SITUATED LEARNING AND MOTIVATION STRATEGIES TO IMPROVE COGNITIVE LEARNING IN CE

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Abstract

This papers describes the results obtained and the main observations made during a year long research project whose main purpose was to integrate situated learning and some motivational tools in an undergraduate civil engineering course (Soil Mechanics I). New teaching material was developed almost from scratch around a main theme and several secondary themes. Oriented discussions and exercises were prepared in order to help the students acknowledge the new professional skills they had acquired. The motivational tools served as means to create a better teaching and learning environment in the classroom and in the laboratory. The response of the students was constantly monitored. The results show that the various activities strategically planned to motivate the students to become active learners and to situate them in the context of the practice of Civil Engineering had a positive effect on several aspects, including their perception the of the significance of the knowledge being acquired, of the reality of their future profession and of the importance of the tools they might need. Another significant increase relates to the perception the students ended up with of their capacity to transfer the knowledge acquired to other situations.

1. General problem

Two of the challenges facing higher education, in particular professional education, are the capacity these programs have (1) to foster the students' ability to use their newly acquired knowledge in other contexts such as practice training sessions and (2) to maintain the students' motivation throughout each course. The programs should aim at encouraging the students to draw links between what they are learning in class and the more applied context of the profession for which they are being prepared. Many professors in universities and colleges orient their instruction so that the students achieve such a transfer of information. However, in regards to student learning and to capacity to use this knowledge, comparing goals to outcomes in terms of teaching does not present an encouraging perspective, especially in the context of professional training (Bédard and Turgeon, 1995).

Higher education today is also struggling with students' loss of motivation and engagement in the parts of the curriculum which tend to present a more abstract set of knowledge that cannot easily be linked to the profession. Students generally enter university programs with high expectations about the usefulness of the knowledge that will be acquired. What the students are offered in the first place are courses presenting abstract concepts, generally given in a lecturing format. Therefore, they tend to disengage from learning activities and from their study.

Maintaining the students' initial motivation and fostering their capacity to transfer knowledge to other contexts represent two important goals for higher education programs. In order to support such changes, different curriculum and pedagogical innovations are actually being considered. Among these, one approach that has received significant attention over the last decade is *situated learning* (Brown, Collins & Newman, 1989 ; Collins, Brown & Duguid, 1989 ; Lave and Wenger, 1991). The use of situated learning as a mean (1) to increase the students' awareness of the significance and use of the knowledge being presented and (2) to engage in more meaningful knowledge acquisition activities has yet to make a distinct impact on higher education programs, specially in the field of engineering.

2. Academic context of the present research

Over the past five years, the Faculty of Applied Sciences at the Université de Sherbrooke (Quebec, Canada), has been quite concerned with how well its students were prepared to face the demands and challenges that most engineering professions are now requiring. In the Department of Civil Engineering, a major effort is being made to ameliorate learning activities and assessment modes. The Department is also engaged in the development of new case studies that will be used throughout the program in order to help illustrate specific issues of the profession, as well as motivate team work, initiative and critique.

The four-year undergraduate Civil Engineering program at the Université de Sherbrooke offers the possibility to alternate study and practical training ("co-op") after completion of four terms. The students spend at least 12 weeks working either for the private sector or for governmental departments, such as Quebec's DOT, a major employer. Soil Mechanics I is taught in the fourth term, concomitantly with other basic Civil Engineering courses such as Structures I and Health and Safety. This first contact with Civil Engineering matters is quite important to the students who start their first practical training period in the fifth term. It is also the first contact most students have with the use of soils as a construction material and how their use is formalized. It is also the first time they will be exposed to the body of knowledge involving constructions with, in and on soils.

3. Specific Problem

Based on past written evaluations, students enrolled in the course Soil Mechanics I have demonstrated loss of motivation during the term and certain difficulties in transferring the acquired knowledge to subsequent courses and to practice training sessions. We also based our initial assessment of the problems on interviews made with 8 students, in order to have a more direct feedback of their grievances. When asking the students to recall information taught the previous year in that course, about half of them were able to remember specific aspects of the content covered. When presented with the course's textbook and asked to tell us in which contexts or situations such and such knowledge would apply and be pertinent, only one student was able to transfer knowledge and explain how it would be useful.

It was then decided that the pedagogical format of the course should be rearranged in order to take into account the difficulties students encountered. One general objective was then set, i.e. to plan learning and teaching activities which would maintain the motivation of the students and help them transfer the knowledge acquired to more applied, profession-like contexts. More specifically, the Authors sought for an active engagement in the classroom activities throughout the term and that the students acquire a better comprehension of the meaningfulness of the curriculum being covered.

4. Theoretical approach

Situated learning. Perhaps as a by-product of the emphasis that has been put on conceptual and factual knowledge (declarative knowledge) in higher education programs, skills and competencies have become abstracted from their uses in the profession. This has serious implications for the nature of knowledge that the students acquire. Higher education is now coming to grips with a similar issue that has faced researchers looking at other levels of learning, namely the inert knowledge problem (Whitehead, 1929 ; Bédard, 1996). Inert knowledge is the knowledge that can be usually recalled when people are explicitly asked to do so (e.g., exam situation) but is not used spontaneously in problem solving or more applied situations, even though it is relevant. Many researchers in education have argued that, in schools, information was particularly likely to be presented in ways that make it inert (Simon, 1980, Resnick, 1987).

Sherwood, Kinser, Hasselbring, and Bransford (1987) presented an illustration of inert knowledge. Entering college, some students were asked to explain how knowledge of logarithms might make it easier to solve problems, why they were invented, and what they were used for. The vast majority of the students had no idea of the uses of logarithms. They remembered learning them in school but they thought of them only as math exercises performed to find answers to logarithm problems. The students treated them as difficult ends to be tolerated rather than as exciting inventions (tools) that allowed a variety of problems to be solved.

This example illustrates how difficult it may be for students to take a body of knowledge acquired in one context and transfer it to another context. One of the primary concerns of higher education should be the students' capacity to transfer knowledge acquired in their program to situations outside universities where it will be useful. The activity and context in which learning takes place should not be merely regarded as subordinate to learning or as fundamentally distinct and even neutral with respect to what is learned. The activity in which knowledge is developed and presented is not separable, or distinct, from learning and cognition. It is possible to argue that learning and cognition are fundamentally situated. Therefore, the more classroom activities are remote from the professional context in which they will be required, the more difficult it will be for the students to transfer knowledge from one context to another.

Situated learning, as a pedagogical proposition, represents a renewed view of higher education programs. It may be used to consider structure learning and teaching activities in order to foster (1) the integration of knowledge and the development of competencies, (2) the transfer of knowledge, and (3) a more positive perception of the learning tasks and of oneself as a future professional. Each of these potential effects represent a significant result that our university programs should aim at.

Motivation : Inspired by the sociocognitive approach (Bandura, 1986), we are defining motivation in a school context as a " dynamic phenomenon originating in the perceptions a student has of himself and of his environment. This phenomenon motivates him to choose an activity, to commit to it and to persevere in its accomplishment in order to reach a goal ”. (Viau, 1994 : p. 7). From this definition, we can design a model of motivational dynamic in which interact the academic context (teaching and learning activities), the student’s sources of motivation and the consequences of this motivation on the student’s learning. Figure 1 illustrates this model.

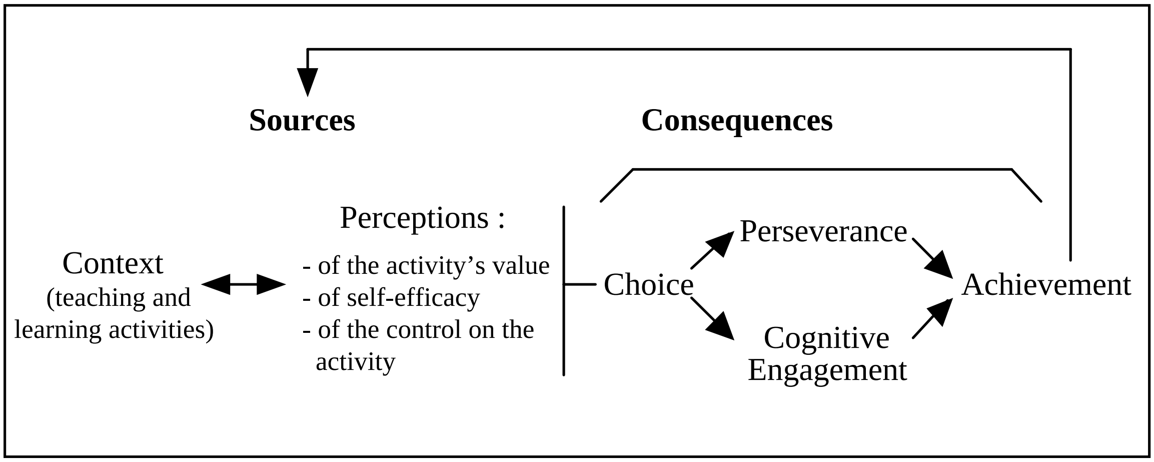

Figure 1 : Motivational Dynamic (Viau, 1994)

THE SOURCES OF MOTIVATION :*The perception of the value of an activity* is the judgment that a student passes on the interest and the usefulness of a school activity in regards with the goals the student aims to reach. Lens et Decruyenaere (1991) have shown that the students who have clear ideals, and goals well spread in time, are more able to perceive the value of an activity. These ideals and goals are called future perspective in the literature.

The perceived self-efficiency is a self-perception by which a student evaluates his capacities to accomplish an activity that requires a certain level of uncertainty concerning his achievement. Studies done in Quebec show that a student with a strong perceived self-efficacy to accomplish an activity tends to use metacognitive strategies (ex. self-evaluation) more frequently, has more perseverance and, in turn, has more success (Bouffard-Bouchard, 1990 ; Bouffard-Bouchard, Parent et Larivée, 1991).

Controllability perception is defined as the perception of the control that the student believes he has on the conduct and consequences of an activity. Therefore, the students who believe they have some control over the conduct of their learning, approach the subject in depth while attempting to understand its different elements. At the same time, students who believe they have little control on their learning limit themselves to trying to memorize the different elements of the content (McCombs, 1991).

In light of the research on perceptions, we deduct that the motivated student is the one who perceives the importance and the interest of the activities that are proposed to him ; who perceives himself as being able to accomplish them and finally, who perceives he has some control over the conduct of the activities.

THE CONSEQUENCES OF MOTIVATION : The motivated student chooses to engage and to persevere. At the opposite, the unmotivated student resorts to avoidance strategies. At the college level, avoidance strategies translate into behavior such as talking with class mates, arguing with the professor to gain some time, or simply, to absent oneself.

Perseverance is an important consequence of motivation, because the more time a student puts on a paper, the more chances he will succeed. An unmotivated student tends to quickly abandon an activity or do the strict minimum.

The cognitive engagement consists in the student using study strategies designated by researchers as “ self-regulation strategies ” and “ learning strategies ”. The motivated student uses strategies that bring him to plan his learning, to evaluate himself, to manage his study time and also to motivate himself (Zimmerman, 1986).

Achievement is the ultimate consequence of motivation. Typically, a student who has good studying strategies and who is motivated to use them, is a student who succeeds. Achievement also influences the student’s perceptions which are at the origin of his motivation. Therefore, achievement that is deserved (1) positively influences the perception the student has of his self-efficacy, (2) makes the activity he accomplished with success much more valuable to him and (3) brings him to think that he has control on his learning.

This brief description of the different elements of motivational dynamic allows us to recognize that motivation is a phenomenon belonging to the student. However, the student’s motivational dynamic is influenced by the teaching context in which his learning occurs.

5. Methodology

Subjects : 59 students participated in this study (17 women and 42 men). All students were registered in the Soil Mechanics I course for the 1996 winter term, at the Faculty of Applied Sciences. The subjects were divided into two distinct classes of 28 and 31 students. The students’ age ranged from 20 to 22 years old. All subjects volunteered to participate in the research.

Instruments : Two instruments were used to assess, (1) the professor’s effective use of situated learning and teaching strategies in class, and (2) the effect on students’ motivation. A more qualitative measure was also used to evaluate the students’ ability to transfer knowledge.

First, the professor was observed throughout the term and rated on teaching activities. This actually took place on 10 of the 15 teaching periods. The intention was to find out how effectively the professor “ promoted ” situated learning in class. The first instrument, an observational grid, presented four dimensions : the kind, the complexity, the precision and the quality of examples (presenting the point of view of an engineer in practice, his culture). Three possible scores could be obtained for each dimension : appropriate (3), partially appropriate (2) or not appropriate (1).

The second instrument, two questionnaires, were administered to students, one in the beginning, the other in the end of the term. These questionnaires aimed at measuring the contribution of the course to the students’ perceptions. A mid-term questionnaire was also filled by the students. A qualitative evaluation of the responses was made but will not be discussed in this text. The two questionnaires dealt mainly with the different components of motivation (14 questions) but also measured the students’ perception of (1) their comprehension of the Civil Engineering profession and (2) the contribution of the course Soils Mechanics I to the development of their competencies as civil engineers (2 questions). For most of the statements (11), they had a five level scale to score from : 1 referred to a more negative value and 5 to a more positive value. One statement used a scale of ten levels. Two questions required to select from 8 possible choices to explain the student's success or failure in school.

From the questionnaire, we calculated the frequencies, the averages and the standard deviation from the mean (σ), both for the pre-test and the post-test. The difference between the mean score for each statement from January 1996 to April 1996 was calculated (Δ). A $\Delta > 0$ refers to an increase between the mean of the pre-test and the mean of the post-test. A $\Delta < 0$ refers to a decrease between the mean of the pre-test and the mean of the post-test.

The students' capacity to transfer knowledge was measured qualitatively in the beginning of the Fall term.

Experimentation : A research assistant was present in the classroom to observe the teaching and learning activities taking place. The assistant would seat at the back of the room and never participate in classroom activities. At times, at the end of a class, the professor would consult the assistant to get some instant feedback.

In January 1996, the pre-test was administered to each group by a research assistant at the beginning of the very first class. The post-test was administered at the very last class of the term. The pre-test lasted 15 minutes and the post-test lasted 18 minutes. In both cases, the students received oral and written instructions on the procedures to follow in order to answer the questions.

6. Results

6.1 Monitoring of the Instructor

The data resulting from the observation of the professor in class were looked at in terms of the mean score before mid-term (Figure 2) and after mid-term (Figure 3), for each of the four dimensions. Scores from both groups were pooled.

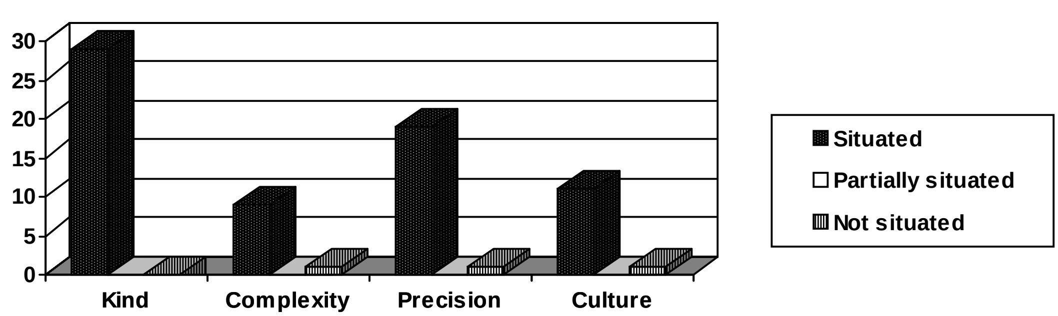

Figure 2 : Teaching in class before mid-term.

The results show that before mid-term, the professor presented many situated examples ; 66% were precise and 33% were complex and referred to the culture of an engineer in practice. After mid-term, the number of examples presented dropped by more then half, but they were precise 100% of the time. Only 20% were complex and 50% referred to cultural aspects of a professional in practice.

Data from the four dimensions were pooled to obtain a general measure of “ situatedness ” for each of the 10 classes. The results from the two groups were also pooled. It was then possible to evaluate the progression of the professor’s efforts to situate learning along the term. Figure 4 shows a decrease of situatedness as the term progresses, with a fairly significant “ midterm effect ”. It is interesting to note that knowledge became increasingly theoretical and abstract as the term went on. The success of the professor to place situated examples became less evident.

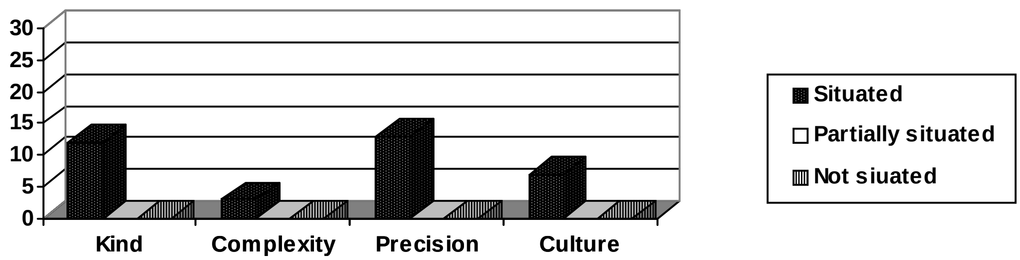

Figure 3 : Teaching in class after mid-term.

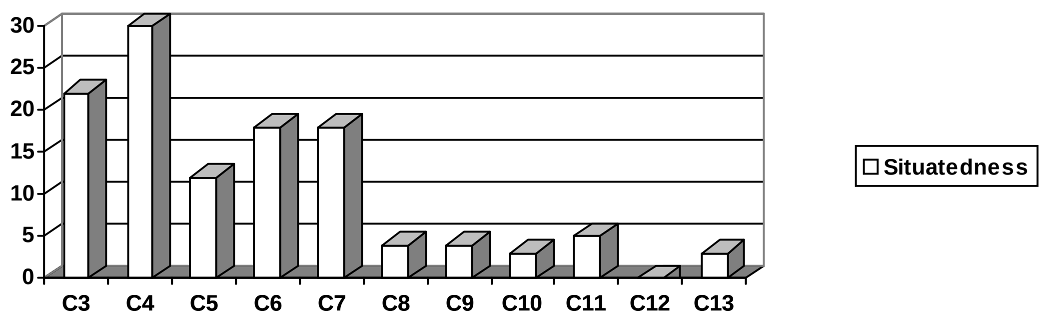

Figure 4 : Evolution of teaching during the term.

6.2 Student Evaluations

As mentioned previously, most of the questions in the questionnaire were related to motivational variables. One question (Q12) dealt with students’ motivation to engage in the Soils Mechanics I course: “In general, does your representation of the Soils Mechanics I course motivate you ?” The mean of the pre-test ($M = 7,45$, $\sigma = 1,41$) is lower than the mean of the post-test ($M = 7,80$, $\sigma = 0,35$). The general motivation toward the course was good at first and slightly increased at the end of the term ($\Delta = 0,35$).

The following three questions dealt with the students’ most important perceptions in relation to their motivation. Q2: “Do you think the course Soils Mechanics I will be useful in your future

Civil Engineering profession ?" Q1: "Does the content of the course appear interesting ?" Q11: "Considering that you know the Civil Engineering profession, do you feel you are in the right field at this point ?"

	Pre-test		Post-test		Δ
	M	σ	M	σ	M
Usefulness (Q2)	4,40	0,56	4,63	0,52	0,23
Interest (Q1)	4,04	0,74	4,23	0,78	0,19
Right field (Q11)	3,83	0,98	4,16	0,97	0,33

Table 1 : Perception of the value.

All three aspects have an average score that is higher for the post-test than for the pre-test. This increase may appear minimal, but considering the scale from 1 to 5, the scores represent a difference of 5 to 8 %. The score for the perception of the value attributed to the course was already high at the pre-test.

The following three questions dealt with the students' perceptions of their competence. Q6: "Since you have started the Civil Engineering (CE) program, do you think it was usually easy to benefit from class-room demonstration and practice sessions ?" Q5: "Since you have started the CE program, do you think it was usually easy to understand the concepts presented in the lectures ?" Q4: "Since you have started the CE program, do you think it was usually easy to do the tasks you were asked to do during the laboratories ?" Table 2 presents the summary of responses for these three questions.

	Pre-test		Post-test		Δ
	M	σ	M	σ	M
Demonstrations (Q6)	3,69	1,02	3,61	1,01	-0,08
Course (Q5)	3,57	0,63	3,39	0,75	-0,18
Lab (Q4)	3,51	0,83	4,38	0,58	0,87

Table 2 : Perception of the competence

Class-room demonstration and practice sessions are some times perceived as a boring activity. The students contest mostly their format, not their existence. Most students suggest to drop the traditional " copy-paste of exercises " choice of procedure. The score between the two measures has not changed significantly.

The decrease of 5% of the perception of competence during classes is slightly higher. It is likely that some students were not comfortable with the new way of looking at teaching and learning that year (their responsibility increased). Therefore, their perception of competence might have been influenced negatively. As far as the laboratory sessions are concerned, the perception of competence has increased by 24,5%. This result might indicate the transfer of knowledge and competence from the class to the lab.

Three other questions dealt with the students' perception of controllability in class. Q7: "Since you have started the CE program, do you believe you had some control over the progress of activities in class ?". Q8: "Since you have started the CE program, to what do you attribute your success?" Q9: "Since you have started the CE program, to what do you attribute your failure ?"

	Pre-test		Post-test		Δ
	M	σ	M	σ	M
Control (Q7)	2,78	0,92	3.05	0,99	0,27

Table 3 : Control of activities.

The perception the students had of their control over activities in class was low at the beginning of the term and increased by 9,7% at the end. The professor's efforts to get the students involved in classroom activities produced an effect, but more should be done to make the students aware of the control gained in such situations.

	Pre Test		Post test		Δ
	Frequency	%	Frequency	%	
Efforts	48	87,3%	49	87,5%	+1
Professor's competence	18	32,7%	21	37,5%	+3
Friends	18	32,7%	7	12,5%	-11
Prior knowledge	14	25,5%	14	14,3%	0
Intelligence	10	18,2%	8	14,3%	-2
Chance	0	0%	1	1,8%	+1

Table 4 : Reasons of success (Q8).

From the answers given to question 8, individual efforts stand out as being the main aspect to which success is attributed. That result is stable from the beginning to the end of the term. The professor's competence come in second in both the pre and the post-tests. The main change takes place in the students' perception of their friends as a significant factor of their success. This value has dropped by more than half. It may be attributed to some students becoming more responsible and autonomous during the term.

Table 5 shows that the students attribute their failure to external events, such as – mainly - the professor's competence and the level of difficulty of the course. It is worthwhile noting that at the end of the term less students attributed their failures to professor's competence, but more students identified the level of difficulty of the course as being a determinant factor. Less students mentioned bad luck, but lack of individual effort was perceived by more students as playing a role in their failure. Again, this result seems to indicate that the students taking more responsibilities in explaining their failure.

Three other questions dealt with the indicators of motivation. Q14: "In average, how much time will you invest each week in this course (not considering class time) ?". Q13: "In general, will your studying strategies in this course emphasize rote learning or comprehension ?". Q3: Do you believe you will use the appropriate studying methods to reach the objectives of the course ?

	Pre-test		Post-test		Δ
	Frequency	%	Frequency	%	
Professor's competence	34	61,8	26	46,4	-8
Course's difficulties	29	52,7	40	71,4	+11
Bad luck	15	27,3	7	12,5	-8
Lack of knowledge	13	23,6	9	16,1	-4
Lack of efforts	12	21,8	19	33,9	7
Friends	0	0%	2	3,6	2

Table 5 : Reasons for failures (Q9).

	Pre test		Post Test		Δ
	M	σ	M	σ	M
Perseverance (Q14)	3,60	1,04	3,36	1,20	-0,24
Learning strategies (Q13)	3,93	0,79	4,11	0,74	0,18
Self monitoring (Q3)	3,81	0,58	3,71	0,72	-0,10

Table 6 : Indicators of motivation.

It may seem surprising to observe a reduction in the quantity of time the students put in their work outside the classroom. It may reflect the fact that the students gained information more effectively in the classroom as the term went on and needed less time outside the classroom to go over their work. There is also a general overload of work arising at the end of a term with assignments from different courses having to be completed and handed in. Study time per se usually suffers from these other activities.

The scale relating to Q13 (learning strategies) varied from 1 to rote learning to 5, associated with comprehension. More students favored comprehension as their learning strategy over rote learning. This result increased a little at the end of the term. The students' perception of their studying method is not particularly high. In fact, it dropped slightly at the end of the term. This result shows how university students still lack confidence in their capacity to use effective working strategies.

Finally, two questions dealt with the students' perceptions of their capacity (1) to understand the profession of Civil Engineering and (2) to situate the content of the course in light of the tasks a Civil Engineer has to accomplish. Question 10 asked : "Do you have a precise comprehension of the Civil Engineering profession ?" Question 16 asked : "Will this course help you understand

and perceive the tasks of a Civil Engineer?”

	Pre-test		Post-test		Δ
	M	σ	M	σ	M
Profession (Q10)	3,58	0,71	3,65	0,69	0,07
Transfer (Q16)	3,02	0,96	3,85	0,77	0,83

Table 7 : Profession and transfer.

Throughout the term, the students maintained a good comprehension of the Civil Engineering profession. Both the mean and the standard deviation remained constant. As far as transfer of knowledge is concerned, there has been a positive change from the pre-test to the post-test. Also, the standard deviation was smaller for the post-test, showing less dispersion among students. The course, therefore, contributed to maintaining the students' understanding of the Civil Engineering profession and to increasing their comprehension of the tasks accomplished by a civil engineer.

6.3 Knowledge transfer

Knowledge transfer was qualitatively evaluated in the beginning of the Fall term (the students are under training during the summer term). The professor helped his colleague in charge of the Soil Mechanics II course preparing a simple question involving the most important issues discussed during the Soil Mechanics I course, which the students would surely need to succeed Soil Mechanics II. The observation of how the students were able to recall the basic knowledge required to solve the problem showed that, with minimum help from the Professors, most students were able to identify what kind of knowledge was required, the logical thinking leading to the solution, and the mathematical tools needed.

7. Conclusions

This paper presented the results of an experimentation made during a second year undergraduate course in the Civil Engineering program at the Université de Sherbrooke, Quebec, Canada. The basic hypothesis of the research is that effectively learning is greatly enhanced by the use of motivational tools and situated learning at the classroom level. The experimentation involved a thorough evaluation of: (1) the effective use of situated learning by the instructor and of the responses he was able arise, and (2) the perception the students had of the profession, of the course (importance of the subject), and of themselves (competence, progress, successes). The evaluation of the professor was performed on a continuous base, whereas the perception of the students was measured in the beginning of the term and in the end of it.

The evaluation of the professor showed that there was a cleavage between the first and second part of the course, insofar as the kind, the complexity, the precision and the pertinence to the engineering culture were concerned (Figures 2 to 4). In the first half of the course the professor was more successful at bringing situated examples to the classroom. As the complexity of the matter increased, it became more difficult to so.

The various activities strategically planned to motivate the students to become active learners and to situate them in the context of the practice of Civil Engineering proved to have a positive effect on several aspects. The perception the students developed of the significance of the knowledge being acquired, of the reality of their future profession and of the (thinking and practical) tools they might need, increased (Table 1). However, a negligible variation was observed in the students perception of their competence to understand the lectures and assisted training sessions (exercise demonstrations and laboratory; Table 2).

The efforts to involve the students actively in classroom activities also produced a slight - though significant - shift in the value the students attributed to learning strategies, as opposed to rote learning (Table 6). Another significant increase relates to the perception the students ended up with of their capacity to transfer the knowledge acquired to other situations (Table 7).

8. Acknowledgments

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