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# Lean courses in process form - do as we learn, success or not?

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**Abstract.** Experience of successful improvements in organizations based on lean methods shows that participation and involvement are the keys. Based on this, a university-level continuing course has been created that focuses on quality improvements. Students gain knowledge of various lean and quality tools, as well as of implementation processes. The students learn essential tools and implementation processes gradually, while at the same time using this knowledge.

The course is structured in modules with intermediate work steps, where the intention is for students is to use their knowledge in quality improvement projects at their workplace. The underlying idea is that the course modules correspond to the Plan, Do, Check, Act (PDCA) methodology. The exam consists of submitting a folder with reports from the intermediate work steps and a final report.

This course has been offered and completed twice, with the third in progress as of this date. We describe the background for our choice in quality and process tools as well as the examination form. In addition, results from a survey among the participating students on their opinions of the course content, structure, and examination form, are presented.

We conclude that students who take this further education in parallel with their regular work are of great benefit to their employers, as the course is module-based, and the participants work on a project at their workplace. In addition, the students appreciate interweaving theory and knowledge training. The course grades are determined on a final report based on sub-assignments where the students do an academic reflection on their improvement project.

**Keywords:** Folder examination form, Lean education, Process-based training.

## 1 Background

Many universities and colleges, for example NTNU, Chalmers, DTU, Aachen, provide courses in lean and quality improvement. However, curricula from quality courses show that many of these courses are traditional, where students learn more about tools and methods, and less about improving processes and implementation. When this

course was developed, it focused on providing knowledge about basic quality tools/methods and lean methodology for improvements and on employees' commitment and organizational development to achieve improvement objectives. The course is structured in modules where students gradually learn different quality tools, methods, and different aspects of improvement processes. Between modules, students practice what they have learned in improvement projects in the workplace.

The course is titled "Management of quality enhancement and continuous improvement." It is focused on modern management tools and the main elements of Total Quality Management (TQM) and lean. In addition, the course focuses on continuous improvements as a method and how organizational culture affects changes. In this context, we also look at which organizational changes are required and how they can be implemented to achieve the objectives for the desired improvement.

The target group for this professional development course is employees working with quality and improvement work. Prerequisites are general study competence (in the Norway education system, or the equivalent) and two years' work experience.

The course has been offered twice (2019, 2020), and a third-round has started in the spring of 2021. There have been approximately 20 students in each course. The study questionnaire indicated that most students have leading positions in public administration, health or work in the private sector.

## **2 Purpose**

We wanted to explore participating student's opinions about the course content, module structure, examination form, and experiences with working on a concrete improvement project in the workplace. Based on students' evaluation of the course, the idea was to develop the course further.

The purpose was to obtain students' views from the two completed courses in retrospect and determine to what extent they anticipate being able to apply knowledge from the course at their workplace. Furthermore, we wanted to learn whether course participants can contribute to improvement work in their organization. In other words, we wanted to find out if our way of implementing the course and testing knowledge through applied improvement work was successful.

## **3 Course structure and content**

The course covers 15 ETC based on the European credit system. The course consists of four sessions of two full days. Between sessions, participants work on a current quality/improvement project at their workplace. The assignment is based on that work. The assignments form the basis of a final report, which is also the exam for grading.

The idea is to gradually give the participants methods and tools used in TQM and lean and use them in their in-house project. The PDCA methodology permeates the structure of the course and the associated assignments. The PDCA cycle is also known by two other names, the Shewhart cycle and the Deming cycle (e.g., Johnson 2016). There is very little research on the success of concept-based education (such as PDCA,

the main tool of the course), hence the value of finding out more about it (Laverentz & Kumm 2017).

Successful implementation of improvement projects is based on strong involvement of people who work close to the operations in organizations or other workplaces. Therefore, the course also provides knowledge of staff commitment, change management, and organizational development.

Our view of the concept of quality is characterized by diversity. Quality is a much more complicated term than it may appear. It seems that every quality expert defines quality in a somewhat different way. Various perspectives can be taken in defining quality (e.g., customer's perspective, specification-based perspective). Garvin's five different perspectives on quality (Garvin 1988) particularly resonates with us.

A contemporary definition of quality derives from Juran's "fitness for intended use" (e.g., Juran 2014), meaning that quality is meeting or exceeding customer expectations. According to Deming (1986), the customer's definition of quality is the only one that matters.

Based on this reasoning, it is essential to understand the customer, the customer's needs, and the environment where the customer will use the product/service. In this context, we have included tools such as the Kano model and Quality function deployment (QFD) or House of Quality. The Kano model offers insight into how product attributes are perceived by customers (Kano et al. 1984) and into how customer's needs can be met or even surpassed (e.g., Oakland 2000). House of Quality is a method to transform qualitative user demands into quantitative parameters (Akaio 1994).

The course also provides insight into traditional quality management tools such as Ishikawa's seven basic tools of quality (e.g., Tague 2005) and Failure Modes and Effects Analysis (FMEA). The syllabus also includes a briefing on statistical process control and Six Sigma as a quality management method.

Unlike the seven basic QC tools, which measure quality problems that already exist, the seven new QC tools make it possible for managers to plan wide-ranging and detailed TQC objectives throughout the entire organization. These tools, some borrowed from other disciplines and others explicitly developed for quality management, include relations diagrams, affinity diagrams, systematic diagrams, matrix diagrams, matrix data analysis, process decision program charts (PDPC), and arrow diagrams (Mizuno 1988).

Working towards improvements in quality is important, beneficial, and rewarding. We have included several different angles on quality improvement work, for example the fact that accidents are often due to human error and poor construction. Therefore, elements are also included on how various human error causes can be reduced and engineered and planning designs improved for reliability and redundancy.

In addition to quality tools and methods, the course provides insight into TQM as an overall concept and International Organization for Standardization (ISO) systematics, including certification. TQM in this context can be a system used by customer-centric organizations that involve all its employees in the process of continuous improvement. TQM is essentially a management practice that focuses on meeting or exceeding customer expectations. A TQM-centric organization focuses on process measurements and controls to achieve continuous improvements in the business process. Thus, it is an integrated approach to improve productivity by using both qualitative and quantitative concepts.

With this integrated approach, there are parallels between TQM and lean, although these two concepts differ significantly in other areas. The philosophy behind continuous improvement based on lean tools is called Kaizen. It involves identifying benchmarks of excellent practices and instilling a sense of employee ownership of the process. Some other lean tools are 5S, seven waste, suggestions for improvement, stand-up meeting, visualization, A3, Kanban, extended value stream mapping, and Andon, Jidoka, Gemba walks.

The basis of the continuous improvement philosophy is the belief that virtually any aspect of an operation can be improved. The people most closely associated with an operation are in the best position to identify the changes that should be made towards improvement. Consequently, employee involvement plays a significant role in continuous improvement programs. Workplace cleanliness, visualization (panel meetings), and employee involvement (proposal activities) are essential components of continuous improvement work. Involving all staff in the lean operation creates participation.

Our starting point in implementing the TQM improvement philosophy is not only that quality and quality improvement is about the customer's perceived quality and how to manage quality with different tools and models, but it is equally an improvement focus on the processes involved in creating the organization's products and services.

Deming's theory of profound knowledge (Braughton 1999) is a management philosophy grounded in systems theory. It is based on the principle that each organization comprises a system of interrelated processes and people who make up the system's components (e.g., Braughton 1999). We believe that Deming's idea that the parts of a system are interconnected is central to implementing changes. Not least, cognitive insight is essential.

To stabilize and streamline processes, it is in some cases necessary to create new processes (BPR) (Andersen 2007). We lean towards the thinking based on continuous improvements as part of a lean approach where we push hard for employee participation (Rolfson 2014).

Change of attitude and behaviour is required to achieve quality improvement in business. Basic knowledge of realizing cultural and organizational changes in a quality context is also required. It is mainly based on Kurt Lewin's theories of groups and group dynamics/ways of change and links to systems theory and organizational culture theory (e.g., Huarng & Mas-Tur 2016, Hussein et al. 2018).

## **4 Pedagogic approach**

The pedagogical approach has been to adapt the course to students who work full time. Therefore, we chose a session-based structure with four sessions of two days (9-16). Furthermore, in line with Bloom's taxonomy (Anderson and Krathwohl 2001), we wanted the participants to practice what they learn.

Problem-based learning is the pedagogical approach for the course. This is self-driven learning, problem-solving, and peer collaboration skills (Pettersen 2005). In Norway, this method is used in medical education (Lycke & al. 2006).

The objective was that the students work on a project in their workplace between sessions. The assignments are handed out after each session and submitted before the next session with students receiving feedback at the next session. During the sessions,

students present what they have done, and everyone must present at some point during the course. The assignments are based on the PDCA methodology. Therefore, the PDCA approach permeates the structure of the course. Another important aspect is that participants learn from each other, and time is allocated during the course for socializing and exchange.

#### **4.1 Evaluation form – 3 phases**

There are three compulsory assignments, an oral presentation and one final report. The assignments are assessed as approved/not approved. All three assignments must be approved before the student can submit the final report, which is graded A-F. The content of the submission assignments should be based on issues from the student's workplace, if possible, with companies' current improvement projects or process-oriented change tasks.

First submission; a presentation of the company's management system and the description of an improvement project that will be completed during the course.

Second submission: a written plan for the improvement project based on the PDCA methodology.

Third submission: describe what has been done in the project. If the project has not started - build further on the implementation description.

Final report (exam): Based on the three assignments, the student writes an analytical and reflective report. In the text, course literature is references.

## **5 Method**

We worked with participants in the 2019 and 2020 courses. We investigated the students' exchange of knowledge from this course format and examination form. We also explored how students experienced working with an actual improvement project in the company where they work while they were in the process of completing the course. Finally, we asked whether the student project has, or will have, a (lasting) effect on the company. This was done through a web-based survey of all course participants who completed the course.

As the target group for our survey were students who had already completed the course and left the university, it was easy to contact them by e-mail with the questionnaire. There were 31 students from 2019 and 2020. As this group was small, we wanted to reach them all. Questionnaire surveys are a systematic method of obtaining data (Groves et al. 2004). Questionnaire surveys are a structured form of standardized questioning: all respondents are asked the same questions in the same way (Ringdal 2013). We chose to use "Nettskjema" as a tool, where the respondents are anonymous. The online tool has been developed and operated by the University of Oslo.

There were four areas we wanted to investigate. It was our objective to determine what the participating students thought about the course content, module structure, examination form, and how they experienced working with an improvement project in the workplace.

As it was not initially a question of testing existing theories, the questions were not linked to a theoretical frame of reference but directly to the four areas of investigation.

The questionnaire was semi-structured, which is a combination of pre-coded, graded, and open-ended questions. Pre-coded questions are questions with several stated answer alternatives (e.g., Johannessen et al. 2016). Some of our questions were designed so that it was possible to choose one or more answers, in addition to free-text answers. Several questions were statements, where the respondents scaled the extent to which they agreed or disagreed with the statement. We used a 7-point scale for the degree of agreement. There are differing opinions among researchers as to whether a neutral middle category should be included. Some believe that such a category is an invitation to the respondent to not really think through difficult questions (Jacobsen 2005). On the other hand, others have good experiences with neutral survey response options (Johannessen et al 2016). The 7-point scale used in the study included neutral response questions.

The questions in the form were divided into four parts. Part 1 covers the respondent's background. These questions were simple and neutral, which helps increase the respondent's motivation to complete the survey (Haraldsen 1999). Parts 2-4 included questions related to our four areas of interest. For brevity, the survey questions are not included here.

When the questionnaire was completed, we asked three people with relevant backgrounds, from outside the study group, to review the form and offer constructive feedback. This resulted in adjustments according to the scope and understanding of specific questions and word choices. We wanted the survey to take around 10 minutes to complete.

The questionnaire surveys were sent in May 2021 as a link by e-mail to all 31 participants. The e-mail addresses provided by students during the course were used. We had an initial deadline of 10 days. However, it became necessary to extend the deadline when we received few responses, and we further encouraged participation. This resulted in several responses, and we ended up with 14 usable surveys. This is a response rate of 45%, which is considered very good (e.g., Nulty 2008). As the answers are anonymous, we have not been able to carry out any deviation analysis of the 14 who responded. The respondents spent between seven and 14 minutes, in line with our goal.

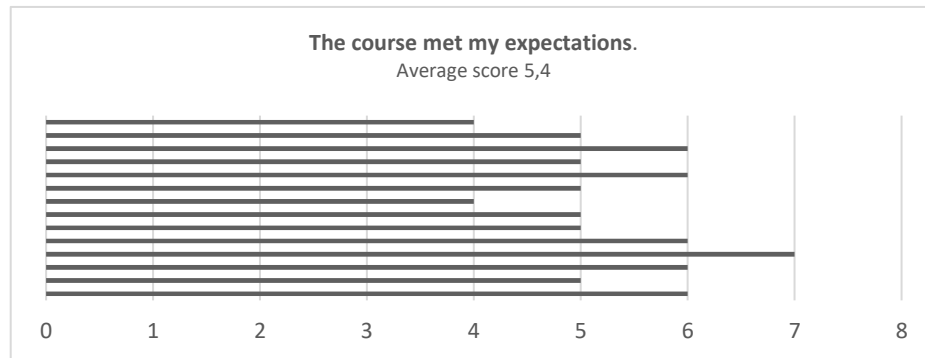
## 6 Findings

Of those who responded, 10 were women and four men. Five respondents were aged 50-59, eight were aged 40-49, and one was aged 30-39. Three of the four men had high school qualifications, and the fourth had a bachelor's degree. Four works in the private sector, others in the public sector, of which five in the health sector. Six works in a position as top manager/management team, one as a middle manager. Four works to a large extent with quality-related work, nine work to a lesser extent with quality and one did not work. Four worked for more than five years with quality-related work. Eight have worked 1--5 years with quality.

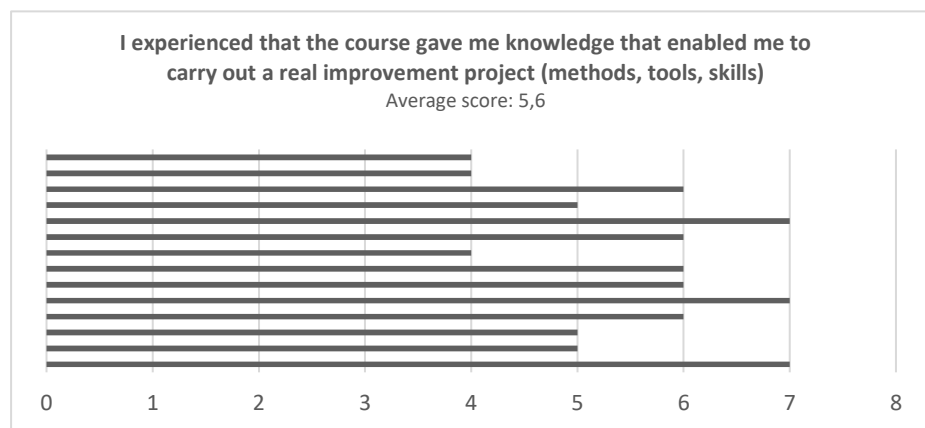
Regarding our first area of interest, what the students thought about the course content, we found that the course content is relevant concerning both expectations (see Figure 1) and that it enabled students to complete an improvement project (methods, tools, skills) at their job, see Figure 2. When asked whether the student can apply what they learned as soon as they returned to work, 12 out of 14 answered yes, and one does



not know. This indicates a relevant selection of principles and methods within quality management.



**Fig. 1.** How the course met the students' expectations. (1 indicates strongly disagree and 7 indicates strongly agree.)

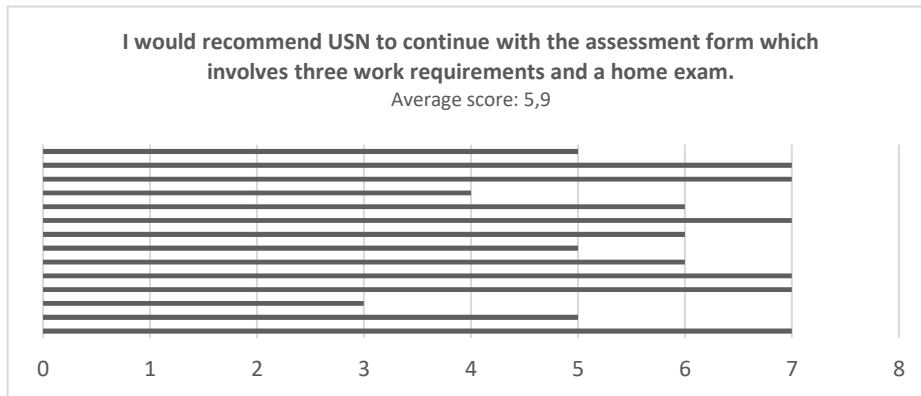


**Fig. 2.** The extent to which the course enabled students to carry out a real improvement project (methods, tools, skills). (1 indicates strongly disagree and 7 indicates strongly agree.)

In the second area of interest, what the students thought about the module structure, the responses were a bit more fragmented. However, most considered that both the workload and the time between sessions were good with an average of 4.8 on the 7-point scale (where value 1 indicates that the workload/time was too small/short and value 7 indicates that the workload /time was too large/long.) We interpret this to mean that the current module structure is a good model for students who are working.

Regarding our third area of interest, what the students thought about the examination form, 12 students preferred an assessment form with work requirements (assignments) and a home exam (final report), for two it did not matter (see Figure 3). For most

students, the form of assessment contributed to improvement work in the company, which we interpret as a positive effect.



**Fig. 3.** The extent to which students would recommend continuing with the assessment form of three work requirements and a home exam. (One strongly disagrees and seven strongly agree.)

Regarding the fourth area of interest, the students' experiences with working with an improvement project in the workplace to apply acquired knowledge, 10 out of 14 students had found it easy to identify a suitable project to work with at the workplace. Four had found it difficult. It is problematic for this course if students do not have the opportunity to work on an actual project. Of course, it is possible to participate in another student's project, but in practice, this is difficult due to logistics. On these occasions, students were able to solve the assignment more theoretically, but this was not ideal.

A comment from one of the students shows that the form of working with one project in parallel with the course was appreciated *"I think it was a great way to put theory and practice together in a gradual process."*

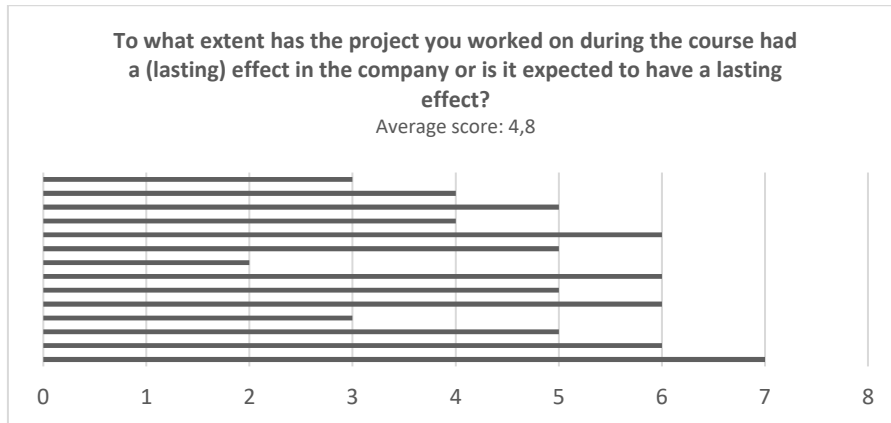
Twelve out of 14 students continued with other improvement tasks according to lean and PDCA thinking after completed the course. The students' projects influenced their workplace (see Figure 4), which we interpret as the course creating benefit for both the individual and employer.

Some comments that show how the students experienced the course and what the course contributed

*"I became more aware and also got tools for how not only I should carry the load but involve others and get this way of working into our [company] culture."*

*"The course helped the improvement project that was planned. It became more concrete and contributed to employees and managers showing interest. Also contributed to facts being obtained, this created the basis for the work further. Facts and involvement contributed to the project continuing."*

*"I would have worked on the improvement tasks anyway, but maybe in a slightly different way. I gained new knowledge and competence in the course, which meant that I adjusted for example my approach."*



**Fig. 4.** The extent to which the project worked on for this course had a (lasting) effect on the company. (One reflects a small effect and seven a large effect.)

## 7 Conclusion

We wanted to explore what students thought about the course content, module structure, examination form, and how they felt about working with an improvement project.

The answers we received clearly show that our selection of methods, techniques, and knowledge of implementation processes has been useful for the course participants. There may be methods and techniques unknown to us, and therefore not used during the course, which could enhance the value of the course. However, what we have chosen has been useful.

A modular structure with full-day collections and intermediate work steps applied to improvement projects in the workplace has worked well for participants who work in parallel with their course implementation.

The examination approach with three assignments and a grade-based final report with reflections and theoretical connections is an appreciated examination form.

Applying knowledge to an improvement project in the workplace has been appreciated. However, some participants were unable to gain access to projects in the workplace, which meant that they did theoretical assignments instead, which is not ideal.

It is our hope that knowledge from this study can be used by others who want to develop courses with an interactive structure and examination form.

To answer the heading question "Do as we learn, success or not?", we would like to say that it has been a success.

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