

Integrating Writing to Provide Context for Teaching the Engineering Design Process

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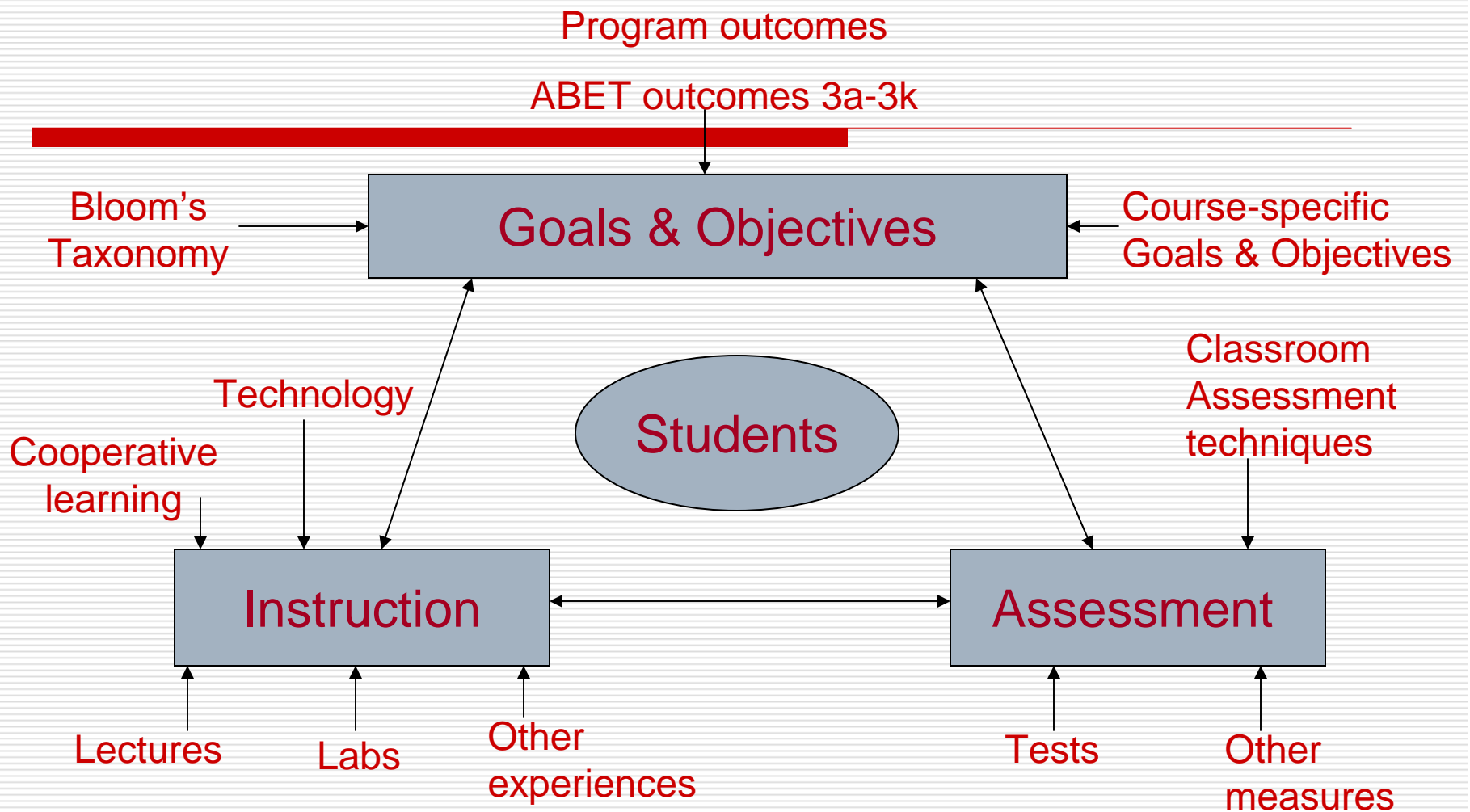
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Presentation Overview

- Review an example of integrating writing with learning new analytical skills
 - Summarize outcomes that address educating students at multiple cognitive levels
 - Summarize outcomes that address departmental and ABET requirements
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Model of Effective Course Design



(Felder, R.M., & Brent, R. 2003)

CE 356 - Fundamentals of Environmental Engineering

- **CATALOG DESCRIPTION:** Introduction to water treatment and water pollution and the analysis and design of selected treatment processes. Credit Hours-3

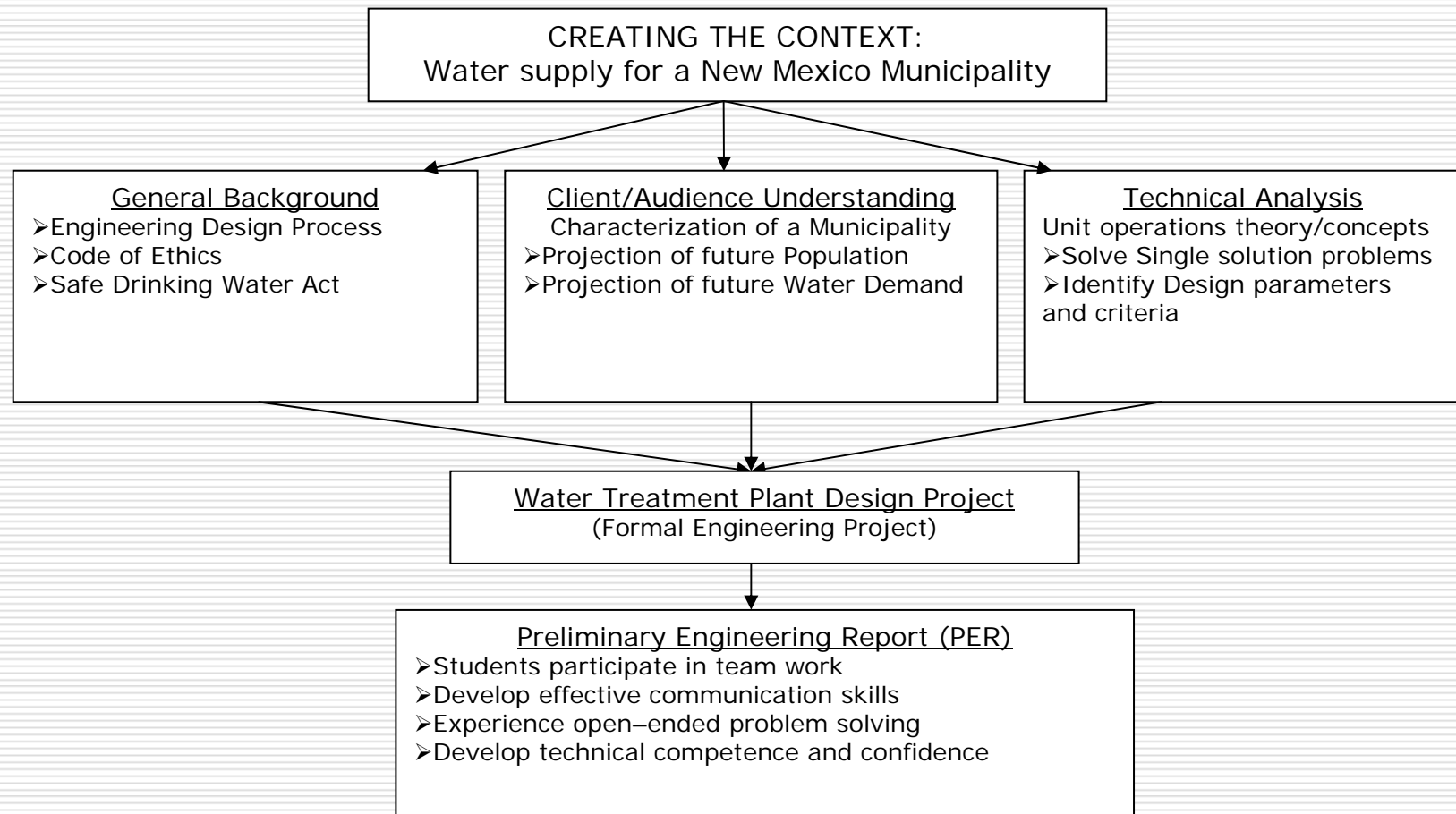
 - **COURSE OBJECTIVES:** The general objectives of this class are to:
 - Learn and apply the engineering design process.
 - Develop and apply skills used by successful practicing professional engineers: critical (reflective) thinking, communication, and documentation.
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Course Learning Objectives

- Apply fundamental environmental engineering principles and perform calculations for designing water treatment and wastewater treatment systems.
 - Use design problems to demonstrate application of these principles and create opportunities to comprehend and analyze conventional treatment alternatives.
 - Develop the comprehension and analytical techniques required to **complete the design analysis and documentation for a facility preliminary engineering report (PER) as typically performed by a professional consulting engineering firm.**
 - **Develop new skills which are generally applicable to the department's capstone design courses.**
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Developing Context for Engineering Practice

Goal: Guide the student's development as a future PE



Bloom's Taxonomy

Assignment Description	Level [†]					
	1	2	3	4	5	6
1) Engineering design process	✓	✓	✓			
2) Population Projection/Water Demands	✓	✓	✓	✓		
3) Single solution problems	✓	✓	✓	✓		
4) Design statements/summary	✓	✓	✓	✓	✓	
5) PER of Water Treatment Facility	✓	✓	✓	✓	✓	✓

† 1. Knowledge (List, recite, reproduce), 2. Comprehension (Explain, Paraphrase), 3. Application (Calculate, solve, determine, apply), 4. Analysis (Classify, Predict, Model, derive, interpret), 5. Synthesis (Propose, create, invent, design, improve), 6. Evaluation (Judge, select, critique, justify, optimize. (Bloom, B.S. & Krathwohl, D.R., 1984)

ABET Outcomes

<i>Assignment Description</i>	<i>ABET outcomes*</i>										
	<i>3a</i>	<i>3b</i>	<i>3c</i>	<i>3d</i>	<i>3e</i>	<i>3f</i>	<i>3g</i>	<i>3h</i>	<i>3i</i>	<i>3j</i>	<i>3k</i>
1)Engineering Design Process	✓			✓		✓	✓				
2) Population Projection/ Water Demands	✓	✓			✓	✓	✓				✓
3) Single Solution Homework Problems	✓				✓						
4) Design Statements/Summary	✓		✓	✓	✓		✓				
5) PER of Water Treatment Facility	✓	✓	✓	✓	✓	✓	✓				✓

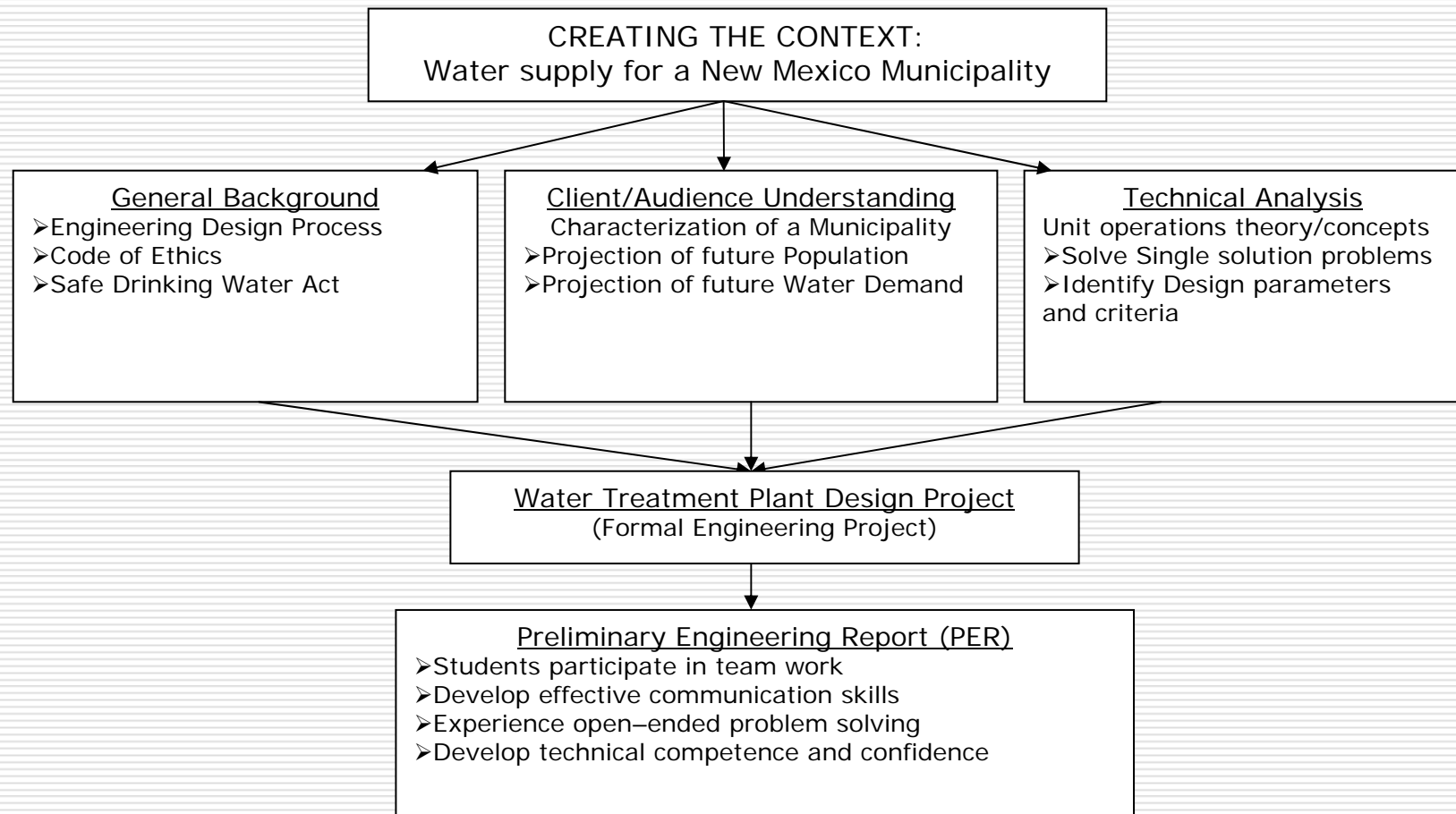
**Outcome 3a:an ability to apply knowledge of mathematics, science, and engineering; 3b:an ability to design and conduct experiments, as well as to analyze and interpret data; 3c:an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability; 3d: an ability to function on multidisciplinary teams; 3e:an ability to identify, formulate, and solve engineering problem;, 3f:an understanding of professional and ethical responsibility; 3g: an ability to communicate effectively;3k: an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

Writing Assignments

- Assignments
 - Population projection report
 - Design parameter/criteria statements
 - Preliminary Engineering Report
 - Functions of Writing Requirements
 - Facilitate integration of assignments into a project
 - Create a foundation for developing the “practical” engineering context
 - Outcomes are a direct result of work related to developing and writing the PER
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Developing Context for Engineering Practice

Goal: Guide the student's development as a future PE



“Value” of Writing Assignments

Assignment Description of the task	Points	
	Writing	Analytical
1) Quizzes		150
2) Engineering design process	50	
3) Population projection/water demands	50	
4) Single solution problems		150
5) Design statements/summary	20	
6) Water/ Wastewater treatment exams		200
7) PER of Water Treatment Facility	50	50
Sub total	170	550
Total	720	

Percentage of writing assignments in total points = ~ 23 %

Written Report Evaluation Heuristic

CRITERIA

- **Consideration of Audience:**
Who is the client and what are the client's needs?
- **Quality of Solution:**
What is the problem and how can it best be solved?
- **Rigor of Engineering Analysis/Design Process:** How and why does the proposed solution present itself as the best choice among several alternatives?
- **Organization and Focus**
 - Is the organization of the document effective?
 - Relevance
 - Sequence
 - Persuasiveness
- **Clarity and Coherence:**
Is the document unambiguous, direct, and effective?
- **Professional Appearance:**
Is the document attractive and professionally prepared following good document design practices?

SCORING

- 1 - Does Not Meet Expectations**
"Lack of Preparation"
- 2 - Needs Improvement**
"Data Dump"
- 3 - Adequate**
"Partial Synthesis"
- 4 - Meets Expectations**
"Full Synthesis"

Factors of Influence

- WAC training initiated and serves as a base for this process
 - Faculty and staff development and TA training
 - Collaboration between engineering and English faculty and professional staff has guided the process through its development
 - Students schedule a consultation at the English department writing center
 - Student resistance to course writing requirements has fostered “tweaking” and “understanding” the process
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Conclusions

- The process contributes to CAGE department outcomes:
 - “Pre-professional experience,”
 - Development of critical thinking-problem solving skills
 - FE exam
 - The process contributes to ABET outcomes:
 - Criterion 3a-k
 - The process provides an engineering Ph.D. candidate (TA) formal training in engineering education along with technical skills development
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