Developing Problem Solving and Communication Skills Through Memo Assignments in a Management Science Course

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The authors describe how to structure a memo format for homework assignments in which a manager requests analysis of a particular issue from the student. The student must respond with a memo stating a recommendation and describing the solution approach. The results from using the memo format include improved student performance and professional writing on word-problem assignments.

Keywords: business writing, critical thinking, word problem

After implementing a memo assignment format, we have been encouraged by the way students have summarized what they gained from building a model and, when successful, their description of their solutions and recommendations in managerial terms. Why has a change in homework assignment structure helped to motivate students faced with problem solving in a quantitative business course? We begin with our observations. Specifically, in short word problems that require quantitative analysis, we define two different formats or levels of problem description:

Level 1: Numerical representation with or without a paragraph containing a brief normative description

Level 2: Highly structured memo presentation with a relevant business context.

For a Level 1 formatted problem description, the word problem provides some information about the decisions and the resource constraints, but it often omits the decision-maker, the sources of data, and those impacted by the decisions. The Level 2 memo word problem includes more business context to provide the students with opportunities to identify the decision-maker, objective, and resource constraints and to assume the role of a business analyst.

In the remainder of this article, we discuss the literature in cognitive science that helps us understand our observations of student benefits from reading the memo assignment and writing a memo response. Additionally, we state the student learning objectives, describe the instruction required for the memo assignment, and provide a detailed example. Although our discussion uses a management-science assignment for exposition, we have applied the memo assignment format to other management courses including operations management, decision support systems, and data communications. We illustrate the contrast between the two levels of problem description. Then, we conclude with student reactions followed by research directions.

Teaching Problem Solving

Cognitive science researchers often describe problem solving as a multiphase process that requires understanding the problem and its context (Evans, 1995; Hall, Kibler, Wenger, & Truxaw, 1989; Mayer, 1982). Yet traditional Level 1 word-problem assignments often neglect requiring students to carefully restate the problem and understand its context through business communications (Lewis & Mayer, 1987; Mayer, 1982; Stuart, 1997). Teaching problem solving that encourages students to use relevant contexts while conversely helping students link real problems to concepts learned in school is necessary (Baranes, Perry, & Stigler, 1989; Grinde & Kamermeyer, 2003; Koedinger & Nathan, 2004; Rittle-Johnson & Koedinger, 2005).

In order to teach comprehension and translation, business educators could suggest students read the problem several times for general understanding, search for details, rephrase the problem by identifying the objective and known measurable quantities, determine the unknowns, and then
write out the conditions and categories of constraints before any computations (Cummins, 1991; Cummins, Kintsch, Reusser, & Weimer, 1988; Debnath, Tandon, & Pointer, 2007; Grinde & Kammermeyer, 2003; Kintsch & Greeno, 1985; Polya, 1985; Pomykalski, 2006; Sankowsky, 2001; Stevens & Palocsay, 2004). Rephrasing the problem for a memo assignment requires the students to write about the problem, describe its context, and identify the decisions to be analyzed.

Although many business programs require a prerequisite business communications course, the potential to integrate business writing with a relevant context into core business curriculum is also essential to student learning (Marcal, Hennessey, Curren, & Roberts, 2005; Prater & Rhee, 2003; Young & Murphy, 2003). Because successful business writing requires students to identify their audience (Anderson, 1991), the Level 2 memo word problem helps students to identify their decision maker and interested constituents. Next, we present the student learning objectives for the Level 2 memo exercise.

Student Learning Objectives for Level 2 Memo Assignments

The goals of the proposed assignment problem format are to provide relevant context and to integrate business communication into business problem solving. Specifically, we propose five student learning objectives.

1. Identification of data information sources: The proposed memo word-problem format categorizes data according to source so that students gain insights into the data sources in common business problems. In the proposed assignment format, students describe the data and its source in their memo response.

2. Identification of the decision makers and their perspectives: Students may find the decision-maker(s) in the “From” section at the top of the memo assignment as well as in the “cc” and “body” of the assignment. In the proposed assignment format, students write a response to the decision-makers and respond to their concerns.

3. Statement of the problem: The students briefly state the problem in business terms along with their assumptions.

4. Formulation of a numerical representation of the problem: In order to answer the problem, students formulate a business model and then solve it by a graphical solution method, algorithmic method using computer software, or both.

5. Interpretation of solution output and recommendation: In answering business questions, students interpret the solution to their model, analyze the sensitivity of their solution to changes in data, and state their recommendation.

Instruction Required

Step 1. Describe how to write a business memo before giving students the assignment. Give students the “Business Writing” handout illustrated in Appendix A to explain the required format and structure. Remind students that making a good impression on the reader includes good grammar and spelling as well as a professional format.

Explain that although most memos do not have appendices, for grading purposes the students are required to attach an appendix to the response memos. Then ask students to construct their appendix to include their legend, objective function, model with constraint descriptions, and software output so that the instructor can provide detailed feedback about their modeling approach. Following the description of a memo, give students two complete example assignments and keys that consist of both a memo word problem and a memo response. Each of these components is described next in Steps 2 and 3 and illustrated in Appendixes B, C, and D.

Step 2. Distribute the assignment memo. Each assignment begins with a memo containing the assigned word problem. At the bottom of each assignment memo is a double-outlined box with traditional assignment instructions that include a brief reminder of memo format requirements, anticipated assumptions, due date, and the grading scale that defines the point values. Appendix B shows an example of an assignment memo and grading scale. In the assignment memo, the word problem is presented in a memo format from decision-makers. Information such as processing times, regulatory limits, and marketing estimates are categorized from different departments in the business organization such as production, environmental, and marketing. For example, marketing may provide demand forecasts with trend predictions. In addition to identifying the source of information and other department perspectives, the memo format may also more directly communicate the decision-maker’s perspectives. An example of an assignment memo is shown in Appendix B. Beginning with Appendix B and continuing in Appendix C, we point out the problem description levels described previously.

The proposed assignment structure in Appendix B provides information concerning which managers want to know the product mix for the production schedule. It also provides information about the sources of information for profit coefficients, material supply constraints, and a promotional constraint. Although, in practice students would have to do more investigative work developing questions and identifying which departments and coworkers have which information, the memo format provides insights regarding where they might seek this information in the future.

Step 3. After students have turned in their assignments at the beginning of class, give students a key with a response memo and appendix showing a detailed modeling approach
as shown in Appendixes C and D, and discuss it with students. Each response memo includes not only the purpose of the problem, background (including data sources), assumptions, constraints considered, and objective, but also the recommendations stated in business terms and answers to any follow-up questions. Additionally, the memo should indicate what method was used to develop the recommendation with a reference to the model in the attached appendix. The response memo format encourages students to write about a problem in order to facilitate their understanding of the problem attributes. Furthermore, it provides an opportunity to develop business writing skills by communicating what problem they analyzed and the value of their recommended solution.

In the response memo appendix shown in Appendix D, the students show what solution approach they used, the definitions of their decision variables, the expression for their objective, and the constraints. They also show their solution method, which may include a graphical method for problems with only a few decision variables or an algorithmic method using computer software for more complex decisions. In Appendix D, both a graphical solution method and an algorithmic method using the Excel solver are shown.

The memo structure helps students to identify, evaluate, and communicate assumptions. For example, the marketing department in Appendix B communicated that “demand continues to be strong for both products.” Consequently, the legend in Appendix D defines the variables in terms of the number of package types manufactured and sold. Because the objective is to maximize profit, the model assumes that products manufactured are also sold so that revenues are generated. When students are asked to evaluate whether assuming that all products manufactured are sold is reasonable, they can reference the marketing department’s recent comments about strong demand. We observed that students were more likely to describe their assumptions, such as the ones just discussed, when they used the memo format. Additional observations are discussed next.

STUDENT EXPERIENCE AND OUTCOMES

We first used the memo assignment format for the four assignments in Fall 2006 in the Management Science course with two sections totaling 56 junior- and senior-level undergraduate students, most of whom were Management or Management Information Systems majors. We continued to use the memo structure in eight subsequent sections of Management Science from Spring 2007 through Summer 2008 that enrolled an additional 209 students. Students worked over 80 different word problems with the memo format during the six semesters from Fall 2006 to Summer 2008. Out of the 10 total sections of 265 students, two were taught at a remote campus whereas eight were taught on the main campus. The student population in the 10 sections included both traditional and nontraditional students. Comments from many of the students with industry experience indicated the high degree of relevancy of the memo assignment structure. Students with less experience were able to visualize how communications work within a business environment. In writing their memos, a number of students wrote from the perspective of an assumed role within the business. For example, some students even added to the story line of the word problems, an indication that they understood the fictitious roles posed in the memo assignment.

Two different students in different sections asked about applying the business logic discussed in class to staff scheduling problems at their present jobs. Several students also commented about the use of the class concepts in their future jobs. In one instance, a student e-mailed that he was enthusiastic about accepting a job offer at a transportation company and continued with “I know I will be able to utilize the skills learned in your course during my career with the transportation company. Another student wrote on the university course evaluation, “homework assignments offered me the opportunity to experience to [sic] find solutions to real-world problems.”

To ensure consistency, assignments were coordinated between the instructors and the same grading scales were used for each assignment. As instructors, we made several observations after implementing the new format. First, the appearance of student homework improved due to the professional format requirement. The responses changed from handwritten spiral-bound notepaper to word-processed documents. Second, we found that the memo homework assignments were actually easier to grade, in part due to the more organized structure. Third, the turn-in rate for homework assignments remained the same despite the added time requirement for students to use the professional memo structure. With the memo response requirement, students were more likely to seek guidance from us so that they could then construct a model that generated a solution. Although no data was collected on number of student queries following introduction of the memo structure, both of us perceived that these increased and the questions asked were less trivial. We believe that students sought our help when they realized that they could not make a recommendation in their response memo until their solution approach generated a recommendation.

Another impact we observed is that student comprehension of the problems and identification of decisions improved. After grading over 1000 assignments with the memo structure over the six semesters, we perceived that students more often defined their decision variables correctly. Modeling also improved as evidenced by improved constraint formulation and improved constraint descriptions. In addition, because students had to describe their solution in business terms, their understanding of the word problem and its context improved. This was evident from their response memos. In traditional Level 1 assignments, the students tended to discuss their recommendation only in terms of $X_1$ and $X_2$. By
using the memo format in Appendixes B and C, students were much more likely to discuss their recommendation in business terms as shown in the Appendix C response memo. The response memo helped students describe the objective, the material supplies constraining the decision, and the promotional production requirement, as well as the recommended product mix and its potential profit.

The class discussion of homework assignments was significantly enhanced by the memo format. Discussion included how to build the model and how to interpret the output. We also asked scenario questions, such as what if the price of millet flour rises by $1/kg or what if there is a shortage of brown rice flour such that only 1200 kg is available? These types of questions provided opportunities for the students to identify how the model and subsequent solution were impacted by common market influences.

RESEARCH DIRECTIONS

We see the potential for research of a more formal nature to determine how memo writing improves student learning. The grading scale shown in Appendix B may be further developed into a formal grading rubric by identifying how each point total is distributed and assigned. Data collected on the student performance with a formal rubric in future courses will provide further insights. For example, it would be interesting to compare the student performances on the memo format, legend, and other modeling requirements of the assignment.

Future research may include examining how students can overcome common difficulties with problem solving and how they understand the context of business decisions. Defining problem-based approaches (i.e., short word-problem assignment vs. case study) is helpful in distinguishing among different types of educational strategies and their dimensions (Harrison-Walker, 2000; Lohman, 2002; Mayer, 2002). The intersection of cognitive science and business word problems provides a rich area for further research.

Because problem solving and professional writing experience may be critical elements in hiring assessment and career advancement for business students, common business school goals are to increase problem solving and business writing opportunities for students (Aiken, Martin, & Paoliillo, 1994; Boatwright & Stamps, 1988; Kimball, 1998). The memo format assists with these goals. Student memos may also provide more information for faculty to assess student problem-solving and writing skills (Carrithers & Bean, 2008). Assessing critical thinking and business writing in policy analysis could be used to evaluate how well students bring their problem-solving and memo-writing experiences to a capstone course. For example, assessing critical thinking and communication skills could provide insights into the impact of our assignment format in the future (Jenkins, 1998; Peach, Mukherjee, & Hornyak, 2007).

REFERENCES


### Appendix A “Business Writing” Handout That Describes the Components in a Memo

One of the most common forms of writing is the business memo. In this course, you will have the opportunity to practice writing memos for your homework assignments. Memos provide structure and organization and require succinct communication. A memo should summarize the recommendations in one page. A memo is not a report. Assume very busy readers.

A memo is composed of the following components

1. **Heading:** MEMO
2. **To:** Recipient’s name(s)
3. **Date of memo**
4. **From:** Your name
5. **CC:** Folks copied on your memo
6. **RE:** Subject of the memo (In your memo include assignment #, problem #, and topic)
7. **Purpose of the problem described in the memo (1 - 2 sentences)**
8. **Important background information about the problem which includes the data sources, constraints, and assumptions (1 or more sentences)**
9. **Summary of work completed (what you have learned) to date on the problem and your recommendations to date. (1 or more sentences)**
10. **The following three items will not be required for your homework assignments but are included in this description for future reference:**
   a) A memo may discuss a weekly update of a problem which would also include a comparison of planned work with work accomplished to date (1 or more sentences and a table summarizing the comparison)
   b) A memo may include any questions you may have for the recipient regarding the problem (1 or more questions)
   c) A memo may include your plans for future work activities (1 or more sentences)

### Appendix B Example Assignment Memo With Word Problem and Grading Scale

```
MEMO
DATE: January 10, 2008
TO: MAN 3550 Business Student
FROM: Prod Jackson, Production Manager; Gluten Free Mixes, Inc.
CC: Michelle Count, Controller
     Bill Spender, Procurement Manager
     Melanie Show, Marketing Manager

Level 2
RE: Product Mix for Gluten Free Mixes, Inc. (HW 1, Problem 2)

Levels 1, 2
Ho
```
Accounting

The profit for product 1 is $35.00/package while the profit for product 2 is $25.00/package.

Procurement

Two raw materials, millet flour and brown rice flour, are required for products 1 and 2. Only 1500 kg of millet flour is available while only 1600 kg of brown rice flour is available. Product 1 requires 20 kg of millet flour and 40 kg of brown rice flour. Product 2 requires 30 kg of millet flour and only 25 kg of brown rice flour.

Marketing

A promotion for product 2 requires that at least 35 of product 2 must be produced each week. Demand continues to be strong for both products.

Appendix C Example Response Memo

MEMO
DATE: January 10, 2008
TO: Prod Jackson, Production Manager; Gluten Free Mixes, Inc.
FROM: MAN 3550 Business Student
CC: Michelle Count, Controller
Bill Spender, Procurement Manager
Melanie Show, Marketing Manager

RE: Product Mix for Gluten Free Mixes, Inc. (HW Assignment 1, Problem 2)

In response to your request to determine the number of packages of each type to produce each week in order to maximize profit, I investigated the accounting profits, available supplies for millet flour and brown rice flour, and marketing promotions. Assuming that each package manufactured is sold, I recommend the following product mix:

- 15 type 1 packages (20 kg millet flour mixed with 40 kg brown rice flour)
- 40 type 2 packages (30 kg millet flour mixed with 25 kg brown rice flour)

Selling this mix of packages each week will generate $1525 in profit. I based my recommendation on a linear programming model that is defined in the attached appendix and solved it using the graphical solution method as well as by using the solver in Excel (Microsoft Office), as shown in the attached appendix. If you have any questions, please contact me.
Appendix D Example Response Memo Appendix for Response Memo in Appendix C

APPENDIX 1: Product Mix for Gluten Free Mixes, Inc. (HW Assignment 1, Problem 2)

LEGEND:  
\[ X_1 = \text{number of package type 1 manufactured and sold} \]  
\[ X_2 = \text{number of package type 2 manufactured and sold} \]

MODEL:

Objective function: MAX 35X1 + 25X2  
Maximize profit

Constraints:
1) 20X1 + 30X2 ≤ 1500  
Millet flour supply (kg)

2) 40X1 + 25X2 ≤ 1600  
Brown rice flour supply (kg)

3) X2 ≥ 35  
Promotion pkg 2 min (package type 2)

4) X1, X2 ≥ 0  
Non-negativity constraint

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<td>X2</td>
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<td>Max Total Profit</td>
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<td>Constraints</td>
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Solver Results

Solver found a solution. All constraints and optimality conditions are satisfied.