CHALLENGING ENGINEERING STUDENTS WITH UNCERTAINTY IN A VUCA SITUATION

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ABSTRACT

Engineering practice is gradually becoming more affected by the need for agility, and the dynamic nature of today's world has impacted how situations are addressed, projects are managed and decisions are made. Anticipating a rapidly changing world, future engineers must have competence to manage situations which may be volatile, uncertain, complex and ambiguous (VUCA). Engineering education programs may therefore want to consider instilling some VUCA aspects into their training, aiming to prepare graduates to confront unexpected situations in the context of decision-making and leadership as recommended in the CDIO Syllabus 2.0.

The engineering programs at Reykjavik University (RU) have for several years run a two day "Disaster Week" early in the first semester, an event were students are faced with a disaster of some sort. In the fall semester event 2017 it was decided to analyze by a survey carried out at the completion of the event, the VUCA dimensions of the event and the dynamics within the teams. The participants were a group of 230 first-year students, working in 40 teams. This study shows that challenging engineering students with uncertainty in the VUCA-spirit is a good way to both train and instill a positive view towards teamwork among students, and may lead to a more confident and positive attitude when faced with volatile and uncertain tasks later in their studies.

KEYWORDS

VUCA, Decision Theory, Experiential Learning, Teamwork, Disaster Week, CDIO Standards: 2, 4 and 8.

INTRODUCTION

Engineering and management practices are gradually becoming more affected by the need for agility and the dynamic nature of today's world has impacted how situations are addressed, how decisions are made and projects are managed. The abbreviation VUCA refers to situations that are volatile (V), uncertain (U), complex (C) and ambiguous (A). Although it was initially coined to describe the severe conditions of unconventional warfare, the business and industry sectors adapted VUCA to enhance skills to deal with unexpected scenarios and events (Lawrence, 2013).

The real social environment of today´s business is complex and ambiguous. The idea embodied in the acronym VUCA can be used to describe the complicated real-world circumstances in which strategic decisions must be made. Recent research has tackled many

aspects of these complicating realities of real-world social perception. The term VUCA describes the dynamic nature of the world today and has caught on in a variety of organizational settings to describe a business environment (Horney et al., 2010; Bennet and Lemoine, 2014).

VUCA in Engineering Education

Future engineers may face challenging tasks on a worldwide scale, and engineering practices are becoming more global due to ease of communication. This imposes new conditions as future engineers may have to make decisions in environments that are VUCA-like. These environments may include unexpected scenarios and events such as financial crisis, surge of immigration, unstable software systems and natural disasters. Business and industry sectors have recognized a growing need to enhance skills that enable them to deal with VUCA situations. Engineering educational programs may therefore want to consider training students in facing unexpected VUCA-type situations in the context of decision-making (e.g. Gaultier Le Bris et al., 2017; Rouvrais et al., 2018), leadership and for facing rapidly changing world (e.g. Kamp, 2016). Among the goals for undergraduate engineering education that are specifically listed in the CDIO Syllabus 2.0 (www.cdio.org) are “analysis with uncertainty, based on incomplete and ambiguous information” (2.1.4) and “initiative and willingness to make decisions in the face of uncertainty” (2.4.1). Universities in the CDIO initiative might therefore consider using VUCA scenarios as a venue for reaching these goals in the teaching of their engineering programs.

VUCA and Disaster Week, First Encounter at Reykjavik University

The engineering programs at Reykjavik University (RU) have since 2011 run a 2-3 day intensive course, Disaster Week, early in the first semester (Saemundsdottir et al., 2012). The main objective is to enhance interpersonal skills, as well as to break up a long semester and open a venue for students to become acquainted with fellow students. The context of the project is an unexpected challenge that has to be dealt with in teams. In the fall semester 2017 the scenario was the eruption of a prominent stratovolcano that is clearly visible from the campus. RU is participating in a European Erasmus+ project, the D‘Ahoy project, along with five other higher educational institutions. The formal introduction of the VUCA theme into RU´s Disaster Week is one contribution to the project. Our objective is to use the experience from this event to aid us in learning how to prepare students for dealing with VUCA situations, and how to define learning outcomes that support VUCA skills (Gaultier Le Bris et al., 2017).

In this paper we describe how we involved VUCA aspects in the Disaster Week event, show the results of a survey, and discuss lessons learned.

VUCA AND DISASTER WEEK HAND IN HAND

Objectives and Planning

The learning outcomes (LO) for Disaster Week 2017 were that upon completion of the course the student should:

1) have experienced teamwork and understand the importance of cooperation and diversity in a group.
2) have been introduced to diverse ways in presenting solutions.

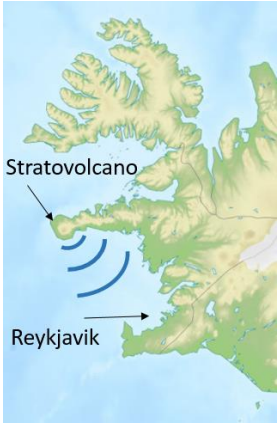
3) have experienced a situation where decisions and planning are based on uncertain information.

The third learning outcome reflects the VUCA emphasis which was implemented in this course for the first time in fall semester 2017. In three prior years, an emphasis was placed on creativity, and training students in a formal brainstorming method had been a part of the Disaster Week course (Audunsson et al., 2015; Matthiasdottir et al., 2016). Training in brainstorming has now become a part of another 1st year course, as the emphasis in Disaster Week has shifted towards VUCA.

A total of 231 students participated in the course, 186 in engineering and 45 in sports science. Students were spilt into groups of 6 to 7 students, hence a total of 39 groups. Ten teachers facilitated in the course, each one advising 2 to 6 groups.

Among the objectives in designing the event was to choose a scenario that would awaken the students´ interest, fit well for teamwork, and to some extent reflect a VUCA situation. A glacier-covered stratovolcano is visible from our campus and, due to its prominence and the steady threat of volcanic eruptions in Iceland, we felt that it would be suitable for the project. It was feasible to make up a realistic course of events that included both minor and major disasters and ambiguous news bulletins, i.e. about the flooding of glacial rivers isolating a small town, disrupted transportation, ash and tephraflows escalating to a imminent major tsunami hitting the city of Reykjavik (Figure 1a).

To give the event a realistic impact at its kick-off, a local TV station helped out by producing a dramatic news alert, including an interview with a well-known local geoscientist. The bulletin announced that an eruption had started, described some initial events and then some speculations on potential development. This resulted in a 3-minute video that was shown at the kick-off session on Thursday morning (Figure 1b).

a) 

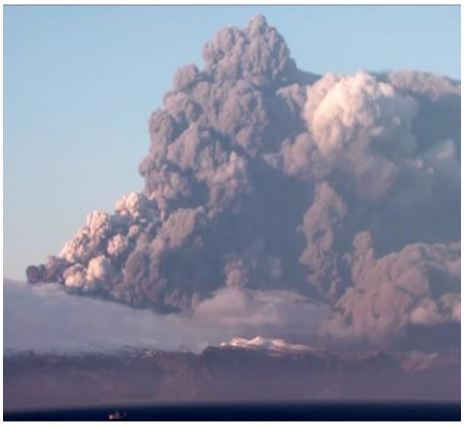
b) 

Figure 1. a) Map of Iceland with stratovolcano Snæfellsjökull. b) Clip from the kick-off video (from Eyjafjallajökull in 2010).

The students´ task was to envision themselves as an advisory team commissioned by the government and set up an action plan. All groups started by focusing on evacuation of the immediate threatened region. This entailed finding information on the web and through the local authorities i.e. about the population and size of the area, how to assess flooding and ashfall, the capacity for transporting people by the local fishing fleet, the capacity of the road

system and other means of transportation, accommodation for evacuees, health issues and crowd control. And of course decision-making at various stages as the whole event unfolded.

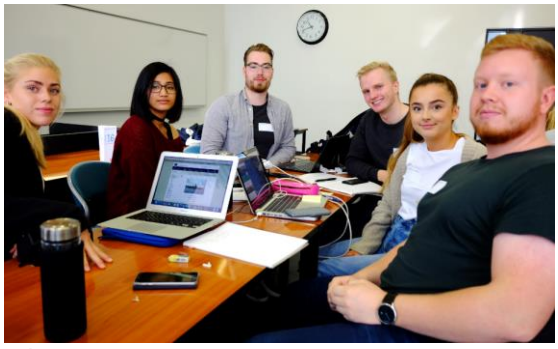
In designing the course, we aimed for a volatile event with dashes of uncertainty, complexity and ambiguity. Our evaluation of the levels of the four VUCA-factors is shown in Table 1.

Table 1. Levels of different factors of VUCA in the Disaster Week 2017 scenario (table adapted from Rouvrais et al., 2018).

Magnitude / variability	Interpersonal	Volatility	Uncertainty	Complexity	Ambiguity
Strong					
Medium	X	X			
Weak			X	X	X

The Event

The Disaster Week started Wednesday afternoon with an hour of short lectures on group- and teamwork, VUCA situations, goals and methods. The unexpected event was introduced early Thursday morning, initiated by a dramatic news bulletin video, and the scenario unfolded throughout the morning (Figure 1) with several fresh news bulletins thrown in to bestow a volatile atmosphere. Students worked in groups most of Thursday (Figure 2a), and at the end of the day there was a short lecture on presentation methods. Friday morning, they worked on summarizing results and designing presentations, which they presented early afternoon Friday (Figure 2b). The chronological sequence of events is outlined in Table 2.



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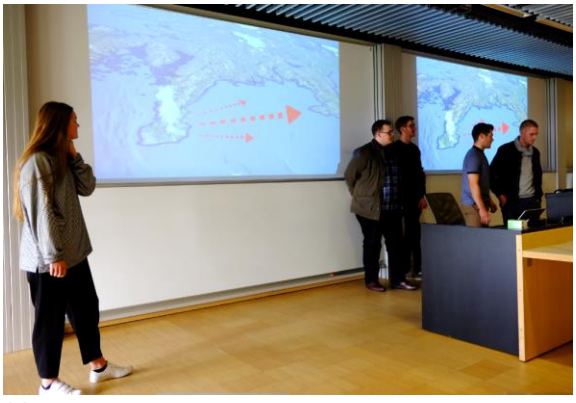

b)

Figure 2. a) Students working in groups on Thursday. b) Students presenting their work on Friday.

Table 2. Unfolding of events in Disaster Week, September 13th – 15th 2017.

Wednesday	
3 – 4 PM	**Four short lectures** (15 minutes each): • Working in a group, • Teamwork and VUCA, • Back-of-the-envelope calculations, and • Finding information on the web
Thursday	
8:30 AM	All students together in a lecture hall: **Outline of the course** for the next two days and on deliverables on Friday.
8:40 AM	**Event presented by a** breaking-news bulletin, **a 3-minute video**: An eruption started early in the morning in a glaciated stratovolcano, flooding in a nearby village, Olafsvik, and it appears isolated. The news focuses on an interview with a geoscientist trying to predict the potential course of events, including glacial flooding, ash and potential tsunami.
9 AM – 3 PM	**Students work in groups.** Students go to their working spaces, 2 to 8 groups in each room. Students start working on their action plan. **News bulletins (**spread over two hours): • Eruption just started in a stratovolcano, clearly visible from Reykjavik. • Glaciated volcano, hence local flooding due to melting, nearby village isolated. • Spectacular eruption as seen from Reykjavik, major confusion among the population. • Urgent request from the government for action plans to be delivered at the end of the day. • Major ash plume is seen rising, and heads for Reykjavik due to the wind. • Pyroclastic flow may rush down the slopes of the volcano and into the sea and hence a potential tsunami is evident, initiating a wave few meters high that might hit Reykjavik.
3:30 – 4 PM	**Two short lectures** (15 min each) on oral presentations, flyers and posters.
Friday	
8:30 AM – 1 PM	**Group work** continues and students prepare presentations.
1 PM	**Flyers**. Each group delivers a flyer (A4-format) on their work.
1 PM	**Seminars**. All groups present the results of their work. 8-minute presentations, about 6 groups in each of 6 rooms. Best presentation in each room selected by attendees.
2 PM	**Survey**. On the VUCA aspects of the course and on group dynamics and teamwork. **Feedback.** Teachers give short written feedback to each group.

SURVEY

An internet survey was carried out at the completion of the event, Friday afternoon, about challenges imposed by the situation facing the student teams, i.e. the group dynamics and the VUCA aspects. A total of 219 students were registered for the course, and 191 of them participated in the survey (87%), 89 females (47%) and 102 males (53%).

Regarding group dynamics, the students were supposed to select one (out of three) statement that best described their group. The majority of students (94%, 176 out of the 188 valid replies) responded that their group had worked as a team to find solutions without any one person taking the lead. Moreover, there is no significant difference in opinion between females and males, 96% and 92%, respectively. Results are shown in Table 3.

Table 3. Results on group dynamics.

	Females	Males	Total
The group worked as a unity (team) to find a solution without any one person taking the lead.	85 (96%)	91 (92%)	176 (94%)
One person decided on his own to lead the work and steered the group in finding a solution.	3	7	10
The group was disorganized and without leadership.	1	1	2
Total	89	99	188

Regarding the VUCA situation, four more statements were presented, each intended to reflect one particular VUCA factor i.e. in compliance with Lawrence (2013). Each student responded by ranking each statement on a Likert scale. The ranking showed how well each statement described the student´s encounter with the VUCA situation. The statements were:

(V) Even though it was uncertain what could happen, and there were many possible solutions to all issues, the collaboration within the team was focused and all team members knew what their goal was.
(U) In spite of many things being unclear and uncertain all team members kept calm, where active listeners and accepted fresh ideas when conditions changed.
(C) Even though the situation was complex, with uncertainty and confusing information, we were able to keep all issues under control.
(A) In spite of a steady stream of unexpected, unclear, ambiguous and confusing information, and it was difficult to predict what would happen next, the team remained effective and solution driven.

As there is no significant difference in responses between females and males, we combined the results as shown in Table 4.

Table 4. Students´ responses to statements on how VUCA factors affected their group.

	Statements in compliance to:			
Number of responses / factor	Volatile	Uncertain	Complex	Ambiguous
Definitely agree	101	115	105	109
Agree	65	51	63	56
Disagree	4	3	3	4
Definitely disagree	15	16	14	16
Total	185	185	185	185

According to this survey the majority (90%) of the students felt that their group worked well and efficiently despite the four potentially inflicting VUCA factors, and about 8% definitely disagreed. Because the responses are so alike for the different VUCA factors, it may be argued that the students did not fully distinguish between these factors in this short event.

Considering that the VUCA survey was carried out at the completion of the event, Friday afternoon, we were concerned that the timing might have influenced the responses. We therefore conducted three in-depth interviews a few weeks later with 6 randomly selected students, 3 females and 3 males, talking to two students together in each interview. The students´ comments in the interviews included:
- uncomfortable initially as the scenario was changing fast
- a little overwhelming because it was their first project at university level
- being expected to estimate instead of detailed calculations was uncomfortable
- confusing how fast things happened initially, but it was interesting
- the project was exciting
- initially we did not know what was expected of us
- appreciated dealing with the project in a group
- the groups worked fine, some mild conflicts initially but they were able to resolve it
- now we know who to work with, and whom to avoid, in future group work
- got to know their classmates better
- there was no conflict in the group - one took the lead in the group, but all participated in taking decisions, so it worked well
- everyone was active in the group, although one was more active than others
- two in the group took the lead and the others in the group were content with it.

The interviews confirmed the results of the survey regarding the group dynamics (Table 3). Also, although one member in a group may have taken the role of a leader, the groups were generally very comfortable with it and no apparent conflict emerged. The interviews showed that, of the four VUCA factors, the volatility was predominating.

RESULTS AND DISCUSSION

Based on the survey and interviews we can conclude that the event provided a very positive experience regarding teamwork. There is no significant difference in opinion between females and males regarding the group dynamics. It is not obvious from the results of the survey conducted at the end of the course that the Disaster Week event is suited to induce strong emotional responses among students regarding the challenges of teamwork under conditions of uncertainty and rapidly changing conditions.

The students were introduced to uncertain information and a volatile situation but in the end they had enough time to make realistic plans, and the consequences of bad decisions were mild as the grading for the course was Passed/Failed. All groups were able to finalize presentable action plans, and most students might therefore have been in a very happy mood when they answered the survey on Friday afternoon. The results of a survey conducted a few hours after they started working on their tasks, i.e. at noon on Thursday, might possibly have been very different. To obtain a more comprehensive view on students´ reactions to working in a volatile, uncertain, complex and ambiguous environment, it would probably be more informative to monitor and assess VUCA factors at various stages of a project, not only at the end. Students did not seem to have differentiated between the four VUCA factors. Most students seem to have given the same ranking to all four statements, without giving the differentiating nuances much thought. It might therefore be appropriate to rephrase the four statements, and/or to make them more related to specific events of the scenario.

Introducing VUCA, although in a mild manner as in this case, so early in a study program encourages personal interaction within study groups. It may also encourage a more positive attitude when students are faced with uncertain and ambiguous projects later in their studies, paving the way for facing more involved and realistic VUCA situations. Both of these are valuable traits, which are not always easy to cultivate in a study program. The VUCA flavor of the Disaster Week appears to be an effective theme to let students experience teamwork and value the importance of cooperation. The three learning outcomes initially stated were fulfilled.

This study shows that challenging engineering students with uncertainty in the VUCA-spirit, in a short course like Disaster Week is a good way to both train and instill a positive view towards teamwork among students, and may lead to a more confident and positive attitude when faced with volatile and uncertain problems later in their studies.

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