Analyzing Student Laboratory Reports*

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Outline

Importance of Laboratory Reports

Setting

Design

Results & Discussions

Questions & Future Study
Importance of Laboratory Reports

• Academia
  – At most universities, students in the introductory physics laboratories are expected to write reports to communicate the information interpreted from the experimental data that they have gathered

• Industry
  – Sought-after skills by employers
    • Ability to formulate writing of technical data and analyses
    • Ability to communicate effectively through this writing

• University of Minnesota
  – An important part of problem-solving-based instructional strategy
    • Learning through synthesis of information
    • Communication of understanding
    • Documentation of solving laboratory problems
    • Grade
Setting

• Lecture
  – ~200 students / 1 lecturer
  – 3 hours / week

• Recitation
  – 15 students / section
  – 1 hour / week

• Laboratory
  – 15 students / section
  – 2 hours / week

⭐ Note:
All parts of the course are integrated such that the problems in lab and recitation are concurrent with the topics being covered in lecture
• **Laboratory**
  – problem-solving-based
  – cooperative group (3 students per group)
  – each student hands in one laboratory report
  – reports consist of different problems
  – TA assigns each student a different problem at the end of each unit
    • no one knows which problems will be assigned ahead of time
  – TA grades the reports
    • report grade = 60% of lab grade
    • lab grade = 15% of course grade
• **Students**
  – 65% Freshman
  – 75% Engineering
  – 79% Male
  – 45% First college science course

• **TAs**
  – 1st & 2nd year graduate students
  – First time teaching a class
  – 2 week Orientation & Weekly Seminar
  – Weekly teaching team meetings
• Workshop on evaluating written communication

– Introduction to general criteria
– Individual grading of sample student laboratory reports
– Whole group discussion on personal grading schemes
– Consensus on grading criteria
– Criteria for Evaluating Written Communication

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## Guideline for grading laboratory reports

<table>
<thead>
<tr>
<th>Problem Report:</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ORGANIZATION</strong></td>
<td></td>
</tr>
<tr>
<td>(clear and readable; correct grammar and spelling; section headings provided; physics stated correctly)</td>
<td></td>
</tr>
<tr>
<td><strong>DATA AND DATA TABLES (GROUP PREDICTIONS)</strong></td>
<td></td>
</tr>
<tr>
<td>(clear and readable; units and assigned uncertainties clearly stated)</td>
<td></td>
</tr>
<tr>
<td><strong>RESULTS</strong></td>
<td></td>
</tr>
<tr>
<td>(results clearly indicated; correct, logical, and well-organized calculations with uncertainties indicated; scales, labels and uncertainties on graphs; physics stated correctly)</td>
<td></td>
</tr>
<tr>
<td><strong>CONCLUSIONS</strong></td>
<td></td>
</tr>
<tr>
<td>(comparison to prediction &amp; theory discussed with physics stated correctly; possible sources of uncertainties identified; attention called to experimental problems)</td>
<td></td>
</tr>
</tbody>
</table>

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• Reports:

– Modeled on short technical memos

– On the order of two to three pages

– Requires approximately two to three hours for grading by the TA
  • laboratories restricted to 15 students per section
Design

- Introductory calculus-based mechanics laboratory
- Selected TA (first year) asked to copy all reports before grading
- Sample consisted of 15 Students followed through a 15-week semester
- Laboratory reports analyzed based on 5 criteria designed for evaluating written communication
• Evaluating Laboratory Reports for Communication
  – Dr. Lee-Ann Kastman Breuch
    • Dept. Of Rhetoric, U of MN

• Writing Across the Curriculum
  – U of MN (Writing Intensive Course)
  – Writing:
    • a way of learning
    • important for learning technical content
    • not separable from content
    • varies from situation to situation
    • students can practice writing documents that are central to their major/program of study
• Criteria

  – **Content:** What is the subject? What information needs to be included?

  – **Context:** What is expected in the discipline for this type of document?

  – **Audience:** To whom is the document written? How will it be used?

  – **Organization:** How can the information be best organized? Can the information be divided into sections?

  – **Support:** What details, facts, and evidence can be used to illustrate main points?
Example of quality levels - Content

<table>
<thead>
<tr>
<th>Addresses content accurately and thoroughly</th>
<th>Excellent</th>
<th>Good</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes accurate and complete technical information, including formulas, explanations, theorems, and data.</td>
<td>Includes accurate technical information, but has missed some important information.</td>
<td>Does not include accurate or complete information.</td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

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Results

• One class of 15 students
  – 11 of which had all 6 laboratory reports from the entire 15-week semester (n = 11)

• Each student is placed into one of three groups based on the grade of the first report
  – Poor
  – Good
  – Excellent
Audience (Averages)

Paper #

Quality

Class(11)
Poor(1)
Good(7)
Excellent(3)

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Organization (Averages)

Quality

Paper #

Class (11)
Poor (3)
Good (7)
Excellent (1)

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Support (Averages)

Quality

Paper #

Class(11)
Poor(8)
Good(2)
Excellent(1)

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Discussions

- Students of all ability levels showed signs of improvement in each of the criteria
  - Except for those students that were initially excellent, every student reached approximately the same quality by the end of the 15-week semester
• Identifiable increases in quality apparent by 3rd or 4th report
  – content, context, audience, & organization

• Slower increases in quality of support
  – majority of students only slightly higher than “good”
• Writings rated not simply as physics reports, but also as technical communications

  – What does that mean?
    • Physics can be wrong and still achieve excellent rating in other criteria

  – Is that useful?
    • Effective communication enables TAs to easily identify where students need help
    • Implement more effective coaching strategies
Questions

• Have we helped?

• Have we attained the goals set by WAC?

• Can we do better?
Future Study

• Larger sample
• Corresponding Laboratory grades
  – Possible modification to actual grading guidelines
  – More comprehensive integration of WAC initiative and our instructional pedagogy
• Effect of report writing on students’ achievements in the course(?)
• Others ...

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