Appendix B

Long-Term Activity:
Curriculum Case Study

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Stanford University School of Education
Appendix B - 242 - The Learning Classroom

The “curriculum case study” assignment structures the writing of a detailed narrative that focuses on teaching and learning during a particular teaching event. The assignment asks learners to explore, apply, and reflect on the course’s main concepts and theories by analyzing what and why students learned during a particular segment of teaching. The curriculum case study requires that learners:

• Examine how they organize their instructional environment, activities, subject matter, and students to facilitate students’ learning processes;
• Consider what they know about students’ learning relevant to this particular teaching event and how they know it; and
• Analyze how theory can inform their understanding of this particular teaching event and develop their own theories to explain the event and inform future teaching.

We have found curriculum case writing to be an effective and powerful central assignment in our teaching and recommend this assignment to frame this course. Using a real example and series of events can help you recognize and consider the complexities of teaching and learning, and the importance of context. Such examples allow you to move back and forth between theory and practice, and between the specific case and general principles of learning and teaching. Curriculum case writing aims to encourage more reflective practice. Through sharing, discussing, and commenting on others’ cases, teaching becomes more public and open to review, thereby building professional communities.

This appendix includes sections intended for learners taking the class and facilitators or faculty leading it:

• Guidelines for a Case Report of Learning and Teaching—a description of a curriculum case and its necessary components
• Guidelines for Case Commentaries—a description of how to conduct case commentaries, offering suggestions about completing the assignment
• A Rubric for Cases of Instruction and Learning that details what is included and expected in distinguished curriculum, proficient, and developing cases

This appendix continues with sections intended primarily for course faculty or facilitators:

• Suggestions for Planning
• Possible Structures To Support the Curriculum Case Activity
• Sample Timeline for a 13-Week Course
• Case Conference: A Guide for Facilitators—an outline of this activity and the role of the facilitator

Finally, the appendix includes three exemplary case studies and their commentaries:

• Marchetti, Jessica Rose (2002). It’s a Process: A Case of Teaching for “Understanding” and “Authenticity.” Unpublished manuscript, Stanford University School of Education, Stanford, CA.
• Naughton, Meredith (2002). Mental Models and the Car Analogy: A Case of Two Classes. Unpublished manuscript, Stanford University School of Education, Stanford, CA.
What Is a Case?

Cases are richly detailed narratives of teaching that are used to (a) guide reflection and (b) teach others. Although they are story-like, “cases are not simply stories that a teacher might tell. They are crafted into compelling narratives, with a beginning, middle, and end, and situated in an event or series of events that unfold over time. They have a plot that is problem-focused with some dramatic tension that must be relieved. They are embedded with many problems that can be framed and analyzed from various perspectives, and they include the thoughts and feelings of the learner-writers as they describe the accounts. Some case writers describe problems that remain unresolved and end their stories with a series of questions about what to do. Others include solutions that may or may not have worked. They all include reflective comments about their accounts that examine what they have learned from the experience and/or what they may do differently in another similar situation” (Shulman, 1991, p. 251). These comments should include the author’s answer to the question, “What is this a case of?” The specific challenges, solutions, and experiences of a single case should be related to general issues and principles of learning, teaching, and instructional design, so that, as a professional community develops its body of cases, it is also developing a more articulate understanding of the general principles of its practice.

In this case, the problem focuses on student learning and seeks to understand what aspects of teaching, of the classroom, and of the broader environment may contribute to what students do and do not learn. The case should center on a series of lessons addressing a central concept, skill, or disposition associated with a discipline or field of study (e.g., photosynthesis, the causes of the American Revolution, the concept of function, strategies for reading a new novel, evaluating explanations, engaging in productive discourse relevant to a particular domain, etc.) The substance of the case will discuss:

- The context of your classroom (relevant aspects of the course, student population, and school)
- Your intentions for student learning (i.e., your learning aims, including aspects of students knowing and learning associated with the development of skills, conceptual understanding, and participation)
- Your account of the learning problem you were trying to address, including your hypotheses about what your students knew and knew how to do (i.e., what you felt you could build upon), as well as what concerned you about what they did not yet know or know how to do
- What you and your students did in the course of the teaching event or process, what resources supported their activities, and how you organized and directed their activities
- What the activities required in terms of student participation, understanding, and skills
- What problems, dilemmas, questions, or puzzles you encountered
- What occurred as a result of your efforts—both intended and unintended consequences, including evidence about student learning
- Your hypotheses about why these results occurred, with reference to what we know about learning and performance
- Your reflections about the event and what you learned, including what you might do differently when you teach this material again
- Your answer to the question, “What is this a case of?”—use terms that would help other teachers use your case report to inform their work when they encounter problems similar to the one you discussed
Basic Components

Three components comprise a case report: (1) the case narrative, (2) the case analysis, and (3) case commentaries.

The Case Narrative (5 to 10 pages)

Although there is no single formula, all case narratives will have some pieces in common:

Plot—Cases should have a plot. The plot often follows a pattern like the following: You plan to teach a particular concept or set of skills to a group of students in a specific setting. This sets a problem for you and your students. Your intentions include a rationale for teaching these ideas, a discussion of what you expect students to learn, and an intended scenario for how the lessons and learning will unfold. When you teach, things usually do not go quite as planned. Either students do not respond as you expected, some respond in different ways than others, they know more or different things than you had predicted, or unexpected blessings or glitches arise. This requires that you adapt to the surprises or otherwise make sense of the events. You may then want to report on how the modifications went or simply on how you interpret what occurred—your sense of why things unfolded as they did.

Context—Cases are situated in specific locations and at a specific point in time. Describe the particulars in the context. Tell us about the school, the community, the students, the history of the class, whatever details are relevant to help your reader understand the situation.

Problem—Embedded in any act of teaching is a learning problem. The problem for your students comes from their need to know, or know how to do, something that they do not already know or know how to do. The problem for you includes deciding on a set of goals or a standard that you and your students will strive to meet, deciding on how you and your students will know whether and how they are meeting these goals, and designing learning activities and resources for your students through which they can accomplish what you hope they will.

In this case, the problem is your sense of what students needed to learn and the questions you had about how to teach these things to them.

Analysis of the content and learning goals—Because your case is one of learning and teaching in one of your subject matters, include an analysis of the content material (e.g., negative and positive numbers, the concept of democracy and dictatorship, *Romeo and Juliet*) and what you wanted students to learn and learn to do, including ways that you wanted your students to participate in the learning activity and how you wanted them to learn to participate.

Provide a rationale for why you wanted to teach this content, these skills and concepts, and these aspects of participation to this particular group of students at this point in time.

Intentions—Actions flow from intentions (whether conscious or unconscious). In your case, describe your intentions, anticipations, and expectations. These typically flow from your rationale. What were you hoping to accomplish? What did you expect would happen in terms of how students would engage in and learn from the activities you planned? What reactions from your students did you anticipate and prepare for?

What happened—if cases were multi-course meals, this element would be the main course. Bring your readers into your classroom and help them to vicariously experience the unfolding events and the questions or dilemmas you struggled with. In developing the sequence of interactions you will want to include, not necessarily in this order, your first encounters, moments of tension, how you responded, how the students responded, and what the result was. What participatory, cognitive, and behaviorist processes do you conclude that the activities actually required as you and your students interacted when you taught the lessons? (This may differ from what you originally expected.)
Evidence of what students learned—You may discuss what happened in many ways—how you perceived what happened, how you felt about the process, how students were engaged, and how students seemed to feel—but you must include some evidence about what students actually learned in relation to your intentions. You can frame this discussion using samples of student work or assessment results (tests, papers, projects, exhibitions, or other products); your own observations of their learning before, during, or after this teaching event; or students' reports about their own learning. You may also find that students' learned some things different from or beyond what you intended. This would be equally useful to note. Be sure to describe the variability in student learning outcomes (who learned what) as well as the norm.

The Case Analysis and Reflection (3 to 5 pages)
The case analysis may consist of a separate section, or it may be woven throughout the case. A reflection will generally be found at the end of the case. The analysis should include:

Discussion of why events unfolded as they did—How do you make sense of what happened, based on what we know about participation, engagement, motivation, and learning? Consider both positive and negative outcomes and both intended and unintended consequences. Your analysis can include references to research we have been reading and discussing in this class, outside research, your own well-reasoned opinions and other cases.

Your reflection on the event—How has this case affected how you think about students and their learning? About the content? What lessons do you take from this case for the future, both for teaching this topic and others in a subject matter? What is your answer to the question, “What is this a case of?” What general principles of learning and teaching does your case illustrate, and what should another teacher understand about your experience to make use of what you learned?

Commentaries (1 to 2 pages each)
Commentaries are relatively brief responses to a case that provide additional perspectives on what happened and why, and offer opportunities for a deeper discussion. A fellow teacher might write a commentary. An administrator, instructor, parent, or even a student could also write a commentary. Guidelines for writing and using case commentaries are described fully in the following section.
What Is a Commentary?

Commentaries are relatively brief responses (1 to 2 pages) to a case that provide additional perspectives on what happened and why. The commentary is an opportunity to deepen dialogue, to raise additional insights or hypotheses, and to bring additional perspectives, experiences, or research to bear. Its major purpose is not to praise or condemn. Neither is it intended to provide editing advice. It may add to the interpretation of the case and/or explain how the case is a good illustration of particular ideas or concepts. It may also comment on the value of the case for the reviewer’s own understanding of teaching practice.

Who Writes Commentaries?

One commentary for your case could be written by your “case partner” (and thus, you will also be writing a commentary regarding the case of your partner). Another can be written by another teacher or administrator, an instructor, a parent, or even a student.

Suggestions for Commentary Writers

Here are some general questions to keep in mind as you write your commentary (and you may also wish to share these questions with your commentators to guide their writing):

- What were the main ideas of the case?
- What challenges was the teacher grappling with?
- What really grabbed you?
- What, if anything, did you personally relate to?
- What makes this a particularly good illustration of the dilemma the author is describing?
- What did you learn from this case that might inform your own teaching?

In particular, you might think about offering an alternative interpretation of the case—writers might share a competing analysis of “what this is a case of” that could present an alternative perspective than that offered by the case author. Another important thing commentary writers can do is to make connections in their commentaries. There are several different kinds of connections you might consider making in your commentary:

- **Connections to practice**—Does this case remind you of any experiences you have had as a teacher? What links does this suggest to your own practice or to what you know about teaching?
- **Connections to theories and concepts about learning**—Does this case bring any particular theories, issues, or concepts (from the course or about learning) to mind? In what way might you add or suggest other ways of analyzing this case, using different concepts or theories?
### Rubric for Cases of Instruction and Learning

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<td><strong>The setting and students: What is the context of the case?</strong></td>
<td>The case provides a clear description of the relevant details about the school and classroom setting. A description of the community may also aid the reader in understanding the context of the case. The students in the classroom are described in terms of both who they are individually (culturally, linguistically, ethnically, personally) and who they are as a group (group dynamics, classroom community, student-to-student interactions). The students are described in terms of their prior knowledge of, and experience with, the content or skills that are addressed in the case.</td>
<td>The description of the context is evident. More details about the school, classroom, or community setting would be useful to aid the reader. The description of the students as individuals and as members of a group is partially complete, but needs more relevant details. The students' prior knowledge of content is addressed minimally.</td>
<td>The description needs more relevant details about the school, classroom, or community setting in order to make the case understandable. Description of the students as individuals or as members of a community needs more development if the reader is to understand their learning and behavior in the case. Students' prior knowledge needs to be addressed.</td>
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<td><strong>Educational goals: What did the teacher intend the students to learn?</strong></td>
<td>The case describes what the teacher intended the students to learn during the instructional sequence (i.e., conceptual understandings, new skills, metacognitive processes, attitudes, or behaviors). The learning goals are clear to the reader, and the learning experiences are described in enough detail for the reader to have a basic understanding of the content being taught. The case provides the curricular context for the learning goals and describes how these goals fit into the broader context of the course or the current unit.</td>
<td>The case describes some of what the teacher intended the students to learn during the instructional sequence. The description of the learning goals and/or experiences leaves the reader partially clear about what content is being taught. More details would be useful. The case gives us a glimpse of how the learning goals fit into the broader context of the course or the current unit. More relevant details would be helpful.</td>
<td>It is not yet quite clear what the teacher intended the students to learn during the instructional sequence. More detail would be helpful. More description of the learning goals and experiences is needed to help the reader understand the content or skills being taught. It is not entirely clear how the learning goals fit into the broader context of the course or the current unit.</td>
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Case Author: ________________________________
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<td><strong>Case scenario: How did the events of the case unfold?</strong></td>
<td>The case has a clearly developed narrative that:</td>
<td>The case includes most or all of the narrative components. The following aspects of the narrative would benefit from more detail or clarification:</td>
<td>The case narrative still needs development in terms of the following narrative components:</td>
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<td>• Communicates the teacher’s intentions and expectations for how the teaching and learning would unfold:</td>
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<td>• Explains any problems, difficulties, or surprises that emerged during or after the instruction;</td>
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<td>• Discusses the students’ reactions or responses; and</td>
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<td>• Describes the teacher’s thinking and next steps.</td>
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<td>Both the teacher’s and the students’ reactions to the instructional sequence are described with supporting evidence (i.e., dialogue exchanges, examples of students’ responses to assignments, descriptions of teacher and student actions, and descriptions of the teachers’ thoughts and reactions during instruction).</td>
<td>Participant reactions are included. More evidence would help the reader to better understand these reactions or particular perspectives. In particular:</td>
<td>Greater understanding of participant interactions is needed. Information and evidence about how students reacted and what they learned should be included. In particular:</td>
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<td>Analysis/Interpretation: How does the teacher make sense of what happened?</td>
<td>The case provides a thorough explanation of how the teacher made sense of what happened by examining what the teacher thought worked and what did not work with regard to student learning and understanding.</td>
<td>The case explains how the teacher made sense of what happened. The case would be strengthened further by more elaboration and/or information about student learning.</td>
<td>The case needs more explanation and/or evidence about what the teacher thought worked and what did not work, with regard to student learning.</td>
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<td>The analysis provides well-grounded reasons, motives, and rationale for why the teacher thinks the instruction and learning unfolded as they did. These are consistent with the evidence provided.</td>
<td>The analysis provides reasons for why the teacher thinks the instruction and learning unfolded as they did. The explanations would be more persuasive if more fully developed.</td>
<td>The analysis needs to include an explanation for why the teacher thinks the instruction and learning unfolded as they did, including motives, reasons, and rationale. The explanation needs to be linked to the evidence provided.</td>
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<td>The analysis draws on larger, theoretical ideas about learners and learning, transfer, culture, curriculum, instructional design, and teaching methods that help support the hypotheses and explanations in the case. These ideas may be drawn from the readings in this course or other courses.</td>
<td>The analysis draws on larger, theoretical ideas about learners and learning. More connections to these ideas are possible and would benefit the interpretation of the case.</td>
<td>The analysis will benefit from drawing on larger, theoretical ideas about learners and learning, curriculum, and teaching. In particular:</td>
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<td>Reflection: What does the teacher (author) learn from the case?</td>
<td>The case looks retrospectively at the events presented and addresses the question of what might be done differently in future instruction. The teacher's reflection explores what has been learned from the case and suggests how future decisions about curriculum, instructional design, pedagogy, or other aspects of teaching might be affected by this new understanding.</td>
<td>The case looks retrospectively at the events presented. It could be strengthened by more attention to what might be done differently in future instruction. The teacher's reflection describes what has been learned from the case and how future teaching decisions may be affected by this new understanding. More explanation would help communicate this to the reader.</td>
<td>The case does not yet reflect on the meaning of the case or address the question of what might be done differently in future instruction. The teacher's reflection minimally explores what has been learned from the case and needs to offer suggestions for how future teaching decisions might be affected by this new understanding.</td>
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<td>Quality of writing: Giving attention to the crafting of the case.</td>
<td>The case engages the reader, using vivid language and details of the interaction and holds the reader’s interest by presenting a provocative or compelling story. The theme is clear and is captured in the case title that describes “what this is a case of.” The organization of the case is easy to follow. The writing is clear and uses conventions (grammar, spelling, etc.) appropriately. The case includes appropriate citations to the research ideas that are referenced.</td>
<td>The case has a clearly developed story. More vivid details could bring it alive for the reader even more fully. A theme is stated and could be further developed to answer the question, “What is this a case of?” The case can be understood. Some structural organization would make it even clearer. The writing is generally clear, and conventions are mostly used appropriately. The case includes reference to appropriate ideas; citations to the research are needed in some places.</td>
<td>The case presents a story that may need more clear organization or the story is told in broad, generic terms that need more supporting detail. A theme needs to be developed to answer the question, “What is this a case of?” The case is a bit difficult to follow and could benefit from more organization and clarity. Revision should include a focus on the use of conventions (grammar, spelling, etc.). The case does not yet include appropriate reference to theoretical ideas or citations to the research.</td>
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<td>Overall: Does the case teach other teachers?</td>
<td>The narrative selected for the case is case-worthy—it addresses an important area of learning and teaching, an uncertainty or dilemma that other teachers can identify with, and has the potential to stimulate other teachers to reflect on their own work. The case successfully shows how the specific classroom situation reflects broader ideas about learning and teaching and provides evidence that the case author has learned from his or her own experience.</td>
<td>The narrative selected for the case is case-worthy. More explanation would help other teachers identify with and reflect on it. The case adequately describes how the specific classroom situation reflects broader ideas about learning and teaching. More explanation of the implications would be useful to readers.</td>
<td>The narrative selected for the case does not yet draw out the significance of the events so that it can inform other teachers’ work. More discussion of the meaning of the situation will be helpful. The case describes the specific classroom situation. It will benefit from discussing how the situation reflects broader ideas about learning and teaching.</td>
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Notes for Facilitators

Suggestions for Planning

Using this assignment takes careful and detailed planning at the beginning of the course. Many of your class sessions may effectively serve to facilitate and guide the case writing, using learners' work in progress to frame your planning for individual sessions. We believe this initial planning offers a big pay-off in terms of learning.

In most sessions, the Write Your Own Curriculum Case assignment—a part of Section V. Other Learning Activities and Assessments, Long-Term Assignment—asks learners to consider their cases by thinking about a series of questions relevant to the session topics. Facilitators may assign these in a variety of forms, including individual reflection, peer sharing and feedback, or an individual learner answering questions from a whole group about his or her case.

Make choices about what you will require for this assignment. In particular, will you have learners act as case partners with one another, participate in case conferences, and/or write case commentaries? How many drafts will be required?

Introduce cases as a writing genre and a reflective, explanatory, and analytic tool to look at student learning and teaching. Here are some suggested ways to begin:

• Reading the sample cases in this appendix and discussing them. [See Long-Term Assignment in Session 1’s Other Learning Activities and Assessments section.]


Additional ways to help support the case-writing assignment include these choices:

• Selecting course sessions where you will use the session's curriculum case-writing questions as opportunities for reflection

• Assigning case study partners

• Selecting class sessions for using the curriculum cases in progress to structure and plan that session's learning activities

• Planning and scheduling case conferences

• Asking students to write case commentaries about each other's cases
Possible Structures To Support the Curriculum Case Activity

Case Partners
Learners pair up, either through self-selection or leader assignment, with a classmate to share, discuss, and critique each other’s developing cases. Partners become familiar with one another’s cases and offer assistance and an additional perspective to help each case writer formulate and deepen the writing and understanding of his or her case. This structure allows for quick or extended partner check-ins, both in and outside class, as well as consistent peer review that can be guided by the preceding Rubric.

Case Commentaries
These are brief written responses to a learner’s final draft of the case. These responses may raise another perspective on the case, draw connections between teaching theories and practices, or support enduring questions and dilemmas that a particular case raises. These commentaries can be the first formal step in using this case with a larger audience to foster professional inquiry and learning, while offering feedback and food for thought to the case’s author.

Case Conferences
These are small-group discussions that center on learners’ cases. Usually, each small group has a guide appointed by the leader (e.g., a supervisor of new or beginning teachers, a more experienced practitioner, or a veteran case author). These conferences occur after one or more case drafts, but before the final draft. Presenting their cases helps case writers to clarify and sharpen those cases. Discussants reflect on, comment on, and raise questions about the case. This is a chance to have rich discussions centered around particular teaching and learning events that can benefit the case writers in their tasks and foster learning for all discussants.

Sample Timeline for a 13-Week Course
The following timeline, designed for a 13-week course, can help guide your sequencing and timing for the case assignment. The timeline is based on the assumption that assignments will be handed back by the leader by the following class. It also includes assignments that depend on the use of case partners, a case conference, and case commentaries. These last three features are optional.

Week 1: Case discussion [see Long-Term Assignment in Session 1’s Other Learning Activities and Assessments section]
Week 3: Summary of the case due: a brief (1- to 2-page) essay about the particular teaching and learning event that the learner will write the curriculum case about
Week 5: Assignment or selection of case partners
Week 6: First draft of the case due, in two copies—one for peer review by the case partner and one for review by the leader
Week 7: Peer review of the case, using the rubric, due to the partner
Week 10: Penultimate draft due
Week 12: Case conferences
Week 13: Final case due (with commentary)
Case Conference—A Guide for Facilitators

In our course, learners are being asked to write a case that focuses on a teaching and learning event. Their cases address challenging dilemmas, questions, or issues that have been raised in the teaching—and learning—of a key concept in their subject matter.

Purpose of the Final Case Conference

The learners have now completed their penultimate draft of their cases, after writing at least two rough drafts. At this point, they have been able to identify and articulate some of the issues, dilemmas, and questions at play in their cases. In this case conference, we want participating learners to have a rich discussion of the teaching and learning in these cases, informed by theory from the course. We hope learners will share different perspectives and insights regarding some of what might be going on in the author’s case. We also hope learners will begin to talk about connections they make to the cases presented (connections to their own practice; to other cases they have read, and/or to the readings in the course).

Format of the Case Conference

With groups of four learners, each learner has approximately 25 minutes for his or her case. This allows time for a five-minute break after two case presentations. We suggest the following timing:

- 5 minutes: the author presents his or her case
- 20 minutes: the author gets feedback from other participants

Please note that each author has a “case partner” who should serve as a scribe—to take notes on the discussion for the author.

Suggestions for Facilitating the Discussion

Often learners have a great deal to say and suggest about one another’s cases. However, if learners need some prompting, you might ask questions like:

- What really grabbed you about this case? What did you personally relate to?
- What makes this a particularly good illustration of the dilemma the author is describing?
- What did you learn from this case that might inform your own teaching?
- Does this case remind you of any experiences you have had as a teacher?
- Does this case bring any particular theories, issues, or concepts from the course to mind? Could using different concepts or theories lead to a different interpretation of this case?

Reference

Exemplary Case Studies

It’s a Process: A Case of Teaching for “Understanding” and “Authenticity”

By Jessica Rose Marchetti*

Setting the Stage
The setting is a freshman/sophomore full-year chemistry class at Peaks High School.** Peaks High School serves 1,400 students and is located in an upper middle class suburb of San Francisco. The sophomores in this class took integrated science the year before as biology is taught after chemistry at Peaks. The course is a required course at Peaks High School and there are no prerequisites. Due to open access at Peaks, and chemistry being the first required science course, the student population includes the gamut of learners at Peak, minus the two sections of students who are in Honors Chemistry. The composition of the class is 19 boys and 7 girls.

The class meets first period every day from 8:05 a.m. to 8:55 a.m. I believe as a combination of the early hour, the personalities of the students, their seemingly disconnected attitude with the material, and some students’ determination that they “don’t understand the material,” the students are typically extremely quiet and not excited about the material during class. The students come from diverse backgrounds, ethnically and economically. Three of the students are English Language Learners, and have come to the United States within the last few years.

The students in this class are respectful of each other, yet they are not what I would consider “friendly.” A couple of students are friends outside of this class and converse with each other in class. The other students mainly tend to keep to themselves and only talk to other students when it is absolutely necessary when they are working in groups. One of my major goals this semester is to create more of a classroom community, wherein the students turn to each other for help and develop academic as well as personal relationships with one another. Right now the tendency is for students to ask my cooperating teacher or I questions rather than ask a fellow student.

For the first semester, I mainly acclimated myself to this classroom and to the school community. I observed my cooperating teacher, got to know my students, and worked with the students one-on-one and in small group settings. Occasionally, I lead the entire class in discussion or presentation of material. Since the beginning of the second semester, I have completely taken over the class and am responsible for leading all instruction and completing all grading. In regards to planning, my cooperating teacher and I prepare together every day. For this unit, in general I am working with my cooperating teacher's lesson plans and sporadically bringing in a few of my own ideas. As the semester progresses, I will be designing more of the presentation of curriculum on my own.

The curriculum for this year is structured around teaching the students problem solving and analysis skills using chemical reactions as the context. The students learn about different types of chemicals, how and in what ratios they react, and what this means on a microscopic as well as macroscopic level.

The format of this course, as designed by my cooperating teacher, thus far has been short teacher-led instruction, followed by small-group work tasks using manipulatives and workbook worksheets, and then hands-on laboratory experiments. The students are formatively assessed on their in-class performance, the completion of homework, and written laboratory reports. The culminating assessment is always a unit test made up of free response and sometimes multiple-choice questions. The test is given by all of the teachers of chemistry and is given on the same day.

* Reprinted with permission from Jessica Rose Marchetti. Marchetti, J. (2002). It’s a process: A case of teaching for “understanding and “authenticity.” Unpublished manuscript, Stanford University School of Education, Stanford, CA. All rights reserved.

** All names of schools and individuals are pseudonyms.
Appendix B - 256 - The Learning Classroom

Behind the Scenes
This curriculum case is focused on the first unit of the second semester, stoichiometry. This unit is the most math-intensive unit in this course. It should be noted that many chemistry courses in high school are taught to sophomores and juniors, who have already taken biology and who most likely have a higher math level than the students I am working with. Stoichiometry is measuring quantitatively the amounts of elements or compounds involved in a chemical change (Heath Chemistry, 1987). This is an essential concept in chemistry, as all laboratory calculations involving chemical reactions and their components use stoichiometry. To teach stoichiometry, we have decided to use dimensional analysis, a method of organizing fractions in a way to convert between different units. For example, to figure out how many meters are in 5 feet, you would start with the given, 5 feet, and use a series of fractional conversion factors to get to your answer:

\[
\frac{5 \text{ ft}}{1 \text{ ft}} \times \frac{12 \text{ in}}{1 \text{ in}} \times \frac{2.54 \text{ cm}}{1 \text{ meter}} = 1.524 \text{ meters}
\]

After teaching for two years on my own in a chemistry classroom and after talking with my cooperating teacher, we agreed that this topic frequently gives students a great deal of difficulty, particularly those students who do not feel comfortable with math manipulations, conversions, fractions, and pattern recognition.

Earlier this year, we introduced the students to the concept of dimensional analysis and the students worked through basic and more complicated calculations. We have continued throughout the year to return to dimensional analysis as a useful tool for tackling mathematical calculations and conversions. While most students feel comfortable with this process, there are a number of students who still appear to be disconnected from dimensional analysis and do not understand how to use it to solve a problem.

In this unit, I had three academic goals for the students and one behavioral goal. First, I wanted the students to come to know how to apply dimensional analysis in a new context, in this case chemical equations. The second goal was for the students to come to know a number of new conversion factors when working with chemical reactions, how to derive them, and what they meant. The final academic goal was for me the most important, for it had real-world chemical and logical applications. We wanted students to come to know a method for taking quantities that they can measure in the lab and predict how much of a substance they will need or produce when running a particular chemical reaction. Arguably, this is an essential skill and can be transferred to any activity in which a person is creating something from a recipe, for in essence that is all a chemical reaction equation is. The behavioral goal was that I wanted to develop a more cohesive, supportive, and personal community of learners in the classroom. I hoped to create an environment in which the students felt comfortable and empowered to learn from and with each other.

In order for the students to come to know these objectives the curriculum was designed around two major components. The first component involved the teacher presenting new facets of this topic to the students, and then the students working in groups to solve these problems. The second genre involved two laboratory experiments, more "authentic" forms of learning and assessments (1999, Oakes & Lipton, 193), in which the students would apply the stoichiometry concepts they were learning to a real-world experiment.

It was our intention that the first two academic objectives would be developed through the first and more structured component. Then, the laboratory exercise would help the students meet the third objective, connecting the mathematical and scientific concepts in the first two objectives to an authentic and real-world task, like the laboratory experiment. To reach the behavioral objective, all in-class activities and learning strategies for this unit were completed in groups to encourage communal learning.

My cooperating teacher and I put a great deal of effort and discussion into the first component. We spent many prep periods discussing how best to present the material and how we could make the concept as engaging and intellectually accessible as possible. Each day new demonstrations were designed and presented to give the students macroscopic and visual representations for the conversion factors we were presenting.

After the first few days of the students listening to our explanations and working through the worksheets, my cooperating teacher and I felt that the students did not fully understand the concepts. They were beginning to confuse a number of the different conversions factors and they were blindly following whatever "pattern of the day" we were teaching with no idea how to discriminate between what pattern to use when and why.
For example, one of the first conversions we learned was that 22.4 liters of a gas is equal to one mole of the gas, at standard temperature and pressure. Later in the unit, we learned that for a liquid solution, we can use “molarity,” the number of moles of a substance per liter of solution, to convert between volume and moles. Once we learned about molarity, the students would use this conversion factor for any question involving volume. They could not discriminate or realize when to use the 22.4 liters and when to use molarity. When I asked the students to “talk me through” how they were solving problems, I realized that even though the conversion factors were for completely different types of substance, one for gases and one for liquids, the students were not visualizing the problems to see what was really being asked for. Instead they saw the symbol for liters or milliliters and immediately started writing numbers and conversion factors down.

My cooperating teacher and I decided to create a game in which the students would physically “walk” through the calculations they were working on and become “part of” the problem and solution. We designed a life-size board game, in which the students chose different paths to take based on the knowns and unknowns in the problem (See Exhibit B-1: Stoichiometry Pathways Game). We hoped this would give the students a visual step-by-step procedure and model for solving these types of questions. The students would first walk through their calculations on the board game while carrying representations of the correct state of matter. For example, for a gas, students would carry a balloon and then trade it in for a bottle filled with powder if they were solving for a solid (See Exhibit B-2: Game Manipulatives). After the students walked through the game, they would color in their path and write down, in mathematical form, what they did as they walked (See Exhibit B-3: Stoichiometry Pathways Worksheet). The game was intended to force the students to think about where they were beginning with a problem, the “known;” what they needed to find, the “unknown;” and how they were going to get there, the conversion factor(s). The game was meant to help the students work through and understand the concepts being taught in class and those asked for on the worksheets.

The second component of this unit was the laboratory piece. The students would complete two labs in this unit. The first lab was a more straightforward experiment with a simple percent yield calculation at the end, while the second experiment involved more complex procedures and analyses. In the second lab, the students were again asked to use stoichiometry to calculate the percent yield, but in addition they had to use stoichiometry to figure out how to make up the reacting solutions, and then to figure out which solution was the limiting reactant and therefore how much product should be produced. (For the lab handouts, see Exhibit B-4: Percent Yield of NaCl Pre-Lab Handout and Exhibit B-5: Stoichiometry in Action Pre-Lab Handout.)

For both labs, pre-lab write-ups were required. A pre-lab is a task in which the students organize and write down what they will be doing in the lab, why they are doing it, what data they will need to collect, and what calculations they will perform with their data.

The labs were meant to give the students real-world and authentic experiences and models for using their understanding of stoichiometry, which is a potentially abstract concept. The students were given pre-written purposes and procedures for each lab. The first lab was done in the second week of the unit and took one day to complete. The second lab was done in the fourth and last week of the unit and took two days to complete. The written report, which follows each lab, was done at home. Both labs involved similar calculations and concepts, however, the second had many more variables and components that the students had to reconcile. The students worked in groups of two to three in the laboratory but each student was responsible for his/her own write up.

Similar to previous units, the summative assessment for this concept would be a free-response test consisting of 13 stoichiometry problems to solve (See Exhibit B-6: Stoichiometry Test).

What Happened
The results of the two types of instruction were mixed. The more straightforward form of instruction with the integration of the board game was a huge success. The students completed the game and the accompanying questions very well. I noticed the students frequently returned to the patterns drawn on the floor to solve subsequent problems. In addition, I observed that many students had sketched the game board pattern on top of their worksheets and tests throughout the unit to help them answer questions.

In contrast, the laboratory activities were mixed. The initial lab activity met with pretty good success; most students said they understood what they were doing, worked thoughtfully in the lab, and turned in well-written and accurate lab reports. The second lab, unfortunately met with much less success. Many students worked in the lab
with little idea what they were doing or why they were doing it. I make this assumption based on the types of
questions they were asking me while they were in the lab and the manner in which they handled the chemicals
carried out the procedure in the lab. The lab write-ups for the second lab were less organized than the pre-
vious lab, and the core calculation for this lab was done incorrectly more than 50% of the time. (See Exhibits B-7
to B-9: Samples of Student Work.) I will discuss in the So What Does It All Mean? section of this paper why I think
this discrepancy between the two labs took place.

Interestingly, on the culminating exam for this unit, the students did exceptionally well, 14 students earned an A,
six earned a B, one earned a C, and three failed. This outcome is substantially higher than it had been on previous
tests. It should be noted, however, that the test problems mirrored the problems the students had to solve in their
workbook pages and during the board game. The questions were formatted in exactly the same way and asked
for the same unknowns. The test questions did not ask the students to be able to do the type of problem identi-
fication and application of concepts to an actual experiment that their labs did.

At the end of this unit, I asked the students to write on the bottom of their tests what aspect of this unit really
helped their learning and any suggestions they had for the future. This was the first time we have asked the
students to do this, and I found the answers extremely helpful and enlightening. The overwhelming response
from the students was that they found the stoichiometry game extremely useful in terms of their learning the pat-
terns. Conversely, a number of students noted that the laboratory activities do not enhance their learning and are
not helpful. (See Exhibits B-10 to B-12: Student Responses.)

The students' reflections correspond directly with my observations of the students' learning during the unit. It is
precisely these findings that inspired me to focus on this curriculum unit for my case study. In this case, I will
explore whether the summative assessment used for this unit truly assessed the students' understanding
of stoichiometry. By understanding I mean the students' ability to interpret what they are doing in the mathematical
calculations and their ability to apply the stoichiometry concepts to other contexts and situations. In this case, I will also
discuss whether the summative unit test assessed the students' ability to meet the objectives we set for this unit.

Students will come to know:

1. How to apply dimensional analysis in a new context, in this case chemical equations.

2. A number of new conversion factors when working with chemical reactions, how to derive them, and what
   they mean.

3. A method for taking quantities that they can measure in the lab and predicting how much of a substance they
   will need or produce when running a particular chemical reaction.

In addition, I will investigate why the students seemed to have much greater difficulty with the second lab, what
I would consider to be the more "authentic" activity and assessment.

So What Does It All Mean?

While the results of the summative assessment suggest that the students gained a basic understanding of the
concept of stoichiometry, inasmuch as they could apply it to the test questions, I am not convinced that they com-
pletely understand the usefulness and the applicability of this concept. Mansilla and Gardner define understand-
ing as the “ability to make productive use of the concepts, theories, narratives, and procedures available”
(Mansilla & Gardner, in Wiske, 1998, p. 162). Similarly, Perkins defines understanding as “the ability to think and act
flexibly with what one knows” (Perkins, in Wiske, 1998, p. 40). Both of these definitions get at understanding from
a performance perspective. While knowledge may be a quantity that can be possessed, understanding is the
ability to do something with that knowledge.

At the beginning of this unit, strategies were used to engage students and to begin to develop a cognitive pat-
tern for them to tackle stoichiometry. The kinesthetic activity of using manipulatives and walking through the
board game is illustrative of Gardner’s Multiple Entry Points (Gardner, 1999). This was successful in creating for the
students an excitement for solving these problems, a visual image of what the question was about, and a kines-
thetic and pictorial representation for how to solve the problems. This was, however, only a start to the process of
developing full understanding.
Darling-Hammond discusses the difference between an expert and a novice as the manner in which an individual organizes information. Experts organize knowledge around central ideas and concepts, while novices organize information around unrelated and chunked facts and patterns (Chi et al., 1981; Larkin, 1981, 1983, cited in Darling-Hammond, 2001). I believe that while many of my students achieved a novice understanding of this topic, few truly achieved expert comprehension as few students were able to adeptly “transfer” the concepts used in the more abstract arena of the game activity and worksheets to the real-world simulation in the laboratory. Gardner argues that “learning with understanding” only occurs when students can successfully transfer what they have to a new situation (Gardner, 1991).

Schools traditionally differ from the real world in that schools focus on abstract reasoning, while everyday settings involve much more contextual reasoning (Resnick, 1987, cited in Bransford et al., p. 62). I believe this, too, was the case in my class. Ninety percent of the time spent on this unit was devoted to the abstract problems and solutions, while only 10% of the time was devoted to working in the laboratory. In this analysis, I will explore reasons for why the students’ performance was so different in the two forums in addition to benefits and disadvantages of focusing on one type of reasoning when teaching.

While the laboratory portion of the course has always been an essential component, I do not think we have structured the course around this form of application, nor do I think we have done all that we can to scaffold the students in how to manipulate and analyze their data. We generally spend one to two days carrying out a laboratory activity and then the students write up their results individually at home. For most of the labs in the past, we have clearly laid out how the students should work through their data and what calculations they need to perform.

This was the case in the first lab of this unit, but not the second. In the first lab, I clearly laid out for the students what each piece of data meant and the calculations they would do with each piece. I also held an all-class discussion about different answers the students may have gotten and what each result would mean. In essence, I gave the students a pattern for solving these problems, just as I had done with the game for the stoichiometry at the beginning of the unit.

In contrast, in the second lab, we turned over all of the responsibility and thinking to the students. We scaffolded or "held the hands of" the students so much up until the second lab and then completely changed the procedure in this second lab. I believe that it is important for the students to be able to manipulate data on their own and create their own patterns, for it shows real understanding. In retrospect, however, I realize that the planning of this activity was not effective in both fostering understanding and assessing it. I think the de-scaffolding was too abrupt for the students and we did not allow enough time for them to work through the concepts with their lab groups.

The second lab was not designed well to let the students truly develop their understanding of what was going on and how they could apply the concepts of stoichiometry to it. We did not afford the students enough time to work through their data and discuss and interpret their results with their lab groups in class. This was the first time the students were asked to apply the knowledge they had to a particular task and tackle the application entirely on their own. I believe understanding and application is difficult to develop and takes time, many conversations, and physical engagement with the materials.

In addition, this activity was an unfair assessment of the students’ understanding because we did not scaffold the students to be able to make these types of applications on their own. We needed to ease the students into independently breaking down lab results and not change the task so abruptly. In this way, as we began to transfer the students from listening to the teacher’s model for how to interpret their results to doing it on their own, we would have provided a middle ground of working in groups so the students could teach and help one another. We needed a time of apprenticeship, scaffolding, and interactive group work before throwing students into the more “authentic” forms of assessment. My cooperating teacher and I hoped that because of all of the structure and help we had provided in the past, that when left on their own they would have all of the tools necessary to complete this lab. In actuality, we were very wrong!

Transitioning students from a novice level of understanding to an expert level, fostering in students the ability to apply and transfer what they are learning to new contexts and real-world problems, and developing in the students the capacity to approach situations with skills of analysis and interpretation involves a great deal of careful planning and reflection on the part of the teacher when designing curriculum. Teachers not only teach students...
content, but they teach them a way to think in a specific discipline and across disciplines. This takes a great deal of scaffolding, modeling, and time.

Collins, Brown, and Holum propose the idea of “cognitive apprenticeship” as a model of instruction in which the teacher makes their thinking visible in order to help novices become experts in a particular field (Darling-Hammond, 2001). The stages to the cognitive apprenticeship process are modeling, coaching, scaffolding and fading, articulation, reflection, and exploration (Collins, Brown, and Holum, 1991). In reflecting on this case, I believe that my cooperating teacher and I have consistently tried to make our thinking visible to the students when discussing past laboratory activities, and we have scaffolded them by giving them models for interpreting their data. It is in the stage of “fading” where I think we have not supported our students as well. Instead of “fading” we just “cut off.” We gave the students our models for analyzing data in previous labs and now asked the students to recall those and apply them to this lab all on their own at home. We also never asked the students or gave them time to critique our models, to create some of their own, and to reflect on the similarities and differences between them.

This was the first lab where the students were totally left on their own with the calculations and the interpretation of results. In addition, this lab involved a number of different components and sources of analysis. This lab was the most complex lab, inasmuch as the type, amount, and difficulty of the calculations necessary, that we have done all year. When I read over the students’ lab notebooks, what I noticed was a number of students confusing what different pieces of data meant and a number of disorganized and incomplete calculations.

In thinking about the obstacles the students had to overcome to fully engage in and understand what was going on in the lab, I would also like to include the idea of a pre-lab in this case study. Before almost all labs, the students are asked to write up these “pre-labs.” The pre-lab asks the students to read over the pre-written laboratory procedure and think about what the lab is asking them to do. It is my hope that having students write pre-labs helps them gain a better idea of what they are going to do in the lab and why they are doing it.

When a person is given the responsibility and opportunity to create a lab investigation and procedure on their own, they have a much better sense of the purpose and design of the lab. However, for a pre-written lab, the student must figure out the purpose and procedure from the pre-written instructions. Ideally, I would like to move to more and more labs in which students are designing the investigation on their own so that they can take greater ownership of the task and have a clearer idea of what they are doing and why.

The second lab in this unit was a two-day lab and was to be conducted during class on Monday and Wednesday. What I noticed on the day of the lab was that only 50% of the students had completed their pre-labs. Without a pre-lab, the students are not allowed to go into the lab, a protocol I established at the beginning of the semester. For the first lab of this unit, only two students did not have a pre-lab. In this second lab, however, only half of the class was able to start the lab on time because they had completed their pre-labs. For the students who did not have pre-labs done, I let them work on their pre-labs in class and then they could go into the lab as soon as they finished. However, depending on how long it took the students to finish, some students would not have time to complete the lab in class. These students had to make time later that day or the next day to finish it up.

The decision I made about holding the students back from doing to the lab raises many questions. What I would like to focus on in reference to this case is, “Why did 50% of the students not do the pre-lab in the first place?” Was it because they are not used to this new procedure and did not expect to really not be allowed into the lab? Did they not have enough time to complete it? Were they too busy the previous weekend watching the Superbowl? Or did they not understand enough of the concepts to complete it or to even know where to begin?

After talking to a number of students and trying to collect data, I realized that it was a combination of all of these. In particular, many students did not understand how to do the preliminary calculations needed to prepare the initial solutions. This piece of formative assessment was another piece of evidence that made me believe the students were not ready to be thrown out on their own yet in writing this lab up. However, we were under the time crunch of having to give the test the following Monday, because that is when the other teachers were giving it, and each day between now and then was already accounted for.

The fact that a number of students had not completed the pre-lab ahead of time meant a number of students had not spent time thinking through what they would be doing in the lab and why they would collect the data they were to collect. These students were forced to write the pre-lab very quickly and rush through these preliminary...
thoughts. As a result, I think many students had little idea of why they were carrying out the procedures they were in the lab and what their data meant.

Finally, I would like to present the results of an unplanned but telling controlled experiment that happened in this class about one month after this case took place. It was towards the end of the next unit, which was on heat. The students once again were working on a complex laboratory experiment, whose write-up involved a great deal of interpretation of data and application of concepts to a number of different types of calculations.

Once again, and against my better judgment, we initially did not have time in the unit to devote in-class time to writing up the lab in groups. Coincidentally, however, the Exit Exam testing days occurred right when the lab was planned. As we could not teach new material on these days because half the class was missing, we decided to give the students an entire class period to write up the results of their lab with their lab group.

It was amazing to see what transpired. The students initially just stared at their data with no idea what to do with it. Hands immediately went up, and the students called me over to tell them "what to do." My objectives for this class period were to encourage the students to start depending on each other and to build their confidence in the fact that while tasks like this are initially overwhelming, they can do it if they work together. My response to each hand that went up was the same, "I want you to talk to each other and figure this out as a group. You are all very intelligent people and if you put your minds together and each contributes, I am sure you will be able to attack this problem." Then I would walk away. Typically, it took the students only about 10 more seconds of staring at each other before they started asking one another questions about what they could do. And wouldn’t you know, within a couple more minutes, they were on their way to organizing and solving the lab calculations.

Later in the period, students again became stuck on different parts of the calculations. Once again, this opportunity to have the students work through their lab reports in class provided a great learning experience. When a group called me over for help, I was able to say, "You know I was just talking to so-and-so's group and they just figured out a great way to approach this part of the problem. You should go over and talk to them." So now, not only were the individuals in the groups working together but the students were walking around the room and collaboratively working with other groups as well. It was a wonderful learning environment to be a part of!

In addition to this evidence that I collected during the class period that supported my hypothesis that the students need more in-class time to fully digest and understand what their lab data means and how to calculate the results of an experiment, the final lab reports were also telling. The difference between the students who wrote up their labs in class and the students who were absent because of the Exit Exam was clear. The students who were in class wrote reports that were more organized, they performed and organized calculations in a manner that revealed more understanding of why they were performing these analyses and how to do them, and these students asked me fewer questions about what to do with their data outside of class.

It was a fortunate coincidence that this event happened just one week before my curriculum case final draft was due. It offered me further evidence to support my assertion that true understanding, in this case the ability to transfer and apply concepts to authentic activities, not only takes scaffolding and modeling but it takes time and collaboration!

Reflection

In this unit, the summative assessment was in line with how 90% of the class time was structured and how the majority of the students’ work was formatted. I would ask, however, were this design and this summative assessment “authentic” for the material and the discipline we were grappling with? I do not believe they were.

The game activity and use of the calculation patterns to answer the workbook and board game questions began to get at engaging the students in critical thinking, problem solving, and pattern recognition; activities and skills which are important to scientists. What was lacking were the ideas of investigation, data collection, and most importantly using the seemingly abstract concepts of chemistry and related calculations in relation to a real scientific investigation and experiment. The laboratory activity was the most authentic form of assessment in this unit and yet it was given the least amount of time, consideration, and development.

Darling-Hammond discusses Bransford et al.’s ideas about understanding by stating that, “Learning must involve more than simple memorization or the application of a fixed set of procedures. Learners must understand a concept or have command of a skill sufficient to be able to use it themselves. They must know how to apply what
they’ve learned to different situations or problems, and they must know when it applies—how it connects to other ideas” (Bransford, cited in Darling-Hammond, 2001, p. 2).

In the end, I am not convinced the students truly understood how to use the idea of stoichiometry in a real-world context. Based on their test scores, the homework they completed each night, and conversations I had with them as they worked through problems, I feel that the students did come to know a great deal about stoichiometry and how to solve word problems using these calculation patterns. What I am less convinced of is the students’ ability to recognize when and how to use these concepts when the data and questions are presented in a less linear and clear way. I am reminded of readings we have done in this class on teaching curriculum in an “intellectually honest” way (Bruner, 1960). Reflecting on this case, I think that we did not do justice to our students and completely teach this topic in an intellectually honest manner.

In the future, I think I would rather devote more class time to using stoichiometry in the laboratory and relating it to the experiments the students were actually working on. Yes, I believe the worksheets and the life-size board game were extremely useful to helping the students recognize and organize the different types of patterns and calculations. In the future, however, I would more obviously structure this unit around the true purpose of stoichiometry, which is to be able to quantitatively measure the amount of a substance needed or produced in a chemical reaction. Next time I teach this unit, I would allow more in-class and group-work time to breaking down the data from a lab and learning how to work collaboratively with their peers to figure out what the data really means, rather than focusing on pre-written word problems.

Learning is a process. There are many levels and stages to learning and understanding. Both concrete and abstract applications and reasoning must be included. In the curriculum unit explored in this case, the process was begun. The students successfully began to engage with the concepts of stoichiometry and their full meaning through a number of different strategies of instruction, yet the students were not given the time nor the environment to fully develop their understanding.

As a student myself, I too realize learning is a process. At the beginning of this assignment, I had no idea what a “case” really meant nor did I understand how to approach the task of writing a curriculum case. It is only through a great amount of time invested, conversations with my professors and peers, continual feedback, and time to reflect do I now understand the purpose and creation of a curriculum case. In addition, as a result of this process, my own understanding of what the events of this particular unit were a “case of” has developed over time.

I know my students’ and my own learning process will only continue....
References


Exemplary Case Studies, cont’d.

Exhibit B-1: Stoichiometry Pathways Game
Exemplary Case Studies, cont’d.

Exhibit B-2: Game Manipulatives
Exemplary Case Studies, cont’d.

Exhibit B-3: Stoichiometry Pathways Worksheet

Name: ____________________________
Walker: ____________________________
Path: ____________________________
Time: ____________________________

Problem: How many grams of aluminum carbonate are produced from 34g of aluminum hydroxide?

\[ 2 \text{Al(OH)}_3 + 3 \text{Na}_2\text{CO}_3 \rightarrow 6 \text{NaOH} + \text{Al}_2(\text{CO}_3)_3 \]

Solution:

What change was accomplished at each step?

Step 1          Step 2          Step 3

Name: ____________________________
Walker: ____________________________
Path: ____________________________
Time: ____________________________

Problem: How many L of carbon dioxide will be produced when 145 g of C\(_4\)H\(_9\)OH are burned?

\[ \text{C}_4\text{H}_9\text{OH} + 6 \text{O}_2 \rightarrow 4 \text{CO}_2 + 5 \text{H}_2\text{O} \]

Solution:

What change was accomplished at each step?

Step 1          Step 2          Step 3
Exhibit B-4: Percent Yield of NaCl Pre-Lab Handout

In this experiment, you will be determining the percent yield of NaCl obtained from the reaction of NaHCO₃ and HCl(aq). After mixing these two reactants and checking for completion of the reaction, you will boil off the water and carbon dioxide byproduct. Only solid NaCl will remain in the beaker.

Percent yield is defined as: \[ \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100 \]

- Actual Yield is what your NaCl product weighs.
- Theoretical Yield is what you calculate (using stoichiometry you should get from the amount of NaHCO₃ you used).
- Percent Yield is thus the fraction of what you should have obtained that you actually did get, changed to a percent.

Place a boiling chip in a 250 mL beaker on a balance and record the combined mass. Then add somewhere between 2.00 and 3.00 grams of NaHCO₃ to the beaker with the boiling chip and record the new mass.

Measure 10 mL of 3M HCl(aq) in a graduated cylinder and slowly add it to the solids in the beaker. Swirl the beaker contents until the solution appears clear. Then add a few drops of the hydrochloric acid until there is no more bubbling when an acid drop is added. Feel the bottom of your beaker.

Place the beaker on a wire gauze resting on a ring attached to a ringstand. GENTLY heat the beaker with a Bunsen burner. Control your flame and be attentive to avoid bumping of the solution out of the beaker due to uneven or too rapid heating. Evaporate the solution to dryness. Let the beaker and solid product cool to room temperature BEFORE weighing. Then reheat the beaker for three minutes and once again let it cool to room temperature BEFORE weighing. Record both masses, but use the smallest one in finding your actual yield.

While you are waiting for the beaker to cool, you can do your Theoretical Yield calculation.

**RESULTS**

a. Write a balanced equation for the reaction.
b. Present the results of all calculations in a TABLE.
c. Label and calculate:
   • actual masses of sodium bicarbonate and sodium chloride
   • theoretical mass of sodium chloride
   • percent yield
d. Describe the appearance of the reaction.

**CONCLUSION**

a. Discuss the reaction with respect to type(s), heat involved before you boiled off the water, and signs of chemical change.
b. State the percent yield. Explain why the yield is not 100% (if it isn’t) in terms of what happened during the experiment.
Exhibit B-5a: Stoichiometry in Action Pre-Lab Handout, page 1

Name: ____________________________

In this lab, you will be determining the percentage yield of NaCl(s) from the reaction:

\[ \text{NaOH(aq)} + \text{HCl(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)} \]

This reaction between a base (NaOH) and acid (HCl) is called a neutralization reaction. One reactant will be in excess, making the other reactant limiting. You will be determining which of the reactants is in excess by chemical means and by calculating the percent yield based on each of the reactants.

**PROCEDURE**

USE ONLY GRADUATED CYLINDERS TO MEASURE VOLUMES

1. With a Bunsen burner, heat an evaporating dish on a wire gauze supported by a ring attached to a ring stand for 3 minutes. Let the evaporating dish cool to room temperature while you are making your solutions. Mass the evaporating dish as soon as it is cool.

2. Prepare 250 mL of 0.432 M HCl by diluting 6.0 M HCl with the appropriate volume of water. You will need to calculate the amount of 6.0 M HCl to use. Do your calculation in the box below.

   **How much 6 M HCl must I use to make 250 mL of 0.432 M HCl?**

3. Measure out 125 mL of distilled water in a graduated cylinder and add this water to an empty 250 mL volumetric flask. Using a smaller graduated cylinder, measure out the amount of 6 M HCl that you calculated, and slowly add it to the volumetric flask. Swirl the volumetric flask to mix the solutions. Fill the smaller graduated cylinder with distilled water and add this water to the 250 mL volumetric flask. Repeat this rinsing of the graduated cylinder two more times. Then add water from the graduated cylinder to the volumetric flask until the bottom of the meniscus reaches the mark on the volumetric flask. Cap the volumetric flask and invert the flask, being careful to place the palm of your hand on the lid when you invert the flask. Turn the volumetric flask right-side-up and upcap the volumetric to release any pressure in the flask. Repeat this process until no more schlieren (wavy lines) are seen in the solution. Check the water level and add a few drops of water if necessary. Mix these drops in by inverting and righting the flask as you did before.

4. Now, prepare the NaOH solution. Prepare 100 mL of 0.653 M NaOH solution. You will need to calculate how much NaOH to weigh out. Do your calculation in the box below.

   **How much NaOH should I use to make 100 mL of 0.653 M NaOH?**
Exhibit B-5b: Stoichiometry in Action Pre-Lab Handout, page 2

5. Place a 50 mL beaker on the balance and record its weight. Then, slowly add NaOH pellets to the beaker until you have added the amount of NaOH you calculated you would need: CAUTION! Do NOT handle NaOH with your hands! Use the tweezers or spatula provided! Add a small portion (about 15 mL) of water to the 50 mL beaker, and swirl to dissolve some of the NaOH. Pour this solution into the 100 mL volumetric flask. Repeat this process for as long as it takes to get all the NaOH into solution, but do not exceed a total volume of 100 mL. Add any water necessary to bring the solution level in the volumetric up to the 100 mL line. Cap and invert the volumetric flask, followed by rechecking the water line.

6. Add 75 mL of the 0.653 M NaOH solution to a 400 mL beaker. Slowly add 125 mL of the 0.432 M HCl solution. Swirl the beaker gently to mix the solutions.

7. Place one drop of your remaining HCl solution on a piece of red litmus paper and another drop of this solution on blue litmus paper. Then place one drop of your remaining NaOH solution on a piece of red litmus paper and another drop of this solution on a piece of blue litmus paper. Record the results of the litmus tests in a data table.

8. Now place one drop of your reaction mixture from the 400 mL beaker on a piece of red litmus paper and another drop of this solution on a piece of blue litmus paper. Record the results.

9. Using your ring stand support system, boil off about half the water and let the beaker cool. Add small portions of the concentrated product solution to the evaporating dish you prepared in step 1. Continue heating the dish until there does not appear to be any water left. Don’t forget to rinse the emptied beaker with a few mL of water and add the rinse water to the evaporating dish. Heat gently to avoid spattering. Let the dish and NaCl cool to room temperature. Then record the mass of the NaCl product. Do a second heating and cooling if there is time.

RESULTS and CALCULATIONS
1. Present the results of your calculations in a table.
2. Label each calculation by what the calculation accomplishes.
   a. Show each calculation that was involved in making up the separate solutions.
   b. Show how you determined the mass of the final product.
   c. Calculate the theoretical yield based on the mL of acid (HCl) solution.
   d. Calculate the theoretical yield based on the mL of base (NaOH) solution.
   e. Which reactant was in excess?
   f. Calculate the percent yield based on the limiting reactant.
3. Does the result of your litmus test confirm the identity of the limiting reactant?
4. Describe the reaction.

CONCLUSION
1. Identify the limiting reactant and tell how you arrived at this conclusion.
2. Report the % yield and suggest consistent reasons for a yield differing from 100%.
Exhibit B-6a: Stoichiometry Test, page 1

Stoichiometry Test (120 points)

Name: ____________________________

1. (10) \[2 \text{Al(NO}_3\text{)}_3 + 3 \text{K}_2\text{CrO}_4 \rightarrow 6 \text{KNO}_3 + \text{Al}_2(\text{CrC}_4)_3\]
How many grams of \(\text{K}_2\text{CrO}_4\) are needed to produce 26.7 g of \(\text{Al}_2(\text{CrO}_4)_3\)?

2. (10) \[\text{Na}_3\text{N} + 3 \text{HCl} \rightarrow \text{NH}_3 + 3 \text{NaCl}\]
What volume of \(\text{NH}_3\) gas will be produced at STP from 22.7 g of \(\text{Na}_3\text{N}\)?

3. (10) \[2 \text{H}_3\text{PO}_4 + 3 \text{Na}_2\text{O} \rightarrow 2 \text{Na}_3\text{PO}_4 + 3 \text{H}_2\text{O}\]
How many grams of \(\text{Na}_2\text{O}\) are needed to react with 76.3 g of \(\text{H}_3\text{PO}_4\)?

4. (10) \[\text{C}_3\text{H}_8 + 5 \text{O}_2 \rightarrow 3 \text{CO}_2 + 4 \text{H}_2\text{O}\]
How many grams of carbon dioxide are produced from 254.6 g of \(\text{C}_3\text{H}_8\)?

5. (12) \[\text{BaCl}_2 + \text{Na}_2\text{CrO}_4 \rightarrow \text{BaCrO}_4 + 2 \text{NaCl}\]
When we mix 250 mL of 0.165 M \(\text{Na}_2\text{CrO}_4\) and 120 mL of 0.327 M \(\text{BaCl}_2\), how much \(\text{BaCrO}_4\) precipitate do we get?

6. (10) \[2 \text{Al(ClO}_3\text{)}_3 \rightarrow 2 \text{AlCl}_3 + 9 \text{O}_2\]
How many grams of \(\text{O}_2\) are produced along with 13.7 g of \(\text{AlCl}_3\)?

7. (10) \[\text{Fe}_2\text{O}_3 + 3 \text{CO} \rightarrow 3 \text{CO}_2 + 2 \text{Fe}\]
What volume of \(\text{CO}\) gas is needed to prepare a 32.7 gram ingot of \(\text{Fe}\)?
Exhibit B-6b: Stoichiometry Test, page 2

8. (10) \[ K_2CrO_4 + 2AgNO_3 \rightarrow 2KNO_3 + Ag_2CrO_4 \]
How many grams of Ag_2CrO_4 are produced from 15 mL of 0.41 M AgNO_3?

9. (10) \[ BaCl_2 + 2AgNO_3 \rightarrow 2AgCl + Ba(NO_3)_2 \]
132 mL of 0.20 M AgNO_3 were needed to react with all the BaCl_2 in 244 mL of a BaCl_2 solution. What is the molarity of the BaCl_2 solution?

10. (10) \[ Ca(OH)_2 + 2HNO_3 \rightarrow Ca(NO_3)_2 + 2H_2O \]
How many grams of Ca(NO_3)_2 can be prepared from 35 mL of a 1.39 M solution of Ca(OH)_2?

11. (5) What is the molarity of a 330 mL solution containing 4.9 g of H_2SO_4?

12. (5) What mass of LiMnO_4 is needed to prepare 150 mL of 0.23 M LiMnO_4 solution?

13. (8) 18 mL of a 2.00 M solution of H_2HSO_4 are diluted to 150 mL of new solution in a volumetric flask. What is the new molarity (M) of the H_2SO_4 solution?
Exemplary Case Studies, cont’d.

Exhibit B-7a: Sample of Student Work from Lab #2, Stoichiometry in Action, page 1

**Stoichiometry in Action**

**Purpose:**

The determine the % yield of NaCl from the reaction of... (Handwritten text)

**Procedure:**

1. First, we heated an evapor dish for 3 minutes.
2. Then, we measured 100 mL of distilled water and added 10 mL of HCl to it. After mixing, we added NaCl pellets into the solution. We then prepared the NaOH, and added 100 mL of 0.65 M NaOH.
3. To the beaker, we added 1 M HCl until we added 10 mL of 0.65 M NaOH. We swirled and added it to the NaOH solution. Then, we added water up to the 10 mL mark.
4. After, we then added 25 mL of 1 M NaOH to the NaCl solution. We added 25 mL of 0.1 M NaCl solution into the NaCl.
5. We then added a drop of HCl on a blue litmus paper. Finally, we added a drop of HCl on a red/blue paper. Then, we did the titration test for each solution.

To make the % yield of HCl, we need to calculate how much 0.1 M HCl to use.

\[
\text{Final HCl} = 100 \text{ mL} 
\times 0.1 \text{ M HCl} 
= 0.1 \text{ M HCl}
\]

On next page. (Handwritten text)
Exhibit B-7b: Sample of Student Work from Lab #2, Stoichiometry in Action, page 2

\[
\begin{align*}
1.53 \text{ M NaOH} & \\
\text{\textcolor{red}{1.000 \text{ mL}} HCl} & \\
\text{\textcolor{blue}{75 \text{ mL NaOH}}} & \\
\text{\textcolor{green}{150 mL HCl}} & \\
\end{align*}
\]

\[
\begin{align*}
\text{mass of final product (HCl)} & \\
41.22 \text{ g} - 38.39 \text{ g} = 2.83 \text{ g} & \\
\text{(curp dish + product) - curp dish = product} & \\
\text{Theoretical yield of } HCl & \\
\frac{41.22 \text{ mol } HCl \times \frac{250 \text{ mL}}{1 \text{ mol } HCl}}{1 \text{ mL } HCl} & = 33.44 \text{ g } HCl & \\
\text{Theoretical yield of } NaOH & \\
\frac{155 \text{ mol NaOH} \times \frac{250 \text{ mL}}{1 \text{ mol } NaOH}}{1 \text{ mL } NaOH} & = 39.14 \text{ g } HCl & \\
\text{The reactant in excess} & \\
\text{is } HCl \text{ because it is the larger of} & \\
\text{the two and } NaOH \text{ is the limiting reactant} & \\
\text{percent yield} & \\
\left(\frac{2.61 \text{ g}}{2.83 \text{ g}}\right) \times 100 & = 92.59 \% \text{ yield} & \\
\end{align*}
\]

\[
\begin{align*}
\text{actual NaCl} & = 3.83 \text{ g} & \\
\text{theoretical NaCl} & = 4.32 \text{ g} & \\
\end{align*}
\]

3) The litmus test proves that HCl is the non-limiting reactant and NaOH is the limiting reactant because HCl turned the red paper blue, this didn't work with the product solution which stayed the same. HCl did nothing to the red paper yet it turned the blue paper red. This is the same as the first product in the experiment proving NaOH was used up and left us as the excess reactant.
Exemplary Case Studies, cont’d.

Exhibit B-8: Sample of Student Work from Lab #2, Stoichiometry in Action
Exhibit B-9: Sample of Student Work from Lab #2, Stoichiometry in Action

Results & Calculations: Calculation for how much 6 M HCl was needed to make 250 mL

\[ 0.452 \text{ M HCl} \]

\[ \frac{250 \text{ mL} \times 0.452 \text{ M HCl} \times 1000 \text{ mL}}{1000 \text{ mL} \times 6 \text{ M HCl}} = 18 \text{ mL} \text{ 6 M HCl} \]

Calculation for how much NaOH was needed to make 100 mL 1.53 M NaOH.

\[ \frac{100 \text{ mL} \times 1.53 \text{ M NaOH}}{1000 \text{ mL}} = 1.53 \text{ g NaOH} \]

Mass of Final Product (NaCl):

\[ 78.9 \text{ g} - 76.25 \text{ g} = 2.65 \text{ g NaCl} \]

Theoretical yield:

\[ \frac{250 \text{ mL HCl} \times 0.452 \text{ moles HCl}}{1000 \text{ mL}} \times 1 \text{ mole NaCl} \times \frac{58.5 \text{ g NaCl}}{1 \text{ mole NaCl}} = 2.18 \text{ g NaCl} \]

\[ \frac{100 \text{ mL NaOH} \times 1.53 \text{ moles NaOH}}{1000 \text{ mL}} \times \frac{1 \text{ mole NaCl}}{1 \text{ mole NaOH}} \times \frac{58.5 \text{ g NaCl}}{1 \text{ mole NaCl}} = 3.82 \text{ g NaCl} \]

Theoretical yield = The NaOH is the limiting reactant.

The HCl was in excess.

- The results of the litmus test say that the HCl was in excess, which agrees with the equation.

Description of Reaction:

Colorless clear liquid. Felt salty. pH = 7.

Slight heat.
The arrow points to the student's answer to the questions, "What was helpful in our teaching of the last unit? What suggestions do you have for what would help your learning in the future?"
Exemplary Case Studies, cont’d.

Exhibit B-11: Student Response

8. (10) $K_2CrO_4 + 2 AgNO_3 \rightarrow 2 KN_3 + Ag_2CrO_4$

How many grams of $Ag_2CrO_4$ are produced from 15 mL of 0.41 M $AgNO_3$?

\[
\frac{15\text{mL} \times 0.41\text{M}}{1000\text{mL}} \times \frac{1\text{mole}Ag_2CrO_4}{2\text{moles}AgNO_3} \times \frac{1\text{mol}Ag_2CrO_4}{1\text{mole}AgNO_3} = 1.02 \text{g}Ag_2CrO_4
\]

9. (10) $BaCl_2 + 2 AgNO_3 \rightarrow 2 AgCl + Ba(NO_3)_2$

132 mL of 0.20 M $AgNO_3$ were needed to react with all the $BaCl_2$ in 244 mL of a $BaCl_2$ solution. What is the molarity of the $BaCl_2$ solution?

\[
\frac{132\text{mL} \times 0.20\text{mole}AgNO_3}{1000\text{mL}} \times \frac{1\text{mole}BaCl_2}{1\text{mole}AgNO_3} \times \frac{224\text{mL}}{1L} = 0.058 \text{mole of BaCl}_2
\]

10. (10) $Ca(OH)_2 + 2 HNO_3 \rightarrow Ca(NO_3)_2 + 2 H_2O$

How many grams of $Ca(NO_3)_2$ can be prepared from 35 mL of a 1.39 M solution of $Ca(OH)_2$?

\[
\frac{35\text{mL} Ca(OH)_2}{1000\text{mL}} \times \frac{139\text{mole}Ca(OH)_2}{1\text{mole}Ca(NO_3)_2} \times \frac{1\text{mole}Ca(NO_3)_2}{1\text{mole}Ca(OH)_2} = 7.97g
\]

11. (5) What is the molarity of a 330 mL solution containing 4.9 g of $H_2SO_4$?

\[
\frac{4.9gH_2SO_4}{1\text{mole}H_2SO_4} \times \frac{1\text{mole}H_2SO_4}{98gH_2SO_4} \times \frac{1000\text{mL}}{330\text{mL}} = 0.15 \text{mole of } H_2SO_4
\]

12. (5) What mass of $LiMnO_4$ is needed to prepare 150 mL of 0.23 M $LiMnO_4$ solution?

\[
\frac{150\text{mL} \times 0.23\text{mole}LiMnO_4}{1\text{mole}LiMnO_4} = 4.3\text{g } LiMnO_4
\]

13. (8) 18 mL of a 2.00 M solution of $H_2SO_4$ are diluted to 150 mL of new solution in a volumetric flask. What is the new molarity (M) of the $H_2SO_4$ solution?

\[
\frac{18\text{mL} \times 2\text{mole}H_2SO_4}{1000\text{mL}} \times \frac{1\text{mole}H_2SO_4}{150\text{mL}} = 0.12 \text{ molar of } H_2SO_4
\]

The arrow points to the student’s answer to the questions, “What was helpful in our teaching of the last unit? What suggestions do you have for what would help your learning in the future?”

Go over the homework is helpful for the test but the lab won’t help
Exhibit B-12: Student Response

The arrow points to the student's answer to the questions, "What was helpful in our teaching of the last unit? What suggestions do you have for what would help your learning in the future?"
Exemplary Case Studies, cont’d.

Marchetti Curriculum Case Commentaries

Commentary 1

By Jean Lythcott, Consulting Associate Professor, Stanford University Teacher Education Program

Overview
This is an excellent example of a curriculum case study, Jessica.

- The organization of this case is both clear and useful to a reader; the clear connections between goals, instructional design, and evaluation are so useful.
- You gave the reader the descriptions and data necessary to understand your analysis and your thinking.
- You showed your own understanding of what it means to learn and understand by referencing what experts have written as it pertains to this case.
- You supported your analysis of what happened in your class and what you propose to do about it by appealing both to data and to expert views.
- Your teacher ethic is clear, viz. that you believe all your students can succeed and that you will take it upon yourself to enable each one of them to do that.
- You reach to understand how the nature of the discipline, chemistry, might be more authentically connected to the learning and teaching of it.

I see the case as involving two distinct segments of instruction: the algorithm and the laboratory work.

The Algorithm
The use of the dimensional analysis algorithm in this case is a success story, at least as it concerns the explicit connection between goals, design, assessment, and achievement.

The first two goals were about helping your students to follow the steps of the dimensional analysis algorithm, ever more fully, surely, and accurately. You described a piece of instructional design to scaffold this learning. You created a modification to the game to have students actually carry into the pattern a gas, liquid, or solid. The goals, instructional design and the scaffolding were, then, well meshed here. The formal, summative test required the completion of many “follow through the pattern of the algorithm” situations and, so, was highly consistent both with the goals and the instructional scaffolding. A greater proportion of your students earned “A” grades on this test and fewer earned “Fs” than in previous units.

The data is clear; the class better reached your goals for them than they had in earlier units. This is a demonstration, then, of how well-crafted scaffolding consistent with clearly stated goals and evaluation measures can enable progress in achievement.

Your case discussion, however, is not about this success; rather you question the very value of it based on the relative lack of success with the lab work.
Exemplary Case Studies, cont’d.

Laboratory Work
There was also a consistent connection between goal, instructional design, and assessment, albeit informal, with regard to the two experiments in the unit. It is clear, however, from the weight given to this aspect of the unit that, for this team of chemistry teachers, it was of secondary importance to the successful completion of the algorithm for their students.

Analysis and Recommendations
You questioned whether the dimensional analysis work was authentic to the “material and the discipline we were grappling with.” Later, you describe the laboratory activity as the most “authentic” form of assessment in the unit. The strength of the case you present, in my view, Jessica, is this presentation of your own struggle to understand what authenticity is in action.

You appeal to the idea that to understand means to be able to “use” some knowledge. From this, it follows that if you can find ways to better help your students “use” the knowledge (from the algorithm work with calculations, I assume?) to successfully prepare and complete a stoichiometric experiment, then they’ll do better on this “authentic” assessment measure.

Data showed that extra time and collaboration supported better lab reports for the sophomores and you described how those better lab reports evidenced better understanding. You recommend, then, that students have both more time to prepare, perform, and conclude an experiment and more collaborative work to promote more successful “use” of what they know. Given that, they should do better on the “authentic” assessment of the lab—it being a measure of the extent to which they can “use” the understanding gained from calculations to manipulate real materials. This argument is internally sound.

My Response
I think that your questions about authenticity are vital for a chemistry teacher to struggle with. Authenticity in teacher work is a very different issue from consistency—and both are necessary. So, I’d like to leave you with some further questions that return to your own issue about whether the dimensional analysis work was authentic to the “material and the discipline we were grappling with.”

What about stoichiometry is authentic to the discipline of chemistry for those who don’t yet understand it? How might learners come to understand this uniquely chemical conception? What experiences, conversations, and negotiations of meaning can enable a learner to see the world through stoichiometric lenses? Can a group of learners figure out how to solve mathematical problems about stoichiometric issues without being taught the steps of an algorithm? And if students could, and did, invent their own, correct, solutions to the types of math problems you were using, would that be an authentic assessment of their understanding of the whole stoichiometric conception? This is to ask: If students could “use” what they know about materials and chemical events to invent a way to get right answers to stoichiometric problems, how more “authentic” to the material and discipline would that be than the reverse? Engaging these questions can turn a lot upside down for a teacher, Jessica, but I think your struggle is reaching for them.

Thank you for asking me to comment on this case; I really appreciated the opportunity.

—Jeannie
Commentary 2
By Estelle Woodbury, Preservice Teacher

In Jessica's case, titled *It's a Process! A Case of Teaching for 'Understanding' and 'Authenticity,'* she looks at many aspects of curriculum, learning, and assessing. The discussion around developing student understanding is a complex one with many contributing and conflicting factors. In the case, Jessica highlights attempting to include authenticity of assessment into the learning experience. The authentic assessment that Jessica describes is writing labs. Her students were able to be successful with the traditional assessment that evaluated what the students learned through workbooks. Yet, she wanted her students to be able to achieve a level of understanding of the topic, stoichiometry, to be able to understand the conversions of a lab. The test did not assess the level of understanding required to be successful on a lab. I as well in my own practice experience conflict around similar issues—how can I structure my curriculum so that it is inclusive of opportunities for students to be able to understand at a level required for authentic assessment? How do I incorporate this learning into my curriculum in a way that assessment will match my teaching goals?

One of my desires as a teacher is that my students will give reasons about their process and their ideas, because students reach a greater understanding when they are able to talk about what they have done from different vantage points. On a daily basis I require my students to give explanations about the reasons why they make the decisions that they do. I am able to do this in both group work and class discussion. This forces my students to look at the topics in math as more than just mindless rote algorithms because there is always a reason for the process of answering the problem. Jessica's case brought to light for me that the assessments that I use do not reflect what I consider important.

How can teachers develop ways of teaching and assessing so that our students are able to understand to the extent teachers find valuable? Jessica's title itself puts forth an idea of a method of approach. If teachers consider “teaching for understanding” a “process,” students will have the opportunity to gain understanding through properly experiencing the process. If I as a teacher want my students to be able to demonstrate their understanding and connect the abstract topics I teach to an authentic situation then I should make that experience possible. As a teacher, part of helping my students achieve that is to provide them the opportunity to learn how to apply what they have learned and how they are connected.

In this case, the assessment being a lab would require that students receive scaffolding, perhaps a way of providing students the opportunity to understand in the ways that we desire in this situation and to demonstrate that understanding in certain ways is to use the learning model, cognitive apprenticeship. A cognitive apprenticeship model suggests modeling, coaching, and scaffolding and fading. If we as teachers construct learning experiences that include these parts of cognitive apprenticeship then students are allowed to know what is important about the assessment. The importance of an authentic assessment goes beyond evaluating what the students know, because it requires that the students apply what they know and show what they know in specific ways. Students cannot be expected to know how to perform on authentic assessments, therefore students have to learn the process and the ways of thinking. Teachers can make this accessible to their students by making their thinking visible through cognitive apprenticeship.
Mental Models and the Car Analogy:  
A Case of Two Classes

By Meredith Naughton*

Recently in Curriculum and Instruction, we were each required to revisit and revise the rationale for teaching social studies written over eight months earlier. Through this examination I found that while my fundamental reasons for becoming a social studies teacher have not changed, several elements of my practical vision have. These changes are a result of my experiences at Kennedy High School*** where I have been fortunate to learn from both my cooperating teacher and my students. The following case describes a lesson where students in one class period demonstrated superior mastery of content material while many students in another period failed to retain significant pieces of the same information. The case involves both the dilemmas and “teachable moments” that are created by personality differences between multiple sections of the same class.

The School

Kennedy High School is a comprehensive Bay Area high school that serves approximately 1,200 students. Close to 90% of Kennedy’s students continue on to higher education upon graduation. Demographically, the student body is approximately 60% White students, 16% Asian, 15% Hispanic, 7% Pacific Islander and Filipino, and 4% African American. Dozens of languages are spoken at Kennedy, although the primary language of the students in freshman honors world history class is English. The class roster for three periods has an ethnic composition made up of mostly Caucasian and Asian students with one African American female and a few Latino students. The learning abilities of the students are high and most are also highly motivated, meaning they turn in their work consistently and participate in class on a regular basis.

Class Context

This case takes place in two sections of a ninth-grade honors world history course. Constructed around a humanities approach to both English and history, the course strives to challenge students to think critically and make connections between the two disciplines. Active participation and student involvement are cornerstones of a framework for learning that emphasizes independence and creativity. The essential question guiding the direction for the entire course is, “How does society shape an individual and how does an individual shape society?”

This particular lesson focused on the rise of Hitler and World War II and occurred in early December, just before winter break. Prior to this lesson, the students spent significant time studying many of the “-isms” related to South Africa, World War I, and Russia, including imperialism, nationalism, militarism, communism, and totalitarianism. In an effort to stimulate student involvement and empathy, the course is consistently conducted with the use of many elaborate and original simulations that last anywhere from one day to one month. For example, students simulated the scramble for land and power in Africa with “Power and Pride” and participated in a simulated World War I battle at “The Battle at Dawn.” The unit immediately before the rise of Hitler attempted to teach students about Soviet totalitarianism and Orwell’s 1984 and Animal Farm through a four-week simulation called Censoria. Here my cooperating teacher became a Stalin-esque dictator and forced the students to either conform or rebel to his rule. In general, the students love these simulations. In many cases, students decided to take the honors course because they heard about the projects from brothers, sisters, or friends who went through the same program. I do not think they were disappointed in their expectations. Students bonded around common experiences on the “battlefield” or in “prison” and a genuine esprit de corps seemed to resonate through all of the sections.

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** All names of schools and individuals are pseudonyms.
Third period especially rallied around this sense of camaraderie. I was not sure if it was the mix of students themselves or the fact that the class met later in the day after brunch, but the tone and character of the class were ideal for lively exchanges of ideas. During the first few weeks of the class my cooperating teacher (CT) and I were actually a little nervous that the class would be completely controlled by an aggressive group of males who dominated class discussion. We were also expecting third period to be the first period to “declare war” during the first simulation of the year, Power and Pride. However, much to our surprise, several females stepped up to the challenge during this simulation and the class was the only one of three to not go to war at all. The class was a delight since then because of a balanced willingness of students to participate, think and act maturely, and respect one another. Almost all of the 27 students in class loved to talk and share their thoughts aloud and many valuable minutes were well spent “off topic” exploring tangential ideas and connections.

Second period was a smaller class in contrast to third with just over 22 students and a very different personality. Most individuals in class were reticent and generally reserved. Students did what was asked of them without complaint and presented few classroom management or discipline issues. Although most of the students were diligent and consistent in their work habits, they were deathly quiet in class discussion. Only two students willingly participated on a regular basis, although all were usually attentive and engaged. Many attempts to draw out this crowd for class participation yielded only minor successes for both my CT and me. The most successful attempts involved small-group interactions where students wrote and shared ideas with a partner and then shared aloud with the rest of the class. This previous experience strongly influenced the type of debate interaction I facilitated at the end of this lesson.

While we studied the rise of Hitler, the students were supposed to be concurrently working on the major assignment of the semester, a research paper on a topic of their choosing. Although the assignment allowed for topics on anything in European history from 1900-1945, most students chose to examine elements of World War II such as the Holocaust, specific battles, and significant people. As a result of this significant and simultaneous project, due just after winter break, I tried not to assign students the same heavy homework load they usually received during my short lesson.

**Architecture of the Lesson**

The “big idea” at hand for the students in the lesson was: “Who/what is responsible for the rise of Hitler?” The entire lesson drew upon previous work and discussion by the class regarding factors in Hitler’s rise to power and the role and impact of an individual on society—our essential question for the year. The main purpose was to help students frame answers to difficult historical and societal issues of responsibility as well as practice skills of inquiry used by professional historians. One particular goal was to get students to probe deeper into the societal and situational factors that might have allowed Hitler to come to power in Germany so that they could better understand different forces that drive history, both good and bad. Another important focus and objective of the activity was to motivate students to think like historians when examining primary source documents and artifacts. Additionally, I wanted students to walk away from our study of Hitler with more questions than when they started and an understanding of the ambiguity inherent in history—there simply was not one right answer to the question presented.

Furthermore, it was important to me that the students learn to empathize with individuals from history. Looking back at the time period with hindsight, it would be easy for students to place all the blame for Hitler’s actions on those who allowed him to rise to power without considering the issues facing society at the time. Keeping in line with the goal of simulations we had done in the past, I encouraged students to try and place themselves in the shoes of an average German. I did this by making stations that included primary sources an average citizen or Jew might have been exposed to on a daily basis (propaganda posters, cartoons, etc.). Finally, the lesson also served as a transition into a more in-depth study of the specifics of World War II such as battles, strategies, the Holocaust, etc.

The structure and scaffolding for this lesson was designed to cover one shortened period (43 minutes), one block period (99 minutes), and one regular period (54 minutes). Over these three days students explored issues around primary sources on the first day, worked through the station activity the next, and participated in some form of debate on the final day. Possible answers to the question about responsibility for Hitler’s rise were presented as follows: political factors, social/economic factors, cultural factors, or Hitler’s genius.
Exemplary Case Studies, cont’d.

1. **Political** factors stemmed from weaknesses in the Weimar Republic including a lack of leadership, democratic tradition, and a strong constitution.

2. **Social and economic** factors accounted for the devastating impact of inflation, economic depression, and fear of communism on the country’s pride.

3. **Cultural** factors took into account a long tradition of fervent German nationalism, anti-Semitism, and militarism.

4. **Hitler’s genius** referred to his personal qualities of leadership and political acumen with propaganda, organization, and powerful speaking abilities.

(See Exhibit B-13: Who/What Is Responsible for the Rise of Hitler?)

**The Lesson**

On the day of the station activity, students met for class in the library where they found multiple tables, computers, and a television/VCR arranged and labeled with a number from one to seven. Each of the seven stations provided evidence for one of the factors described above. Examples included primary source propaganda posters, reading selections from Hitler’s autobiography *Mein Kampf*, a film clip of a speech made by Hitler in 1933, charts and graphs illustrating the impact of economic depression and hyperinflation, an Internet Web site of a common German publication, an anti-Semitic political cartoon from 1853, and selected articles from the Weimar Constitution. Students moved in groups through these 10-minute stations and attempted to sort and gain evidence for their argument in favor of only one of the possible factors. Each student was responsible for answering three to four questions per station on an accompanying worksheet that almost every student completed and turned in after the debate (see Exhibits B-14a and b: Rise of Hitler Station Activity Organizer).

For homework, students were instructed to make an outline of their chosen factor with relevant details and evidence from class and the stations. Although I wanted students to appreciate that there is no one right answer to the question, I used a “forced choice” method to make them consider and evaluate the evidence for at least one argument thoroughly. Also, it would have been logistically impossible to have a debate where everyone agreed a combination of factors was responsible. The following day students debated the ideas and arguments of students with opposing viewpoints in one of two formats—a silent written debate for second period and a traditional oral debate for third. I chose these formats based on the personality of the two classes. I wanted to ensure participation in the quiet second period and foster participation in third.

In an effort to scaffold the students for the breadth of information they were about to encounter and to encourage oral communication between students, they were assigned a short essay to read the night before about one of the possible factors. The students were then to jigsaw with the other three factors before rotating from station to station. However, several students did not read their essays and therefore, the jigsaw component took extra time and failed to give students a big picture of the factors involved in the debate. Despite my attempts to get them to discuss and share what they read, most members of the group seemed to get the major points of the argument from copying straight off one another’s papers (see Exhibit B-13: Who/What Is Responsible for the Rise of Hitler?). Consequently, the jigsaw component also failed to set a tone of discussion and cooperation among the group members in second period.

Already battling tendencies for reticence, I organized the station groups to get a mix of students who would work well together. I think part of the reason many second period students did not speak up in class discussions was because they were afraid of being “wrong” and because they knew one particular student would typically speak up and provide an insightful comment. In an effort to neutralize these status issues of confidence and competence and provide an opportunity and space for everyone to contribute, I intentionally grouped students who would not be intimidated by one another, at the same time separating good friends who might be inclined to stray off task. I am not sure whether it was the early morning lag or overly defused group dynamics, but there was only a soft hum of conversation for most of the station work. Each table required students to consider specific questions and then answer other sets of questions on a worksheet they took with them, but instead of brainstorming reactions and possible answers to the discussion questions, students continually completed their individual worksheets alone (see Exhibits B-14a and b: Rise of Hitler Station Activity Organizer). For example, though
the station with a video of Hitler giving a powerful speech left students with their mouths gaping open and hearts beating fast, they failed to share their reactions and thoughts with each other, much less discuss with each other the issues it raised. Admittedly, I “hovered” and often went to each group during the round to ask more questions and attempt to spark discussion. Sometimes this effort paid off for a few minutes, but overall I was a little disappointed with the lack of sustained enthusiasm and dialogue the stations provided.

As a result of the fact that the second period class climate was one of consensus and shyness, the format for the Hitler debate was written. Students silently debated their position with an assigned partner for three rounds of roughly five minutes each. I was very pleased with the 100% participation rate this adjustment provided and pleasantly surprised that by the end of the period, a few typically quiet students wanted to vent their passionate positions aloud to the entire class. In reading these documents later, however, I found that the students seemed to understand some of the basic points of the arguments for each factor but overall lacked specific evidence or a deep level of understanding about the complexities of each. They tended to use repetition to get their point across more than specific pieces of evidence or analysis (see Exhibit B-15: Student Writing).

Third period, in contrast, had no problem voicing opinions assertively or confidently defending positions. The students were a little more rowdy to work with than second period but provided a stimulating and respectful atmosphere for exchange of ideas. Third period’s love of learning impressed me most, increasing as the year went on. I think teachers always strive to instill in their students a love of learning in whatever form they can. I was lucky because I felt like that curiosity was already inherent in many of these students and my job was to keep that spark alive with engaging and stimulating activities that would challenge and push the students even further. Third-period students were immediately engaged in the station activity and seemed to actively discuss the questions I presented with each set of documents/materials. Perhaps this was a result of my giving better, more explicit instructions the third time around. Or maybe the group dynamics were such that there was just enough difference of opinion to allow more thoughtful inquiry at each station. Although I think the great participation was a result of a combination of both of the above factors, I think the most significant factor was the class personality in general. With a little push and the right task, they created their own learning. I think Rachel Lotan and Elizabeth Cohen (1994) would agree. Their research indicates that “group-worthy tasks” are those which are open ended, create interdependence and individual accountability, use multiple intellectual abilities, and are organized around “big ideas” or central concepts. The nature of the station activity and the debate created an authentic, group-worthy task by the above measures and consequently led to a high percentage and level of participation for my students. The true test of the effectiveness of this participation would be to see whether this participation also led to an increase in student learning.

Based on the general description of my third-period students and the amount of interest they displayed during the stations, I was not surprised that the debate scheduled for one period actually carried on to two. Although my CT and not the students themselves facilitated the debate, the students were definitely in charge of the floor. One of the first comments on the second day of the debate initiated the “car analogy.” It was presented by a young man eager to convince his classmates that Hitler was a thief who was only able to successfully “steal” a car because he possessed the necessary skills and personality, not because the door was left unlocked.

This analogy took off immediately and soon every student and group was twisting the car analogy to fit his or her own argument. The analogy was successful because as Howard Gardner (1999) writes, “analogies and models drawn from familiar territory can also help students gain a first understanding of an unfamiliar terrain” (187). While I was initially pleased with the connection and amused at its extensive application by group after group, after nearly an entire period I was beginning to think the debate was off track and losing steam. Instead of cutting off this line of thinking, however, my CT unexpectedly and masterfully used it to further the student’s grasp of the concepts and solidify the analogy in their memory. With only about 20 minutes left in the period, he gave each of the groups an overhead and told them they had five minutes to graphically describe all the relevant points of the car analogy they supported their side of the argument. The products of this quick maneuver are excellent examples of abstract student thinking and what I hypothesize to be potentially deep and memorable understanding (see Exhibits B-16 to B-19: Car Analogy Drawings). Students drew their own representations of a complex concept and illustrated it with symbols, words, and facts and they did it all with no preparation other than discussion, and in less than 10 minutes. Thus, they illustrated what Mansilla and Gardner (1998) would consider performance understanding through symbol systems mastery. With the visual analogy they “purposefully used symbols to support representational goals” and, through this, presented a high level of understanding (194). There was definitely
The Learning Classroom

Exemplary Case Studies, cont’d.

a great buzz of excitement and collaboration that filled the room during this frenzy to illustrate the analogy visually. As a teacher, it was especially rewarding to see and hear the exchange of ideas and intellectual debate continue within groups. Then each group got up in front of the class and presented their analogy, often causing several hands to immediately go up to protest a point or contest an interpretation. Needless to say, we did not have time to raise and continue to discuss all of these hotly debatable issues.

The Learning Question

The question posed in this case goes beyond my lack of flexibility with the debate and car analogy to one of considering which class better learned the concepts involved with Hitler’s rise to power. I was curious to find out two months later which class of students could recall basic elements of the question “Who/what is responsible for the rise of Hitler?” I predicted that the students in third period would be able to draw upon the car analogy to help them remember both broad and specific points better than students in second period who debated the question more concretely. I gave very open-ended instructions to students in both second and third periods regarding what I wanted from their responses, because I did not want them to feel pressure to remember everything. To that end, I only requested that the students write down what they remembered about the four factors we discussed as an answer to the question and instructed students not to write their names on their papers. Students in both classes requested to be able to glance at their notes or talk to someone next to them to refresh their memories, but I held my ground and did not give in to the convincing pleas.

The Results

As I expected, second period struggled with my request and also demonstrated that unexpected things can “stick” in their heads. While 15 of 21 students showed some understanding of at least one of the factors involved in Hitler’s rise to power, six others brought into play factors and theories we never discussed in class. Oaks (1999) found that “old meaning can get in the way since firmly fixed schemes do not easily change to accept new experiences, people often alter their perceptions to make them compatible with their existing schemas” (72). Six of my students illustrated this basic dilemma for teachers—mental models that get in the way of understanding. For example, one student brought up a theory that Hitler gained control because he was famous for writing *Mein Kampf*. Another student persisted in her theory that the “Hitler himself” factor involved only his desire to gain power, and a third student mentioned an ambiguous story about a Jewish doctor that let Hitler’s mother die. These mental models might have originated as explanations my students already had in their heads or they may have developed as a result of the station activity itself. Donald Norman agrees with Oaks and writes, “The student comes to the learning situation with a large set of preexisting ideas, and the material that is presented is interpreted according to these ideas” (42). On the other hand, maybe these theories illustrate more developed theories the students picked up outside of class but simply failed to explain clearly in their responses. I know that at least one student in the class researched Hitler for his major paper assignment and read several theories, some more reliable than others, about what forces shaped the dictator’s life.

Additionally, several students in second period who did not necessarily indicate misconceptions also did not exhibit a clear understanding or even recollection of the factors involved in Hitler’s rise (see Exhibits B-20 and B-21: Student Writings). These student responses tended to be vague, extremely short, and generally uninformative. For example, one student wrote, “Social and economic things that were going on in Germany. What was happening at the time helped him rise. I don’t remember any more.” Another student struggled to come up with anything more than the titles of each factor; she wrote, “Culture, religion, Hitler himself, the economy.”

Considering both the station activity and the debate, I should also consider whether the structure of the lesson inhibited students from learning and understanding to their full potential. While it required them to grapple with ideas, make connections to previous topics, and practice inquiry skills, it left a lot up to them to figure out on their own. I designed these ideas to be examined closely in student groups, but we did not discuss the evidence presented in the stations before the debate. I attempted to initiate a conversation and debrief about the various elements at each station before the debate, but got little response from the students and did not force it. Consequently, students jumped in and out of the debate, perhaps too quickly to retain solid understanding.

In contrast to the disappointing learning results of second period, the responses of third period exceeded my expectations. Even though I asked them to respond to the prompt almost three weeks after I asked second period, once they started writing and remembering, I had to force students to stop. After the collective groan that
exploded from the class as I made my initial request died down, their memory kicked in. Almost every student submitted a complete, thorough, and accurate response to the question (see Exhibits B-22 to B-25: Student Writings); in addition, half of the class's responses included connections to the car analogy (see Exhibits B-24 and B-25). Usually these car analogy references came in addition to a complete summary of the main points of each argument. A few students even went as far as to redraw the image their group presented to the class two months earlier to reinforce the argument they found most persuasive. I was impressed with specific examples and evidence many students included also. For example, one student mentioned Hitler's failed Beer Hall Putsch as his first attempt to "steal the car." These students exceeded my expectations because they were both able to remember and they were able to draw upon their original and creative symbolic representations.

Reflection

Based on student responses more than two months after our study of the Rise of Hitler, I am convinced third period really did learn the material better than second. Although my assessment of this understanding did not include a way to test for all of the goals I had for the lesson, it indicates that something went right in third period for them to remember basic information more completely. In the broadest terms, I believe that the rate and method of participation in third period allowed for and instigated these larger learning gains. Obviously this class has many qualities going for it to this end that are absent in second period, such as enthusiasm for sharing thoughts and verbally debating ideas. Third period was more engaged with the stations and they were deeply invested in the two-day debate. Essentially, they taught themselves and each other the material at a higher level through this ongoing interaction.

The icing on the cake was the car analogy, for which the students were completely responsible. Regardless of whether they mentioned it in their latest writing or not, I believe many of the students remembered the information better because they made connections and applications earlier. They created for themselves a mental model and framework as well as a visual representation that they could hang the requested bits of information on and recall later. Linda Darling-Hammond's (forthcoming) conclusions on knowledge transfer support this theory. She asserts, "people rarely transfer knowledge automatically from an initial problem to a novel one, but when they are provided with scaffolding or an analogy, there is a much higher rate of transfer" (8). Therefore, "if students are asked to apply what they are learning to a particular task or analysis, the likelihood that they will be able to use their knowledge again later is increased" (9).

Equally important, the discussion and analogy was memorable to the students because it was fun and engaging and stimulated student ownership in the concept. Several students commented after turning in their responses that they would remember the car analogy for a long time. One girl even said, "We should do more analogies." Although I agree, I cannot help but wonder if it would be possible for me to construct an analogy for them that would have the same effect. The car analogy was imaginative because it came from a student and the students made all of the connections themselves. Gardner (1999) is sympathetic to this dilemma, yet supports the benefits to students of making their own analogies:

Skilled teachers and researchers struggle to discover fruitful, apt analogies and metaphors... Once students enter more deeply into a topic, they should be encouraged to come up with their own analogies and metaphors. Not only are these likely to work for the particular individuals, but also students' discussions of the virtues and limits of particular comparisons can prove enlightening (p. 201).

Though I am not sure that students in second period would have dug in as deeply if I had given them the analogy to consider, it is clear they could have benefited from the analogy. If I teach this curriculum again in the future, I know I will remember the car analogy and probably see if I can use it as a starting point from the top down. A long-term goal is to get all my students to share ideas and take risks with analogies with the same alacrity as this third period. To facilitate interaction that will hopefully encourage this, in the next stations activity student groups will complete and turn in one station guide together rather than turning in four individual worksheets. I will also spend more time debriefing the activity and materials to make sure that the point of each station is clear and the foundation will be better set for a more productive, lasting, and meaningful discussion. The end goal remains the same—a high level of learning and understanding for all classes and students.
Exemplary Case Studies, cont’d.

References


Who/What is responsible for the Rise of Hitler?

German Culture

1. philosophy: devotion to state (worship)

2. militarism: long history of progress

3. anti-Semitism: Jews associated with money hated by Germans in poverty, believed they loved religion more than country.

Hitler: a political genius

1. great speaker

2. cover propaganda & scapegoating

3. master of organizing

4. iron determination

Politics

1. no political party could gain enough power to rule effectively.

2. Treaty of Versailles: many people claimed loss of WWI on the new democratic govern. instead of

3. the military: repayments made German marks worth almost nothing.

4. needed a strong authoritarian gov. to help recover from the shock of WWI; not new losing demo.

Social/Economic

1. inflation

2. Hitlers fasism last (hope) choice for people

3. pride

4. capitalist saw Hitler as a politic that wouldn't interfere with business.
Exemplary Case Studies, cont’d.

Exhibit B-14a: Rise of Hitler Station Activity Organizer, page 1

Rise of Hitler
Station Activity Organizer
Please rotate through the following stations in order. Use this form to guide your understanding of the factors (social/economic, cultural, political, individual) involved in Hitler’s rise to power.

Station #1: Mein Kampf
What category do the excerpts from Mein Kampf fit under? Hitler

What do the quotes tell you about Hitler’s intentions for Germany if and when he gained power?

Through propaganda he would influence the masses.

Station #2: Nazi Propaganda
What category do the materials at this station fit under? Hitler

How were you impacted by the posters?

They were scary. Especially the one on Hitler’s head just there.

Do you think they were effective sources of propaganda for the German people? Why?

Take into consideration the context (what was going on at the time) of each poster and other examples of propaganda we have studied. Explain your answer.

I think the propaganda was effective. The Germans were weak and the people were desperate.

Station #3: Video
What category does the video clip at this station fit under? Hitler

You did not have time to view the video clip of President Hindenburg giving a speech, but as an 80-year-old leader, his style was much different from Hitler’s. In general, he was a slow and decrepit speaker who made short appearances in front of small audiences. How might this difference affect the reaction of the people present?

It’s easier to go along with the crowd.

What emotions does Hitler stir in his audience and in you?

He gives his audience hope for a better Germany. He is vociferous and makes the audience want to cheer.

Station #4: Weimar Constitution
What category does the document and information at this station fit under? Political

What article of the Constitution would allow a President to legally become a dictator? How?

Article 25, §48, the president can suspend personal freedom, free speech, freedom of press. They can also take certain measures for public instruction.
Exemplary Case Studies, cont’d.

Exhibit B-14b: Rise of Hitler Station Activity Organizer, page 2

Station #5: Internet
What category does the information at this station fit under? German Culture.

What themes of German culture are expressed in the documents you found?
Propaganda.

What do these themes tell you about the nature of racism and nationalism in Nazi Germany?
They did not like the Jews. They discriminated them. They were democratic & prejudice.

Station #6: Unrest and Discontent
What category does the information at this station fit under? Social Economic.

Given the conditions you see illustrated in Germany between 1913-1933, what do you think the attitude of most Germans was toward their government?
They didn’t like the Weimar Republic.

In the shadow of such crisis and instability, what were most Germans looking for in a leader? Use empathy (putting yourself in their shoes) how would you have felt?
They wanted a leader who would change the conditions.

Do you think people in Germany wanted someone to blame for their misery? Who might they have directed their anger toward? (there are several possible answers)
I think they blamed Weimar Republic. They also blamed the Jews.

Station #7: Anti-Semitism
What category does the cartoon presented at this station fit under? German Culture.

What fears and emotions does this cartoon attempt to stir?
That Jews would completely dominate Germany.

What do these illustrations tell you about the racism and anti-Semitism present in German culture before Hitler came to power?
Anti-Semitism was rooted before Hitler came to power.
The reason for Hitler's rise in Germany was because of Social & Economic Factors. If it wasn't for how the economy was, then Hitler would have been around. The German people were poor from the depression, they could hardly manage to live. They wanted something to happen, and they wanted it to happen fast. Hitler was their solution. He would get rid of the depression, and that is why the people of Germany backed him up and made him a powerful leader. There would be no Hitler the leader if there wasn't an economic depression.

That had nothing to do with his rise. He is his own person and acted the way he wanted. As I said before, that may have had an impact (like, that might have given him a little push forward towards leadership). But although this had impact upon him, he still didn't have to act as he did towards Jews. The depression had no impact for his ways against Jews. I mean, come on, he baked them in ovens for crying out loud!!! The depression did not make him do this. He chose to do the things he did because he wanted to.

The people disliked the Jews also. They were scared of them and how the world would change their country and make it Communist, so he used it to rise to power from the people and stop it from happening.

The economy.
Exemplary Case Studies, cont’d.

Exhibit B-16: Car Analogy Drawing—Hitler Himself
Exhibit B-17: Car Analogy Drawing—Culture

Kicked out!

Weimar Republic

Bad, old, slow driver

Car filled with Germans who open the door for Hitler.

(Hitler)

Come on in!

(Whispered)

(Culture)

Licensed driver

(Blamed for the bad condition of the car)
Exhibit B-18: Car Analogy Drawing—Social/Economic

(culture) - gas
Soc. Eco. - locking system
person whole car open - government

Jan, 1923: 1 dollar = 17,992 marks
Nov, 1923: 1 dollar = 4,200,000,000 marks
Exemplary Case Studies, cont’d.

Exhibit B-19: Car Analogy Drawing—Politics

- Beer Hall Putsch
  - Hitler failed to steal car—caught.
  - Weimar Republic came.
  - Hitler successfully stole car.

Politics
Exemplary Case Studies, cont’d.

Exhibit B-20: Student Writing (J)

Who/what is responsible for the rise of Hitler?

- Social and economical things that went on in Germany.
- What was happening at the time helped his rise.

I don't really remember any more.

Exhibit B-21: Student Writing (L)

Who/what is responsible for the rise of Hitler?

- Weak economy - money meant nothing.
- The treaty of Versailles.
- Hitler himself.
- I don't really remember anything else.

Exhibit B-22: Student Writing (N)

Who/what is responsible for the rise of Hitler

- German culture
- Government (Weimar Republic)
- Hitler himself
- Propaganda
Exhibit B-23: Student Writing (Q)

1 - Social/Economic conditions
2 - Hitler himself
3 - Weimar Republic
4 - German culture

1 - Germany was in a downfall (inflation) because of the war. The people were looking for someone to end the horrible career crisis and inflation.

2 - Hitler was a great man. His "wonderful" speeches made the people feel good. No one else is like him. He alone made the Holocaust happen.

3 - The government wasn't very organized. New and democratic, didn't make things immediately better, made Germans mad. Hitler promised to fix the government.

4 - German culture positioned Germans from birth to hate Jews. Their hatred and nationalism led Hitler to power.
Exhibit B-24: Student Writing (U)

Car analogy
- Hitler was the "driver"
- This was used to argue that Hitler himself was responsible
- The passengers represented the German people
- Weimar Republic, being weak and incompetent, left the car doors open for someone to steal
- Car = Germany / German people
- Could be also argued that Weimar Republic was to blame, with the argument that anyone could have "stolen" the car, because the doors were left unlocked
- Anti-Semitism was the "fuel"
Exhibit B-25: Student Writing (W)

I thought that Hitler was mainly responsible for his rise to power. He saw an unlocked car (Germany) in a parking lot and he decided to steal it. Anybody could have stolen it at that point, but he was the only one that was able to. German culture was sitting in the back seat of this car and previous anti-Semitism assisted him. The unlocked door was the currently weak government. When someone steals a car, we blame the person who stole it, not the forgetful owner who left it unlocked. Hitler was a very enthusiastic person who had no trouble tempting and leading a large group of people. Also at the time, the economy was very poor. So, Hitler seemed like he would be their savior from inflation, poverty and bad times.
Naughton Curriculum Case Commentaries

Commentary 1

By Kelly Kovacic, Preservice Teacher

Meredith’s case raises an interesting dilemma that all teachers face. This case focuses on trying to teach the same material to two very different classes. While both classes are Honors World History, the students in each class interact differently with their classmates, teachers, and the content. It raises two important questions for teachers to ponder:

• How much do you modify a lesson to fit the dynamics of the individual class?
• Do these modifications ever impact what the class will learn?

Meredith chose to teach the content slightly different to her second-period class (which is rather quiet) than to her third-period class (which is much more talkative and assertive). The third-period class had a verbal debate over why Hitler rose to power; whereas the second-period class silently debated the issue in a written format. The second-period class also had less time than the third-period class to discuss their debate as a class after completion of the writing activity. The result was that the third-period class took off with the “car analogy” during their oral debate and seemed to remember and understand the material better two months later. Had Meredith tried to introduce the “car analogy” to the second-period class, it is uncertain whether the students would have connected as well as third-period class did. What occurred in the third-period class was an amazing “teachable moment” in which the students began to make meaning of the content by creating an analogy on their own that allowed them to understand the unit question better.

It seems that part of the reason the analogy seemed to work so well in the third-period class was that the students created it themselves. They came up with the analogy and changed it to fit their own viewpoint. As a teacher, it could be hard to recreate this exact same learning experience in another period. It may be necessary for the teacher to look at the larger picture and figure out why the students are able to connect better to the material. Then, the teacher can try to recreate that experience in other periods. For instance, in this case, the students seemed to connect to the material because of the analogy. While it may not work as well in the second-period class to just introduce the same analogy, a teacher could introduce the general concept of an analogy and how it can help make meaning and articulate one’s viewpoint. It may have been beneficial to ask the second-period class to come up with their own analogies in groups and share them with the class. Having them work in groups would also give them the opportunity to discuss their viewpoints, practice sharing their analogies, and consider other viewpoints in the group.

The challenge for any teacher is to create lessons that will reach students in each period. It is difficult for a teacher to determine what changes should be made for each period to create the best learning experience. Often, it may be necessary to experiment by adapting lessons in ways you think will work best for each class. When “teachable moments” happen in one class, try to recreate the experience in other classes as best you can without making it too artificial. Try to look at the larger picture and the elements that made it such a teachable moment; whether it was creating analogies, visuals, written commentary, etc. With so many periods in a day, teachers constantly face the challenge of teaching each period in a way that will allow students to connect with and truly understand the content. Meredith’s case brings to the forefront these very important issues for teachers to consider as they create and adapt lessons.
Commentary 2

By Tuckie Yirchott, Supervisor, Stanford University Teacher Education Program

The “title” is not meant to describe two periods of students, i.e. one is positive and rich and one is slow and poor. However, your description does focus on the differences between period two and period three. You have the luxury of being able to plan, implement, and analyze your teaching and your students’ learning of a specific unit of study. You also have the opportunity to dig deeper into analyzing class dynamics and revising activities for deeper understanding for your students.

You have spoken often of the difference in personality between periods two and three. I have observed both classes but more often the period three. After reading your case, I am compelled to revisit period two more often in the coming months. The curriculum case assignment has provided an opportunity to give more attention to instruction and student outcomes. This is not to say that you don’t consider this all of the time. However, to have two world history classes back to back that are very different in character calls out for analyses and reflection—curriculum case or not. It is common to compare classes of the same course. It is a plus when one gets the mileage out of analyzing the differences that can inform your teaching—for the students’ benefit.

Your analysis of class dynamics and student interaction in both classes has informed your instruction. That is, small group interactions in which students share first with a partner and then report to the class. The livelier period three can thrive in a more vocal and interactive environment. A question for period three—You comment that “almost all 27 students love to talk and share....” What about those few who do not? How can you make all 27 students confident and competent to participate fully in class discussions?

The three-day lesson that focused on “Who/What is responsible for the rise of Hitler?” continues to be posed, and not only in the classroom. Getting students to think and act as historians, empathize with major actors in world history, and develop ability to examine a range of perspectives that are present in any historical event are important skills and understanding for students to learn. Using simulations is a key instructional strategy to understand history and its contemporary context. Your statement that the lesson was, “...a transition into a more in-depth study of the specifics of World War II such as battles, strategies, the Holocaust, etc.” is a puzzle for me. How does the rich stations activity followed by the debate on the question of Hitler connect with battle strategies? I didn’t read anything about your connecting the guiding question with a contemporary context? Lessons learned? Your three-day lesson and year-long question are robust enough to generate contemporary dilemmas.

The station activity which I observed was rich. I did wonder if 10 minutes per place allowed enough time to review directions and complete the task. Were students able to digest this in the time allowed? The multiple points of access for the students (video, computer search, analysis of primary documents including photographs) was commendable. You have indicated in the case that time was a factor. Individual worksheets often reduce the amount of interaction. An individual response could be done for homework. You want the students talking to each other while they are gathering information from the stations—i.e. Who/What was responsible for Hitler’s rise to power?

The information is important as context for getting the mileage from the station activities. How might you incorporate this next year?

The “forced-choice method” for selecting the most important factor of Hitler’s rise to power is a realistic decision on assessment grounds. I wonder if you had thought about asking the students to ‘rank order’ the factors including a rationale. This may be too much to ask for homework. However, it would give you a “picture” of what they understood about the four factors. The jigsaw activity did not work as well as you had planned.

Period two’s silent debate—reading the students’ work—did inform you on what students had learned. What would/can you do differently with this quiet class?

Your analysis or musing regarding students’ engagement and learning caught my attention. Period three is the “third time around.” It is not uncommon for teachers to “tweak” instruction from one period to the next. “Group dynamics and class personality in general” are definitely operating for you in this case as it is in the classroom.
Two Months Later

...Did you plan to check for understanding to determine what still remains in their brains? It is an effective instructional strategy to find out “what sticks” and why. With your explanation and analysis of the analogy lesson, it probably does not surprise you that students remember (learn) what they have been able to connect into their own ever-growing repertoire. The difference between Periods two and three is dramatic. Visual representation, and student-generated responses usually do “get solidified” into their brains. The seemingly full class participation with the car analogy (at the time) did make a difference in deeper understanding that lasted more than one period.
Deceiving Myself:
Building on a Weak Foundation

By Eduardo Ochoa* 

Students come to high school from various middle schools and backgrounds. As teachers, we need to recognize this fact because it is one of extreme importance. They signal a couple of issues that we always need to be conscious of when dealing with our students. First, students receive different types of educations before coming into our classrooms and they have all been learning different curricula at their respective schools before coming together for their freshman year of high school. Second, because their education is so varied, their misconceptions will also be just as varied, leading to a dilemma of sorts for the teacher to work out. This case deals with my ability (or inability) to account for the great diversity found in my classroom as well as my inability to plan ahead for the different levels of education I would uncover throughout a lesson. Most of all, it deals with the mistake of assessing my classroom using a small sample of students and not looking for the appropriate feedback when it is most needed. It simultaneously deals with my ability to dissect a situation and modify my instruction to reach all my students, thus solidifying an existing weak foundation.

The Setting

Edgar Hills High School** is located near one of the business districts within the city of San Jose. The school caters to approximately 1,300 freshmen, sophomores, juniors, and seniors. A faculty of roughly 40 teachers allows classes to be within the range of 25 to 32 students. Edgar Hills is one of the most diverse schools in the area. The student body consists of 60% Hispanic, 14% Caucasian, 7% Asian, 5% Pacific Islander, 3% African American, and 11% “Other” students.

The third-period Integrated Math-I class consists of 24 freshmen. It is the requirement that every student at Edgar Hills must enroll in and pass at least two math courses in order to graduate. Integrated Math is simply a combination of Algebra, Geometry, Algebra II, and Trigonometry that can be taken up to three years. The concept behind the Integrated Math is one of a spiral curriculum where mathematical ideas are introduced during the first level and revisited and expounded upon during the subsequent two levels. Testing before entering high school helps determine whether students need to begin at the first level of Integrated Math. If they score high enough on the exam, they have the choice of going directly into Integrated Math-II. Most incoming freshmen find themselves placed in Integrated Math-I, although there are many upperclassmen that find they need to repeat the course after their first year as only 50 to 60% of freshmen pass it the first time they take it.

The student composition in the third-period freshman class is quite heterogeneous. There are students who have clearly been misplaced and deserve to be taking Integrated-II but cannot due to a lack of availability and excessive class sizes. These students clearly need extra challenge problems to keep them interested in the math on a daily basis. On the other side of the spectrum, there are students who struggle with the most basic mathematical concepts and skills including elementary mathematics—addition and subtraction being the most common. One area where students are very homogeneous, however, is their motivation. Nearly 80% of the class fails to do their homework on a consistent basis and a majority fails to complete the daily class assignments. Those who do the homework tend to be students—including ELL and special education—who tend to do extremely poorly on the exams (35% or below), but try to balance it out by keeping up with the homework. Those who never do the homework are the students who know they can pass the final exam at the end of each unit. In my classroom, if a student passes the unit exam with a 70% or better, they will receive credit for that unit and a “C” grade, regardless of what their entire grade happens to be. They can have an “F” for quizzes, homework, class work, etc., yet as long as they pass the unit test they are content with receiving a “C” for the class. It appears that the majority of students are holding out on passing this test and ignoring all the other factors that go into their grade.


** All names of schools and individuals are pseudonyms.
Exemplary Case Studies, cont’d.

One of the goals throughout the year has been to set the norms of the classroom and to be consistent with them. As students come into the classroom, they grab their portfolios from the back of the room and write the daily agenda and objectives in their journal. They then take the remainder of the allotted 10 minutes to work on the warm-up or correct their homework with a partner while Mrs. Aldridge (my CT) and I go around and check whether they did the homework. Students know that there will be homework every night and that homework quizzes will be given twice a week in class. They also know that the majority of their class time will be devoted to group work while their teachers circulate the room to provide clarification of the tasks or to answer any pressing group questions. Within this setting, communication and cooperation is emphasized as well as self-discovery of important mathematical concepts.

Educational Goals

After finishing the unit on direct variation, my CT and I sat down to plan the following unit on linear functions. It was our hope to use an Interactive Math Program (IMP) in addition to the Integrated Math curriculum called Baker’s Choice to introduce the class to linear functions, inequalities, and maximization. As we looked at the IMP book, however, it made several assumptions about students’ backgrounds. More explicitly, these assumptions were that students:

1. Have a general familiarity with the concept of the graph of an equation.
2. Have some experience graphing linear equations.
3. Know at least one method for solving pairs of linear equations in two variables.

After a lengthy discussion and class assessment, Mrs. Aldridge and I decided that our students were not prepared for the IMP unit (Unit 5). For Unit 4, students had learned about linear functions and inequalities, but a good deal of the latter part of the unit was rushed due to the unit testing we had to give our students. This meant that the material had been covered, but the students could still use additional practice.

There were some students who had some of the material from Unit 4 and Unit 5 when they were in middle school. These students had taken Algebra during their eighth-grade year and were essentially reviewing a small portion of the material from these two units. Most of the other students, however, had either taken Pre-Algebra or the equivalent to computational mathematics, which meant they came into Integrated Mathematics-I with no algebraic background whatsoever. We needed the students to “catch up” and practice many of the concepts they had briefly learned or had not learned at all before coming into high school.

Instead of starting the unit with Baker’s Choice, we decided to shore up several computational and conceptual deficiencies our students had by giving them two days to work on practice problems. With each period being 100 minutes long due to block scheduling, this was equivalent to a week’s worth of class. The practice time would allow students to identify the areas they needed help with, and give them the opportunity to ask the teacher or their partner for assistance so they could be well on their way to being comfortable with the ideas and calculations before moving on with the rest of the unit.

Although the majority of the work during the two days would be used to review material already covered in other lessons, the worksheets and activities planned for the day would also cover the first few objectives of the current unit. These objectives were to:

1. Identify the slope and y-intercept for linear functions.
2. Graph linear equations.
3. Write the equation of a line.

All Integrated Math-I students should have already touched upon the material either in middle school or the previous unit so we assumed that familiarity with the tasks should not have been a problem.
Exemplary Case Studies, cont’d.

The Learning Problem
The lesson plan I had constructed for the two days involved much group and individual participation. I wanted students to “see” some of the concepts for themselves instead of using rote memorization methods and techniques. After learning a concept, it was in my design for students to apply that concept to a set of problems in their practice packets.

Using the first page of the first packet where each problem contained an equation, a table, and a graph, students were instructed to complete the table of solutions for each equation. They were then to use the table to graph the solutions and draw a line through the points. Using their prior knowledge from the previous unit, they were to identify the slope and the \( y \)-intercept for each line.

Students were to work in pairs for the first 20 minutes and as they worked, I would observe their progress and assign a few of the problems to some of the pairs. These pairs would be given individual graph boards to graph the line and once completed, place the graph up at the front of the class. Once all graphs had been assembled and the slopes, \( y \)-intercepts, and equations written above each graph, people would be able to identify the patterns between the equation and the slope and the \( y \)-intercept for each graph. This activity figured to get the entire class involved. If they were not placing the graph boards at the front of the class, each individual or pair would be trying to identify the common pattern for each problem. The pattern is that each line can be written as \( y = mx + b \) where \( m \) is the slope, and \( b \) is the \( y \)-intercept. This helps in showing students that the equation is not as foreign as they may perceive it, but to simply write the equation on a line, all one needs is the slope and the \( y \)-intercept.

The second part of the class would be devoted to a teacher-led discussion I would use to discuss the meaning behind slope and \( y \)-intercept using a few of the examples from the review packet. My intention was to tell the class very little about the problems and instead elicit responses to what students think certain words mean, and how to identify each when given an equation in the form of \( y = mx + b \) or in standard form \((ax + by = c)\). The class could then branch off and discuss in small groups what each graph is actually describing in real-world terms.

The final portion of the class was slated to cover the writing of equations using slope and the \( y \)-intercept. Given three data points, students could plot the points on a graph and draw a straight line through them. Analyzing the graph, students would once again be asked to find the slope by finding the rise and the run and the \( y \)-intercept by looking at where the line crosses the vertical axis and record the data in an empty table. After finding this important information, students would be expected to write the equation of the line described by the graph. They would then check the validity of each equation by plugging in points and verifying whether the equations held true. The second day of practice was to be used as an extension for all the types of problems encountered on the first day.

By the end of the two days, students should have a conceptual understanding of slope and \( y \)-intercept as well as a good understanding of the literal meaning or definition of each. Using their prior knowledge of plotting points, calculating the slope and identifying the vertical intercept, they would then be able to competently write the linear equations.

Case Scenario
It was Friday morning and I was excited to lead the class. That day, I planned to introduce a few new ideas, but the majority of the time was to be used for the practice exercises before going on to the heart of the unit. The following week we would be using the IMP so this week was set aside to solidify understanding of graphing using a variety of methods.

Class began with the regular routine. Students picked up their work portfolios from the back of the room, took out the homework, and worked on a math problem while my CT and I went around and checked the homework. Once the homework was checked, packets of practice problems were passed out. The intent here was to have the students feeling comfortable graphing, working with tables, and writing equations of lines before going on to more difficult inequality work later in the unit.

While students worked, I went around and randomly selected pairs of students to place the solutions for a problem on a graphing board. This board would be placed at the front of the room. With it, students would identify the \( y \)-intercept and slope of the line described by the equation and the graph. After 15 minutes had
elapsed, I noticed that the pairs of students working on the graphing boards as well as the students who were
doing the identical problems on worksheets were getting nowhere. Not one pair had completed the table of fig-
ures, they had not plotted their coordinates and drawn a line through them, and they had not made the connec-
tion between the slope and y-intercept and the equation of the line. There were individuals here and there who
had made some progress on the problems, but as a whole, the class had not accomplished much.

I took this opportunity to stop the class for a brief lesson at the white board at the front of the room. My guess
was that they had trouble remembering what the slope and y-intercept signified so I asked the class a few ques-
tions. “What is slope? How do you calculate it? What does the y-intercept represent?” Before taking any answers, I
asked the class to put down their pencils for two minutes and discuss these questions with their partners. I imme-
diately saw very encouraging signs.

Adam, Gustavo, and Jessie are a very special trio that happened to be grouped together near the back of the class
that day. Although most people were in pairs, I allowed the three boys to work as a group because we had an odd
number of people in class that day. As I listened in on their conversation, Adam asked valuable questions that the
other two boys fed off of. In particular, he commented, “If the y-intercept is where x is 0...right here x means hours,
then...that means that’s how much money he has at 0 hours. I don’t get that...how can he have money...and how
do you work 0 hours?” Gustavo, who is an ELL student and who predominantly remains silent in class, leaned over
and answered in broken English, “He didn’t work any hours...money he start with.” Adam, who was still confused
as to how the situation could be represented with a graph, asked, “How do you know what line to draw?” At this
moment, Jessie awakened from his morning slumber and told him to use the slope. “You use the slope to draw
the line because you can get the next point by using the rise over run. It’s basically telling you that you go up 5
dollars for every hour that he works.”

The two minutes I gave the class flew by in an instant. I had not gone around the room to listen to the other con-
versations taking place because I was mesmerized by the interaction that had gone on between the boys. Adam
is a boy who rarely comes to class, yet when he does, he arrives at least 20 minutes late. Therefore, he misses out
on a majority of the mathematics and relies on others to catch him up or requires a substantial amount of assis-
tance from the teacher. Gustavo surprised me quite a bit because it is difficult to assess how much he is learning
when he refuses to speak in class and fails a number of the exams. In addition, he had just concluded a two-
month-long trip to Mexico where he missed the entire instruction during the month of December and a majority
of January. Jessie is the student that nearly every teacher has at least once a year. He comes in late, but when he
does, he is unprepared, and he appears unmotivated and disinterested in learning as all he does is sit down in his
seat and does not take out his notebook or journal or even a pencil. Frequently, he disengages from the class alto-
gether and goes to sleep. Jessie is not like the other students at the school. He has had a superior education in
Boston where he lived up until this year. Due to the flashes I have seen from him, it appears that he already knows
this material, but because he joined the school after the first month, he was not tested for mathematics placement
and was instead placed with most other freshmen in Integrated Math-I. He is bored because for the most part, he
is unchallenged. At the same time, his mother passed away last summer and coping with her loss has proved to
be extremely difficult, thus, trying to reach Jessie has not been easy, making challenging him that much more dif-
ficult. The fact that all three boys were working together and having a very fruitful discussion gave me hope that
the students were actually understanding the material and were ready to move on to the more demanding topics.

I told the class to proceed to the next section where they would be drawing lines and identifying the slope and
y-intercept of each graph. At this moment, I handed out the graph boards to random partners to show their work
and present to the class. Students were given 10 minutes to do their assigned problems and organize their pre-
sentations. The time came and went and the pairs were nowhere near finishing. I gave them another 10 minutes
to work on the problems thinking that I may have underestimated the time they would need to get ready to
present.
Appendix B - 308 - The Learning Classroom

Exemplary Case Studies, cont’d.

My concern grew at the end of the next 10 minutes when the groups had nothing more on their graph boards than what they had started with. Either one data point and some partial mathematical operations were written on the boards and graph paper or they had graphed the line, but were completely lost when they had to identify the slope and y-intercept. During the two 10-minute intervals, I had been going around answering questions, but only when students raised their hands and called me over. It is the classroom norm that the teacher will not hover or interrupt group work unless a representative of the group has a question from the entire group. Since most of the groups did not call me over, I focused my attention on getting the next activity ready.

To my dismay, the first activity had not yet been completed even after the 20 minutes had expired. Most of my students had been pretending to work. They had scribbled down unintelligible calculations and drawn sketches of graffiti on the graph boards instead of working on the actual problems. Not only had we wasted a great deal of class time, but the students were completely turned off to learning and were confused about what it was they had to do.

The strange thing about the situation is that the instructions given on the worksheets and at the beginning of class were extremely clear and detailed. Several examples had even been demonstrated at the overhead before students got to work so it was inconceivable that they did not know what they should be doing. I was intent on salvaging the remainder of the period so I got up to the board and decided to go through each of the sections of the packet with the class. For the remainder of the class, I lectured on how to do the problems by identifying the slope and y-intercepts, plotting points on a graph and writing equations of lines. Before I knew it, the class period ended and the students were given permission to leave with the homework being to finish the packet they had started in class.

On Tuesday, the class reconvened and they went through their classroom routine of writing the daily agenda in their journals, getting their portfolios, and presenting their homework to me for credit. The exception that day, however, was that only two people had even attempted to finish the packet. Everyone's packets had some work written in them, yet they were only the problems I had gone over at the end of the class the previous day.

I figured I had let the problem go on long enough and that I should address it before it got out of hand. Noticeably irritated, I stated, “Okay, so last time we went over this entire packet, but you guys still refuse to do the rest of it or even attempt it.” Most of the students could not even look at me as they stared down at their desks or doodled on in their journals. “Come on, what's going on?” After an extremely long pause, Darren spoke up. “We don't get it.” I nearly fell over. “You went too fast the other day. I didn't know how to do most of it.” Had it come from any other student in the class, I would have questioned the validity of the comment, but Darren has always been one of the top students in the class and is extremely motivated. I knew he in some way was the spokesperson for the class. “We barely went over the slope and the y-intercept at the end of the last unit, but my group still doesn't know how to do it very well so we're still confused about how to write these equations.”

**Analysis and Reflection**

Darren was right. So was the rest of the class. I had gone too fast too soon without creating a firm mathematical base to build the new concepts upon. I freelanced that day's lesson. My CT was away at a conference so I felt comfortable changing the lesson plan without consulting her. We went over the same material as the day before, but at a much slower pace and with much more explanation behind the concepts. Whether it was a good idea or not, I went over the same activities as the previous day, except I modeled more of the problems before letting them go off on their own. The graphing boards again went out with different pairs of students getting another chance of solving the problems on the first page of the packet. This time, they were more successful at graphing the given points and identifying the slope and y-intercept of each graph. The result was one that I wanted to have come the day before with students actually seeing for themselves that all one needs to do to create the equation of a line is identify the slope and y-intercept. It may have helped that the scaffolding for the class work was a bit better.

One problem with the first lesson was that I did not have a clear understanding of what students did and did not know. Although they are usually hesitant to speak up, much less present anything at the front of the class, I got a few confident volunteers to present some examples of problems on the large graphing board at the front of the room and others at the overhead projector. For this class, I wanted to take a step back and see with an outsider’s point of view what students were doing correctly and what their misconceptions were. This meant that I had to have them explain everything in their own words. In order to learn, students must have the desire and ambition.
to learn for themselves. This means that they must take control of their own learning and recognize when they understand something and when they need more information or guidance to continue the process. In effect, students must have a “deep foundation of factual knowledge and organize knowledge in ways that facilitate retrieval and application,” but the student is the only person who can fit the knowledge in their existing framework (Bransford, 1999, p. 12).

Whereas before, the lesson consisted of mostly a teacher-led discussion and where I was in control of most of the topics and presented problems I thought would interest them, I allowed my students to assume more control the second time around. Maybe they felt more comfortable talking with each other about the problems or their comfort with the material had grown, but there was much more discussion and the quality of the questions and comments where students genuinely wanted to know how to do a certain problem or wanted clarity on an area of difficulty had grown. Needless to say, the day’s lesson was much more successful. In part, my willingness to delegate authority to my students and give them much more say on what they wanted to learn and do may have had a lot to do with the success. At the end of the day, no new material was presented, but my students were finally getting a good grasp of the material they did not understand the first time through.

For the first day, I attempted to salvage the class by reverting to a transmission model of teaching (described by Oakes) where I was the sender transmitting knowledge to the receivers (students). Essentially, it was a one-directional method of communication—typical of most lectures—but it asked that I break down all the information for the students and spoon-feed it to them while getting very little information about their understanding in return. Under different conditions, this method may have worked, but because I was so rushed to speed through all the material I had planned for that day, I ultimately set myself up for re-teaching the lesson. My lesson plan included a lack of structure and support for my students.

A positive change I implemented on the second day was an increase in scaffolding. According to Oakes, “scaffolding . . . provides a temporary structure around the ‘construction’ of student’s learning and helps hold concepts together during the early stages of ‘sort of’ knowing something, but not having it ‘all together’” (Oakes, 1999, p. 80). I already knew by the way things fell apart on the first day that students did not have a solid foundation in the concepts which ultimately led to a lack of confidence in their ability to do the work. By modeling more of the problems on the second day and talking them through more problems to the point that I could remove myself from the “teacher role,” I scaffolded the students enough that they were confident in their abilities to solve problems and question themselves and each other about key concepts and procedures.

After class, I decided to look back at the detailed exam results from the direct variation unit we had concluded only weeks before. Usually, I only glance at these results and instead focus more on the formative assessments I give my students throughout the unit. I dislike summative assessments, especially when they are standardized tests mandated by every math department in the district, so I tend to pay very little attention to them. It was a mistake to do so this time because the results revealed much about my students’ current mathematical understanding, their misperceptions, and their lack of knowledge. Bransford maintains “new knowledge must be constructed from existing knowledge [and] teachers need to pay attention to the incomplete understandings, the false beliefs, and the naïve renditions of concepts that learners bring with them to a given subject” (Bransford, 1999, p. 10). If we forget or ignore our obligations as teachers to do this, the understanding of the content our students develop will be incomplete or it can be quite different from what we intend it to be.

At the end of the last unit, we had just begun to cover slope and the y-intercept when we had run out of time and were forced to give our students the unit exam lest we break the deadline for exam results passed by the district. A paltry 14% of all the Integrated Math-I classes received passing marks for the objectives covering slope and y-intercept, yet I had assumed that students had already mastered the material when I decided to give them the worksheets with little scaffolding or modeling. This decision was a detriment to their learning because I was trying to build on a weak or non-existent foundation. It is extremely difficult and improbable for students to learn how to graph a line or write the equation of a line if they do not know what a slope or y-intercept is let alone know how to plot a point!
Exemplary Case Studies, cont’d.

Usually, I do well at assessing the level of understanding of all my students and adjust my lesson plan accordingly so I am careful not to lose students who need extra support, yet do not go so slow that I fail to push or challenge my higher performing pupils. The point where I made my biggest error is when I failed to informally assess the progress of the entire class on the first day when they were discussing the meaning and significance of slope and the \( y \)-intercept by listening in on their conversations. Instead, I had focused my entire time listening to Jessie, Gustavo, and Adam instead of roaming around the room to listen to others.

I deceived myself into thinking that if three students—an English Language Learner, a student who sleeps half the class away, and another who is absent half the time—can have a meaningful discussion about slope and \( y \)-intercept, then the rest of the class should have been able to do the same. Another thing I failed to realize was that these three boys had not yet shown a mastery of the material. Their conversation was merely a discussion for giving the process meaning. They had actually just gotten a good start on producing meaning from the problems that I confused with full understanding of the concepts. What I should have done is realize that I needed to build on their process to develop a solid understanding. In effect, they were not at the end of the learning process yet.

I took a small sample of students and based on their performance surmised that their abilities and performances reflected those of the entire class. I never should have made that assumption. I conducted a few informal interviews of the three boys later that week to figure out how I had deceived myself so badly.

Gustavo, I learned, had been coming in for math tutoring after school and had been working diligently one-on-one with my CT and with another math tutor to catch him up on the material he missed while he was on vacation and to reinforce the material he was currently learning. Jessie, who had recently moved from Boston, had already learned all of this material. As for Adam, he may have been the one I should have focused on the most because he was just like the other people in the classroom. Much like Adam, the majority of the class is usually absent or tardy, so if Adam had problems knowing what was going on in class, what made me think the rest of the class knew?

It was not only ridiculous not to go around the room to check for understanding, but to assess an entire class based on one group’s conversation was foolish and showed bad judgment. What if it had been a more successful group of students that consistently achieve high marks and can easily explain their thinking? Would I have used them to represent the entire class? Absolutely not. I used three students whom I identified as low performers for one reason or another and used them as the standard of the class. If they could do the work required of the class, then anybody could! The preconceived notion that the trio of boys could not outperform the rest of the class entirely skewed my expectations for the rest of the class. Not only that, they did not even show they could do the work, they simply showed a glimpse of understanding. They may have shown a glimpse, but when encouraged and instructed to go further, they showed they could not do the entire task I had planned.

This type of bias is harmful not only to the class, but to the group of boys as well. Do I expect them to perform consistently lower than the rest of the class? Jessie already knows most of the material, but shuts off because I cannot challenge him enough to keep him awake. Gustavo is a bright ELL student whose only limitation is his fluency with the English language. I should be pushing these two students to excel because one already came in ready to take the next step and the other will work hard enough to succeed whatever the challenge placed on him. I need to identify all of the biases and misperceptions I have about all my students to truly become an effective teacher. It also would not hurt to circulate the room and check for understanding in better ways to avoid situations like this in the future and simply to know where my students always are in their level of understanding.
Future Instruction

For future instruction, I need to look no further than Bransford’s advice for teaching and the implications of one’s teaching on the understanding of students and Collins’s view on cognitive apprenticeship. It is my intention to implement these sound strategies into all of my lessons from hereoforth as well as advocating many of these strategies to other teachers so they will not encounter the same problems I was faced with and hopefully, that they too can experience some of my success.

“Teachers must draw out and work with the preexisting understandings that their students bring with them. This requires that...the teacher must actively inquire into students’ thinking, creating classroom tasks and conditions under which student thinking can be revealed. Students’ initial conceptions then provide the foundation on which the more formal understanding of the subject matter is built” (Bransford, 1999, p. 19). A big problem with the tasks I had planned was that they did not reveal too much about student thinking—at least in a setting where I could assess most students accurately. In the future, I will set out to create activities and tasks where they expose their prior knowledge and misconceptions out loud either to myself, another group of students or the entire class at the beginning of a unit. From there, I will be able to craft a more honest curriculum and one that is much better scaffolded than if I knew nothing about their prior knowledge. With any luck, the foundation for the unit and for the rest of the year will be solid and sound because of the adjustments I make early on.

The role of assessment is one that I also must review and change. Assessments must tap understanding rather than merely the ability to regurgitate a bit of knowledge I impart that same day while also distinguishing between memorization and understanding. Individualized and creative production on the part of the student can potentially reveal a student’s true understanding and grasp of content than if it were solely based on reproducing a task, skill, or reciting a definition from the mathematics book. Open-ended tasks and authentic assessments will not only capture what individuals understand, but they will also give a better overall picture of the entire class.

A great way to get students to think and become self-sufficient learners is through modeling and scaffolding instructions as if the students are apprentices—which they are. As the expert in the classroom, I must show my students (the apprentices) how to do a task, watch if they do the task correctly and continue to turn more responsibility over to the student as they learn more and grow more comfortable with the task. My job as the teacher, according to Collins, is to “show the apprentice how to do a task and help the apprentice to do it” (Collins, 1991, p. 8). This is what occurred on the second day of the lesson. Without knowing it, I had scaffolded the problems well enough for the students to begin to feel comfortable with them. I then handed full responsibility of learning the material over to them and watched them accomplish a great deal. This is what I need to do for all my future classes. As students learn as apprentices, I will assume more of a coaching role where I “provide hints and scaffolding, evaluate the activities of the apprentices and diagnose the kinds of problems they are having while challenging them, offering encouragement and giving them feedback along the way” (Collins, 1991, p. 9).

Perhaps the most important thing I can take from this experience is to realize that learning is the acquisition of knowledge. Learning is also the filling in the gaps of knowledge we take from one situation to another where we acquire a necessary piece of information and try to fit it neatly into our existing network of knowledge (Norman, 1980, p. 39). This is true of every learner. We cannot take knowledge and fit it neatly into our existing structure if it is beyond our understanding. As the teacher, I must find ways to identify gaps of knowledge and then become the bridge between what students understand and that which they do not quite understand but is still within their zone of proximal development. This approach will help me avoid the pitfalls of building on a weak foundation. One cannot build a good structure without a solid foundation. Attempting to build on a weak foundation will only lead to confusion, misconceptions, and negative attitudes toward learning—in other words, the structure will be unstable.
References


Ochoa Curriculum Case
Commentaries

Commentary 1
By Mariana E. Lanning, Preservice Teacher

In essence, this teacher was forced to deal with the fact that all students do not come from the same lines of education. Some students carry with them a stronger foundation, or simply the lessons come naturally to them. Other students may struggle with material that may not have been made clear to them in previous math classes. Labeling students in any way, such as by saying that one student may not know more than another is not the way a teacher should gain an understanding as to what his or her students know. There have been cases where students who “slack off” in the classroom do in fact know the material and choose to appear foolish. Another thing every teacher must remember is that each student’s affective filter, as defined by Krashen, becomes high or low in different situations. In the high school setting, a student’s affective filter is much higher because they are attempting to appear “cool” and do not want to be embarrassed by not knowing an answer. Group work may cause this affective filter to become lowered in that the students are surrounded by people who they know and feel comfortable with.

One of the questions I wondered while reading through was whether or not selecting pairs at random was a good idea because two students have very different backgrounds in math so they may not be on the same level when working together. However, it occurred to me that it may be just this that in fact helps students solve problems because they are using one another to gain an even better understanding. They are teaching each other.

The teacher spent much of his time labeling and assuming throughout the first day of his lesson plan. A teacher should not be afraid to really get involved with a discussion that a pair of students may be having. It not only forces students to stay on task, but it also shows the students that the teacher is there acting as a support even if they are too afraid to ask for help. The teacher realized this by the second day. The students did not understand the material, as the teacher had thought, and while the teacher may know what he expected, this needs to be made evident to the students. It is difficult to really put yourself in the position of someone who is learning a subject from scratch because if you already know something, it seems innate. However, to students who are reviewing after a long time, or even learning for the first time, the material needs to be taken slow and simple as to allow everyone to be able to partake in the class (whether that is by participating or observing).

This case proved to be interesting in that it showed me, first of all, how Piaget’s assimilation and accommodation are truly put into play. A student is constantly attempting to accommodate their current knowledge to fit new information. This is done, however, one step at a time. The foundation that one has when entering a new classroom is being built on, but the teacher must be careful not to assume, or underestimate what that student knows. Balancing out a fair lesson plan is one of the most intricate events of a teacher’s career. Labeling is another thing that a teacher must watch out for when conducting a class. A teacher must be aware of taking into account all students’ concerns and not allowing one student to represent the whole. If your students’ knowledge is growing, and accommodating new material into their schema, then you too are growing as a teacher.
Commentary 2

By Mary Anne Kochenderfer, Preservice Teacher

This is an incredible case! The setup of this class—ranging from students with very few basic math skills to students who really ought to be in the next class up but for whom there is no room in the higher level math class—is every teacher’s nightmare. This coupled with the fact that in order to pass the class students only need to pass each unit test makes it extremely difficult for a teacher to get students to do their work in a timely manner.

Ed takes a challenging class and what must have been a fairly painful teaching experience and through thorough analysis seems to have found the key to preventing a repeat of this experience.

Ed fell into a common trap for many teachers: He based the understanding of the entire class on a conversation he overheard between three boys. Because three students perceived by Ed as low status appeared to grasp the material, Ed figured that everyone in the class understood. It took Darren (a high-status student) complaining that he did not understand the material for Ed to realize that the material had not been explained well enough.

The key point in this case is how Ed reacted once he finally understood that his students weren’t “getting” the material. Rather than berating their lack of effort or telling them to reread the chapter, Ed carefully retraced his steps. Bringing the students back to the starting point of the lesson, he engaged the students in a discussion that eventually enabled them to teach one another. Ed’s willingness to admit that he needed to go back and start all over again is probably what saved this lesson for the students—even if it may have cost a couple of days of class time.

Although it tells of a teacher’s vast underassessment of student learning, I believe that Ed’s case study is a success story. He was able to take a highly frustrating lesson (to students and teacher) and re-teach the material in a way that was accessible to the student—no small task considering the height of the students’ affective filters after their initially very frustrating introduction to the topic.

Although it made it hard for Ed to assess the understanding of the other students in his class, his eavesdropping on the three-boy group was no loss either. Through this experience he was surprised at the abilities of the students, challenging his previous perceptions of this group.

Teaching in a classroom with such a wide range of abilities is no small task. I believe that Ed did well considering the previous information he had at the time. More importantly, he was able to teach the students important material in spite of confusing them the first time around. Ed’s recovery impressed me, and it is clear that he learned a great deal from this case—lessons that will undoubtedly benefit his future students.