Soil mechanics laboratory classes as an integral part of the learning process

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ABSTRACT: Laboratory classes can be regarded as important to help students grasp the fundamentals of Soil Mechanics, but this is sometimes discarded as impractical or bound to be restricted to demos, especially in large classrooms. Demonstrations can, after all, be simply presented in the classroom, even by means of videos or YouTube clips. Notwithstanding the merit of such displays, the point is made in the paper that students can reach a better understanding of the fundamentals if they have a hands-on experience in the lab. Moreover, this experience can be designed so as to also foster development of soft skills which are valued competencies of the engineer of the 21st century. A tested method of doing so, even with large numbers of students, is described, as well as the involvement required from those students in terms of self-learning. Soil identification and classification is also learned by means of a carefully designed hands-on laboratory experiment that usually meets with joyful involvement by the students.

1 INTRODUCTION

Readers over 50 years old have probably witnessed different trends regarding laboratory classes over time. The author himself has had a rather limited exposure to the Soil Mechanics laboratory while an undergraduate at the Polytechnic School of the University of São Paulo. When he became a teaching assistant, a new professor had assumed the course and eliminated the laboratory classes altogether, on grounds of impracticability (for over 100 students) and potential better use of that time for lectures and exercises. Later on, again under a different professor, laboratory classes were reinstated, but rather as demonstrations with very little hands-on experimentation.

Distinguished members of our community have voiced many different views on the subject. Mitchell (1999) discussed the changes in the role of laboratory testing in education and practice, pointing out that in situ tests, numerical analyses, and prior experience and soil properties correlations had contributed to the reduced emphasis on laboratory testing. Graham, in his “forward to basics” plea (Graham and Sayão, 1999), advocates a reduction – but not elimination – in classification, compaction, and hands-on laboratory skills, among other topics.

The BOK2 (ASCE, 2008) report, on the other hand, lists “Experiments” as one of the 24 desirable competencies of Civil Engineers, to be developed by undergraduate curricula to level of achievement 4 of Bloom's taxonomy (Bloom et al, 1956). Level 4 (Analysis) refers to the “ability to break down material into its component parts, so that its organizational structure may be understood”. JTC3 of FedIGS suggests, as a “starting point” (progress report, Turner and Rengers, 2010) that “Experiments” be split into two competencies: “Site investigations and 3D geo-engineering modelling (physical and numerical)”, and “Natural materials science and testing”. This latter competency is an expansion of “Materials science” in the BOK2 (ASCE, 2008) report.

At the same time, both reports (BOK2 and JTC-3), among many others, emphasize skills that cannot be overlooked in the education of engineers for the challenges of the 21st century, in particular communication, leadership, teamwork, and lifelong learning skills. Ionescu (2008) gives and example of improvement of soft skills by means of laboratory teamwork.

While being exposed to such ideas, the author was put in charge of a Soil Mechanics undergraduate course at the Polytechnic School of the University of São Paulo, and decided it was time to put those ideas to work in practice there.

During the Christmas vacation of 2011 a poll was conducted among students as to what they felt about the role of laboratory activities in their (just concluded) Soil Mechanics course. The poll took the form of an enquête in the very same Moodle interface the students had used during the semester. Unless otherwise noted, students have been asked to express their feelings on a scale of 0 to 4 (integers), 4 meaning, in accordance with the context of the question, the highest level of a feeling, the most favourable or desirable result, or full agreement with the statement, whereas 0 means the opposite. Participation was voluntary. Thirty students responded. Their answers are summarized in the following sections.
2 ABOUT THE DEGREE AND THE COURSE

The undergraduate Civil Engineering degree at the USP includes 4 required geo-courses from all students: Geology, Soil Mechanics, Earthworks, and Foundation Engineering. There is no specialization at the undergraduate level, thus all civil engineers that graduate from EPUSP have received essentially the same education (except for about 10% elective courses). Specialization occurs at the graduate (Master’s) level, but it should be pointed out that such a degree is far from being valued as a pre-requisite for employment of civil engineers in Brazil.

The Soil Mechanics course covers essentially all the classical Soil Mechanics topics, from origin and nature of soils, index tests, classification, site investigation, compaction, stress distribution, seepage, consolidation, and strength. There is a general feeling that the Soil Mechanics-Earthworks-Foundation Engineering sequence must be re-organized, so as to allow more time for the fundamentals of Soil Mechanics, which should be distributed among two courses, interspersed with earthworks and foundation engineering applications. But this is a change that shall not take place before 2013.

For the past few years (and up to 2012) those Soil Mechanics topics have to be covered in 15 weeks of 200-minute per week classes (lecture + demonstrations + exercises), plus 8 weeks of 100-minute per week laboratory classes. Typically students have laboratory classes every other week. These classes had been used lately for demonstration purposes, with essentially no hands-on experimentation. Despite the recognition of the value of such demonstrations (Jaksa, 2008; Herle and Gesellmann, 2006) which, by the way, are also still in use in the course, it was believed that hands-on laboratory experimentation could lead to better understanding of the fundamentals, while developing a wider range of desirable competencies, as shall be discussed below. The course typically has an enrolment of about 150 students, distributed in 4 classrooms.

These are the boundary conditions for the experience conducted in the Soil Mechanics learning process.

3 GENERAL GUIDELINES FOR LABORATORY CLASSES

The changing role of laboratory testing was, of course, recognized: hands-on experience in laboratory testing is not essential per se for the education of 150 future civil engineers. It was decided to rely on hands-on laboratory testing as a powerful aid to the understanding of the fundamentals of Soil Mechanics: students do not run direct shear tests because all of them will need to know how to run shear tests to be successful in their professional lives; rather, they run direct shear tests as part of their learning process of soil strength. A demonstration (or a lecture, for that matter) is not as effective as hands-on testing to sediment those concepts, provided tests are run by teams that do not have too many members, that members are stimulated to take active part in the experimentation, and are previously instructed as to what to look for, both in the laboratory and after, when analysing the results for report preparation.

Each classroom (about 36 students) is divided into two halves, A and B, and each half is further sub-divided into three teams, thus A1, A2, A3, B1, B2, B3. Teams A have laboratory classes on odd weeks, teams B on even weeks. Such an arrangement typically yields 6-member teams, which is not ideal, but still manageable. Some ways to ensure and foster individual participation are discussed in section 4.

4 SCHEDULE OF EXPERIMENTS AND STUDENT PREPARATION

Table 1 shows the three “experiments” (frequently more than one test per session, as explained ahead) each team must accomplish.

For certain experiments (such as permeability and shear strength) the laboratory is not equipped to accommodate more than one test at a time. This fact implies that each of the three teams of students present in the laboratory at any time must be running a different experiment. For example: A1 running C, A2 running P, and A3 running R. These practical constraints forced the adoption of a schedule which required all teams to run at least one of the experiments before the subject matter involved had been covered in the lectures and exercises (Table 2). The decision to adopt such a schedule was not considered inappropriate because of two firm beliefs:

1) it is good to have the students take the initiative to learn some topics on their own; as a matter of fact; most recent studies on the future of engineering value the self-learning skills (BOK2 ASCE, 2008, Rengers and Turner, 2010);
2) no topic is completely learned upon first contact; it is a good idea to revisit certain themes at different times and circumstances, in order to review and sediment important concepts.

Figure 1 tries to somehow depict the actual degree of advance formal exposure of the student to the theme of each laboratory session: 0.0 means no exposure, thus self-learning required; 1.0 means no self-learning required.

Table 1. Experiments.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Compaction (Proctor), unconfined compression, consolidation (one load increment)</td>
</tr>
<tr>
<td>P</td>
<td>Permeability (constant head), grain-size (sieve) analysis, Atterberg limits</td>
</tr>
<tr>
<td>R</td>
<td>Shear strength (direct shear test)</td>
</tr>
</tbody>
</table>
Table 2. Semester schedule of laboratory activities.

<table>
<thead>
<tr>
<th>Week</th>
<th>Teams</th>
<th>Activity</th>
<th>Details 1(1)</th>
<th>Details 2(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week #1</td>
<td>All A’s</td>
<td>Laboratory visit and familiarization</td>
<td>Normal</td>
<td>below w_{OPT}</td>
</tr>
<tr>
<td>Week #2</td>
<td>All B’s</td>
<td>Laboratory visit and familiarization</td>
<td>Normal</td>
<td>below w_{OPT}</td>
</tr>
<tr>
<td>Week #3</td>
<td>A1</td>
<td>Experiment C</td>
<td>c_{MIN}</td>
<td>25,100,400</td>
</tr>
<tr>
<td></td>
<td>A2</td>
<td>Experiment P</td>
<td>c_{MIN}</td>
<td>50,200,600</td>
</tr>
<tr>
<td></td>
<td>A3</td>
<td>Experiment R</td>
<td>c_{MIN}</td>
<td>25,100,400</td>
</tr>
<tr>
<td>Week #4</td>
<td>B1</td>
<td>Experiment C</td>
<td>Modified</td>
<td>above w_{OPT}</td>
</tr>
<tr>
<td></td>
<td>B2</td>
<td>Experiment P</td>
<td>c_{MIN}</td>
<td>50,200,600</td>
</tr>
<tr>
<td></td>
<td>B3</td>
<td>Experiment R</td>
<td>c_{MIN}</td>
<td>25,100,400</td>
</tr>
<tr>
<td>Week #5</td>
<td>A1</td>
<td>Experiment P</td>
<td>c_{MIN}</td>
<td>50,200,600</td>
</tr>
<tr>
<td></td>
<td>A2</td>
<td>Experiment C</td>
<td>c_{MIN}</td>
<td>25,100,400</td>
</tr>
<tr>
<td></td>
<td>A3</td>
<td>Experiment C</td>
<td>c_{MIN}</td>
<td>25,100,400</td>
</tr>
<tr>
<td>Week #6</td>
<td>B1</td>
<td>Experiment P</td>
<td>c_{MIN}</td>
<td>50,200,600</td>
</tr>
<tr>
<td></td>
<td>B2</td>
<td>Experiment C</td>
<td>c_{MIN}</td>
<td>50,200,600</td>
</tr>
<tr>
<td></td>
<td>B3</td>
<td>Experiment C</td>
<td>c_{MIN}</td>
<td>25,100,400</td>
</tr>
<tr>
<td>Week #7</td>
<td>A1</td>
<td>Experiment R</td>
<td>c_{INT}</td>
<td>above w_{OPT}</td>
</tr>
<tr>
<td></td>
<td>A2</td>
<td>Experiment C</td>
<td>c_{INT}</td>
<td>50,200,600</td>
</tr>
<tr>
<td></td>
<td>A3</td>
<td>Experiment P</td>
<td>c_{INT}</td>
<td>25,100,400</td>
</tr>
<tr>
<td>Week #8</td>
<td>B1</td>
<td>Experiment C</td>
<td>c_{INT}</td>
<td>50,200,600</td>
</tr>
<tr>
<td></td>
<td>B2</td>
<td>Experiment R</td>
<td>c_{INT}</td>
<td>50,200,600</td>
</tr>
<tr>
<td></td>
<td>B3</td>
<td>Experiment P</td>
<td>c_{INT}</td>
<td>25,100,400</td>
</tr>
<tr>
<td>Week #9</td>
<td>All A’s</td>
<td>Synthesis explanation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week #10</td>
<td>All B’s</td>
<td>Synthesis explanation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week #11</td>
<td>All</td>
<td>Synthesis presentation, C+P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week #12</td>
<td>All</td>
<td>Synthesis presentation, P+R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week #13</td>
<td>All</td>
<td>Synthesis presentation, R+C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week #14</td>
<td>All A’s</td>
<td>Identification and classification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week #15</td>
<td>All B’s</td>
<td>Identification and classification</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Normal or modified Proctor (compaction energy), void ratio (for permeability and strength tests)
(2) Moisture content (of compacted specimen for unconfined compression test), normal stresses (for strength test)

Figure 1. Your contact, in the laboratory, with the experiments indicated took place before (0) or after (1) the lectures and exercises on the subject?

Results in Figure 1 do not have a straightforward explanation, given that each laboratory session of a given team involves more than one experiment (Table 1). Considering only the Proctor compaction test, experiment C should yield a value of at least 0.9, given that compaction is taught at the very beginning of the course. If, however, only the consolidation test were taken into account, this number would be 0.0. Experiment P should, in fact, score slightly over 0.4, in view of the lecture schedule. The result for experiment R, however, is somewhat surprising, since all teams were formally lectured on soil strength after they had performed the shear strength test in the laboratory. A result close to 0.0 could therefore be expected. Previous exposure to the concept of friction and to strength criteria in other courses may explain the value of 0.3.

The decision to require a certain degree of self-learning has some important practical requisites and implications. The first requisite is that a good and objective textbook is needed, so that each team can be efficiently directed to the appropriate chapter or chapters in preparation to run the laboratory experiment. Fortunately such a textbook is available (Sousa Pinto, 2001). The second is that a guideline to each experiment must be made available well in advance, so that the team can prepare itself in due time. Current guidelines attempt to:

1) formulate the experiment(s) within the framework of geotechnical design and construction; it is important to know why the test is being run;
2) pose the most relevant questions, both conceptual and practical, and indicate where in the textbook the answers can be found;
3) describe the activities to be undertaken in the laboratory;
4) describe the template for report preparation.
Team leaders are advised to plan a team meeting in advance of the laboratory class, in order to discuss the guidelines, study together the required chapters of the textbook, and try to answer the questions. For better results, such meetings should ideally be officially scheduled, tutored (by teaching assistants, for example), and assigned credit points (such as ECTS credits) in accordance with the hours spent, much in the same way lectures and exercise classes are currently accounted for. According to the prevailing school policy, however, such activities are left to the discretion of the students themselves, frequently with less than satisfactory results. This situation will probably be changed in the curricular structure reform being planned for 2013.

On the day of the laboratory class the students are individually subjected to a 10-minute quiz covering the questions formulated in the guideline of that particular laboratory session. Quizzes are graded by a factor ranging from 0 to 1, which multiplies the grade to be attributed to the team laboratory report. This is, at this point, the way devised to foster individual participation.

The reaction of the students to the aforementioned aspects, namely self-learning and quizzes is depicted in Figures 2 to 4. In all cases a possible desirable result might follow a 45-degree line going from [0; outraged] to [4; stimulated], at least from the point of view of the educator. Actual results clearly indicate that students have mixed feelings, with more significant departures from “ideal” in the region of positive reactions. It is interesting to note that self learning causes more outrage and discomfort than 10-minute quizzes. Students were also polled on the relevance of those quizzes to foster preparation for conducting the experiment: the average answer was 2.2 on the same 0–4 scale, which suggests that formulation of those quizzes demands more attention in the future.

The author would, of course, be delighted to see his students more stimulated by the challenges set before them. Maybe these were not the most suitable challenges. Under the circumstances, however, self-learning in preparation for laboratory sessions was an inescapable requisite. Rejection levels, on the other hand, were by no means alarming, and indifference was low. All in all, the author believes that pedagogical benefits far exceed some discomfort or lack of motivation felt by students.

The template for report presentation stresses the requirement that reports should be limited to one A4 page. The reader should not be surprised if he recalls having heard of a similar requirement elsewhere; the idea is not original and he is referred to “The Infamous One-Page Summary” in “Ralph B. Peck, Educator and Engineer” (Dunnicliff and Peck-Young, 2006). This admittedly causes some stress, but the template goes into detail as far as the layout and required plots, the idea being that students need training in summarizing their main points in meaningful and well conceived plots and figures. Different alternatives have been tried, including extensive reports. They took too long to grade, in part, in these internet days, because most were stuffed with pointless descriptions and transcriptions generated by mere “cut and paste” activity. It
was then decided that the course educational contribution to the development of report writing skills should be restricted to a single aspect: making the essentials concisely meaningful to the reader in limited space.

Figure 5 clearly indicates a stronger rejection than other aspects of the laboratory activity (Figures 2 to 4), but no changes are planned: along their professional careers, those engineers will grow to appreciate the benefits of this exercise.

5 EXPERIMENTS PERFORMED

Given the tight schedule and the goal of using laboratory experimentation to better learn Soil Mechanics fundamentals, it has been necessary to limit the number of experiments, trying to select the most significant and most efficient for those purposes. Recall that each laboratory session lasts 100 minutes and takes place every other week for each team.

Experiment C consists of compaction of clayey silt at a single water content, subsequent unconfined compression of the compacted specimen, and application of one load increment to a different consolidating soft soil. Different teams are assigned different water contents and different compaction energies, according to Table 2, and the grade is partly related to the “distance” between the point obtained by the team and the “real” Proctor compaction curve, which is not known to students in advance. For a couple of years an attempt has been made to construct the compaction curve from the results obtained by different teams (2 points per team), but this test is prone to large uncertainties, mostly derived from improper energy application by different inexperienced students, and consequently those results tended to be less didactic than one would hope for.

![Figure 5. How did you feel about the need to present one-page reports?](image)

![Table 3. Schedule of load increments for oedometer test.](table)

<table>
<thead>
<tr>
<th>Teams in Classroom 1</th>
<th>Classroom 2</th>
<th>Classroom 3</th>
<th>Classroom 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>LI from</td>
<td>high OCR</td>
<td>low OCR</td>
<td>approximately $\sigma'_p$</td>
</tr>
</tbody>
</table>

as a matter of fact, the shape of those Proctor curves departed so much from the usual that it was feared that they might have a negative effect on the learning process.

In the past an attempt was also made to construct a consolidation curve from increments applied by different teams. The experience was not successful, but it is believed that inadequate communication of the results was then the root of the problem. Nowadays all interaction of the course is made by means of a Moodle interface and students populate a database with the results of their experiments, so there is renewed hope of including consolidation – undoubtedly a most relevant topic – into the laboratory-based learning process. For time being (2011) each team has just been asked to apply one load increment (see Table 3 for scheduled sequence of load increments), and calculate the coefficient of consolidation for that increment. The good results of 2011 suggest that an attempt at construction of the full compression curve may be justified for 2012. Figure 6 summarizes student opinion about several aspects of Experiment C.

Experiment P consists of a permeability test (constant head) of a sand, grain size sieve analysis of that same soil, and Atterberg limits of the clayey silt used for Experiment C. Each team is required to prepare the

![Figure 6. Please evaluate the various aspects of Experiment C, taking into account preparation, execution, and report writing.](image)
Figure 7. Please evaluate the various aspects of Experiment P, taking into account preparation, execution, and report writing.

specimen for the permeability test with a different relative density, as indicated in Table 2. Moreover, each of the four classrooms tests sand from a different origin. From a practical standpoint, students should check whether the tested sand is suitable as filter material for the compacted soil of Experiment C (grain size distribution of that soil made available in the guideline). Figure 7 summarizes student opinion about several aspects of Experiment P.

Experiment R is run on the same sand of Experiment P (one for each classroom), which is subjected to a direct shear test. Again, each team is required to prepare the specimen with a different initial relative density, as indicated in Table 2, where it is also shown that different teams use different normal stresses. Figure 8 summarizes student opinion about several aspects of Experiment R.

Figure 6 to 8 invite several comments. Students do not look especially satisfied with the guidelines, which might therefore deserve some improvement. The guideline for Experiment P is already of a significantly better quality than the other two, including more detailed explanations of each step of the testing procedures and photographs of the equipment. Nevertheless, student opinion about that guideline is not at all different from that about the other two; as a matter of fact, its average grade is 0.1 lower! Maybe a different type of improvement is needed, and alternatives are under investigation.

On average students felt that the experiments were about 65% effective (approximately 2.6/4) in helping them better understand some key Soil Mechanics concepts. There is no similar effectiveness assessment for the demonstration-type laboratory classes previously adopted, thus one can only speculate that the current result validates the new approach. Experiment P scores slightly above the other two, which makes one wonder whether this result could be credited to the more elaborate guideline.

6 REPORT SUBMISSION AND RESULTS DATABASE

Each team is required to upload its one-page report to the Moodle interface before the next laboratory class (usually fourteen days after the day the experiment is run). In addition, the team leader is required to save all pertaining information in a Moodle database structured so as to facilitate the analysis and synthesis of the results. 

The professor of each classroom grades the ensemble of three reports of each team on the basis of content, adherence to the template, and general format (legible and meaningful plots, etc.). Each student receives a mark that is the product of this team mark by the average of the personal factors obtained on 10-minute laboratory quizzes (see section 4). This compounded mark has a weight of 10% on the final student grade. It is believed that this percentage could be increased by 5% in the near future.

7 SYNTHESIS AND PRESENTATIONS

The so-called synthesis is perhaps the most important component of the proposed learning process. After all
teams of all classrooms have saved their results in the Moodle database, each team is required to analyse all data available and prepare a presentation (no written report) which synthesizes the main conclusions about the influence of state and nature on the engineering behaviour of different soils.

Again, students receive a guideline for the synthesis of each experiment, so that they are made aware of what influencing factors and relationships they should be looking for. At that point in the semester the course has reached a stage when some of these relationships have already been discussed in lectures and exercises. Nevertheless, that synthesis is a challenging undertaking.

Three 100-minute sessions of synthesis presentations are organized with 4 presentations (and two experiments) per session (12 presentations per classroom), as indicated in Table 2. Each team makes two randomly selected presentations, in two of those three sessions, and teams A compete with teams B. Non-competing students vote for the most enlightening presentation (A or B) and this peer vote has a moderate influence on the grade attributed by the professor to the presentation. The purpose of this exercise is twofold: cement important concepts, influencing factors and relationships that govern soil behaviour, and train students at communication skills.

These presentations usually entice vivid discussions among students about the conclusions drawn and the quality of the data (obtained by themselves), during which the professor has the opportunity to review with the students the most important concepts, while discussing their relevance to practical applications, such as: influence of deviation from optimum water content on mechanical properties of compacted soils (and its relevance to embankment zoning, for example), influence of nature and origin of sands on the permeability and strength, influence of relative density of a sand on its permeability and strength, influence of the shape and position of grain size curve in its ability to act as a filter-drain to a soil, etc.

The students’ opinions about the synthesis exercise are summarized in Figure 9. The idea met with moderate approval, although implementation needs to be perfected, especially with respect to the guidelines and the database. Perhaps this was one of the causes for the benefits to have been rated slightly below those derived from the individual experiments themselves (compare with Figures 6 to 8). Despite the fact that the poll involved all four classrooms, it is curious to note that, in terms of quality of results, the students rated their own classroom above the others, and their own team above the others in the classroom.

All teams are required to upload their presentations to the Moodle interface before the first presentation session (Week #11 in Table 2).

The professor of each classroom grades presentations on the basis of relevant (and visually enticing) content, ability to convey ideas by means of well designed graphs, and ability to discuss results in response to peers’ and professors’ questions. This mark is multiplied by a factor, either 0.9 or 1.0, depending on which of the two presentations (A or B) the non-competing peers preferred. For the purpose of assessing those factors, all students receive a guideline as to what type of “quality” they should be looking for in each presentation. The resulting mark is, by definition, the team mark. Finally, the members of each team gather to decide themselves on what should be the individual mark of each team member in this activity, under some restrictions; the most obvious restriction is that the team mark should be preserved as the average of individual marks. This compounded mark has a weight of 10% on the final student grade. It is believed that this percentage also could be increased by 5% in the near future.

8 IDENTIFICATION, CLASSIFICATION, AND PROPERTY ESTIMATION EXERCISE

The laboratory activities are closed with an exercise in identification, classification, and engineering properties estimation (Table 2).

Identification and classification is usually taught at the very beginning of most Soil Mechanics courses, but it is believed that the subject becomes more relevant before the eyes of the students when they are faced with the real problem of estimating relevant soil properties on the basis of classification and a boring log, which is a common situation in practice. For this approach to be possible, it is essential that students
be exposed to the engineering properties of interest, say permeability, stiffness/compressibility, strength, \textbf{before} they can effectively tackle the problem of estimating soil properties by means of a boring log and soil classification.

Teams go to the laboratory where they find six soil samples (A to F) and six folders (1 to 6). Each folder contains results of index tests (grain size distribution, Atterberg limits, etc.) of one of the soil samples, as well as a boring log with SPT values of that soil. Teams are required to match folders to soil samples and to classify the soils using, for example, the Unified Classification System. They are then invited to advance estimates of engineering properties of interest, using correlations found in their textbook and other sources that they are referred to, all available from the Civil Engineering library. One of the aims of this exercise is to raise the students’ awareness to the competency of being able to determine parameters for analyses, as emphasised, for example, by Atkinson (2008).

Currently this activity is not graded, although all students are required to participate. As a matter of fact, students tend to tackle with joy the fun-filled activity of matching soils and folders. Their opinion about this exercise is found in Figure 10.

Figure 10 indicates that this activity is one of the most popular among students in terms of relevance and perceived benefit. According to them, guideline and general implementation could be improved, and the identification exercise could be proposed somewhat earlier in the semester. The reason to have a single exercise that encompasses identification, classification, and property estimation is primarily motivational.
The schedule of laboratory activities (Table 2) are also being considered.

The laboratory activities described represent a substantial amount of work on the part of students and professors alike. It is believed that if this ensemble of “laboratory learning resources” has its weight in the final student grade increased, this might foster the level of work that the students will be willing to undertake for them, possibly with some extra gains in learning.

The educator has, of course, a viewpoint that is significantly different from that of the student. One should not be expected to endorse all of the opinions of the other. Even if outcomes cannot be objectively validated yet, the proposed approach addresses many of the concerns of the BOK2 (ASCE, 2008) report and incorporates many of the objectives pointed out by Feisel and Rosa (2005) as fundamental objectives of engineering instructional laboratories. For these reasons, no change under consideration will be implemented if any doubts about its positive pedagogical impact persists.

ACKNOWLEDGEMENTS

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