A Guide to Writing Better Lab Reports for ASTR/PHYS 119

General Thoughts:

- Keep in mind the big picture goals of a lab report! You’re trying to answer a question and set the stage for your audience to understand the answer.
- Remember you are writing this lab report for a lay audience. Explain terms they may not know. Avoid unnecessary scientific jargon. Keep the goals in sight.
- Use either first person plural (we) or some other way to avoid the use of personal pronouns.
- Keep the report as short and direct as possible while still presenting the necessary evidence. Cramming in too much information may confuse or bore the reader. Their time is valuable and should be respected. More is not always better.

Structure:

The papers that get the best grades will have the following sections in them:

- **Objective**
  - This is the quick description of what it is you are trying to do and why.
  - It makes it clear what the goals of the experiment are and makes it explicit what the question is that the experiment tries to answer.
- **Procedure**
  - This section quickly tells the reader how the experiment was performed and why it was set up/designed to gain the data necessary to use as evidence towards the experiment’s goals.
  - The procedure is not just a listing or a description of all the steps, but instead is a description of what you were trying to do, rather than the details of how you did it.
  - Do not repeat the questions in the Pre-Lab section and then answer them.
- **Data**
  - This section should include the figures and tables that summarize the data. It should not include the raw data tab-delimited text files.
  - The figures and tables show the data in a way that makes sense to the reader and shows evidence in a simple and easy to understand way.
  - Be sure to put a few sentences in the main text to explain to the reader what the data IS and what it represents.
  - Label all figures as Figure # and tables as Table #. Be sure to reference each one, and to do so using the same number throughout the report. You may place them either interspersed throughout the report as the topics arise, or at the end.
o To decide whether a particular figure or table should go in the data section or in the results section, ask yourself “Is this figure/table showing just the output of the experiment?” if so, the figure/table probably belongs in the data section.

o Each figure and table should have a caption which is a couple of short sentences describing the content of the figure/table.

- Results

  o This section should discuss the interpretations of the data and conclusions that can be drawn from the data in the figures and tables.
  
  o Share with the reader the thought processes which led your team towards the conclusions.
  
  o Be sure to explain any assumptions or calculations you may have made during the process. Example calculations can be helpful, but too many are distracting.
  
  o Include any figures or tables that summarize the interpretations of the data and explain what the evidence is and what you conclude from that evidence. These figures should be designed to help draw, prove, or show conclusions.
  
  o To decide whether a particular figure or table should go in the results section, ask yourself, “Is this figure/table designed specifically to help draw conclusions for the reader’s better understanding?”
  
  o Figures and tables should have the same format as in the data section (give each a number, a short caption, and refer to it directly in the text). Each figure or table should be referenced at least once in the text.

- Conclusion

  o This section should summarize the final conclusions and the evidence that supports the conclusion. By the time you’re done, the reader should be confident about your conclusions and logic/arguments behind them.
  
  o Tell the reader what the final results are and why they should be believed.
  
  o Keep the original question in mind!
  
  o This is not a time to recap the details, but to summarize them quickly and tie them together. In some sense, this is the “summary argument” a lawyer would make to the jury at the end of the case. It should summarize the results of the detective work you and your team did during the experiments. If you like, this is Velma explaining who-done-it at the end of Scooby-Doo1.

Example Sections:

In this section, we give some short-and-sweet examples of some of the various sections in an excellent lab report. We’ll also comment on what makes them excellent.

Objective:

The grades of students are an important statistic for teachers to consider when trying to evaluate their classes. This experiment follows the grade pattern for three students with stereotypical behaviors over the course of the semester to study the impact of work ethic characteristics on their grades in Physics 201 (Classical Mechanics). By comparing the grade progressions to the work ethic personality traits, we hope to find a correlation which can be used to better encourage and empower students.

This is an excellent objective section because it clearly:

- Defines the problem.
- Displays some motivation about why we need to explore the problem.
- Explains how we plan to answer the question.

Procedures:

For this experiment, three students were selected and their work ethic was estimated. Student 1 was selected as an example of an average student because they took some physics classes before, but still worked hard to do well in the class. Student 2 was selected because they were observed to display the work ethic of a student who suffers from “senioritis”, or someone who starts with a decent level of work ethic, but quickly declines as the end of the semester nears. Student 3 was selected because they had never taken a physics class before, but nonetheless gave a consistent high level of effort throughout the semester. To track the successes these students had in their assignments, they were each given the same weekly homework assignment over the material covered that week and their grades were recorded in a grade book.

This is an excellent procedure because it clearly:

- Explains the important factors that control the experiment.
- Gives a quick overview of the steps of the experiment without coming off as a list of steps or explaining the process with too much depth.
Data:

Each student was given the same weekly homework assignment over material covered in Physics 201 each week for 15 weeks. The quizzes were designed to be straightforward, consistent, and a direct reflection of the knowledge gained that week. The assignments were graded on a scale of 100 and recorded in a grade book. Table 1 shows the results for three of the students chosen for this experimental comparison.

<table>
<thead>
<tr>
<th>Week</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student 1</td>
<td>90</td>
<td>91</td>
<td>94</td>
<td>89</td>
<td>96</td>
<td>92</td>
<td>91</td>
<td>96</td>
<td>95</td>
<td>98</td>
<td>93</td>
<td>92</td>
<td>93</td>
<td>95</td>
<td>91</td>
</tr>
<tr>
<td>Student 2</td>
<td>90</td>
<td>88</td>
<td>89</td>
<td>85</td>
<td>82</td>
<td>79</td>
<td>77</td>
<td>83</td>
<td>75</td>
<td>73</td>
<td>69</td>
<td>50</td>
<td>52</td>
<td>57</td>
<td>51</td>
</tr>
<tr>
<td>Student 3</td>
<td>65</td>
<td>76</td>
<td>82</td>
<td>88</td>
<td>81</td>
<td>85</td>
<td>90</td>
<td>82</td>
<td>86</td>
<td>83</td>
<td>80</td>
<td>77</td>
<td>88</td>
<td>84</td>
<td>89</td>
</tr>
</tbody>
</table>

Table 1: Physics 201 Grade Book – This table shows the grades per week on the quizzes for three students taking Physics 201.

This is an excellent data section because it clearly:

- Gives details about how the data was taken, and why the methods of evaluation are valid.
- Does not explain the results or conclusions this data could provide. The section stays factual and does not appear to support any conclusions yet or assume any answers.
- References the table of data taken for the experiment directly.

This is an excellent table because it clearly:

- Contains column and row labels with [units], an appropriate number of cells, a table number labeling, and a caption
- It has cells that are appropriately sized such that the table takes up a minimum total area.
- Has column and row labels that are bolded to distinguish them from the data points.
- Is labeled below the table and numbered. The table number and title are bolded, while the caption is written in plain text. The caption is a short description of what the data shows.
- This table belongs in the data section because it shows the grades in an easy to understand format without providing any information about conclusions that can be drawn from it.
Results:

After the data was collected, the team analyzed the data by plotting the grades for each student over time and by finding each student’s average. The plot, shown in Figure 1, displays each student’s grades side-by-side over time. The overall averages were 93, 73, and 82 for Students 1, 2, and 3 respectively. This seemed to correlate well with the work ethic shown over the course of the semester. The student who had some physics experience but still worked hard (Student 1) had their hard work rewarded with an “A” average. Their work ethic and grades were both consistently high. The student who suffered from senioritis (Student 2) gave a very poor work ethic in the latter half of the class. This directly correlated with their weekly grades and proved detrimental to their overall average, knocking it down to a “C”, even though the student started the semester doing very well, when their effort was also high. Finally, the student who started the semester a bit discouraged, but quickly learned the appropriate amount of work ethic (Student 3) also showed a direct correlation between effort and grades and still wound up with a “B” despite their initial failing grades. The overall results gained by interpreting the grade book can be found in Table 2.

![Figure 1: Weekly Grades for 3 Students](image)

**Figure 1: Weekly Grades for 3 Students** – This figure depicts the grade each student received on the homework assignment for each week over the course of the semester. Student 1 is known to be a hard working student, Student 2 is known as a student who is suffering from Senioritis, and Student 3 is known to be a student who has not taken a physics class before, but tries hard and learns to succeed.
This is an excellent results section because it clearly:

- Discusses the interpretations of the data and why they are valid. It follows the thought-process of “This is what we see… and this is what we think about it…”
- Reminds the reader of the important details of how the experiment was set up, which lead to the most effective answers to the question/objective of this experiment.
- Takes a look at the data from both a detail point of view, and an overall point of view.
- Refers to the figures and tables directly in the text.

**Table 2: Student Comparison** – This table shows the overall work ethic, numeric grade, and final letter grade for each student studied.

<table>
<thead>
<tr>
<th>Student #</th>
<th>Work Ethic</th>
<th>Numeric Grade</th>
<th>Letter Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hard working</td>
<td>93</td>
<td>A</td>
</tr>
<tr>
<td>2</td>
<td>Senioritis</td>
<td>73</td>
<td>C</td>
</tr>
<tr>
<td>3</td>
<td>Hard working</td>
<td>82</td>
<td>B</td>
</tr>
</tbody>
</table>

This is an excellent figure because it clearly:

- Contains axis labels with [units], a key/legend (if more than one set of data is displayed), an appropriate range selected for each axis, a figure number labeling, and a caption. Since this figure has multiple lines, it also has a legend which displays a short title for each set of data and is displayed to the side of the figure.
- Has a properly labeled x-axis of Time with the units of [Weeks]. It extends from 1 to 15 because those are the weeks which grades are reported.
- Has a properly labeled y-axis of Grade with the units of [points/100]. It extends from 0 to 100 because that is the range of grades possible for a student to earn. Excel likes to set these ranges differently, but it doesn’t make sense to show the y-axis all the way to 120 if those grades are not even possible.
- Is labeled below the figure and numbered. The figure number and title are bolded, while the caption is written in plain text. The caption is a short description of what the data shows.
- This figure is appropriate for the results section because it has been designed in a way to allow the reader to directly compare the students with a physical understanding over time. It helps the reader to see the conclusions better than Table 1 did.

This is an excellent table because it clearly:

- Shows the data in a form which displays results which support the conclusion.
- Contains the same excellent details tables should have (as described about Table 1).
Conclusions:

Upon comparing the grade progression to the personality traits associated with each student, the results show that students who give the class a proper amount of effort, regardless of their background knowledge of physics, are capable of earning high grades. The student who suffered from Senioritis, however, may have given the class proper effort in the beginning and done well, but as their effort declined, the grades also dropped. We note that in the case of the student who has never taken a physics class before that although the effort did not immediately pay off, as the student became more acquainted with the expectations and style of the course, the continued level of effort began to pay off in the general trend of grades. Because these students were selected as displaying very stereotypical behavior in regards to their work effort, we have good confidence that the study has shown a valid example of how a typical student might perform when displaying similar tendencies. However, while these results are indicative of a trend, a study with many more students is needed to ascertain whether this conclusion is more widely applicable.

This is an excellent conclusion because it clearly:

- Answers the problem addressed in the objectives.
- Explains the results as they relate to answering the problem.
- Speaks of specific examples which reinforce the answer to the problem.
- Mentions the validity of the experiment.

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Last modified: 1/16/2012 by D. Toback