Towards better learning by increased student engagement

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Conference Key Areas: Engineering Education Research

Keywords: active learning, learning by doing, engineering education, blended learning, evaluation method

INTRODUCTION

To increase the effectiveness of the university education one major goal set by the Finnish Ministry of Education is to shorten the study time. To streamline the studies, one of the major tools is the recognition of the bottleneck courses and the possible overlap of contents. On the other hand, the need for better student engagement and motivation has also been recognized to ensure both learning and completing the courses and eventually the degree.

The most economical teaching method for large groups is lecturing. However, only less than half of the students seem to attend the voluntary lectures and the portion of active followers is even smaller. Therefore, other teaching methods should be used instead or parallel to lecturing to ensure the learning. Based on the debated Dale's Cone presented in *Fig. 1* the lecturing results the smallest retention rate, while practice by doing and teaching others results much better learning [1]. Similar results are found in

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research on active learning and other methods increasing student engagement, even during the lecture [3].

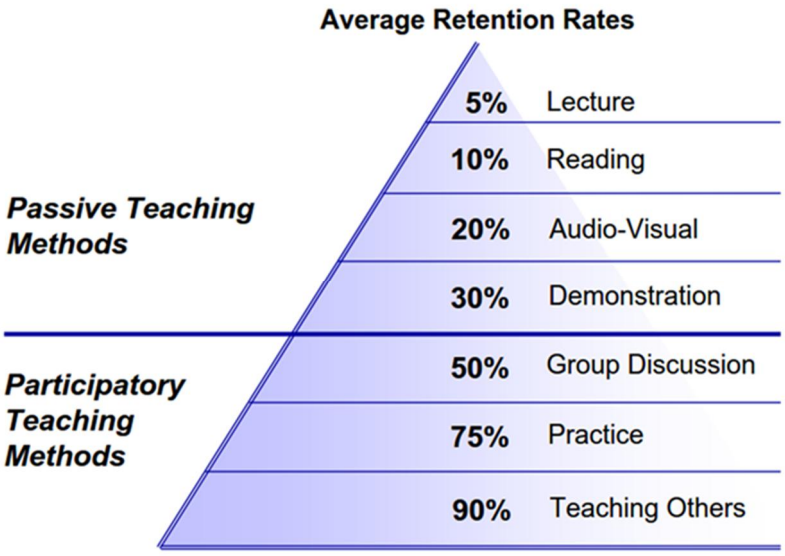

Fig. 1. Dale's Cone [2]

The actual field of studies and the learning outcomes will determine whether the passive teaching method or participatory method is selected. In engineering studies a mixture of various pedagogical approaches in teaching and learning is often used. Typically, the lectures presenting the theoretical background are combined with practical calculation and design exercises. This rather traditional methodology may even be called blended learning, because it contains at least two different pedagogical approaches [4]. However, the more modern way of defining blended learning is more variant integrating face-to-face learning with on-line learning and combining different kinds of instructional technologies and didactic methods. [4]

Improving the student engagement to studying is a diverse task, which entails on the other hand the socio-cultural, behavioural and psychological perspective but also the more pragmatic perspective of the teaching and evaluation method selection and setting the learning outcomes and goals. In order to enable the student to manage challenging tasks and to extend their academic abilities, the role and resources of the teachers are crucial. [5] [6]

The evaluation and feedback are also important tools for giving the students a holistic perspective of their learning. When the grade is determined traditionally only by the final exam, most of the students don't really start working until the exam week even if there are weekly exercises or other activities. As a consequence, there is simply not enough time to learn and assimilate the new information [7]. The activating continuous evaluation is needed to ensure the construction of the knowledge during the course implementation.

1 OBJECTIVES AND RESEARCH METHODS

In this paper the influence of the modified teaching methods and increased classroom interaction on the learning results is studied based on grades, passing percentage and experienced atmosphere. The study concentrates on the development process of three pre-major study courses dealing engineering geology, geotechnical engineering and soil mechanics. To reach the goals, a development process was started already in the beginning of the year 2012. The objective of the development work was to implement the first new course during the academic year 2013-2014. The main goals for the

development work were to improve learning results, to get better passing percentage and to improve and organize the contents of these obligatory courses to enable the students to get a more holistic understanding of geotechnical engineering and soil mechanics. The other major goal was to improve the student engagement to studies in order to achieve better learning results.

In this study, the student engagement is defined as student involvement: the student has the ownerships of his/her learning and is him/herself responsible for his/her learning. He is continuously active in his studies and reacts to the teacher's feedback on his learning. To achieve this, the teaching methods were developed to enable learning by doing, collaborative learning and blended learning. One aim was also to foster new learning relationships between students. All the assignments were planned to be significant and also pedagogically justified.

The data for analysis was collected from multiple sources: partially from the records kept by the teachers, the university syllabus system, data mining of the student register, and the feedback system. Discussions with the teachers and their observations were also included.

The main comparison is based on the yearly passing percentage and the grades. To promote the active learning and continuous working instead of the last night desperate preparation for the final exam, the interval exams are considered preferable over the final exam. Therefore, the amount of the students passing with the interval exams and the first trial of final exam is analysed.

The student feedback is used to evaluate the student experiences and their motivation. The new obligatory student feedback "Kaiku" was implemented in autumn 2014 and since then, the comprehensive data is available. Earlier, the feedback has been collected semi-systematically at the end of the courses.

2 THE DEVELOPMENT PROCESS

2.1 The problems and implementation of the old courses

The three old courses were a basic course on engineering geology, a course on geotechnical site and laboratory investigations and a course focusing on calculation methods in soil mechanics. The courses are compulsory in the bachelor degree of civil engineering and especially the course on soil mechanics has been recognized as a bottleneck course, for example, when passing percentage of the interval exam or the first exam is considered. Some of the challenges identified in all three courses were the motivation and preconceptions of some of the students. In addition, the conventional teaching and evaluation methods based only on the final exam were identified to be the main reasons for the low passing percentage in the first exam, or the low grades in the final exam. The defects of knowledge were noticed in the following courses, which decreased further learning results unless revisions were made.

The main evaluation method of these three courses was still the conventional written exam even though they were already partially pedagogically developed towards learning by doing during the past years. The course on engineering geology had only one exam at the end of course, while the two other courses had two interval exams as an option to the final exam. If the two interval exams were passed no final exam was needed to pass the course. In one implementation, three final exams are organized (grading scale 1 to 5).

All three old courses had different kinds of partial performances e.g. demonstrated laboratory exercises, calculation exercises and soil and rock identification tests. The

partial performances were obligatory but didn't effect on the grade. As it is generally known, the evaluation is guiding the students' performance, therefore an exercise without a prize is neglected. The other explanation for hanging performances is their poor time management and study planning skills.

Table 1. Collected data from three old courses. The presented values are numbers of students.

	Academic year		**2007 - 2008**	**2008 – 2009**	**2009 - 2010**	**2010 - 2011**	**2011 - 2012**	**2012 – 2013**
Engineering geology course (old)	Registered students		120	133	147	127	121	Organized for a special group (20 registered student)
	Active students		100	119	139	109	105	
	Passed(1 after the 3rd exam attempt(2		94	111	124	89	95	
	Grades(1 after the 3rd exam attempt	*1*	*18*	*28*	*37*	*16*	*23*	
		2	*37*	*15*	*22*	*15*	*15*	
		3	*23*	*28*	*26*	*21*	*24*	
		4	*13*	*21*	*28*	*16*	*18*	
		5	*3*	*19*	*11*	*8*	*15*	
Site and laboratory investigations course (old)	Registered students		91	106	117	139	122	124
	Active students		87	94	103	117	105	104
	Passed(1 after the interval exams		64	69	59	66	47	77
	Passed(1 after the 3rd exam attempt(2		92	95	105	122	103	101
	Grades(1 after the 3rd exam attempt	*1*	*34*	*18*	*21*	*15*	*25*	*21*
		2	*31*	*28*	*22*	*29*	*29*	*18*
		3	*20*	*32*	*27*	*10*	*22*	*25*
		4	*7*	*16*	*27*	*30*	*16*	*28*
		5	*0*	*1*	*8*	*8*	*11*	*24*
Soil mechanics course (old)	Registered students		Data not available	124	140	147	144	121
	Active students			116	120	125	118	93
	Passed(1 after the interval exams			51	42	63	50	43
	Passed(1 after the 1st exam(2			62	75	96	82	79
	Passed(1 after the 3rd exam attempt(2			88	94	105	99	87
	Grades(1 after the 3rd exam attempt	*1*		*34*	*33*	*25*	*21*	*16*
		2		*29*	*34*	*28*	*27*	*10*
		3		*16*	*18*	*35*	*22*	*19*
		4		*12*	*18*	*23*	*9*	*18*
		5		*16*	*16*	*13*	*3*	*16*

1) from active students

2) cumulative

Based on the enrolment data, typically 10…15 % of students depending on the course are passive, in other words they are not participating on the course or drop the course at the early stage. In addition there is a small group of students not keeping up to the schedule or requiring alternative or individual tasks. These students cause a lot of extra work and excessive communication for the teacher. The major challenges in finalizing the courses were missing partial performances or missing or failed final exams. Based on experience and statistics, the exam result was generally not improved if not passed at the first attempt, because the course contents are quite wide. The collected data of the old courses are shown in Table 1. Based on the statistics, on average 10 % of active students were still not passing the old courses after three exams. In the old soil mechanics course the average percentage failing the course was about 17 %.

The new syllabus system “Rock” was implemented in 2008 and since then the registration for the courses has been mandatory and a comparable data has been available. As shown in table 1 the number of registered students is increasing compared to yearly intake (on average 100) as the drop-outs are re-registering year after year until they manage to pass the course.

2.2 The implementation of the new courses

Instead of developing a single course these pre-major courses were partially redesigned based on the determined learning outcomes of the bachelor studies. The three old courses were merged into two new courses with the same total amount of credit units as before. The first new course was called basic course on geotechnical engineering and the second one was the course on soil mechanics. The good components, such as laboratory and field exercises were retained, and the teaching and evaluating methods were developed towards a student centred learning environment using methods based on learning by doing. One important aim was to teach students to work continuously and not just for the final exam. A learning platform called Moodle was introduced in the new courses.

Fig. 1. Learning by doing in the soil laboratory exercises.

These courses have challenging targets, like most of the basic courses serving both the professional and general needs. They are aiming to rouse the student’s interest, to create the elementary knowledge for future studies and to provide a wide familiarity of civil engineering. In order to achieve the targets a lot of necessary terminology and basic issues of soils and rocks must be adopted. Thus the method of learning and teaching them is important. The method selected was to make the students use and experience the new subject in different types of exercises and partial assignments.

In the new basic course on geotechnical engineering, the most significant change was waiving the final exam. The course fulfilment consists of seven learning assignments, each involving student action either in group or individually. The learning platform

Moodle was used to provide flipped and blended learning. All learning material, communication and tasks were in Moodle. In addition, group exercises were organized almost weekly during two teaching periods; four of them in the soil laboratory and one at field. The evaluation was supporting learning, e.g. there were Moodle quizzes before and after the exercise, and the evaluation was transparently connected to the learning outcomes. Also collaborative learning was involved, while most of the learning happens in groups were students can freely discuss. In the calculation exercises each got their own initial values and the results were peer checked in pairs.

In the new course on soil mechanics the most notable change was organizing the weekly calculation exercises in smaller parallel groups, instead of having the whole year (100 students) in an auditorium at the same time as before. In the large group there was very little interaction during the calculation exercises and since the most of the student's didn't attend the lectures, they just learned mechanically how to solve a certain problem rather than comprehended the design approach. Now, the calculations were made together slowly and gradually. In smaller groups the atmosphere was more allowable for conversation and questions.

In addition, the mandatory personal design tasks with individual feedback were added. The lecture attendance and regular studying was motivated with weekly quizzes in Moodle, producing bonus points improving the grade of two interval exams, but not the final exam, to urge the students rather take the former option.

3 RESULTS

3.1 Passing percentage and grades

The new basic course on geotechnical engineering has been implemented three times (2013-2016) and the course on soil mechanics twice (2014-2016). The impact of the pedagogical development and changes is analysed by comparing the data from the three old and two new courses.

The amount of the students passing the courses during one implementation is clearly higher than before; over 95-98 % of active students pass the new basic course and 92-93 % of active students pass the new soil mechanic course (*Fig. 3*.). Besides, a larger section of participants pass the course by interval exams instead of the final exam.

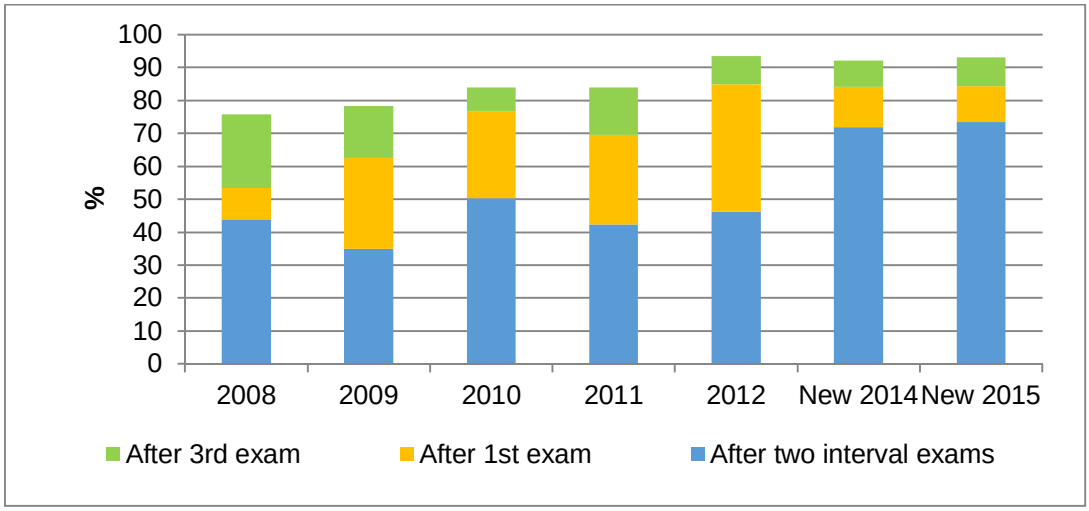

Fig 3. Cumulative passing percentage of active students of the old and new courses on soil mechanics.

If the number of passed students is compared to the number of registered students the passing percentage is naturally lower (i.e. in the old soil mechanics course on average 70% and in new course 83-84 %) since that includes also the students who have interrupted the course. However, the number of drop-outs during the course is decreasing. One clear explanation may be that those who can't commit to regular studying give up already in the beginning of the course.

Table 2. Collected data from the new courses. The presented values are numbers of students.

Course	Academic year		2013 - 2014	2014 - 2015	2015 - 2016
Basic course on geotechnical engineering (new)	Registered students		125	101	111
	Active students		111	91	99
	Passed(1 after the partial assignments		106	89	97
	Grades(1 after the partial learning assignments	1	0	0	0
		2	33	45	22
		3	73	44	49
		4	0	0	25(2
		5	0	0	1(2
	Grades(1 after the 3rd exam attempt	1	0	0	0
		2	31	41	22
		3	65	34	48
		4	5	9	26
		5	5	4	1
Soil mechanics course (new)	Registered students		Not organized	126	113
	Active students			114	102
	Passed(1 after the interval exams			82	75
	Grades(1 after the interval exams	1		1	4
		2		12	7
		3		8	19
		4		41	26
		5		20	19
	Passed(1 after the 1st exam attempt(3			96	86
	Passed(1 after the 3rd exam attempt(3			105	95
	Grades(1 after the 3rd exam attempt	1		12	9
		2		15	10
		3		12	25
		4		46	31
		5		20	20

1) from active students
2) grade 4...5 possible without the exam since 2015
3) cumulative

The evaluation of the new basic course was based on the assignments and during the first implementation the best possible grade without exam was 3. Based on the student feedback the evaluation system was modified to enable earning the maximum grade of 5. The average grades of the new basic course during the three implementations are quite good, 2.5…3.5. Improved learning has also been noticed in the following courses.

As shown in figure 4, more than 50 % of students got very good grade (4-5) in the new soil mechanics course whereas the grades in old course were much poorer: typically only 15-30 % got very good grades. The very good grades in interval exams of the new course were partly result of bonus points earned from the weekly quizzes, but also a stronger guidance and support towards continuous working probably has had an impact.

Based on the passing percentage and the final grades, and the student feedback, these improvements together with development of lectures and example answers of assignments, the learning of soil mechanics has improved.

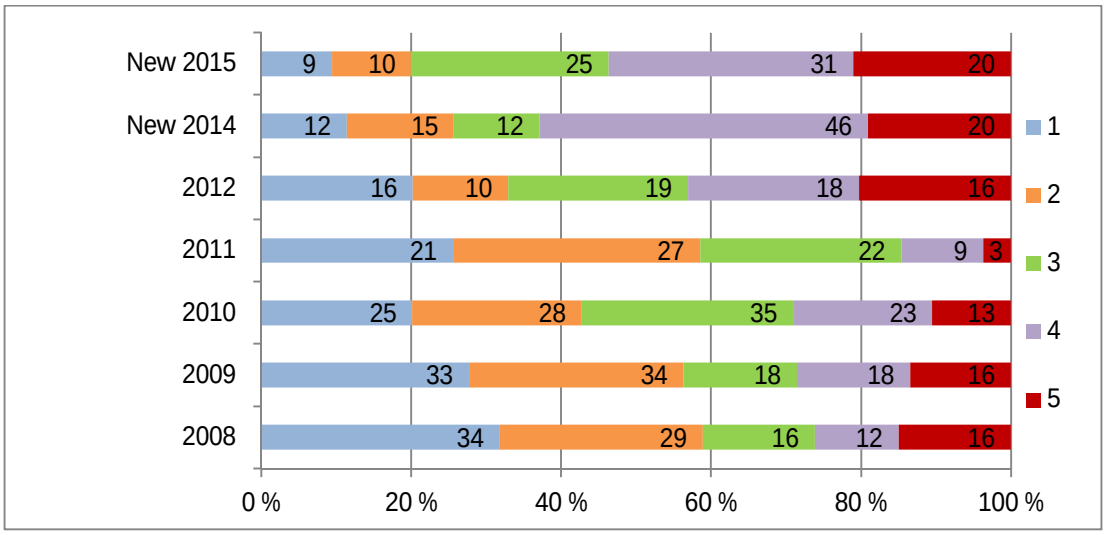

Fig 4. Cumulative grades of active students passing the old and new courses on soil mechanics after 3rd exam.

3.2 Communication and interaction

The new learning platform Moodle and electrical syllabus Rock provide better possibilities for informing and interaction. However, both students and teachers still need training to fully exploit the possibilities.

The second year students still need a lot of support and practice in learning skills. Keeping up with the schedules of several parallel courses is demanding.

The hidden agenda of weekly exercises in small groups is to increase the student engagement and responsibility of their studies and learning. In a smaller group the interaction both with the teacher and between the students is significantly improving the learning. The student feel that they are no longer alone responsible of their learning but the teacher's interest and the pressure, or rather the support, of the group are assisting. In a small group the positive and open atmosphere is easier to achieve.

The distance between teacher and student has a long history in the academic world. In small groups this gap gets smaller and it becomes easier for the students to start a professional discussion with the teacher. With personal encounters both parties are showing interest and real influence and understanding is possible. This is also changing the studying culture.

The student feedback has been used already in the planning phase and will be used in further development. In the post-course feedback questionary of "Kaiku" there are several questions on teaching methods and it is possible to give open feedback. Students are giving good ideas for further improvements. Based on the results, students are pleased about the instructions and feedback given in the new basic course and there is a clear improvement compared to the previous years (*Fig. 5*).

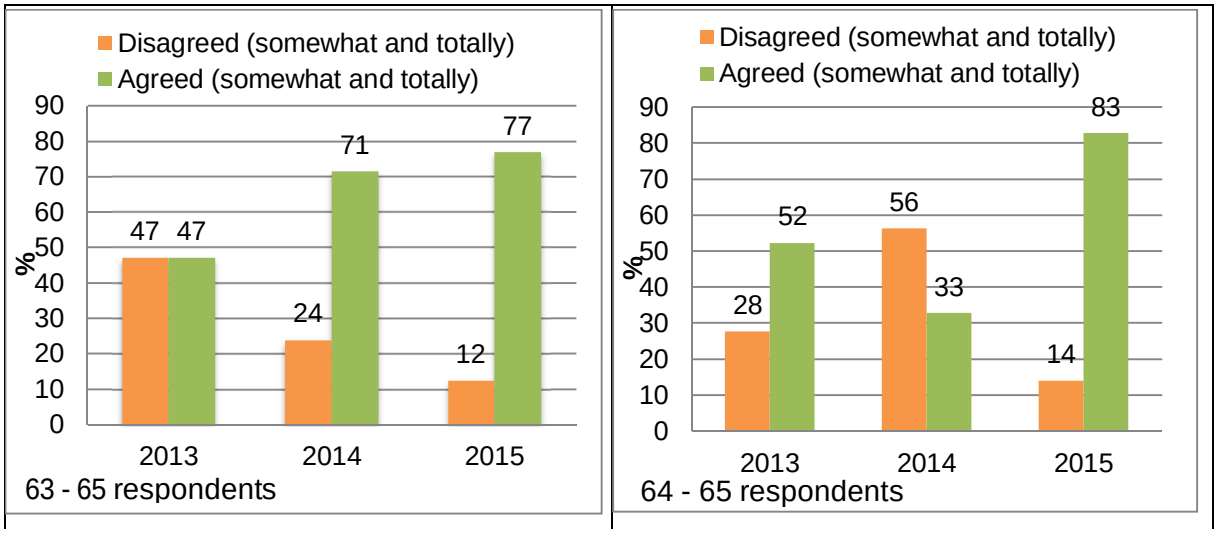

Fig 5. The selected feedback from the new basic course on geotechnical engineering. On the left answers to the question: "*I got enough instructions for independent and for group work.*" On the right answers to the question: "*I got enough feedback from my assignments and learning*".

One factor affecting the student's performance is his attitude towards the course. If the student considers the subject of the course unimportant for his future career and studies, their motivation can be low. This is a common problem in the basic courses obligatory for all students. In addition, laborious or demanding courses easily get an ill fame. Senior students have major influence on the image. Younger students can be quite uncertain of their abilities and their own viewpoint on the upcoming studies, thus being at their most responsive to external influences. Rumours can easily create a negative bias which are hard to change afterwards. It takes several years to change to heritable prejudices.

4 DISCUSSION AND CONCLUSIONS

After three implementations of the basic course on geotechnical engineering and two implementations of course on soil mechanics the following conclusions can be drawn. The number of incomplete performances has decreased. In addition, the number of students passing the course with assignments or interval exams requiring continuous working is evidently increasing. The teacher's workload has decreased or at least expanded to the whole semester. Better learning results have been reached based on the grades. Improved interaction and continuous feedback guide the student's performance and improve the course reputation and atmosphere.

However, we acknowledge that our data includes uncertainties, and the learning results can't be reliably statistically evaluated, since the student material changes every year and the implementations are not identical, since the development work is ongoing. The data presented in this study has been collected partially during the transitional period, and may not provide the full effects of the changes. Based on the teachers' experience, the students' improved abilities are visible in the following courses.

All changes take a lot of resources to plan and implement. The resources, both teachers and classrooms, and the amount of the students are guiding the choice of teaching methods. Most of the changes implemented require more teaching resources than the old methods. For example, coordinating the self-directive working in the soil laboratory requires a lot of preplanning and preparations. Organizing the calculation exercises in five small groups instead of one large group increases the need of

teaching and class room resources. However, the teacher's time is now used better and more effectively in terms of learning results, in our opinion.

The lectures are now concentrating into the core content and more resources are used to follow up and give guidance and, if necessary, to support the learning, especially concerning the disengaged students. Increased interaction gives the teacher better understanding what has been learned and which parts are still obscure. The teacher's feedback is rather formative than summative. The students get confidence in their competence and take the responsibility on their learning.

The development of these courses is continuing every year. The experience from this development process has also reflected to other courses and has also increased the discussions about pedagogical solutions among the university teachers and researchers.

Most graduated students look back on the soil laboratory practices as a memorable experience, but after these changes aiming for better student engagement in future, they are expected to also understand what they have learnt.

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