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Making Concrete Less Abstract

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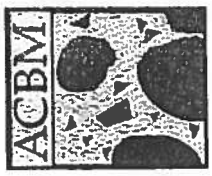

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MAKING CONCRETE LESS ABSTRACT

David N. Richardson[1]

ABSTRACT:

CE 313 is a second level properties of concrete lecture course. In an effort to make it appear less abstract to the students, over the course of several semesters several learning strategies were tried, including journaling, muddiest point, entering the academy, role playing, bookends-on-a-lecture, and hands-on lab projects. Most recently, an emphasis on short writing-to-learn papers, a problems-based stance, and an integrated lab project was used. Student evaluations indicated that the lab projects and the increased writing was of significant benefit in promotion of learning.

Introduction

CE 313 Properties of Concrete is a three credit hour semester-long senior elective/ entry level graduate course taught in the department of Civil Engineering at the University of Missouri-Rolla (UMR). Enrollment usually ranges from 12 to 25 students, mostly seniors. Most of the students will have already taken a required undergraduate construction materials course that features a large portion of course work pertaining to concrete. Over the years, I have come to realize that no matter how carefully I attempt to craft my lectures, concrete can be too abstract for our students.The traditional 50 minute lecture with the students in a passive mode was not working as well as I would have liked, evidenced by students' lack of understanding of basic fundamentals as demonstrated on tests and homework assignments.

During the last several times I taught the course, I have tried a number of some of the more recent learning strategies. Additionally, our campus is in the midst of implementing a Writing-Across-the-Curriculum program. Because I have been heavily involved in this movement from the very beginning, CE 313 was designated as a Writing Emphasized course, starting in the fall 1998 semester. During this semester, I tried a somewhat different approach than I had been using by attempting a combination of several strategies. My objectives were to increase the students' interest, improve their level of learning, introduce them to the academy by involving them in their own research, and contribute toward their improvement in writing.

Learning Pedagogies

In the past, CE 313 was taught in the traditional manner: three 50 minute lectures per week at regularly scheduled times, with end-of the-chapter short question or problem homework assigned periodically, graded by the instructor and returned. Assessment was limited to homework and four one-hour exams. Sometimes a term paper was assigned, with the topic chosen by the student from an instructor-supplied list. The paper was turned in at the end of the semester with no chance of editing. Many times the graded papers were never picked up by the

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students.The course material was presented deductively, that is, the derived fundamentals were slowly and inexorably piled up, building toward completion of the basic background for the concepts. Then, the students applied the fundamentals to solving problems.Thus, the instruction was teacher-directed, the questions raised were from the instructor, not the student, the writing was aimed at pleasing the instructor, not as a learning tool, and the students were pretty much in a passive mode. Considering the vast amount of material I had them copy from the board and overhead transparencies, I am reasonably sure I turned out some rather good stenographers.

Research over the past two decades on learning has shifted the focus from a passive-type learning experience where learning is viewed as the transmission of knowledge to a more active view of learning where students construct knowledge. This approach begins with student inquiry which creates intellectual challenges for students and is the source of intrinsic motivation and growth that leads to life-long learning. According to Karl Smith (1), a member of the Department of Civil and Mineral Engineering Department at the University of Minnesota, this paradigm shift is mainly achieved through collaborative learning experiences where students are actively engaged in talking, writing, reading, and listening as they become discoverers and transformers of knowledge. Significantly, students learn through relating and understanding rather than through memorization and mimicing which ensures that students are cognitively, emotionally, physically, and psychologically actively constructing their own knowledge.

Learning Strategies That Initiated the New Paradigm

Over the years I have tried to incorporate some active learning strategies. These have included written and oral assignments. Examples are role-playing, muddiest point statements, bookends on a lecture, small group discussion/presentation, dialectic journals, and peer question and answer. The writing was aimed primarially at improving the students' understanding of the material, with a secondary goal of actually contributing toward improving their writing. Thus both informal writing-to-learn and the more formal writing-to-communicate were used.Various stategies tried in the class are as follows.

Journals. Students were assigned to read an article out of a trade magazine such as *Concrete Construction*. They were to keep a journal, sometimes a dialectic journal, which is a journal where one not only writes down one's thoughts, but the answers to the questions as well. Each page was divided down the middle. On the left hand side the student would summarize the main points. As the writing progressed, the student might pause in the summarizing to ask a question. Thus the students own questions were formalized as they occurred. At the beginning of the following class period, the students would immediately huddle in their small group (two to three persons) to discuss each of their summaries, trying to answer each others' questions. After about five minutes, I would bring he discussions to a halt, and call on a group to summarize the article for the rest of the class. Then I asked for questions that they could not answer themselves, and we would work our way through them. The journal pages were handed in; depending on my energy level, I would either look over and respond to each journal or respond to a sample of the writings. I would make sure that I would respond to everybody at least once during the term.

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Sometimes, instead of summarizing the article, I would have the students write three things they learned, three things they were unclear about, three things they wanted to know more about, and one thing that they could make a connection to from their own experience, which did not have to be about concrete. The questions were handled in the above manner. Although this strategy aligns more closely with learning theory in that the students are not simply regurgitating what the articles say, I found that the 3x3x3x1 sometimes tended to be somewhat contrived and perhaps even trivial.

In either case, the writing that the students did was informal and risk-free. That is, their efforts were not graded in any way except for content. As I later came to understand, summary writing represents a deductive mode that does not actually improve writing, and it runs counter to student inquiry which creates interest for the student.

Muddiest Point. Another form of informal writing involved my asking the students at the end of the class period to write down one concept that was presented during the period about which they were confused. Then I would have them swap the questions with their neighbors, who were to answer the questions if possible and turn in the next period. I would look over these, trying to divine parts of my presentation that needed work. It also got the students to ask their own questions and to look at a concept from another's viewpoint. Explaining something to someone also sharpens one's own understanding, an essential part of learning.

Entering the academy. So many times our students' perceptions of information has been limited to the concept that the course content resides in two or three places: the course textbook, course notes, and with the instructor. In an effort to drag the students into the academy (from which we do a bang-up job of excluding the students), I attempt to get their noses into other forms of technical literature. One thing I have done is to have each of them read an article about, say, D-cracking, in *Concrete Construction* to get an overview. Students then exchanged questions with their partners for peer response. Next they were asked to read and respond to a prepared research summary concerning D-cracking. This generated lots of questions. Finally, they were each given a different research paper to read and again go through a question and peer response cycle. For most, this was their first foray into the literature beyond their textbook, and to plunging deeper and deeper into a given topic.Once students learn that there are resources beyond the course textbook, you have opened them to the possibility for life-long learning. In the future I plan to begin as I have explained here, but use the strategy as a scaffolding technique that preceeds their second level investigation where I send them in search of data from various sources on the last set of questions.

The other aspect of introducing students to the academy is to begin to get them to understand that knowledge is not necessarily material that is held by the written word or residing with another person, rather, it is something that is created in their own minds, and when they do any kind of "research," they too are creating knowledge--thus becoming a part of the academy, as opposed to an outsider looking in, forever excluded. Once you are a member, you can access its tremendous potential, and again you are better equipped to be a life-long learner.

Role-playing. One example of role playing I have used was to have the class read several articles

on a controversial topic, say, on the use of chloride-containing admixtures, and be prepared to play either the pro or con side of the issue in a debate type of setting. This kind of activity definitely falls under the active catagory and can get pretty boistorious.

Turn-to-Your-Partner. Research has shown that the attention span of the typical student is about 12 minutes (1), and thus it is pretty optimistic to assume that they are staying with you the whole 50 minutes. Karl Smith (1) advocates a strategy known as Turn-to-your-Partner, which simply is a planned stopping of the lecture several times to engage in a more active endeavor. In CE313, that activity usually entailed turning to one's neighbor and discussing something such as coming up with a way to test for a certain aggregate property.

Lab Projects. An old proverb goes something like this:

> I hear and I forget
> I see and I remember
> I do and I understand

Every semester, as a part of our student evaluations, the students in my materials lecture classes have commented on the fact that they would like to see some hands-on activities to help drive home some of the concepts presented in lecture. This request is somewhat amazing because students typically grumble about courses with labs, and here they are, asking for some kind of activity. So, lately I have been obliging them by assigning a group lab project which takes the place of the traditional term paper. I have tried differrent approaches in regard to how a group settles on a topic, anywhere from outright assignment to letting each group pick its own. The students meet on their own time, plan and execute the project, make a presentation to the class, and turn in a written report. In the past, each group's topic has been unrelated to the others.

Winter Semester 1998 Strategies

Short Papers. To enhance learning and promote better writing, as well as fulfill Writing Emphasized criteria, I have begun to integrate numerous short writing exercises into my courses. These papers are typically three to five pages long and were confined to the subject at hand, such as cement, aggregates, pozzolans, strength and fracture, admixtures, and so forth. The way that seems the most sucessful in terms of instructor workload, benefit to the students, and student attitude is to first assign the creation of an outline. We then discuss in class what ought to be a minimum in the outline. The students then revise their outlines, turn them in, and I quickly respond to them. Next, based on the outline, the students write a rough draft. The first draft is exchanged with a peer and responses made. A second draft is done and turned in to me with the changes highlighted in bold so that the entire paper need not be reread. I respond to the draft and attach a content rubric, showing the content that is lacking. They are also given a point distribution rubric showing how the points will be apportioned (Figure 1). The final draft is then turned in.

Problems-Based Learning. In my classes I am slowly heading toward a case-based approach which the order of presenting material is reversed from the normal deductive teaching method. As

a prelude to my own comfort with transforming my teaching, I have begun with a problems approach. The problem is presented first, then the class brainstorms as to what information is necessary to solve the problem. Each requirement is then followed out to its logical conclusion. In this manner, the material that normally is presented in the more traditional method is present in the case-based approach, however, the material will have been uncovered by the class as opposed to being covered by the instructor, an important distinction.

Recently, I divided the course syllabus into three segments, revolving around three different mix designs, each with its own unique characteristics. In the first segment, the class is required to design a mix for a footing. They discuss what properties are important and proceed from there. The next problem is a design for a reinforced box culvert, thus other properties come into play as well as more ingredients in the mix. Finally, a pavement slab mix is designed.

Integrated Group Projects. Early in the semester, the class was divided into eight groups of three students each. When I made the group assignments, I tried to put some experienced people into each group, such as graduate students, ACI student chapter members, students with summer materials experience, and so forth. This resulted in groups that could function autonomously without much supervision from me, and thus the lab work did not add to my work load appreciably. Each group was given a portion of the entire class project, which was to explore the effect of seven variables (at two levels) on several properties of a concrete mix design. The variables were :

Water content
Cement content
Flyash content
Coarse aggregate/fine aggregate ratio
Water reducer dosage
Superplasticizer dosage
Air entrainment dosage

Coupled with the base mix, there were three levels of variation per mix. The students were required to develop their mix, demonstrate and present their portion of the project to the rest of the class, and write a report which integrated the entire findings of the class. As can be seen from the figure, most of the groups' work built on the work of previous groups.The order of when the students did their labwork and made their presentations followed the order of class topics. Each student was given a timetable (Figure 2) which set out target dates for all the steps. In this way, if we both did our jobs and stuck to the plan, we could all avoid the last minute rush of trying to finish at the end of the semester.

Each group met, planned the exercise, and developed a list of required equipment, supplies, and a one page outline of the report. I responded to their first attempt; they reworked their plans, list, and outline, and we met again. By this time, we could discuss how to best fine-tune their mix. Within a week, they turned in the first draft of their report, which included a section on the required materials and equipment and a section on expected outcomes. This is a revelation to the students--how could they write about something that had not happened yet? The idea was that the planning and writing about expected results involved a projection in their minds into a detailed step by step imagining of what they would be doing; this should have enhanced their abilities to begin to understand how concrete works-a cause and effect sort of thing. I

responded to their first draft. At some point, it was their turn to make their mixes and practice their demonstration. With eight groups making mixes and then demonstrating, it was important that the timetable be adhered to. After the class presentation, the group's report only lacked the results and conclusions, and could turn in the third draft without a lot of pain.

The first group was responsible for developing the basic mix to which all other mixes were to be compared.The mix was plain (no admixtures), lean, low slump, medium water cement ratio (w/c), with a traditional coarse-fine aggregate ratio. All the other groups each changed only one variable. The variables were changed by exchanging equal absolute volumes, so mix proportions remained constant mix to mix. As the semester progressed, basic components were changed first, like water and cement contents. Then gradation and finally admixture types and dosages were varied. In the lab, each group mixed their materials and ran slump, unit weight, and air content. To match the design part of the course where they would develop mixes for the reinforced box culvert and the pavement slab, two kinds of workability were checked. First, they cast a 200 mm (8 in) thick reinforced concrete wall in a specially fabricated re-usable steel wall form which had one side made of plexiglas so the effects of placement and vibration could be observed. They also cast a small slab to get a feel for finishability. Finally, they cast cylinders to be broken at 7 and 28 days to assess effects on strength.

As each group finished its lab work, results were discussed in the lecture period and comparisons made to results from all other groups to promote continuity of the project and to reinforce the lecture subjects. During the group presentations, hardened slump and slab specimens from each group were examined by the whole class. Typical group presentations included the use of slides, overhead transparencies, equipment displays, and sometimes videos or physical test demonstrations.

Assessment

Student Evaluations. One method of assessment as to how well all of this worked involved an examination of the student evaluations taken at the end of the semester. Student written comments were unanimous in support of the lab work. Typical statements were "...the lab experiment helped put a lot of the material together," "The lab experiments were a very effective learning tool..." This is in spite of the fact that the course is only a lecture type course and all lab work had to be done outside of class, and no course credit hours are given for their efforts. I believe one can take the sting out of this extra work by keeping the lab work to something that can be done in one or two afternoons, making sure that the work is done early in the semester so that it does not interfere with other classes which clog up during the latter part of the semester, keeping things organized, and making sure that the students are getting enough support so that they are not fighting equipment that is either not working or difficult to get. One student suggested that all the groups should have watched the first group make the basic mix to get a better feel for the baseline mix. Only one person out of 24 felt that credit (course hours) should be given for the lab work. I have been doing much the same thing in my pavement design lecture class and in previous offerings of CE 313, and these statements of support are typical.

Student evaluation comments about the increased amount of writing were generally

positive and displayed an understanding that writing things down helped in the understanding and learning process, although for some writing is still a chore. They seemed to like the ideas of starting with a good outline and having the opportunity to do multiple drafts. Typical comments were " Papers... helped solidify the facts we needed to understand even though they were a pain to write," "Papers are a good idea, start with outlines.They make the papers easier to write," and the instructor "lets us do drafts of all major reports." I did not require outlines for some of the papers; rather, I relied on the content rubrics to guide the writers as to minimum expectations of content. Some students found this required quite a bit of revision, and were frustrated by it.

Subjective Assessment of Performance. Although no formal assessment was made this semester as to an improvement in the level of understanding, a subjective assessment of classroom discussion and performance on written exams and homework assignments indicated that even the weaker students seemed to have a pretty solid grounding in the basic concepts, which was an improvement over previous semesters. The writing forced the students to formalize and organize in their own minds their understanding of the material, and the lab project provided them with an opportunity to obtain a hands-on connection to the concepts.

Peer Response. Peer work was beneficial in two respects: first, it was a superior way for people (both the writer and the responder) to learn, as opposed to a teacher-directed scenerio, and second, quite frankly it helped reduce the burden of grading. If a paper was in its second or third draft by the time it reached the instructor, it may very well have been in pretty good shape. The content and grading rubrics were also a great aid in communication between the writer and the editor- their use cut down on the guesswork on the part of the writer, and reduced the amount of written comments that would have had been made by the reviewer.

Problems

The problems in this class centered around the instructor's ability to process the homework in a timely manner. An unusual amount of outside activities engulfed the instructor just as the semester got underway. The timing was extremely unfortunate because it made examination of the effort needed to conduct a Writing Emphasized and lab project-augmented course rather difficult. This lack of time also led to a lesser effort on my part in checking for blatent paraphrasing, plagerism, and accountabilty in terms of the number of references and paper length. Students tend to stick to as few a number of references as possible (such as staying exclusively with the text), and not being concise. These problems represent an obvious lack of student ownership and personalization. The task for me is to create more student inquiry in the assignment by creating a structure that allows for much student autonomy.

Other perceived problems concerning all of the strategies include consternation on the part of the instructor because of the loss of lecture time through the class time given over to demonstrations and class discussion of journal questions and lecture bookends, plus the time to write the muddiest point. It is true that less material will be covered by the instructor during the semester, however it is believed that more material will be uncovered by the students. Isn't that what we are really after?

Conclusions

1. A variety of learning strategies can be used in a materials class, including written, oral, and hands-on.
2. Student-centered writing helps student learning when it is from an inductive approach rather than a deductive one.
3. Student-led discussion techniques, such as turn-to-your-partner and journal questions can lead to higher energy and interest levels in class.
4. Peer response to writing helps the writer, the responder, and the instructor.
5. Muddiest point and journal questions can be tools for the instructor as well as the student.
6. Entering the academy helps make students aquire the language of the discipline and become life-long learners.
7. Students believe lab work assists in their understanding of course material and are not dismayed by having to do it, even though no semester hour credit is given.
8. Students believe that writing increases their learning, but still tend to find it burdensome.
9. An integrated lab problem promotes cohesiveness of the class learning environment.
10. Problems-based learning hooks students into the course more quickly and provides a more intuitive basis for approaching a body of knowledge than the more traditional deductive method.

References

1. Smith, K. And Waller, A., *Cooperative Learning For New College Teachers,* in *New Paradigms for College Teaching*, Interaction Book Co., 1997.

CE 313 GRADING RUBRIC

Author:_____ Reader:_____ Draft:_____

Item	Score Range			Score
Written in own words (not just a bunch of facts cleverly paraphrased from the text and lumped together into paragraphs	1	3	4	
Writing is easily understood by the reader	1	3	4	
Writing is edited for grammar, spelling, and punctuation	1	3	5	
Writing is typed, double-spaced			3	
Font size: 12 Font face: universal			1	
Proper number of pages			2	
Turned in with all previous drafts	1	2	3	
Changes are highlighted in bold	1	2	4	
All salient concepts present			50	
All concepts correctly interpreted			24	
Subtotal			100	
One point deducted for each reviewer's comments not addressed				
Two points deducted for each day late; 50 points deducted for submission after class set is graded				
Total				

Figure 1. CE 313 Paper Point Allocation Rubric.

CE 313
WINTER 1998
GROUP LAB PROJECT
TIMETABLE

STEP	ACTION	TARGET DATE
1	Meet, plan the lab exercise, develop written questions and a written list of required equipment and supplies for instructor; turn in a one page outline of the written report.	by 1/21/98
2	Meet with instructor to finalize planning.	by 1/26/98
3	Turn in preliminary draft of lab report, with anticipated outcome.	by 1/30/98
4	Instructor approves or suggests modifications.	by 2/6/98
5	Make your mixes, practice your demonstration, work the bugs out; may have to do several times.	**Start week of 1/25/98** **2 squads per week:** Groups 1&2: 1/25/98 Groups 3&4: 2/1/98 Groups 5&6: 2/8/98 Groups 7&8: 2/15/98
6	Demonstrate lab and present results to CE 313 class.	Group 1: week of 3/22/98 Group 2: week of 3/22/98 Group 3: week of 3/22/98 Group 4: week of 3/29/98 Group 5: week of 4/5/98 Group 6: week of 4/5/98 Group 7: week of 4/5/98 Group 8: week of 4/12/98
7	Turn in second draft of your report Instructor will return for revision	One week after your demonstration
8	Turn in final draft of report	**NONE** later than 4/30/98 except Group 8: due by 5-6-98

The main objective of all this is for you and your classmates to learn a concept in regard to the behavior of concrete, and maybe to have some fun in the process. In regard to more mundane things, your grade will be based on a combination of your apparent preparedness during your lab demo, your individual level and quality of participation, and on the professionalism and content of your written report.

Figure 2. CE 313 Group Lab Project Timetable.