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Learning a Lean Way

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Abstract

“Learning a Lean Way” reflects on if and how students could improve their own learning by applying an A3 Problem-Solving approach. Results from three student groups are compared. The first group were students in chemistry in 2013 writing a mandatory assignment in a course in Total Quality Management applying an A3-template. The two other groups were students in Logistics 2017 and 2018, in a course “Production Management and Process Improvement”, who agreed to voluntarily apply the same A3 template. All students participated as groups with 2- 4 members.

Results, given by the students’ filled-in A3 formats and short interviews with some of the students in Logistics, all indicated that students have a quite clear understanding of what “good learning behavior” implies, but they do not seem to transcend this understanding into their own learning practices. Even though quality in higher education, and evaluation formats, have been extensively focused both in research and as political aims, very little research has focused on students own perceptions of how they could improve their learning. Could Lean-thinking-A3, with its process focus on process improvements contribute and make them become more aware of how they learn and improve their learning practices? Based on their filled in A3 templates and discussions with them, four important results appeared 1) Students were surprised of how unfamiliar they were with perceiving improved learning as a result of their own actions. 2) All groups of students included preparation, actively participation in lectures and afterwork, as well as not being tired, as “good learning behavior” 3) In their root-cause analysis students gave many similar explanations to why they didn’t act accordingly, bad planning, low priority, deficient study techniques and class atmosphere. 4) The students in Logistics were very reluctant to share experiences with their other classmates. Afterwards, students expressed that applying the problem-solving A3 had, to their surprise, heightened their awareness and understanding of how important own practices were to results achieved in studies. Small changes, they realized, were also important, like avoiding distractions. Students experienced some challenges which could be addressed to improve students’ learning in higher education.

1. Lean in Higher Education

Lean in higher education has received a growing attention. The network Lean Higher Education (LHE) 4), a worldwide (US, Europe, Australia) network, was established back in 2000. Conferences, communication blogs etc. have been initiated to exchange experiences and insights from higher educational institutions. Lean approaches at universities from the three continents USA, Europe and Australia have given remarkable results. Special focus has been on improving administrative processes in higher educational institutions such as the process of finance, library procedures, student accommodation, administering foreign student

applications or efforts of cultural change. Many projects have involved pupils, students and/or different groups of employees. Studies have shown how time-consuming and inefficient many administrative processes can be (Emiliani 2015). Great improvements can be achieved by applying Lean principles and focus on waste reduction (ibid).

Few studies have I found investigate how Lean principles could be applied in teaching and learning, with Bob Emiliani (2015) 5) as an exception. Attending the LHE-conference in Tromsø in November 2018 6), it turned out that none of the participants, or in their very widespread networks, were familiar with any Lean-projects to improve students' learning. Emiliani has departed from "identify and eliminate waste, unevenness and unreasonableness in academic processes and strive to achieve flow in all processes" (ibid). In teaching and learning, focus has been on Teaching Lean rather than Lean Teaching (ibid). All educational offerings containing Lean, emphasize the value of applying an A3.

1. A Problem-Solving A3

"A3 is a powerful tool. It establishes a concrete structure to implement PDCA management. It helps draw the report author(s) to the problem or opportunity, and it gives insight into how to address that problem" (Shook 2008) 7) Companies and organizations, private or public, customize A3s to a variety of situations and purposes: sharing documentations, product-improvements, process-improvements or in strategic planning (Richardson 2011) 8).

"The most fundamental use of the A3 is as a simple problem-solving tool. However, the underlying principles and practices can be applied in any organizational setting. Given that the first use of the A3 as a tool is to standardize a methodology to understand and respond to problems, A3s encourage root cause analysis, reveal processes, and represent goals and actions in a format that triggers conversation and learning" (Shook 2008) 9).

There are further many different types of Problem-Solving A3s and templates (Sobek & Smalley 2008, Shook 2008, Richardson 2011, Ballé 2011) 10,11,12,13), but they share central common characteristic: They are written on a single sheet of paper, in an A3 size. Background and goal are essential to be made explicit from the beginning. Then a gap-analysis, between current state and future state, is performed i.e., by presenting it as a Value Stream Mapping (VSM) chart. Then, departing from a few defined key performance indicators (KIP's) root-causes are analyzed. In analyzing root-causes an Ichikawa diagram (fishbone) or 5 Why could be used. Recognizing alternative root-causes opens up for a variety of countermeasure options and thereby getting a better understanding of the complexity of problem and causes. When detecting countermeasures to the root-causes, Michael Ballé (ibid) underlines the importance of presenting more than one solution to a root-cause: "Think of two or three distinct solutions to the same problem ... Distinct and valid solutions demonstrate that the problem space has been thoroughly understood and explored and make it easier for others to get on board with the proposed countermeasures." (Ballé ibid)

Then a few root-causes and attached countermeasures, are chosen for an implementation plan, outlined in a chart, containing the 5 W+1H, What to do, Why do it, How to do it, Where to do it, Who will do it and When will it be considered "done" or re-evaluated. Results are registered and followed up, deciding how to proceed by applying a PDCA-circle. A problem-

solving A3 follow a general structure and rely on charts and graphics to “tell the story” and gives a “language” for discussion to be shared.

According to John Shook (2008) 14), a problem-solving A3 has, at least, three essential objectives: 1) To heighten awareness of problem, process, solution 2) To structure knowledge and the process of problem solving 3) To make sharing possible through visual presentations. An A3 is a step towards “learning to learn” (ibid).

2. Lean-A3 to enhance students’ learning

«We spend 50 % of our time at school attending lectures. The learning outcome is not proportionate to the time spend in class.» 1) This was the problem addressed by the students in chemistry engineering when they, free of topic choice, decided this to be their problem addressed. Their overall aim was to “Take a lead in your own studies – become a superstudent!”. They focused on “How to maximize learning outcome from lectures” Their systematic approach followed an A3 template handed out to them by the teacher in the TQM-course (Wig 2009) 2). Following the template, they described their current state and gave an outline of the future state they intended to reach at the ending of the course in chemistry. Deciding on 5 Key Performance Indicators (KPI’s) and indicating their performance on a scale from 1-25 by self-registrations, their progress and goal could be given in numbers, and they continuously monitored their improvements, summing up results every four weeks. Their decided KPI’s were 1) being present in class, 2) having focus in class, 3) preparations, 4) afterwork and 5) attending class on time. As their summed up goal they agreed upon: “Everyone (in their group of four students) were to reach a minimum of a score of 20 out of possible 25 points” by the end of the course in chemistry. At their final exams, the students in chemistry slogan: “Improved process, improved results! (Emiliani 2003) 3)

I had been reluctant to ask students in Logistics, attending my Lean-course, to voluntarily participate in a project similar to the chemistry students’. They already had another mandatory assignment and exam to complete. My reluctance was due to a hesitation not to overburden them. But autumn 2017 and the following year, I asked my students if they recognized and had similar experiences from lectures as the problem the students in chemistry had addressed. All my students nodded and agreed, it was, for them, a well-known problem. To them, applying an A3, would not be embarking on a new theme, they were already familiar with the method and approaches in Lean-thinking from my course. Both years, 2017 and 2018, the students conceded to voluntarily participate, or at least try out an A3 to improve their learning. They chose to address “improved learning”, not just from lectures. They struggled with describing their current and future state as well as reaching a clearer understanding of what they were aiming at. The few groups, from both years, who found solutions to occurring challenges when applying A3 to own learning reported gained insights in how to improve their learning. Challenges they faced will be commented on below.

3. A3 material from the students

Meeting the students every week, in scheduled lecturings, they could all the time bring up with me questions or comments. Mid-term they gave me their preliminary A3s and at the semester-end they all handed me in their A3s.

In interviews, afterwards with some of the students in Logistics, 10 in students in 2017 and 8 students in 2018, I started by introducing them to questions I had prepared about their more general experiences, suggestions of improvements and would they agree to share their A3s with the other classmates.

They all allowed me to record the interview sessions. The interviews took place in a small room at the premises and lasted from $\frac{3}{4}$ - 1 hour. The interviews became a mix of focus groups and dialog between us. To the interview sessions, I had brought with me their own A3s. Many remembered their A3s with excusing smiles, but most importantly, they told me that when they saw their A3s they now recalled better where they had struggled and where they had been insecure – as well as what they thought it had gone well. Seeing their A3s again became to them very helpful to their recollections and aftermath reflections.

4. Students' Experience

Students' KPI's indicated what they perceived as "good learning behaviors". The students in Logistics decided on KPI's similar to the chemistry students. They all mentioned KPI's of learning activities before class, in class and after class. Preparations, being active during lectures by note-taking and participating in discussions, afterwork as well as not being tired, hungry, or thirsty. Lastly some focused on acquiring learning content by being up to date on syllabus, learning new concepts as well as being motivated, interested, and arriving on time/being present.

Reasons for not practicing these good behaviors were revealed in the root-causes they listed. Comparing the students in Chemistry with the students in Logistics, several similarities appeared also in their suggestions of root-causes. Low priority, bad planning, distractions (phone, scrolling on computers and small talk), class atmosphere and deficient study techniques, often appeared in their A3s, in addition not having learning materiel/equipment available. Being tired, thirsty/hungry and attending part-time jobs were also written down as root-causes for weaker learning behavior.

The students in Logistics gave much attention to low priority and being tired, hungry/thirsty. more detailed explanations why preparations were given low priority: laziness, yesterday's partying, disturbances at night (noice from outside) and their day-and-night rhythm. On being tired, students in Logistics elaborated it by writing Not enough sleep, having overslept, having partied too late, sleeping in wrong bed, visits at night and/or in bed, poor sleeping pattern, stress, noise, computer gaming and Netflix at night or attending late night concerts. Specifications of being hungry/thirsty as root-cause was due to not enough time for breakfast, time-schedule at school: too short brakes, poor economy not being able to buy food and drink at the cafeteria. One group in 2017 mentioned bad weather, transportation problems and seating in the classroom as reasons for not being present.

Except for deficient study techniques and class atmosphere, all these root-causes could be addressed and acted upon by every group mentioning them without strenuous efforts. In interviews students told me that the thinking process connected to reasoning about root-causes had been an eye-opener and, sometimes, not very pleasant to acknowledge. As eye-opener I was told that they never before had been aware of how much time they spend on distractions

and that they now knew they could implement not that demanding actions to improve their learning.

While the students in chemistry chose five root-causes to suggest countermeasures for and develop plans for improvements, the students in Logistics chose three. Their choices again revealed similarities between the student groups. Give priority, make a plan and stick to it, focus in lectures, get to bed in time, reduce hours at part-time jobs, and remove distractions. Readings before and after lectures were listed as countermeasures for lack of preparations and afterwork.

In their implementation plans, they were asked to argue why they had chosen the different countermeasures to follow up on, they presented more general arguments. Some had difficulties in giving a specified relationship between root-causes and countermeasures. Being more prepared was presented as to get a better understanding of learning content and be more attentive. Be prepared, read ahead, be prepared for class, or just prepare. Get increased outcome of lectures, being better prepared for exams, improve written hand-ins, being more focused and being able to enter master studies. A few were preoccupied about their future standings in the labor market; getting a great job, receive a good salary or be able to implement knowledge and competences in praxis. A couple of students also mentioned that enhanced learning could contribute to their sense of personal achievement. A few students had difficulties finding arguments for why improved learning could be valuable to them. They mentioned a variety of reasons. One student, on the contrary said, why should I improve I am happy with my grades!

Filling in the “what-column”, what would they do, most all students gave little detailed information in their A3 of how to proceed; read curriculum ahead of class, read more, read topic, read lecturing files. Only one student group in Logistics in 2018 made a detailed improvement plan showing what to do specified and linked to the next lecture. This group also made a detailed registration of their accomplishments from week to week, presented in a bar chart, just as the chemistry students had done in 2013.

All students, all three years, also focused “distractions” as reason for weaker learning behavior. As why was mentioned “to improve focus in lectures”, making time useful in class, be active in class or actively participate in class. Those who chose countermeasures to avoid distractions showed they could easily make changes by removing phones, not taking them up during lectures, putting them back in rucksacks or pockets, stop scrolling and focus attention to lectures. Several groups made plans for improving their sleeping pattern, not that difficult to be conscious about.

While chemistry students chose outside jobs as root-causes for weaker learning behavior, the students in Logistics were also aware of this challenge for their learning, but they did not address it as a separate root-cause to include in their implementation plans. Instead “jobs” were put as a root-cause for not reaching other KPI’s connected to priority and afterwork. In all students’ plans, every group member was made a responsible participator and the improvements plans would be implemented both at school, in lecturings, and/or at home. When they would stop and check, in a PDCA-circle, all students in Logistics presented very general and superficial comments setting a time-check.

In the follow-up section of the A3 the students in chemistry had a clear and systematic approach. They had chosen a scaling from 1-25 on a scorecard for every group member, self-registrations made every 4 weeks. In their follow-up registrations, few Logistic students made systematic self-registration of proceeding. Their scaling varied from 1-5 or 1-10 or 5-20, for individual members or for the whole group which could have made it more confusing to them what to register. Instead of self-registration of scores, they looked at their estimated improvement effects of their chosen countermeasures, given as percentages, but the students had difficulties linking estimated effects to their defined goal, percentage improvement of learning. A couple of groups in Logistics, both in 2017 and 2018, registered systematically on their chosen score-scaling in a bar chart.

The students in Logistics had decided to make self-registrations at very variable intervals ranging from “all the time” (give priority), “weekly” (preparations) or every specified weekday (remove distractions during lectures). Even though the students in chemistry had similar self-registrations from “all the time” (give priority to lectures), “every day”, “after agreements” (in the group) or “during lectures”, they proceeded with score registrations systematically. In their final A3, they presented as results their registrations from every four week. The results achieved by the students in Logistics were missing in their A3s.

5. Challenges when students are applying an A3 on learning

According to Lean-thinking (Liker & Meier 2006) 15), focus is on creating value for customers, but how are students to be perceived when they apply a problem-solving A3, perceived by themselves and by teachers and in academia? Whether students are perceived as customers, producers, co-producer or employees, applying a problem solving A3 by students shift focus of learning improvements to the learner, in contrast to what Grinfelde (2019) 16) found: “A majority of students refers to extrinsic motivators as defining factors that make them to invest effort in studies. Consequently, students are more critical regarding teachers’ performance than their own and do not always see a direct link between their efforts and study outcome.” Students become an actively participating party in reaching the intangible end product of education, competence, unique for each student. In line with Lean-thinking teachers become coach, or sensei. The “Respect for people” (Ballé 2015) 17) pillar in Lean becomes crucial in the reciprocal relationship between students and teachers. Here lies a cultural challenge to be addressed in academia (Fadnavis et al 2020) 18).

In Lean-research, surprisingly minor attention has been given to the “Respect for People” (Badurdeen, 2017) 19) pillar compared to studies of applications of tools and methods within Continuous Improvement. (Ballé 2014, Emiliani 2010, Cardon 2015, Netland 2016) 20,21,22,23). Further research may be required.

Moving from examples and case-texts in lectures to own life experiences was challenging for many students. Several times questions occurred, especially about goals and metrics. It appeared to me easier for them to conduct an Ishikawa diagram with KPIs and root-causes. Having had that experience in 2017, when the same problems reoccurred in autumn 2018, I suggested these students to start with that part of the A3. Flexibility when working on an A3 was recommended, moving back and forth. The templates are not strictly to be followed section by section.

Students also experienced challenges attaching metrics to learning goals, to grasp learning as a value stream, some remarked on their deficient study- or learning techniques, and addressing different overburdens and wastes connected to their learning. Contextual considerations are of crucial importance for students' learning. When Womack in "Gemba Walks" (2013) 24), he argues the need for understanding the context improvements are made in, possibilities, boundaries, and characteristics. The context, higher education, represents the frame of understanding students' problems. Were they asking the right question? Re-framing problems could give a deeper understanding of the problem addressed in its context. Framing and re-framing problems is discussed by Thomas Wedell-Wedellsborg (2020) 25) in his book "What's Your Problem? To Solve Your Toughest Problems, Change the Problems You Solve". Alternative interpretations of the problem could heighten students' comprehensions of learning.

In Lean-thinking it is emphasized the importance of being able to register whether or not improvements are achieved, therefore using metrics is recommended. Metrics enables tracking process proceedings and used as checkpoints towards reaching goals. Or in M. Ballé's (2015) 26) words: "what gets measured gets done!" Students expressed that they were very unfamiliar with thinking of improved learning as goals in metrics, except when they thought of grades – even though these are now in letters. Initially, many therefore wrote «an A» as their goal. To avoid metrics, others wrote «improve learning». Thinking in measurements and metrics required close coaching to all the students in Logistics. The lack of clearly defined metrics made it difficult for many to connect improvements effects to initial framed goals. Tracy Richardson (2014) 27) recommends to read an A3 first from left to right and then backwards, calling it "Reading in Reverse". This reading enables to discover cause and effect logic in the A3 back and forth. This recommendation could help students understand their A3's as continuously changing working material, which an A3 is when combined with PDCA.

Learning as a value stream

Two distinct problems occurred for students when trying to map their learning process as a Value Stream (Shook 2004) 28). In their final A3's "start and end point" varied from group to group, ranging from within a day from morning to bed-time to encompassing a whole course-span. Regardless of their choices, none of the students connected any learning activities to their value streams. In addition, describing a current and future state became for almost all of them such a de-motivating experience that we agreed to leave it unfinished. There has been "... little direct attention to the process of students' learning and the effect of teaching on it." (Entwistle et. al 2015:2) 29). Further research was needed.

Study- and Learning techniques

In both years, some students in Logistics wrote "deficient study techniques" as a root-cause to weaker learning outcome during class. They tried to increase their notetaking during lectures and to be more active by asking or answering questions when asked, but they did not quite succeed due to what they perceived as a non-inviting and judgmental class atmosphere.

Dunlosky (et al 2013) 30) has reviewed research on different learning techniques and their effectiveness. "Improving educational outcomes will require efforts on many fronts, but ... one part of a solution involves helping students to better regulate their learning through the use of effective learning techniques». As a motivational reason for their review they cited

McNamara 2010 (Dunlosky (ibid p. 46) “There is an overwhelming assumption in our educational system that the most important thing to deliver to students is content, ... teaching students content and critical-thinking skills, whereas less time is spent teaching students to develop effective techniques and strategies to guide learning”

Of the 10 learning techniques they reviewed chose to review, two learning techniques could be documented to have high utility: Practice testing (Self-testing or taking practice tests over to-be-learned material) and Distributed Practice (Implementing a schedule of practice that spreads out study activities over time). Utility was defined to what extent the techniques contributed to “Cued recall, Free recall, Recognition, Problem Solving, Argument Development, Essay Writing, Creation of Portfolios, Achievement Tests, Classroom Quizzes” (Dunlosky et al ibid p. 6 Table 2). Getting a better understanding of learning-techniques with high utility could help students give more detailed suggestions in their accomplishment plans.

Practice Testing could also be advantageous for teachers “... teachers could also incorporate some of them into their lesson plans. For instance, when beginning a new section of a unit, a teacher could begin with a practice test (with feedback) on the most important ideas from the previous section” (ibid p. 46). Both in 2017 and in 2018 students wrote assignments analyzing possible improvements in a chosen company based on, in addition to participating in Kahoots to recall and tune in on the course agenda. Both of these students found valuable.

PDCA-plans, more consciously implemented, was a challenge experienced by all students in Logistics. Again, perceiving A3 as a working document was needed.

6. Concluding remarks

From all three groups of students, it appeared that they knew very well what good learning behavior implied. Initially they were less preponed to act accordingly as students. Compared to the three essential objectives in an A3 implementation, according to Shook (2008) 31), all students confirmed that applying A3 had been an eyeopener realizing how their own conduct influenced their learning. They had gained heightened awareness of problem, process, solution. To structure knowledge and the process of problem solving, students in Logistics, could improve. Only a few groups systematically followed up their plan, in contrast to the students in Chemistry. On sharing through visual presentations Shook (ibid), none of the students in Logistics were willing to share with other classmates outside their group. This was the case both in 2017 and in 2018. This view was partly due to the perceived class atmosphere. Students who managed to fulfil their projects were quite pleased with themselves and valuated A3 as being both helpful to their learning and an awakening call. In interviews they underlined how surprised they had become acknowledging the importance of their own contribution to reach increased learning and how much time they spend on non-educational activities, distractions as phone and computer scrolling. An A3 is both a method, a tool and focus on improvements as a thinking process for all those implied, students as process owner and teachers as coaches (Ballé 2019) 32).

The similarities between the three student groups on KPI's, root-causes and countermeasures could seem to be used as a departing for a questionnaire and statistical analysis, but then a most vital point when using an A3 would be lost: the thinking process. Some students said

with a smile that they had cherished participating, making use of the A3 and “learned a lot”. Participating had enhanced their thinking about good and weaker learning behaviors.

It is not possible to link the students’ use of the A3 to their final grades. Although, final grades for the students in Logistic, both on their mandatory assignments on their written exams were very good. The students in Chemistry received “excellent” as grade both in the TQM-course where they had developed their A3 but also in the chemistry course they wanted to improve learning outcome from lectures.

Finally, flexibility, PDCA-focus, learning-techniques could all contribute to improved benefits from applying A3 by students. An A3 approach could contribute to new perspectives on how to achieve heightened quality in higher education. As Emiliani wrote (2015) 33) Lean is Learning – both for students and teachers!

Appendix:

The Chemistry Students A3 (2013), filled in. The same template used by the students in Logistics.

Take a lead in your studies – become a superstudent!
 “How to maximize outcome from lectures?”

Problem description and KPI

Learning outcomes are essential for students, but:

- 50% of a university day is spent in lecturing rooms and
- Learning outcome does not cohere with time spend listening
- Key Indicators: attendance, focus during lectures, preparations, relection / study afterwards + appearing on-time

Aim / Target

Everybody shall acheive a minimum of 20 points out of a total of 25

All group members are to attend all lectures. appear on-time, being prepared at all times and being alert and focused during the lectures.

Everybody commit themselves to work on tasks and reflection notes afterwards.

Present situation

Nåstatus	Oppnåtte	Fokus	Forarbeid	Etterarbeid	Møte tidsnok	Totalt
Eirin	2	3	1	1	5	12
Hege	3	3	1	1	5	13
Helene	4	3	1	1	2	11
Iris	5	4	2	1	5	17
Rosmari	2	2	1	3	3	11

Total

STUDENTS:
 Eirin Emma Lønningdal, Hege Skjøldal, Helene Rossi Axelsen,
 Iris Renate T. Krokvik, Rosmari Valdersnes
 Dato: 17.09.12 - 04.11.12

Analysis: Root Causes

Countermeasures

PDCA	Hva	Hvortil	Hvordan	Hvem	Hvor	Når
DO	Fjerne distraksjoner fra pulten	Forbedre fokus i forelesning	La mobilene ligge i sekken	Alle gruppedlemmer	På skolen	forelesninger
	Prioritere forelesninger	Øke læringsutbytte	Møte opp	Alle, spesielt Rosmari	Over alt	Hele tiden
	Forberedelse	Forbedre forståelse i forelesning	Les aktuelle forelesningsnotater	Alle gruppedlemmer	Hjemme eller på skolen	Når dette er satt av tid til
	Legge seg tidsnok	For å bli mer opplagt	Forbedre kveldsvaner	Alle gruppedlemmer	Hjemme	Hver dag
	Sette av tid til skole	Øke læringsutbytte	Betere planlegging	Alle gruppedlemmer	Over alt	Hver dag
	Kutte antall arbeidstimer (jobb)	Få mer tid og energi til skole	Jobbe mindre etter samtale med arbeidsgiver	Eirin og Helene	På jobb	Etter avtale

Follow-up Plan

- Measure attendance on-time + perform self-evaluation each day
- Status meeting after 4 weeks and at ending of semester

RESULTS

Totaloversikt – Total score:

Everybody reached the goal of min 20 points!

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