A better way to assess lab notebooks: There's an app for that!

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Abstract
We believe in the importance of general chemistry students developing lab notebook keeping skills. Until recently we quickly graded the students’ notebooks as they left the lab so they could have their notebooks to write their report and to prepare for the next lab session. This didn’t allow us to make constructive comments and we recognized that there were inconsistencies in grading that depended upon lab section and how quickly they finished the lab. In 2015, we introduced a scanning app for phones into the laboratory. Students scan their notebook at the end of each lab creating a pdf file which is submitted through Blackboard for grading. Submission through Blackboard (already used for pre-lab preparation and report submissions) allows us to annotate notebooks with comments and consistently apply a rubric. This simple change has allowed us to maintain a traditional lab notebook while providing timely feedback that is consistent.

Our story – why we adopted this tool
Our general chemistry students keep traditional lab notebooks. We stress the importance of the permanent record giving them examples of patent documentation, graduate school, and industry. We previously graded their notebooks as students left the lab session. There would be times when 3 to 5 students were waiting to have their notebook graded and the next lab group was soon to arrive. Faculty felt time constraints and were pressured to forgive minor infractions by the students. Chemistry offers up to 8 lab sections a semester covered by 3 to 6 different faculty. We were concerned about grading consistently.

We first introduced the practice of scanning notebooks and submitting to Blackboard in a small junior level analytical chemistry course to determine feasibility. This trial allowed us to develop instructions for use by general chemistry students. We are happy to share these instructions since they have minimized issues for our students.

<table>
<thead>
<tr>
<th>Levels of Achievement</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proficient</td>
<td>Needs Work</td>
<td>4 to 4 points</td>
</tr>
<tr>
<td></td>
<td>Correct Table of Contents, page #s, partner, dates Correct style, no white out, no scratched out numbers. Purpose.</td>
<td>0 to 3 points</td>
</tr>
<tr>
<td></td>
<td>A short overview of the lab given with hazards. Chemical equations</td>
<td>0 to 4 points</td>
</tr>
<tr>
<td></td>
<td>Can you repeat the lab? All “important” details included.</td>
<td>0 to 4 points</td>
</tr>
<tr>
<td></td>
<td>Masses, volume, colors, conductivity, malleability, density of products. Show calculations clearly for % yield for step 1 and step 2. Show calculations for the density calculation and % error.</td>
<td>0 to 5 points</td>
</tr>
</tbody>
</table>

Rubric as the students see it on Blackboard. Blackboard allows the faculty to award all points by clicking on proficient or to award partial credit with feedback explaining concerns.

When grading, the scanned notebook and rubric with space for feedback are on same screen. Unfortunately, the feedback box does not allow formatted text such as subscripts.

In addition to using the feedback section of the rubric, feedback can be given directly on the scanned notebook in various ways. While typed text can be highlighted or struck through, scanned work can only be circled or pointed to for comments.

Results
Before adopting this change, most students scored all of the points for the lab notebook with very little differentiation. Comparing scores for one year before and after the change shows that the average notebook score went from 99% to 91%. More importantly, the relative standard deviation went from 4% up to 14% demonstrating that different scores are being awarded to recognize different performance. We have also noted that overall lab performance in the second semester is improved. The addition of this app has allowed students to maintain a traditional lab notebook as well as receive timely feedback that is consistent.

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Student using app available from www.camscanner.com