FACING DISASTER
LEARNING BY DOING AT REYKJAVIK UNIVERSITY

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ABSTRACT

To motivate first year students and expose them to real-life engineering, Reykjavik University initiated the “Disaster Week” in the fall semester of 2011. The semester was broken up with one week of joint project work, introducing the students to some of the main CDIO concepts. During this week, engineering students developed an action plan for dealing with an unforeseen event of some complexity, demanding interactive group work, planning and decision making. In tectonically and volcanically active Iceland, the first “Disaster Week” started with students receiving an announcement that a volcanic eruption had started and the lava flow was heading towards the city of Reykjavik. This paper describes the experience of running this project for the first time. Most of the students were very satisfied with the course; they liked the social interaction in the groups and were stimulated by the idea of the “Disaster Week”. It was the general opinion of the faculty that there is clear value in making this educational experience a permanent part of the first year programmes in engineering.

KEYWORDS

New educational experience, problem based learning, group work, engineering methodology, natural disaster.

INTRODUCTION

Teachers want to stimulate and motivate students in order to increase their satisfaction and educational performance. Many of them are constantly looking for and developing teaching methods that can support their aims in different subjects. Rapid changes in technology require students to be prepared for self-learning or self-driven learning, along with other skills such as communication and creative thinking [1] before they graduate. Students have different learning styles and the approach they take in learning is the main factor in determining learning outcomes [2]. It is therefore important to use a variety of teaching styles to reach out to all students. Engineers are focused on analysis and practical problem solving in their work. Problem based learning (PBL) seems to be a good choice of methodology to train students for their future work environment. The increased emphasis on cooperative learning methods in the teaching of mathematics in the last decade is considered to be one of the key changes [3] and the use of

cooperative learning to promote a more equitable learning environment in mathematics has been widely recommended [4].

Problem based learning (PBL) started in the ‘70s with the emphasis on student-centred teaching with an interdisciplinary focus. The characteristic of PBL is group work where students work on complex problems with a real-life connection, with the support of a supervisor or a coach. The problems are often ill-structured and open-ended and the assessment is focused on self- and peer assessment [5]. The teacher is no longer the focus of attention; he/she is now a facilitator who helps the students find resources, supports the group work and takes an active part in the learning process. PBL calls for good preparation of material, especially in defining the project, but that is common for all good teaching. In PBL the situation can be unfamiliar and demanding, even shocking for some teachers and students. Teachers must be prepared to step away from the lecturing role. Students must be prepared for self-directed learning that may result in mixed feelings at the beginning, but later on increases their confidence and fosters a positive attitude [5].

In higher education group work is used to develop student collaboration skills, teach them to adjust to different roles and share responsibility, but also to support peer learning. Group work can also improve responsibility among students as each student´s contribution is important for the group´s success [6]. Table 1 shows some shared purposes of group work that have been classified by Light, Calkins and Cox [6] into four categories; intellectual, personal, social and practical.

Table 1
Small-group work and the Critical Matrix **[6]**

Intellectual	**Personal**
Developing cognitive understanding	Providing opportunities for practice in self-expression
Appreciation of other perceptions, points of view	Developing self-awareness
Changing conceptions	Encouraging autonomy
Questioning assumptions	Encouraging commitment
Developing oral and written skills	Weakening defensive attitudes
Providing feedback to faculty	Improving attitudes to the subject
Social	**Practical**
Encouraging cooperation and an awareness of others	Developing teamwork skills
Developing a sense of social identity	Developing entrepreneurial skills
Developing a sense of belonging and community	Solving practical problems
Enhancing communication	Carrying out specific tasks
Developing leadership	Creating artefacts or designs
	Writing reports
	Presenting/reporting knowledge

Table 1 supports the opinion that group work is useful and should be incorporated in education. Many science teachers may consider group work challenging and time-consuming, some feel that it takes time from “necessary” lecturing and some may not be convinced that it enhances learning. Many science students may also be sceptical although research has suggested that students today are more team-oriented than before [7].

Engineering at Reykjavik University (RU)

The School of Science and Engineering (SSE) at RU offers BSc, MSc and PhD degree programmes in biomedical engineering, civil engineering, electrical engineering, energy engineering, financial engineering, industrial engineering, engineering management, mechanical engineering, mechatronics engineering and software engineering. The programmes' aim is to provide students with a solid theoretical foundation, as well as specific skills for further study and careers. All the programmes are designed so that they can lead to professional engineering certifications [8].

The School of Science and Engineering is always seeking ways to motivate students and enrich their learning experience. In this paper we will describe our experience of running a special course called *Disaster Week* for the first time in the autumn semester 2011.

DISASTER WEEK

At Reykjavik University, as in many other universities, first year students who have chosen a specific field of engineering spend much of their time in lectures and large groups studying mathematics, physics and other basic sciences. There is little exposure to engineers or engineering in their chosen field and students may easily become demotivated. As a remedy, Reykjavik University initiated *Disaster Week*, one week placed in the middle of the 1st semester in which all first year students of engineering participate, a course with emphasis on learning by doing.

The three main goals of this course are:

1. To motivate students by giving them a chance to become acquainted with the engineering faculty and specialists in their chosen field of study
2. To open a venue for them to become acquainted with fellow students in their programme, paving the way for study groups
3. To give students and faculty a chance to recharge their batteries by taking a short break from the daily routine

At the conclusion of the course, students are expected to (learning outcomes):

- Have experienced working in a group and understand the importance of team work
- Have been exposed to moral issues in their field of study
- Have been introduced to good practice in engineering working methods
- Be able to acquire and work with data
- Be able to tackle ambiguous data
- Be able to take a well-founded stance in problem solving, suggest feasible solutions and interpret findings
- Be able to introduce and present findings in a clear and concise way

Last autumn approximately 150 students took a break from their studies in basic subjects and worked intensively, in groups, on one “real-life” project for a whole week. The project should generally be an unforeseen event with some degree of complexity and ambiguity, an event which calls for interactive group work, quantitative estimates, quick planning and decision making. It does not necessarily have to be a natural disaster, but something that the students can identify with in real life and is likely to stimulate their interest. There is an emphasis on individual participation in presenting ideas to the others in the group, as shown in Figure 1.

Figure 1. Students working on an evacuation plan on the first day of *Disaster Week*.

Iceland is both tectonically and volcanically active and certain areas in southern Iceland have been especially "lively" in the last few years. On Monday morning of RU´s first *Disaster Week* in October 2011, all students received an announcement that a volcanic eruption had started in *Hengill*, a volcanically active area close to Reykjavik, the capital of Iceland, and that the lava flow was heading towards the city. This setting is realistic in the sense that a similar event happened some two thousand years ago. Figure 2 shows a geological map of *Hengill* (the red dot) and adjacent area, located approximately 20 km east of Reykjavik.

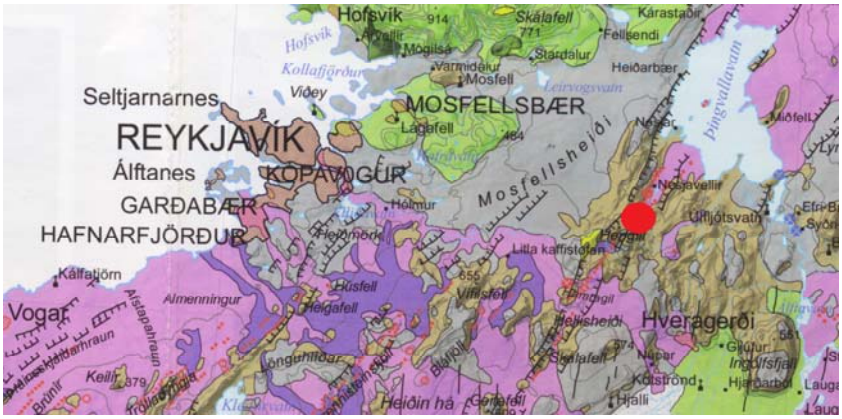

Figure 2. Geological map of the tectonically and volcanically active Hengill area (red dot in figure), located 20 km east of Reykjavik. The figure is from a geological map of Iceland [9].

Students were divided into 27 groups of five to seven students each, and each group received an assignment touching on their discipline of study. The groups were supposed to independently seek all relevant information and develop an action plan in order to deal with a certain part of the necessary general action plan. Students received information on the event and how it evolved through news-like reports on RU´s local network, updated as the event unfolded for the first two days, information on both the eruption itself and its effect on the population in Reykjavik. Table 2 describes the schedule of information flow to the students through news broadcasts on Monday and Tuesday. In addition to the events listed in Table 2, a few short announcements were broadcasted relating the disaster to actual concurrent events (earthquakes in the area, field trips, etc.) and also for fun. The students presented the results of

their work on Wednesday. They then had the option of using Thursday and Friday to catch up on their regular studies in tutorial sessions that were offered by all teachers, or simply to take a break from their studies. At noon-time on Thursday and Friday, specialists held guest lectures and discussions on the themes “Volcanic activity” and “Rescue work”.

Table 2
Timeframe and events of *Disaster Week*

Time	**Event**
Monday at 8:30 AM	**Initiation, all students and supervisors together:** Short talks on team work, ethics and project management. Students then split into small groups.
Monday at 9:30 AM	**News broadcast:** Shallow earthquakes during the night, culminating in volcanic activity and erupting lava at 2 AM located 20 km east of Reykjavik at the site of a young central volcano. Lava flows, some heading for Reykjavik, unrest and traffic jams in Reykjavik. Ambiguous news, unusual traffic at emergency wards – general call for civil protection.
Monday at 10:00 AM	**News broadcast:** More detailed news from geoscientists, active eruption and lava streams crossing roads, cut-off of several crucial electric power lines, cut-off of the geothermal water supply (essential for the district heating system in Reykjavik). News is erratic and ambiguous, and conflicting reports on the internet are causing public unrest and frantic behaviour. Semi-drastic description, albeit realistic. Formal request from the Civil Protection Authority for an almost immediate action plan. Student groups are to focus on five specific tasks; evacuation, public health, energy contingency, public security, information. All tasks are only briefly described.
Monday at 8:00 PM	**News broadcast:** Volcanic activity increasing, more specific news on the lava flows. Destruction of electric power-lines and supply of geothermal water. Geoscientists say that there is no risk of the lava streams flowing into Reykjavik. Continuing havoc in Reykjavik and misleading news. Increasing seismic activity.
Tuesday at 8:30 AM	**News broadcast:** Continuing activity. A small eruption started a few kilometres north, as predicted by the earthquake activity last night, cutting off one more power plant. Dust in the air, breathing problems, traffic jams, exhausted rescue workers, conflicts on who is in charge. Public asks for shelters all around the city, in part to offer relief due to stress and other health problems. Students are told that the situation has stabilised. They are asked to produce final action plans according to the task their group was assigned yesterday. Due time is 4 PM in the afternoon. Tomorrow morning they will present their finding to their colleagues in seminars.
Wednesday morning	**Seminars**, all groups present the results of their work. All presentations are finished by noon.
Thursday noon	**Talk** on volcanic activity and hazard by a volcanologist.
Friday noon	**Talk** on rescue work in the aftermath of earthquakes by an active rescue worker.

As shown in Table 3, students in the different engineering disciplines focused on different aspects of the eruption and their consequences. We tried to match the topics that each student group worked on with their field of interest and, to some extent, with the instructor´s field of interest or expertise.

Table 3
Assignment of groups to tasks in *Disaster Week*

Task of group	**Students assigned**
Energy contingency: Analyse the eruption's influence on energy production and distribution, both electrical and geothermal. Prioritise the different consumers and make a contingency plan for the transport sector.	Mechanical engineering (1 group) Mechanical and energy engineering (3 groups)
Public health: Work on ways to deal with the mental and physical stress in the city´s population due to the impending danger and disruption, from infants to the elderly.	Biomedical engineering (6 groups)
Public security: Work on public safety and security matters, work on ways to deal with public unrest.	Electrical engineering (3 groups) Industrial engineering (1 group) Civil engineering (1 groups)
Evacuation: Make evacuation plans for different residential areas, and define means and routes for transportation.	Engineering management (3 group) Financial engineering (2 group)
Information: Work on means of gathering data and distributing reliable information to the public through efficient use of the internet, radio or whatever.	Mechatronics engineering (4 groups) Software engineering (3 groups)

During *Disaster Week*, all faculty members in engineering took part in supervising student groups, each one supervising a group within his/her own discipline. One of the goals was to expose students to specialists within "their own" chosen profession and the teachers were well aware of this goal. They were encouraged to discuss their work and their research interests with the students and, if feasible, to try to link the students´ project works to their own field of expertise. They were also encouraged to link issues such as engineering ethics, good engineering practice and project management to the students´ work. In some cases, graduate students took part in the supervision of the projects.

At the end the groups gave presentations of their work and the supervisors gave feedback, both on the group´s work in general and on the presented results. Figure 3 shows one group giving their presentation.

Figure 3. Students presenting their project in *Disaster Week*.

LESSONS LEARNED

At the end of the *Disaster Week* there was a meeting with all the teachers involved. Most of the teachers were satisfied with the week, some were extremely happy. They felt that the students had taken the project work seriously - most students worked hard, were enthusiastic and did a good job. The teachers agreed that the group work gave the students a good opportunity to get to know each other and some experience in working as a team.

Some teachers felt that the students could do with more motivation, for example by introducing a competition or giving prizes for the best solutions, or simply by giving grades. Others were totally against this; they felt that the students should work solely for the sake of enjoying their work, that this week should be a break from graded assignments.

Some teachers wanted the main project and the tasks for each group to be clearer and better defined, as the students are not used to such open-ended projects. Others very much appreciated the opportunity to work with an open-ended project and considered that to be more like real life, forcing the students to think of prioritising – and in addition giving the students the space to define to some extent how they wanted to tackle the task at hand.

Several teachers mentioned that they would have liked the students to be more quantitative in their approach. A few teachers mentioned that some students were anxious about presenting the results of their work, that it was not clear to the students what was expected of them.

Students were able to evaluate and comment on the course anonymously at the end of the week. Of 152 students who participated in the course, 105 students graded the course and 37 wrote comments. The average score, on a scale from 1 to 5 (3 being neutral), was 3.6. The students´ comments were in many ways similar to the comments we received from the teachers.

Students generally liked the idea of the *Disaster Week* and were stimulated. They were very positive on working so closely with fellow students and getting to know them better. Many remarked that their teachers were enthusiastic, but there were also some remarks that the teacher did not seem interested or was not sufficiently prepared. Some students mentioned that they would have liked to have tasks with a more direct connection to their chosen field of engineering. Several comments indicated that the students would have liked more information

on the final presentation. A few mentioned that students were able to pass the course as "free-riders", without any real contribution.

A few comments from students:

> "This was a fantastic course, which my friends in another university envy me of being able to participate in. I learned a lot from the course, especially how it is to work with other engineers in a group."
>
> "The course could have been better organised with focus on better communication between the groups. The project should have been used to intertwine groups that were focusing on different things like evacuation, health and safety and get them to work together. Some groups did coordinate their work on their own initiative, but then they were not able to present their work together at the end."
>
> "The allocation of rooms for the different groups to work in was not well planned. We did not know what was expected of us in the final presentation and our supervisor did not seem to know either. It was all a bit chaotic."

In short, in preparing for the next *Disaster Week* we need to have the following in mind:

1) Prepare the teachers better and make sure that they are all enthusiastic and motivated to take an active part in advising students
2) Re-think the assessment of the course and increase motivation of the students, for example by the use peer review and self-evaluation.
3) Give students more time for the project, three or four full days
4) Put more emphasis on quantitative methods
5) Put more emphasis on linking the project work to engineering practice
6) Put more emphasis on linking the students´ tasks to their chosen field of engineering
7) Coordinate guest lecturers from the industry and public sector to the students´ work
8) Advise students on preparation for the final presentation
9) Incorporate the CDIO ideology into the project in a systematic way

CONCLUSIONS

Based on the experience of the first *Disaster Week*, it is the unequivocal consensus of the faculty in science and engineering that there is great value in making this educational experience a permanent part of RU´s first year curriculum in engineering. The objectives of the course were fulfilled more or less, and faculty members are enthusiastic about planning the course for next autumn. By far most of the students were happy with the course; they liked the social interaction in the groups and were stimulated by the general idea of the *Disaster Week*. There were only a few students who were not satisfied. There is definitely room for improvement, including preparing and initiating the staff and faculty involved, and the faculty responsible has compiled a list of things that will be revised when we run this course for the second time in October 2012.

To break up the autumn semester and use one full week on a project like this is a bold endeavour and quite a few things developed differently than we had expected. So in the end we are quite relieved that this first *Disaster Week* did turn out so well, it could have been a real disaster week!

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