Educating Land Development Engineers about Construction Activities through a Field Journal Technique

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Introduction

Land development is a very eclectic area in civil and environmental engineering. The practitioners must be knowledgeable in many fields of engineering and other disciplines ranging from accessibility to zoning and many topics in between, including construction engineering. It is also recognized that civil engineering students should have closer contact with real-world construction, and in many cases this has been accomplished with bringing construction site aspects into the classroom, but may also be accomplished by bringing the classroom to the construction site [1]. In addition, the Accreditation Board for Engineering and Technology (ABET) system, which is used for accreditation of most of the collegiate engineering programs in the United States [2] lists one of the outcomes that must be demonstrated is that the graduates of these programs have the ability to communicate effectively [3,4]. One of the areas important for engineers in land development is being able to communicate field information effectively. Added to these important issues, is the belief that spatial visualization contributes to success in engineering [5]. Thus, the idea of a field journal exercise covering progress at a nearby construction site was considered as an assignment for use by engineering students studying land development, so that these students could observe construction activities and learn to translate their visual observations at a construction site into a written and/or sketched format.

There has also been much discussion about a *New Paradigm for Engineering Education* in engineering journals. Some of the attributes include inquiry-based learning and preparation for life-long learning, a stress on systems thinking, communication skills, and a focus on such issues as sustainable development, timeliness and health and safety [6]. The field journal concept at this particular construction site was also conceived to be able to address some of these items.

The Civil and Environmental Engineering Department at the University of South Carolina has recently introduced an introductory course in land development issues for engineers. In order to give the students exposure to many of the aspects of a land development project 'system', and also to increase comprehension for the time related items in construction, it was decided that the students follow a nearby project with a field journal instead of the more traditional approach of taking these students on field trips to one or more different construction/land development sites.

There were two main goals of employing the journal technique. The first was for the engineering students to develop field journal skills, and the second was to introduce these students to some aspects of construction engineering and have them analyze what occurs. Six skills have been identified for evaluation for each of these goals. The evaluation is based on a pre/post survey [7]. This survey-pair questions the students about their opinion of their own competency at these 12 skills both after the first journal entry and after the last. In addition, the last survey asks for any additional comments on the field journal technique. The survey was also a mechanism by which the instructional objectives of the field journal could be formulated so that the students could better understand the assignment [8].

Journal Assignment

The field journal assignment was given out at the first class of the semester in the fall of 2003 at the University of South Carolina for a course in the Civil and Environmental Engineering Department entitled *Land Development for Engineers.* The course is an upper level engineering course which both undergraduate and graduate students may take. The students were asked to visit a construction site next to the engineering quadrangle for nine occasions spaced almost weekly over an eleven week period starting the second week of the semester. A new student housing development was being built at this site by the University of South Carolina. It was a convenient location for the students, on a block neighboring the engineering facilities, and also the project was of a fairly large scale (approximately $29 million dollar project), which afforded the students many different activities to witness. When the assignment started, the ground at the site was rough graded, many of the site utilities were installed, and the foundations were started for some of the buildings. At the end of the assignment, much of the structural and exterior work was complete, including the roof framing, on some of the buildings. The site was very active throughout the assignment. Another unique feature of the construction project related to sustainability issues. It is the first LEED (Leadership in Energy and Environmental Design) certified residence hall being built at the University of South Carolina, and one of the first LEED certified dorms at major universities in the nation [9,10].

The students were given small university bluebooks for use as the journal medium. It was estimated that completing from 3 to 4 sides of the books would take about a half hour, and this was set as the goal for each visit. The students were allowed to choose any aspects of the construction project that they would like to record. It did not matter if these were related to engineering, labor, construction or support services issues, or a complex combination of several. It was suggested that the students attempt, for several of the entries, following one or more aspects of the job with the intention of increasing their comprehension of how the construction process progressed over time. The students were allowed to record the information in any manner they preferred, with sketches, written notes or both. One student even preferred to take digital photos and paste them into the field journal. Examples of recorded information went from a sketching study of safety signage at the site to details of the structural elements in one of the buildings. Labor issues were commented on frequently. The students also had access to a complete set of plans for the facilities and a university housing website that featured a webcam view, in case they were interested in learning more about the details.

The students were not allowed on the construction site for safety and other reasons, but were able to observe through the chain link fence surrounding the site on all four sides. They were also asked not to interrupt the workers or management crew. The housing authority was notified of the class field journal project ahead of time and was very supportive of the assignment. The field journals were not reviewed for accuracy, however, comments were made if it became apparent that a student did not spend enough time on the entries. Questions raised by the students in the field journals were not discussed in detail in class, nor were they reviewed by the engineering faculty. The intention was not to provide an engineering review of the project, but rather for the students to learn through field observation. The field journal represented ten percent of their semester grade for the course.

Survey

The initial survey was given to the students just after the first entry in the field journals was due. The final survey was then taken after the ninth entry was completed. The initial and final surveys were identical questionnaires, asking the students to describe their own opinion of their competency in 12 different skills. The intention was to see if these changed as a result of the assignment. The final survey also contained two additional items. The first item was a question to see if the students thought that after the assignment was complete, that their view of their initial competency may have been incorrect. The second item provided an area to write any additional comments or suggestions about the assignment.

The 12 different skills were divided into two categories, one focusing on field journal skills and the other relating to construction engineering skills. These skills concentrated on communication and observational skills under field conditions for the first goal of competency in field journal techniques. The construction engineering skills tracked are vastly different, emphasizing construction engineering knowledge and proficiency. Both sets of skills were chosen by the author based on her experience and knowledge in construction and recording of field information. The categories are:

Category I: Field Journal Skills

1: Labeling journal for who, what, when, where
2: Taking notes under variable field conditions
3: Field sketching
4: Observing details
5: Recording details
6: Reporting information objectively and with integrity

Category II: Construction Engineering Skills

1: Sequence the steps needed to perform a construction activity
2: Estimate the human workforce needed for a construction activity
3: Describe the tools/equipment needed to perform a construction activity
4: Recognize health, safety and environmental issues related to a construction activity
5: Estimate the time needed to perform a construction activity
6: Visualize how the item under construction might appear on a plan

The students were asked to rank their competency in these 12 different skills on a scale of 1 to 5, with 1 being *not yet competent* and 5 meaning *very competent*. This type of pre/post survey, with self-evaluated competency ratings, has been used previously by engineering faculty at the University of South Carolina in evaluating other course activities and in evaluating aspects of a K-12 fellowship program [7].

Survey Results

Eighteen students completed both the initial and final surveys. The average ratings for each of the 2 categories surveyed are tabulated in Table 1 under the heading of Full Data Set. Of these 18 students, 4 answered in the final survey that they thought that they may have not rated their initial skill levels very well, now that they had learned more. It was anticipated that this might occur sometimes, since, without prior experience, many people assume that the task may sound easier or harder than it actually is. The skill averages were then modified by using the data without the rankings given by these 4 students and these results are also given in Table 1 under the heading of Modified Data Set.

Table 1: Average Survey Results

Data Set	**Full**			**Modified**		
Survey	**Initial Avg. Rating**	**Final Avg. Rating**	**% Increase**	**Initial Avg. Rating**	**Final Avg. Rating**	**% Increase**
Category I: Field Journal Skills	**3.5**	**4.0**	**16**	**3.4**	**4.1**	**21**
Category II: Construction Engineering Skills	**2.8**	**3.6**	**30**	**2.8**	**3.8**	**33**

Initially, the students ranked their field journal skills (average 3.5 out of 5) as significantly higher than their construction engineering skills (average 2.8 out of 5). After the assignment was complete, they felt that their field journal skills had increased by nearly 16% to 4.0, and that their construction engineering skills had increased a full 30% to 3.6 out of 5. Deleted from the modified data set were the answers from the 4 students who felt that their initial rankings may have been incorrect after having completed the assignment. This modified data set shows even higher increases in skill rankings. This is consistent with the presumption that some people may mentally oversimplify or fear incompetence in a skill or task, until they are more knowledgeable about it. The increases of the ratings in the modified data set were more than 20% for the field journal skills overall, and 33% for the average of the construction engineering skills.

The final survey also had space for writing additional comments and recommendations. In general, the comments were very positive and recommended using this technique in future land development and engineering classes. One student described the assignment as ‘brilliant’.

The main recommendation for improvement was to limit the number of entries to 5 or 6 longer ones, each with an average two week span in between to allow for more activity to occur. This recommendation might also be very useful for using the technique when a construction site is not

as convenient for the students to get to as this one was, allowing for less frequent travel time delays.

There were also many comments made about the assignment in class over the course of the semester. In the first few weeks, several students commented that they did not know how an assignment that was not corrected for accuracy like a typical engineering homework assignment could be meaningful. Some of the students were at first annoyed that the questions they posed in their field journals concerning some aspects of the site were not being discussed and answered immediately in class. However, as the weeks progressed, many of the students were able to answer their own questions by further observation and mentioned this in their journals. For instance, one student asked what a particular hole in the ground was going to be used for, and answered the question a few weeks later when a foundation was poured there. Many of the students realized that they were learning by observation. One student stopped by to tell me several weeks after the assignment was complete, that she still stopped and looked to see what was happening at the site when she walked by, instead of ignoring the construction as she had done prior to the assignment. For her, it had improved her lifelong learning skills. Inquiry-based, and lifelong learning are both aspects of the *New Engineering Education Paradigm* [6].

There were also a few unexpected benefits derived from the exercise. One student commented that writing in the journal in the field made his hands hurt, and several others noticed how difficult it was to remain by the site for even a half hour when the weather was extremely hot. They came to appreciate some of the physical difficulties of working in land development. Another student was very excited to announce in class about halfway through the 11 week period that she had seen her first lady in a hardhat at the site.

Summary and Suggestions

Based on the results of the survey, the field journal assignment appears to be a very effective tool in increasing competency for the 12 skills itemized. It seemed to be particularly effective in the perception of competency in construction engineering skills for the students involved. The University of South Carolina does not have a separate construction engineering field of study in the Civil and Environmental Engineering Department, so it was expected that this additional exposure to construction practices in land development would be very meaningful. The three skill ratings that improved most significantly were the students' perception of their abilities to estimate the human workforce needed for a construction activity, describe the tools/equipment needed to perform a construction activity, and recognize the health, safety and environmental issues related to a construction activity.

The survey was not tested for validity or reliability. Reliability information can be better achieved after the class is offered several more times and the pre/post survey results from these additional offerings compared. A possible way to test the validity is to also offer this pre/post survey to students taking other courses, and see if the change in their perception of their skills is perhaps also a function of the point it is taken in a semester, or their general engineering education development. Another validation concern is that after the course is over, and substantial time has elapsed, the students may take the same survey and rank themselves differently again. It is very difficult to do this validation exercise since the course is mainly given

to upper-level students and many would graduate before a follow-up survey might be performed, or may take another course in which one or many of these skills might also be developed.

It is recommended that the assignment be modified slightly by reducing the number of entries from 9, to 5 or 6 entries of longer duration, and that for similar construction projects, these entries be spread about two weeks apart. This will also help reduce travel accessibility issues to the construction site for the students, when a suitable project is not as close by.

This assignment represented only about 10% of the effort and grade in a 3 credit upper level collegiate engineering course and yet gave a large increase in the self ratings of the listed skills by the students. It is therefore recommended to keep using it as an experimental educating tool for classes in land development engineering until further survey information can be gathered and analyzed. It might also serve as an effective technique in other engineering courses.

This assignment also addressed several of the attributes in the *New Engineering Education Paradigm,* particularly, using an inquiry-based learning approach, teaching a technique that can be used for life-long learning, using a complex construction site to stress a 'system', and focusing on health, safety and sustainable development issues [6].

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Biographical Information

LIV HASELBACH is an Assistant Professor of Civil and Environmental Engineering at the University of South Carolina. Her teaching focuses on computer aided engineering drawing, land development, air pollution control engineering, environmental modeling and sustainable development. Her research interests center around sustainable development and environmental issues associated with construction and transportation corridors.

Appendix A
Initial and Final Surveys

ECIV 570 Fall 2003-Initial Survey Last 4 digits of SS#_____

We are collecting data to evaluate the impact of the Field Journal assignment for engineering educational purposes. Your candid response will help evaluate this tool for future use in ECIV 570 and maybe other engineering courses.

Part 1: For each item please circle the response to indicate how well you feel you are able to implement the skill at this time.

	Not Yet Competent		Competent		Very Competent
Category I: Field Journal Skills					
1: Labeling journal for who, what, when, where :	1	2	3	4	5
2: Taking notes under variable field conditions:	1	2	3	4	5
3: Field sketching:	1	2	3	4	5
4: Observing details:	1	2	3	4	5
5: Recording details:	1	2	3	4	5
6: Reporting information objectively and with integrity:	1	2	3	4	5
Category II: Construction Engineering Skills					
1: Sequence the steps needed to perform a construction activity:	1	2	3	4	5
2: Estimate the human workforce needed for a construction activity:	1	2	3	4	5
3: Describe the tools/equipment needed to perform a construction activity:	1	2	3	4	5
4: Recognize health, safety and environmental issues related to a construction activity:	1	2	3	4	5
5: Estimate the time needed to perform a construction activity:	1	2	3	4	5
6: Visualize how the item under construction might appear on a plan:	1	2	3	4	5

ECIV 570 Fall 2003-Final Survey Last 4 digits of SS#_____

We are collecting data to evaluate the impact of the Field Journal assignment for engineering educational purposes. Your candid response will help evaluate this tool for future use in ECIV 570 and maybe other engineering courses.

Part 1: For each item please circle the response to indicate how well you feel you are able to implement the skill at this time.

	Not Yet Competent		Competent		Very Competent
Category I: Field Journal Skills					
1: Labeling journal for who, what, when, where :	1	2	3	4	5
2: Taking notes under variable field conditions:	1	2	3	4	5
3: Field sketching:	1	2	3	4	5
4: Observing details:	1	2	3	4	5
5: Recording details:	1	2	3	4	5
6: Reporting information objectively and with integrity:	1	2	3	4	5
Category II: Construction Engineering Skills					
1: Sequence the steps needed to perform a construction activity:	1	2	3	4	5
2: Estimate the human workforce needed for a construction activity:	1	2	3	4	5
3: Describe the tools/equipment needed to perform a construction activity:	1	2	3	4	5
4: Recognize health, safety and environmental issues related to a construction activity:	1	2	3	4	5
5: Estimate the time needed to perform a construction activity:	1	2	3	4	5
6: Visualize how the item under construction might appear on a plan:	1	2	3	4	5

After completing the journal assignment, do you feel that your answers to the preliminary questionnaire about your skill levels may have been incorrect? Why?

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Please write down any comments/suggestions you have about the field journal assignment.

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