt to the second attempt. This indicates that for the most part, students are using the feedback to improve their understanding and can then correct their mistakes on a second quiz attempt.

FUTURE WORK
Questions and feedback in the test bank will continue to be modified and improved upon for future classes as the feedback seems to be having the intended effect of improving student learning.

Future classes will continue to be analyzed to see if feedback continues to result in improved student learning.

Students will be asked questions regarding the feedback to gauge how many students are actually utilizing the feedback and how useful they find the feedback to be.

Analysis of retention will be explored by examining any correlation between quiz attempts and exam scores to see if feedback is having an effect on improving retention of material throughout the course.

REFERENCES

MATERIALS and METHODS
Students were quizzed over a lecture material via on-line quizzes, which were open for a specific time period and each student was allowed 1 hour to complete the quiz (open-book and notes). The quizzes consisted of 10-15 multiple-choice and/or true-false questions randomly pulled from a question bank (each student had the same number of questions over the same concepts). After taking the quiz, the scores were immediately posted and students could view their scores, along with the questions and feedback (detailed explanations and/or a numerical step by step solution). Students could then choose to re-take the quiz (before the due date) to improve their score knowing that if they chose the second attempt, their second score would be their grade for the quiz, even if it was lower than the first score. This was done to minimize the number of students not taking the second attempt seriously.