A pressure cooker – coaching framework for teaching soft skills in an engineering master's programme

A successful way to educate graduate students the essential skills for collaboration in large, complex infrastructure projects

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Civil engineering projects increasingly involve a wide range of stakeholders with diverse interests and multidisciplinary teams. Engineers need soft skills to deal with these teams and stakeholders. "How to educate these soft skills to engineering students?" is the central question for technical universities. The course Collaborative Design and Engineering in the Dutch master's programme Construction Management and Engineering is an answer to that question. Feedback, however, indicated that the course did not meet expectations. The course needed a radical redesign. This paper describes the redesign and resulting framework of the course. The principles of the redesign are constructive alignment, activated learning and not to lecture the skills as 'dry stuff'. The resulting course is based on a 'pressure cooker – coaching' framework. The pressure cooker part creates a situation in which the students will experience stress. The students work in large groups on a complex assignment under time pressure. A mix of group and individual assignments creates tension between students. The coaching part provides structure and guidance. Theory on the necessary soft skills is introduced early in the course in workshops. Consultation meetings help to keep the students on track. The course has now evolved over three years. Theoretical evaluation shows that the 'pressure cooker – coaching' framework fulfills the requirements of constructive alignment. Practical evaluation, using feedback, shows a consistent high score. We consider the 'pressure cooker – coaching' framework broadly applicable and is successful enough to continue in our CDE course. Elements of the course can be improved. We consider introducing more theoretical depth and psychology without violating our idea of 'no dry stuff' and 'action learning'

Keywords— soft skills, active learning, constructive alignment, engineering education

I. INTRODUCTION

Civil engineering projects have become more and more complex and require a multidisciplinary approach. The projects involve a wide range of stakeholders with diverse interests. On top of that the members of the multidisciplinary team also have diverse interests. Civil engineers need soft skills to deal with these diverse and conflicting interests. The perception of soft skills differs from context to context. In this paper we define soft skills as the personal attributes that enhance someone's ability to interact effectively and harmoniously with other people. These skills are complementary to someone's hard skills, which is made up of someone's knowledge of a certain specialism or discipline. Examples of soft skills are communication skills, negotiating skills, conflict management, work ethics, cultural awareness and teamwork capability. For engineers these skills and attitude can act as a lever for the value of their technical knowledge, their hard skills. This is in line with the concept of the T-shaped engineer where the depth is the specialism and the breath is the competence to work in teams and within the stakeholder network [1]. For universities their task is not only to educate technical knowledge, but also skills and attitude. Universities have to educate these competencies not only for understanding but also for synthesis, for the delivery of results. However, a big challenge for technical universities is to educate graduate students the essential skills for collaboration in large teams. The question is: "How to educate these soft skills to engineering students?"

The need for engineers with the right soft skills is internationally recognized: '…engineering graduates now require a far broader range of skills and attributes than the technical capability' [2]. Nquyen also states that engineering education needs to be revised. More recently Male [3] identified dominant deficiencies in education: 'communication skills, self management and appropriate attitude, problem solving, and team work'. And in the UK the Royal Academy of Engineering identified that ' ... the engineer as integrator reflects the need for graduates who can operate and manage across boundaries, be they technical or organisational, in a complex business environment' [4]. In 2004, in recognition of the need for different skills and knowledge for future construction managers the Dutch State Secretary of Education, Culture and Science supported the initiative to create a new master's curriculum between three universities of technology in the Netherlands. The Construction Management and Engineering (CME) master's programme, which started in 2007, is a main contribution to this need [5]. Although the CME programme focuses on soft skills, hard factors are also further developed (as in the course Probabilistic Design). The programme consists of two main blocks: a general block (five cornerstones) and a specialization block. Among others, the cornerstones cover Project Management, Process Management and Collaborative Design and Engineering (CDE). The course Collaborative Design and Engineering was intended to focus most on the (soft) skills and attitude of the students. However,

feedback in 2011 indicated that the course did not meet the study goals and the students graded the course 2,3 on a scale of 5. The course needed a radical redesign. This has led to a redesign based on the principle to actively engage students. The idea behind the redesign was not to lecture the soft skills as 'dry stuff' from group dynamics textbooks, but to create circumstances in which soft skills would become necessary. To the challenging circumstances we added coaching for the students to give them guidance and the opportunity for consultation of the lecturers. Over the following years we further improved the course based on feedback from students, colleagues and on our own experience. In 2012 the redesigned course was given to 40 students, in 2013 to 56 students and in 2014 to 78 students – see figure 1 for the total number of students in the CME programme. We expect about 90 students in the 2014/2015 academic year. Over the last three years the students graded the redesigned course 3,9 on a scale of 5.

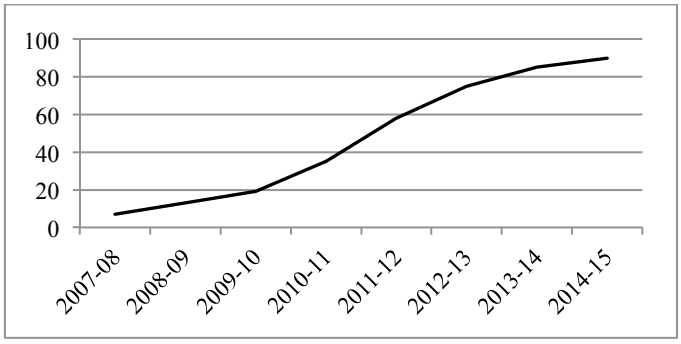

Fig. 1. Total number of new students in CME (2007 – 2014)

This paper starts with a description of the context of the CDE course in section II. Section III describes the method and principles for the redesign. Section IV explains the resulting course design and in section V the results is evaluated against theoretical criteria and student feedback. After the conclusion in section VI we describe our ambitions for continuous improvement in section VII.

II. The CME Master's Programme

The course is part of the MSc Construction Management and Engineering (CME). The CME programme comprises all aspects of the construction process, including the definition, appraisal, design and delivery, as well as the lifecycle management of objects (asset management). The programme addresses the interests of all stakeholders involved, such as client/sponsors, governmental organisations, private sector, and NGO's. Distinctive features of the MSc programme are the design-oriented approach, the strong connection between scientific research and construction engineering practice, and the emphasis on integration of disciplines [6]. The CME MSc programme has a core programme of five cornerstones:

- *Legal and Governance Aspects;* presents knowledge and understanding of the main legal aspects (of both civil and public law) involved in the planning and construction of works of a civil engineering nature.
- *Project Management;* presents the foundations of project management and is developed primarily to understand the role of project management in construction.
- *Process Management*; aims at providing students with insights, concepts and skills needed to understand the nature of interaction between actors.
- *Integration and Orientation;* enables students to integrate methods, techniques, aspects and tools for problem solving and decision-making in an asset management context.
- *Collaborative Design and Engineering – the course of this paper*.

Collaborative Design and Engineering is a 7 European Credits course and deals with processes in which multiple actors work together for a given civil engineering problem, in a complex environment. One European Credit corresponds to 25-30 hours of work. In this course students will gain understanding of Collaborative Design and Engineering by carrying out a certain aspects of a project in collaboration. These aspects include design, operations, governance, maintenance, and risk management. In this project, students work together, deal with stakeholders with diverse interests, and use value and scenario concepts for dealing with complexity [7]. The course focuses on the soft factors that are key for successfully dealing with complex problems in large groups.

After the course students will be able to apply collaborative design skills, not only the necessary technical competences in civil engineering design, but also collaboration skills, dealing with organisation, management, teamwork and effective use of information technology. The study guide [7] mentions the following learning objectives. The student will be able to:

- Work with incomplete data, requirements and scenarios
- Work in teams with people of various backgrounds, cultures and personalities
- Define the performance of infrastructures systems in a dynamic environment
- Interact and collaborate with various disciplines
- Interact and collaborate with various stakeholders
- Integrate the aspects of maintenance in the design
- Manage process and project risks
- Identify the conditions that are crucial for collaboration in groups

These learning objectives will be described in more detail in the next section, using the method of constructive alignment.

III. Method and Framework for Redesign

The redesign of the course is based on the directions given in *Designing an Effective Course* from *A Guide to Teaching and Learning Practices* from FSU [8] and the constructive alignment as described in *Teaching for Quality Learning at University* [9]. Right from the beginning we placed alignment of the learning objectives, teaching activities and assessment

central in the design of the course. A second important point in the redesign is the principle of activating students. This principle also supports the learning objectives: we are not educating students to become experts in the field of social psychology of group dynamics but we want them to develop the necessary skills and attitude to become better engineers while working in teams. In line with the learning objectives their newly acquired skills and attitude should act as a lever for the benefit of their (technical) knowledge.

Early in the redesign process we realized that we had to create stressful circumstances in which soft skills would be required to successfully finish the course. This resulted in a framework we later labelled as a *'Pressure cooker – coaching'* framework. This framework is illustrated by this caption from the Study Guide [7]: 'You will experience a lack of time and a lack of information during this course. This will take you out of your comfort zone. It will enable you to learn.' The framework of the course will deliberately bring the students in a situation they don't know and where they have to appeal to their soft skills. The lecturers will coach them through the process. The coaching will learn them how the react and behave in such a large group.

A. *Charateristics of the pressure cooker part*

In the *pressure cooker* the students will experience a substantial amount of stress, which is representative of a complex situation. This situation will ask the utmost from the students, and in which the students will become aware that to simplify complexity is not always the best solution [10]. The first step was to create very large groups: 25 to 30 students. These groups consist of graduates of different nationalities (of which about 75% Dutch) with different (technical) backgrounds: civil engineering, and technology, policy and management (TPM). Second we introduced a variety of group and individual assignments. The individual assignments have to compete for attention and time with the group assignments. This will create a tension between personal interests and group interests. With a final individual grade based for 50% on the group assignments and for 50% on the individual assignments, the mix will also mitigate the risk of free riding in large groups. The group assignment has to be large and complex. It should involve an overload as well as a lack of information, demands a lot of time and great variety of technical knowledge from the students, so they have to deal with constraints in time and information. The final aspect that adds pressure to the group assignment is the use of external assessors in a real life case. This alignment with the future workplace – external assessors and an authentic assignment - will also foster long-term learning [11].

B. *Characteristics of the coaching*

In the pressure cooker environment the students cannot be left to their own fate. Certain checks and balances have to be built in. Guidance with respect to the case and *coaching* in respect to interpersonal problems is needed. First, students need coaching to guide them through the project of the group assignment. Second, theory on the necessary soft skills needs to be introduced in the first weeks of the course. To activate the students this will be done in workshops where the students learn about aspects of group dynamics, which they are already experiencing. Lectures and homework assignments have to give guidance to start their group assignment. Later on in the course consultation and progress meetings will help the students to keep on track with the group assignment and off-class availability of the lecturers will help prevent the escalation of problems of any kind.

IV. RESULTS – THE COURSE

The course is a project course – central in the course is the large group assignment. The course lasts eight weeks. In combination with the 7 EC weight this results in a weekly workload of about 25 hours for each student. There are two lectures every week that introduce new knowledge and give guidance to the project. The final assessment is done on the team (group) and the individual (personal) results of the various assignments. This section consists of four paragraphs. First we will describe the pressure cooker, followed by the coaching aspects. Then we will show the theoretical aspects that are part of the course and finally we will show how the course adheres to the principles of the constructive alignment (between learning objectives, teaching method and assessment.

A. *The pressure cooker – creating a sense of urgency*

The group assignment is a real life case. The students have to deal with the future challenges of the Oosterschelde estuary and the storm surge barrier in the Netherlands. This estuary was compartmentalised in second half of the 20th century and the storm surge barrier came into operation in 1986 and has a design life of 200 years. Due to adversarial effects, changing climate conditions and new demands it seems unlikely that in the longer run continuation of the present management regime of the Oosterschelde will be sufficient to maintain the safety of the hinterland [12]. The central research question in the group assignment is: "What is a realistic solution for the management regime to make sure the Oosterschelde will live up to the safety, environmental, economical and ecological demands in the long term (2100 – 2200), based on a preferred strategy?" [7].

Fig. 2. Students visiting the Oosterschelde barrier (2012)

The students are divided in large teams. The members of the teams are selected by the lecturers to create a balance between Dutch and international students and between civil engineering, architecture and technology and TPM students. The students will divide the roles, tasks and responsibilities within their team. The first phase of this project is primarily

about gathering information and analysing the interests of different stakeholders of the case. The first phase lasts three week and is finalized with a report and a presentation by the team on their analysis. In the second phase (four weeks) of the project the students will prepare a solution based on the results of the first phase. At the end of the course each team will produce a report and give a final presentation to the client, who will judge the final results and will select the best solution from the three final reports.

Next to the group assignment the students will have to work on two individual assignments. In the early stage of the project they will have to do a literature study on in the area of collaborative design in construction and/or asset management. This assignment competes in time with the first stages of the group assignment. At the end of the project the students have to hand in a reflection report. The student has to describe and reflect on an incident that occurred during the assignment and while working in his or her team. The format of the reflection report is based on the four phases of experiential learning of Kolb [13].

The last aspect of creating a sense of urgency is the 360-degree peer feedback. Halfway the course students are asked to measure each other's contribution to the group assignment. This is done in order to learn from each other, and is meant to positively change working attitude, attendance, and contribution to the group. At the end of the course this measurement takes place again. The scoring of the fellow team members then becomes a part of the final mark (summative assessment).

TABLE I. OVERVIEW OF ASSIGNMENTS AND DEADLINES

	Assignment	Type	Deadline (working days relative to start)
1.	Literature study	Individual	10
2	Partnering Charter	Group	5
3	Belbin test (online)	Individual	10
4	Project Management Plan	Group	10
5	Report Case assignment Phase I	Individual	15 – before presentation
6	Leary's Rose test (online)	Individual	20
7	Formative 360 feedback	Individual	20
8	Report Case assignment Phase II	Group	35 – after presentation
9	Reflection Report	Individual	35
10	Summative 360 feedback	Individual	35

B. The coaching – providing structure

The first coaching aspect in this course is the excursion to the Oosterschelde estuary and storm surge barrier. This excursion not only provides insights in the specifics of the case but also provides a good opportunity for the students to get to know each other and discuss the set up of their teams. Essential is the timing of the excursion in the first week of the course. Experts from the asset owner Rijkswaterstaat provide introductions on various aspects of the case.

The overall structure of the course and the lectures is to provide a controlled environment for the students throughout the course. All (group and individual) assignments (see table 1) and assessment criteria are linked to back that up. The (smaller) assignments for the students are meant to become in control over their large group assignment. Each assignment has its own specific learning objectives. E.g., the group assignment to develop a Project Management Plan has the following specific learning objectives [7]:

- Be able to work in a team on the development of a management plan
- Identify your personal team role
- Identify your professional role in a team
- Negotiate your interests and objectives
- Present a project management plan in writing and speaking

The scoring rubric for each assignment is linked to the learning objectives. The scoring rubrics are available upon request. The criteria in the scoring rubrics are a balance between criteria for proper scientific research, depth and quality of the results and the ways the results are presented. The students know the assessment criteria before the start of each assignment.

In the first weeks and in line with the design principle to actively engage students, we offer three workshops that focus on three topics, which are the basis of a good team, as mentioned in Adair [14]:

- Results, which refer to the task orientation of the team;
- Building and maintaining the team, which refers to the relation orientation;
- Individual development in professional behaviour and attitude, which refers to the individual competences.

These workshops help in providing structure and also help in educating the appropriate soft skills (see next section). In the first workshop the students prepare a Partnering Statement. In this Partnering Statement the students describe the commitment they reach between themselves and their team members. The Partnering Statement describes the aspects they agree on and which can be seen as the design and process parameters of their collaboration. A compulsory part of the Partnering Statement is the *grade* that they aim for. This requirement usually leads to a lot of discussion between the students and creates awareness about the differences between their individual ambitions.

The second workshop is about team roles. A team role is tendency to behave, contribute and interrelate with others in a particular way [15]. We mention the many different approaches to identify team roles (e.g., management drives, MBTI) and we use the eight Belbin team roles in our course. In line with our principle of 'no dry stuff' we have the students experience, observe and discuss their team roles in a game. In this game based on the Zin Obelisk [16] students have to solve a problem where each of the group members (about 12) has a small piece of the information needed to solve the problem. Only verbal communication is allowed. This workshop is accompanied by an online Belbin test. After the game and they discuss their team roles and, based on that, the possible changes in setting up their subgroups within the large team of 25-30 students.

The third workshop focuses on the interaction between team members and their individual development. Input for this workshop is an online test based on Leary's Rose, an interaction behaviour theory that demonstrated a strong and consistent interdependency of behaviour between people [17]. This workshop also pays attention to giving feedback, for instance by asking questions.

The Partnering Statement from the first workshop is input for the Project Management Plan (PMP) that the students have to hand in ten working days after the start of the course. Important aspects of the PMP are the research question, the scope, the work breakdown structure, the organisation break down structure, the definition of the quality, time and of course the resources. All teams create subgroups to distribute the work between the team members. By requiring a PMP from the students at an early stage, they are incentivised to create structure to tackle the large group assignment.

Furthermore, the whole group assignment is split in two phases: an analysis and a synthesis phase. This also provides structure. The students are required to thoroughly analyse the problem at hand and cannot start working on a solution after a proper analysis of the problem. After three weeks their problem analysis is assessed the lecturers as well as by experts from Rijkswaterstaat. The comments they receive (within one ore two days after handing in the report) give guidance to the second phase.

In the second phase the consultation and progress meetings give further guidance. To emphasise the collaboration aspect and team results the students that represent the teams at the weekly meetings and presentations have to rotate. The progress meeting is more formal, the students have to prepare a progress report based on a Prince2 template [18], covering the most important activities and achievements of the past period, points of interest and possible problems, a review of activities for next period and the risks and the mitigating measures. The consultation meetings focus on collaboration aspects and solving problems within the teams.

C. *Skills and attitude: theoretical aspects*

Over the last three years we have been able to tweak and tune the theoretical aspects that we provide the students. The theory we now provide is based on dealing with the circumstances the students experience during this course. Most of these theories are covered in Group Dynamics [19]:

- Group think – using the Abilene Paradox [19, p.340],
- Johari window – a model of self-awareness (Luft & Ingram) [19, p. 492]
- Situational Leadership – a model of leadership styles (Hershey & Blanchard, Blake & Mouton) [19, p. 270],
- Core qualities - a model to gain an understanding of mutual relationships (Ofman) [20],
- Iceberg model – a model to understand the visible and invisible characteristics of individuals (McClelland) [21]
- Stages of group development – a model that describes the stages that are necessary and inevitable in order for the team to grow (Tuckman) [19,p.19]
- Giving feedback – strategies to improve frequent and effective feedback to increase productivity and team harmony (own material)

To have a fine balance between theory and practice students are also activated to find their own way in the literature by means of the literature study (individual) assignment.

D. *Constructive alignment.*

The theory from Biggs [9] and many consultations with colleagues and students has been input for the constructive alignment. For example, we wanted the course to be as interactive as possible. The use of the three workshops for the active participation of the students is part of this. These three interlinked workshops not only learn the students more about the theory but also more about themselves while working in groups. Because the workshops are done in the first weeks, the results of the workshops are also directly applicable in the execution of the group assignment.

The tables 2 and 3 summarise the results of three years of designing, redesigning, delivering, evaluating and improving the course. The tables are based on the actual description of the course in the study guide [7]. For readability the table has been split in two.
The column 'Teaching/learning activities' refers to the course plan in the study guide. The column 'Assessment' is linked to the assignments within the course. A full overview of the assignments and assessments is given in the study guide. The text in the column 'Explanation of the alignment' uses phrases from *Seven principles for good practice in undergraduate education* [22]. We have added a column to include a reference to the levels of Bloom's taxonomy.

TABLE II. CONSTRUCTIVE ALIGNMENT OVERVIEW

	Learning objectives	Teaching/learning activities	Assessment (Assignment)
1	Work with incomplete data, requirements and scenarios	Group Assignment	Report Case Assignment Phase I and II
2	Work in teams with people of various backgrounds and cultures	Group Assignment	Case Assignment Phase I and II
3	Define the performance of infrastructures systems in a dynamic environment	Group Assignment	Case Assignment Phase I and II
4	Interact and collaborate with various disciplines	Group Assignment and workshops	Case Assignment Phase I and II
		Workshops	Belbin test (online); Leary's Rose test (online); Formative and summative 360 feedback
5	Interact and collaborate with various stakeholders	Group Assignment and workshops	Case Assignment Phase I and II
6	Integrate the aspects of maintenance in the design	Group Assignment	Case Assignment Phase I and II
7	Manage process and project risks	Group Assignment	Project Management Plan Partnering Statement
8	Identify the conditions that are crucial for collaboration in groups	Lecture, workshops	Literature study, Reflection Report

TABLE III. CONSTRUCTIVE ALIGNMENT OVERVIEW (CONTINUED)

	Learning objectives	Explanation of alignment	Bloom's Taxonomy
1	Work with incomplete data, requirements and scenarios	The scoring rubric of the case study report focuses not only on the quality the final report but also on the process of collaboration and how the students dealt with the inherent problems.	Analysis, Synthesis
2	Work in teams with people of various backgrounds and cultures	Students are assigned to teams by the lecturers, who make sure that the teams are a mix of Dutch and international students with various background (Architecture, Civil Engineering, TPM, etc.).	Analysis, Synthesis
3	Define the performance of infrastructures systems in a dynamic environment	The research question in the case assignment forces the students to focus on this aspect.	Analysis
4	Interact and collaborate with various disciplines	Students are assigned to teams by the lecturers, who make sure that the teams are a mix of Dutch and international students with various background (Architecture, Civil Engineering, TPM, etc.)	Analysis, Synthesis
		In the workshop students are actively involved in doing small assignments, discussing and evaluating and applying the results. The workshops also develop reciprocity and cooperation among students	Application, Evaluation
5	Interact and collaborate with various stakeholders	Combination of 3 and 4	Application
6	Integrate the aspects of maintenance in the design	The content of the case for the group assignment has a maintenance component, this has to be addressed in the final report	Analysis
7	Manage process and project risks	The early stage of compiling a PMP encourages contact between students and to respect diverse talents. The PMP also emphasises the aspect of time on task.	Application
		The Partnering Statement encourages contact between students and to communicate their expectations	Application
8	Identify the conditions that are crucial for collaboration in groups	The required knowledge to identify the conditions is gained through this literature study (and accompanying readings)	Knowledge, comprehension
		In the individual reflection report the student has to how well he is able to apply the group dynamics theory and evaluate his own behaviour (based in Kolb's learning cycle)	Application, Evaluation

V. DISCUSSION

In this section we will evaluate the resulting framework in two ways. The first approach is more theoretical and will use the five evaluative questions from Teaching for Quality Learning at University [9]. The second, more practical approach will use the results of the student feedback questionnaires of the past three years.

A. Theoretical evaluation

In order to assess the constructive alignment of a university course Biggs and Tang propose five aspects. Each of the aspects is discussed below:

- *Enabling students to take control and be reflective in their learning:* Students can take control over their work using the guidance given by Partnering Statement, the PMP, the division of the group assignment in two phases and the progress reports. The opportunity for reflection is given by the individual assignments literature study and reflection report and the peer formative feedback.
- *Providing relevant learner activities:* The three workshops, the presentations and the consultation and progress meeting all provide relevant learner activities. The group assignment implicitly also provides multiple learner activities, from organising, to presiding and logging meetings and writing reports.
- *Providing formative feedback on your students' learning progress:* Within a few days the phase I report is graded and feedback is given. One of the students states in her Reflection Report: "When I first heard our grade for the phase 1 report, I was disappointed and confused. I thought until that moment that we did a good job. When I heard the explanation of the grade, I totally agreed with the grade." Formative feedback is also given at the consultation and progress meetings.
- *Providing appropriate motivation:* Two ways of providing motivation are worth mentioning. First, the use of an external assessor, who is also present at the presentation of the reports. Second, in order to bring out the best in the students, the team that has the best final presentation and report of de case study is awarded the (annual) CME1200 award. This award is a certificate and voucher for (enough) drinks in the faculty cafe. The award has only one further condition: the drinks have to be shared with the other team(s), i.e. the whole course is about collaboration. This award ceremony marks the end of the course and has also proven to be a good way to create informal interaction between students and academic staff.
- *Constructing a base of interconnected knowledge:* As shown in the previous section, all parts of the course are somehow linked. The theoretical aspects are linked to real time experiences of the students in doing the assignments. This is also shown through the reflection reports in which the student link actual experiences with the literature study and theory that was presented in the lectures.

B. Practical evaluation results (3 years)

Each year we evaluate the course using an online questionnaire. This questionnaire is sent out to every student that is enrolled in the course. Some examples of questions from the evaluation are [23]: 'The lectures were instructive; The consultation/progress meetings gave guidance during Phase II of the project; The team workshops contributed well to the course'.

The response to the questionnaire is 43%. The overall score of the course (on a scale from 1-5; totally disagree - totally agree) has a stable 3,9 over the last three years and over 90% of the respondents agree that the course fits well into the CME master's programme. For comparison: over the last three years other CME master's courses scored an average of 3,7 and ranged between 4,1 and 3,2.

The first fifteen questions are rated from 1 (totally disagree) to 5 (totally agree). Figure 1 show the results of the past three years, where the x-axis displays the number of the question and the y-axis the score on a scale from 1-5.

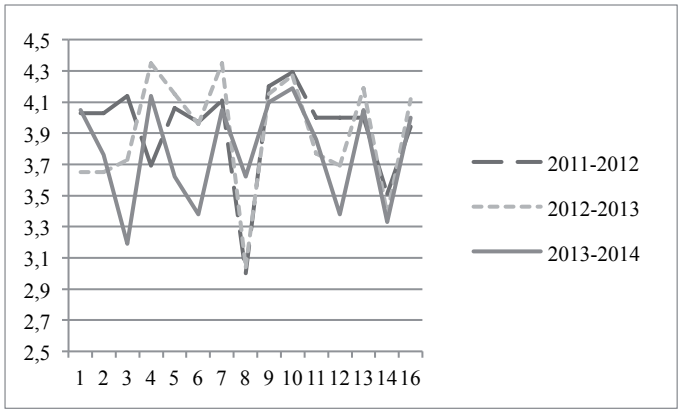

Fig. 3. Scores of online questionnaire (2012 – 2014)

A few outliers in the last year stand out. Questions five and six deal with the quality of the presentations by the experts from Rijkswaterstaat. Cleary, the presentations were not received as well as by the students as before. This is recognized by the lecturers and will certainly be a point of attention when preparing the excursion next year. Question three is related the workshops and the online tests on Belbin and Leary. Over the years the students population has grown from just 40 students to nearly 80 in 2013. A consequence of this growth is that students do not know each other when starting this course. This probably leads to the difficulty the students have expressed in assessing each other in the Belbin and Leary's Rose tests. Especially the Belbin test is done early in the course when many students do not know each other well. A possible remedy for this is the have the students propose subgroups of students that score each other on the Belbin aspects.

Looking at the open remarks of the questionnaire, another aspect is not well received by the students. This is probably related to the lower score last year for question 12 where the students were asked to which degree they agreed to the statement that the assessment criteria are clear. Students want a more transparent scoring model for the grade that reflects how well they have contributed to the group assignment. This grade is mainly using an anonymous online test in which students have to score their peers on their contribution to the group assignment. This test consists of five questions, e.g., 'How well each one kept to the

agreements made during the assignments'. The algorithm that eventually calculates the grade is not clear to the students.

Last year we paid a lot of attention to improving the literature assignment. Our efforts are received well, as the score of question 8 'The literature assignment helped to gain insight in collaboration', rose from 3,0 to 3,6.

At the end of the course the students hand in their reflection reports. Quite often the students refer positively to the coaching structure and soft skill theories that were offered during the course. In discussions with peer lecturers about this course their most recurring remarks are that this *'pressure cooker – coaching'* model provides a strong framework. The latest annual survey of the CME master's programme across all three universities of technology specifically mentions Collaborative Design and Engineering as a course that provides a good link between theory and practice [24].

VI. Conclusion

In the Collaborative Design and Engineering the method of creating constructive alignment has proven to be successful. Positive feedback from the students confirms this. The *'pressure cooker – coaching'* framework is a good means to create circumstances to actively learn an improve skills in a controlled way. Based on the (over 150) reflection reports we can conclude that this course gives triggers for further development of the graduates in this field and helps the new professional to recognise potential incidents, problems, conflicts in their new working environment and to link that to appropriate theory and tools to deal with these situations. We think that this *'pressure cooker – coaching'* framework is broadly applicable, and is at least successful enough to continue its application in the CME programme.

The coaching aspect is very important as the course (i.e. the case assignment) is intensive and requires a lot from the students. Because the course requires a lot of self-organising and self-initiative from the students the consensus among our peers is that this framework is not applicable for undergraduates.

VII. Continuous improvement

First of all the results of the online evaluation, the remarks from the students – as mentioned in the evaluation paragraph – are input for our strive for continuous improvement. For the course next year we will create more transparency in the grading of the personnel impression and the setup of the Belbin test will be improved to create more familiarity between the assessors.

The framework within the course is certainly satisfactory, but can the elements within the framework be improved? We consider introducing more theoretical depth (psychology) within the course. In doing so we need to strike a balance between theory and learning objectives. The course is not aimed at educating social psychologists but at educating engineers. Can a (trained) psychologist improve the workshops? We have already set the first steps on this path. In 2014 we invited a psychologist to participate in our second workshop. The course will start again in April 2015. We now consider providing more background theory on team roles and team interaction by a specialist in that field of knowledge. The challenge for us is to integrate that into the course without violating our principle of 'no dry stuff' and 'action learning'.

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