Project Write-Up Guidance

The following is a general outline for a project report. Some items mentioned below may be relevant to your report while others may not be relevant. What it is important to compose a concise, chronological and/or procedural development, analysis and results of your project that can be easily read and understood by others not necessarily familiar with the topic. At a minimum, your report should address the following:

Title Page. In accordance with DOWW

Abstract. As you progress through the curriculum, you may be asked to include an abstract. An abstract is a one-page document providing information on what the project concerns, the bottom line results and conclusions. Think of this as the Superintendent's version of your work. The Superintendent is a very busy person and does not have time to read and digest every project report that he may be responsible for. It is your job to distil your analysis into a concise document where he can get the idea of what you found. The most important component of this document is your findings. This page is not numbered and does not count to any "page budget".

Table of Contents. As you progress through the curriculum, you may be asked to include an abstract. Outlines each major section of your report and its location in your document.

Main Body

- **Background.** A general description of what it is you are trying to solve for in the project. Assume that the reader was not privy to the reading contained in the project handout. Start by stating the problem that you are going to solve as well as why it is important, interesting or worthwhile to solve.

- **Facts.** State known facts that influence the question. You can and should include any given data or circumstances. Examples are the actual data (tables, graphs, etc.) from your project hand-out.

- **Assumptions.** State information not known as facts, but which you assume in order to address the real-world problem. Explain why each assumption is both valid (reasonable) and necessary for your mathematical model. In addition to listing assumptions, you must explain why they are valid and reasonable and address the impact on the model of a violation of the assumption.

- **Analysis.** A detailed description of the logical investigation of the question you are answering. This section is very specific to your project. Make sure you clearly define all your variables and state the domain of these variables such that people will understand what you are talking about. Within your detailed description of the logical investigation of the question; incorporate mathematical symbols, expressions, pertinent graphs, tables, and calculations with coherent sentences to convey meaning. Include enough discussion of the mathematics such that a reader could replicate your procedures. **Do not** simply write line after line of unexplained equations. The computer program that we use has an equation editor to make mathematical formulas. It is not hard to use and it adds a professional touch to your work. For example: $f(x) = x^2 + e^x - \pi$

- **Discussion of Results.** This is the thinking and reasoning part of the report that logically weighs the evidence developed in the analysis. Discuss the meaning of the mathematical analysis in the context of the original problem's setting. (Transforming the *Math world* to the *Real world*). Address the pro and cons of courses of action or be prepared to sensitivity analysis (what if the value of x changes to …, etc.) Address the effects of assumption not being valid. The key is that you describe what is happening mathematically in English. Try to explain it so that your mother or father or anyone else who is reading your work can understand your work no matter how strong their mathematical background.

- **Conclusion and Recommendations.** This section is a presentation of your conclusion attained from your results and the recommended course of action dictated by your analysis and results. Perhaps several courses of action can be prioritized, but a clear recommendation should be made. Also include any recommendations on how to improve the quality of the current study (e.g., by considering factors that the current study assumed negligible, by varying the assumptions, by adopting a different analytical approach, etc.) or on suggestions for further study.

Appendices. These are appropriate if the project involves large amounts of tabulated data (such as spreadsheet calculations), annotated sample calculations, detailed mathematical derivations, supporting plots and graphs, computer output, data lists, or supporting material which may be essential to the completeness of the submission, but which would be distracting or unwieldy if placed in the report. Each appendix must be referenced in the body of the report as an enclosure. As decision makers may not look at these additional enclosures, do not bury important information solely in an appendix -- ensure you reference it in the main body. Additionally, Appendices should stand-alone – even a brief introductory sentence at the beginning of an appendix will go a long way to helping your reader understand what is contained in your appendix.

Documentation. Endnotes or footnotes are your specific attributions. You must also include a list of sources (also called Works Cited or References). You may list a source without having a corresponding endnote, but any endnote should also have a corresponding source listed. The format for entries is available in the Documentation for Written Work.

Note: Remember that this is college-level work. Handwritten formulas or charts are not appropriate. Your project should be written in Times New Roman font, size 12. Text in the abstract and appendices is single-spaced. Text in the main body is double-spaced.

Mathematical Writing Tips

- Do not start a sentence with a symbol or a numeral. Either reword the sentence, or, for a numeral, spell out the number [1].

- Italicize the variables that you use in your paper. This can be done when the written work is completed, and it will add a professional touch to your paper [1].

- Use correct, sophisticated terminology [1].

  Incorrect: “Next, plug in 5 for x.”
  Correct: “Next, substitute 5 for x.”

- Watch the use of pronouns. It is better to repeat a term than to replace the term with it or they if there is a chance that the reader will get confused [1].

- Don’t be judgmental. Phrases like “It is easy to see that …,” “It is clear that …,” or “Simply …” should not be used. Something obvious to the author may not be to the reader [1].

- Type mathematical expressions using some form of equation editor. Do not import Mathematica output.

  Incorrect:

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In[1]:= Solve[3 x^2 + 5 x - 2 == 0, x]

Out[1]= {{x → -2}, {x → 1/3}}
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  Correct: Solving the quadratic equation

  $$3x^2 + 5x - 2 = 0$$

  produces the following roots

  $$x = -2 \quad \text{and} \quad x = \frac{1}{3}$$

- Use headings and subheadings to divide you’re your paper into different sections at logical junctures [1]. Refrain from using part 1 or part 2 as a heading, select an appropriate heading that summarizes the activities in that section, for example:

  Model Development

- Number all tables and figures and write a caption for each [1].

- Algebraic Details – Given that the reader is reasonably sophisticated mathematically, you can leave out most of the mundane algebraic details. For example, it is perfectly acceptable to say, "The time at which the ball hits the ground is the positive root of the quadratic equation $t^2 + 4t - 5 = 0$, which is $t = 1$," or "Let $f(x) = x^2 e^x$, whose derivative is $f'(x) = (x^2 + 2x)e^x$." You need not show the calculations. In some cases, you might wish to provide a description of the technique used, such as, "Using the quadratic formula, we found that the roots were …," or, "After factoring and rearranging terms, we solved for *x* and *y* …." In other cases, you may in fact need to include some algebra. If that is the case, think carefully about which steps are necessary to keep the reader on the right track. Do not merely copy the calculations you performed to come up with the answer [2].

- Connections – Each step in the argument should flow logically from the preceding step. To emphasize the connection between statements, you should freely use words such as *therefore*, *thus*, *so*, *hence*, *it follows that*, *consequently*, *from this*, *and so on*, where appropriate [2].

- Grammar and Punctuation – Remember that mathematical symbols are "words" and should be used with proper grammar and syntax. Use periods at the ends of sentences, even if the sentences end with mathematical symbols. Use commas, semicolons, colons, and dashes, where appropriate. Do not, however, use exclamation points unless you mean "factorial."
  The equal sign (=) is a verb and should be used *only* between mathematical symbols. So you could ay, "let *x* = 2," but not, "The perimeter of I triangle = the sum of the lengths of the sides."

- Graded Homework Submissions – Graded Homework submissions may be typed or handwritten and specific requirements may vary from instructor to instructor. The following guidance applies to all.
  - Be neat and logical in your presentation.
  - Number each problem and present them in order.
  - If your assignment submission has multiple pages, staple your assignment.
  - Include a title page and properly cite all references and assistance received.
  - Example:

    Problem: Determine and classify the critical points of $f(x) = x^3 - 3x$.

    Solution: Let $f(x) = x^3 - 3x$, whose derivative is $f'(x) = 3x^2 - 3$

    Upon setting $f'(x) = 0$, we find that the critical points are $x = 1$ and $x = -1$.

    The second derivative of f is $f''(x) = 6x$.

    Since $f''(1) = 6 > 0$, then $x = 1$ is a local minimum.

    Conversely, since $f''(-1) = -6 < 0$, then $x = -1$ is a local maximum.

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[1] Gerver, R. (2004). Writing Math Research Papers: A Guide for Students and Instructors. Emeryville, CA: Key Curriculum Press.

[2] Levine, A. (2000). Discovering Higher Mathematics: Four Habits of Highly Effective Mathematicians. San Diego, CA: Academic Press.