Using Applied Writing Projects in Undergraduate Math Classes

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Ohio Section NExT
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**What are Writing Projects?**

an idiosyncratic definition

- *Applied*, (more-or-less) *Real-World* math problems
- Presented as a *Contract Letter* or *Letter Requesting Help*
  - *Dear IMC: The Spate Gallery has recently been approached by an antiques dealer...*
  - *Dear Calculus Students, I have a problem...*
- Worked by *Groups* of 2–3(+) students
- Requiring a *Written*, multi-page solution paper
- Produced over 2–3 weeks
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Dear IMC:

The Spate Gallery has recently been approached by a dealer of antiques with headquarters in the outskirts of Athens, who has offered us first purchase rights to a so-called ancient tapestry. However, we are concerned with its authenticity and so are contacting you to ascertain its age.

The dealer asserts that the tapestry is 2000 years old, having been loomed sometime in the first century B.C. In order to determine the veracity of this claim, our technical analysis department was able to obtain a small portion of the tapestry and has done an analysis of Carbon-14 present therein. They report the presence of 190 nanograms (ng) of Carbon-14 in the 1 gram sample they took.

As you will of course know from your own references on the subject, the amount of C14 present in the environment has varied with time. This amount is constant in living creatures, and then decays (with a half-life of 5,780 years) after they die. The figure below shows the amount (in ng) of C14 (per gram) present in the environment for the past 2,100 years. This was compiled by our consulting scientist, Dr. LaRose, so we have every reason to believe its accuracy.

We need from you as accurate an estimate of the age of this tapestry as possible, so as to determine both whether we should pay the dealer’s usurious price and whether we should continue dealing with the company he represents. Unfortunately, we are under some time constraints, as the dealer requires an answer soon; we therefore need your report by the 22nd of this month. In addition, as it is in both of our interests to assure the successful and timely completion of your project, our consulting scientist, Dr. Gavin LaRose, is available to answer any and all additional questions that you may have regarding the technicalities or requirements related to your effort. You are urged to contact him as a group with any questions you may have—and, as is also indicated in your contract, you should see him (also as a group) to give a progress report on the project by the 15th.

Sincerely,

M. Ike Langelo, President
Art Inc.
I like “really” applied projects.

But: Reality is in the eye of the beholder…

And even the perception of reality has advantages:

- *Fun* and *Motivation*
- Material is *Positioned* in the text, course, curriculum, and field(s)

Applied letters provide a context for students’ responses

Involved projects demand *conceptual understanding* and *problem solving*.

… and writing.
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**Logistical Details**

- **Small Classes** (≤ 30 students) are a very good thing

- Groups are good
  - \( \frac{30}{2} = 15 \), and \( \frac{30}{3} = 10 \)...
  - Projects may be challenging opportunities to demonstrate comprehensive understanding...

- Propaganda is a key part of these (and [m]any other) teaching efforts...
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- 2–3/semester makes sense, in one class at a time.

- 5–20% of course grade (?)
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- **Propaganda** is a good thing...
  
  ...Groups are Pedagogically Sound! Groups make Hard Problems Easier! Groups are Revered and Loved by all!...

- **A Group How-To**  
  
  (not)

  - Self-selected
  - Heterogeneous
  - Four, three
  - Instructor-assigned
    
    mix-up groups, delegate blame
  
  - Match ability
    
    pedagogy? group dynamic?
  
  - Two students
    
    pedagogy? freeloaders?
  
  - Solving projects in advance is a good idea.
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Holistic Grading

I am one with the infinity of papers I have read.

Do not question the master.

C−.
Grading aerodynamic stair assessment?

- **Holistic Grading**
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- Rubrics
  Emphasize the mathematical solution to the problem.
  Structure, (quality, and) format are graded implicitly.

- Checklists
  Emphasize the general mathematical process and paper structure.
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Creating Rubrics

- **Identify steps** in the solution to the problem
- e.g., find exponential decay model;
- verify approx. age of tapestry;
- calculate actual age using model and data

- **Assign each 1–4 points**
  - 0 = no sensible model
  - 1 = model, error in all params
  - 2 = one of base, initial value, exponent correct, or two with poor derivation.
  - 3 = two of base, initial value, exponent correct, or all three with poor derivation
  - 4 = correct and well-explained model

- Assign some points for **clarity/quality** and **deadlines**
  (total \(\approx\) 15–20 points)

- Read each paper once + spot-check.
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## Sample Rubric

for project *Into the World of Art*

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<tr>
<th>Objective</th>
<th>0 points</th>
<th>1 point</th>
<th>2 points</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exponential Model</td>
<td>no sensible model</td>
<td>exponential model, errors in base, initial value and exponent</td>
<td>one of base, initial value, exponent correct, or two correct with questionable derivation</td>
<td>...</td>
</tr>
<tr>
<td>Correctness of Claim</td>
<td>no determination age is &lt; 2000 years</td>
<td>statement age &lt; 2000 years, no or poor argument</td>
<td>statement age &lt; 2000 years, good intuitive or mathematical argument</td>
<td>...</td>
</tr>
<tr>
<td>Age of Tapestry</td>
<td>no determination of actual age</td>
<td>estimate of age, little or no logical support</td>
<td>estimate of age, referring to data, with logical gaps, errors, or inclarity</td>
<td>...</td>
</tr>
<tr>
<td>Clarity and Organization</td>
<td>yuck</td>
<td>multiple unclear sections and limited organization</td>
<td>some unclear section(s) or spotty organization</td>
<td>...</td>
</tr>
<tr>
<td>Deadlines</td>
<td>all deadlines missed</td>
<td>one or more deadlines missed</td>
<td>all deadlines made</td>
<td>...</td>
</tr>
</tbody>
</table>
Checklists

- A checklist indicates what is expected of a student paper:
  - *required components* (problem statement, solution, acknowledgement...)
  - *content* (explanation of solution, definitions, labeled diagrams...)
  - *format* (scientific paper or business letter...)

- Each is worth *1–2 points*
- *Total = 10–15 points*
- Read each paper once + spot-check.
A checklist indicates what is expected of a student paper:

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Sample Checklist
from Elyn Rykken, Muhlenberg College

Instructions given to students with the checklist:
Please attach this page with a paper-clip to your writing assignment when you turn it in.
This list will be used to grade your assignment and will be returned to you with comments. Keep a copy of your paper for your
own reference
Use this checklist as a guide for yourself while writing the assignment

<table>
<thead>
<tr>
<th>Form</th>
<th>(5 points)</th>
</tr>
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</table>
| Does this paper: | 1. clearly (re)state the problem to be solved (including the essential details)?  
2. explain what level and types of math will be used?  
3. solve the question that was originally asked? (2 pts)  
4. give acknowledgment where it is due (did anyone work with you on the math)? |

<table>
<thead>
<tr>
<th>Content</th>
<th>(7 points)</th>
</tr>
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</table>
| Does this paper: | 5. give a precise and well-organized explanation of how the answer was found? (2 pts)  
6. define all variables, terms and notation used?  
7. explain how each formula is derived or where it can be found?  
8. clearly label diagrams, tables, graphs or other visual representations of the math?  
9. contain correct mathematics? (2pts) |

<table>
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<th>Presentation</th>
<th>(3 points)</th>
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| Does this paper: | 10. use standard business letter form?  
11. use correct spelling, grammar and punctuation?  
12. look neat? (typing helps with this!) |

Comments:
Concluding Thoughts

- Picking topics: let the *syllabus* be the guide

- There are varying levels of application and realism for these projects
- Grading isn’t prohibitive... (but it does take time)
- I’ve never dwelt on teaching writing (!)
- It is not necessary to write all your own projects...
Concluding Thoughts

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<th>W</th>
<th>F</th>
<th>Classes Start</th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>7</td>
<td>9</td>
<td></td>
<td>First-Order Diff Eq</td>
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<td>12</td>
<td>14</td>
<td>16</td>
<td></td>
<td>Linear 2nd Order Diff Eq</td>
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<td>21</td>
<td>23</td>
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Resources

- Others’ projects on-line (Annalisa, me, Tommy, Elyn . . .)
- Textbooks and modeling texts, esp. Hughes-Hallett et al. (Wiley); also **Mathematical Modeling. . .**, Hadlock (MAA, ’98); **Mathematical Biology**, Murray (Springer ’90); Differential Equations texts (esp. Borrelli & Coleman, Wiley ’04); . . .