

Lean Software Design, Lean Education? Lessons from a Collaborative University-Industry Seminar

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1 INTRODUCTION AND RELATED WORK

Software engineering as a field of practice has evolved to such maturity level that the industry is creatively adopting new trends and approaches. Especially since the agile manifesto was launched in early 2001 [6], companies have actively pursued for the ideal production process to achieve top quality, actively trialling different existing methods and tools and developing their own practices. To name a few, just over a decade or so we have witnessed the spread of concepts like extreme programming (XP), test-driven development (TDD), and user experience (UX).

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In such rapidly developing field, what is taught at the universities can fall behind from what is the status quo in the industry [2]. Both the engineering students and the companies hiring them demand for concrete know-how of the methods and tools that are currently topical. This creates a fundamental challenge for universities' curriculum planning. Our work was driven by the question "how to follow the rapidly developing and very diverse practices in the industry in order to educate professionals with concrete and currently relevant knowledge and skills?" At the same time, how to ensure that also more general scientific skills like critical thinking, scientific practice, and creative problem solving remain in the curriculum? This paper addresses these very gaps and presents a case study of collaborative teaching between university and industry, focusing on learning from the practices in the industry and authentic project context.

A study on engineers' own perceptions on needed skills of engineers working in industry [1] suggests that the learning experiences should (1) include problem solving and be based on team work, (2) integrate technical and communication skills, and (3) include the constraints based on business, like time and budget. The authors recommend that implementation projects are suitable for this purpose. To be effective, these projects need to be authentic, the client needs to be involved, they need to be complex, and the evaluation strategies need to be efficient [1].

As a result, hackathons, code camps and other hands-on events have become increasingly common and successful in involving students in realistic projects. These activities, however, focus on technical development activities (e.g., software architecture, implementation, testing). Considering the design of user-centric aspects and user experience (UX), similar events and activities do not exist in large scale. The approach and practical case we present here explores a way to provide design students with learning experiences in an authentic context, with a real customer case, and guidance given by practitioners.

1.1 The emergence of Lean

One of the most recent paradigmatic production process innovations relates to the Lean philosophy [4,8] and Design Thinking [3]. Lean is all about optimizing the production process, which often means *removing waste* (i.e., unnecessary tasks or deliverables) and focusing on identifying *the right product* as early as possible [4,8]. This calls for, for example, development of rapid prototypes that can help validating (i.e., assessing goodness of) the envisioned solution with minimal production cost.

While Lean thinking originates from manufacturing industry with quite different production processes, also the software industry has readily welcomed this philosophy. As software processes are largely dictated by people's ways of working and collaborating—rather than the production environment and equipment—various enterprise-specific applications of the general principles have rapidly evolved.

Emphasizing the importance of identifying the *right product* means that UX design is increasingly important in modern software production. The customer's and end users' problems and realities must be properly understood to allow for designing relevant and effective solutions. However, as the problems that are solved with software are getting increasingly complex, it can be hard to envision the most suitable solutions upfront and validate them early. This has resulted in concepts like *minimum viable product* [4] where the aim is to identify the product's most critical features that need to be demonstrated—and validated—before rushing into implementation of the entire envisioned product. Furthermore, as the competition in the software business is

constantly getting tougher, the companies need to excel in terms of usability and UX. All this requires plenty of design insight as well as inter-disciplinary talent.

1.2 Educating Lean philosophy in UX Design

The skills emphasized in Lean software production include, e.g, fluent interaction with the customer, empathizing with the end users, creatively solving ill-defined problems, defining the optimal project scope for the particular case, as well as a trial-and-error mind-set [4,10]. It is important for the UX professionals to be able to rapidly produce and iterate on designs as well as work according to the current project context (not only the schedule and budget but also, e.g., the customers' business goals, end users' desires, and the particularities of the intended context of use).

Interestingly, many of the aforementioned skills are so called meta-skills, which engineering schools struggle to fit in the curricula [2]. What is problematic for the education of such meta-skills is that it requires project work in authentic environments, as also often underlined in problem-based learning (PLB) [9]. Educating ideologies like Lean can easily remain as preaching—i.e., talking about general principles—as it is hard to provide authentic cases and hands-on experiences at universities. Even if real-life problems were provided, there may be lack of real customer contact and feedback, the resource related constraints might be missing, and authentic methods used in the industry might not be used; rather, scientific rigour and methods are applied. Teaching such “soft aspects” of software engineering still lacks expertise in terms of the contemporary methods used in the companies as well as new approaches to expose the students to such issues. Traditional PBL approaches, including aspects of collaboration, self-assessment, self-directed projects, and so on, provide only a partial solution to this pedagogic challenge. What is additionally needed is true customership and concrete methods and tools utilized in day-to-day operations in software production, particularly w.r.t. design activities. Collaborating with the industry has been argued as a fruitful approach [5,7,11] but example cases particularly from UX viewpoint are scarce.

This paper presents our pedagogical trial where an intensive UX design seminar (called *Design Weekend*) was organized in close collaboration with a renowned digital agency and a realistic customer organization. The design weekend applied a design methodology developed by the digital agency in an authentic case for the customer organization. We describe the implementation of the seminar, followed by analysis of the didactics-related experiences from both the students and the organizers. The paper concludes with lessons learned and discussion of the benefits, drawbacks and practicality of the presented teaching approach.

2 CASE STUDY: DESIGN WEEKEND ON LEAN UX

Design Weekend was an intensive 2-day hands-on seminar—or rather a *workshop*—in which five groups of 3-4 students closely followed a particular Lean methodology that the collaborating digital agency (**anonymized**) has iteratively developed over the last two years.

2.1 Goals

The goals of the seminar were (1) to provide a possibility for more practical and hands-on learning of Lean and Design Thinking, including a customer organization with an authentic case (e.g. existing business need and target users), and (2) to explore how well this kind of industry-oriented approach would fit in the curriculum of master and doctoral programs on UX. Furthermore, we expected to, in the long run, increase the

students' market value in the highly competitive job market. The main approach was to provide our students with a learning experience that includes both a highly tailored design process used in the industry, a true customer with a concrete but broad problem, and needs for the increasingly important meta-skills in practical project work.

2.2 Collaborators

The collaborating company was selected because of their highly tailored lean design methodology and agile production practices. The company (**anonymized for review**) is an international consultancy providing design and SW development services as well as analytics & business consultancy for digital products and services.

The customer organization was selected based on a call for participation sent to various non-governmental organizations (NGO). To avoid problems with respect to the digital agency's business relations and intellectual properties of the solutions, we considered it better to select a new case organization than to focus on one of the digital agency's existing customers. In the end, the customer organization was a non-profit child rights NGO (**anonymized**), which allowed both the company and the students to do something good on a societal level. This NGO was selected because of their genuine need for a digital solution for one of their business problems and because of their possibility to contribute to the workshop. For the focused problems no digital solutions existed, which made the case particularly interesting for *digitalization* and utilizing computational solutions instead of costly human-facilitated solutions.

For the digital agency, the motivation to closely collaborate in the seminar related to increased visibility amongst students, recruitment opportunities, and general good will by sharing their professional expertise with the next generation.

2.3 Pedagogical approaches

The seminar was intended for final-year Master students and Doctoral students; the students already had a strong background in the general methodology of user-centered software development. The participants consisted of altogether 23 students of user experience with rather diverse backgrounds: 12 males & 11 females, 19 with engineering background (several disciplines) and 4 from design schools, 14 different nationalities. The students were grouped in 5 groups by the university teachers, aiming to form as diverse as possible groups and to avoid the traditional friendship-based group formation for further authenticity.

In practice, the student groups ran through an intensive process that included problem definition, brainstorming, service concepting and sketching, concept evaluation, and finally presentations by the groups in an informal setting. A central aspect of authenticity included running the seminar in the company premises instead of at the university. Furthermore, to add further motivation and create positive competition between the student groups, the group with the best concept were promised a fast track for job interviews and a possibility to continue the collaboration through an open-source development program coordinated by the digital agency.

2.4 Workshop procedure

The total workshop duration was 13 hours, split into two days and four main phases. The target of the first phase was to get familiar with Lean Service Creation (LSC) method and the customer's needs and to produce concept ideas based on those. In the next phase, the concept ideas were validated with the customer's representatives. This was followed by the groups selecting one of their concept ideas and developing it

into concrete designs of user experience, interactions and visuals. Finally, the students presented their resulted designs to the other groups and the customer representatives.

LSC is a multi-disciplinary way of working that is intended to maximize the probability of creating successful digital services. It combines Lean Startup, Agile SW Development and Design Thinking practices into an iterative process of gathering customer and end user insights and ideating based on them, building concrete UI mockups and interactive prototypes, validating the features needed for the MVP, measuring the success of the MVP through analytics and UX methodology, and using all the gathered data to create new insight.

The workshop started with an introduction to the basic principles of LSC, which are: (1) Find a problem worth solving, (2) Love the problem, not the solution, (3) Get out of the building, (4) Build, measure, learn.

In order to teach the LSC methods to their clients, the collaborating company has created a set of workshop posters to serve as concrete playgrounds of collaborative work. The posters are meant as a comprehensive and structured design process for creating successful digital services. The entity is modular, allowing the process to be tailored according to the case. No other deliverables or documentation should be needed. The detailed topics focused on in the posters include (the ones used in this seminar are marked with an asterisk):

- Business goals and project limitations (e.g., security, budget, schedule) *
- Immersion into the domain (customers/end users, competitors, potential market disruptors, etc.) *
- Customer/user segmentation *
- Customer/user insights
- Idea creation *
- Concepting *
- Creating value propositions () *
- Creating material for validating the concepts with end users (e.g., fake advertisements) *
- Considering the business model and market size
- Defining the MVP features
- Creating a measurement plan

Only selected parts of this poster set were used in the Design Weekend workshop, because the intention was to get to concrete designs during the two days. Each workshop section started with an introduction to one or two of the posters and then the participants collaborated around each poster for 15-30 minutes.

The Design Weekend started with the customer's representatives giving a presentation about their needs and realities. After this and plenty of questions from the students, the groups focused on the Business goals and limitations and Segmentation posters. This was followed by a poster on Ideation. For each concept idea, they filled Concept a sheet and created Value propositions. Finally, the 1st workshop day ended by sketching Fake advertisements to present the concepts.

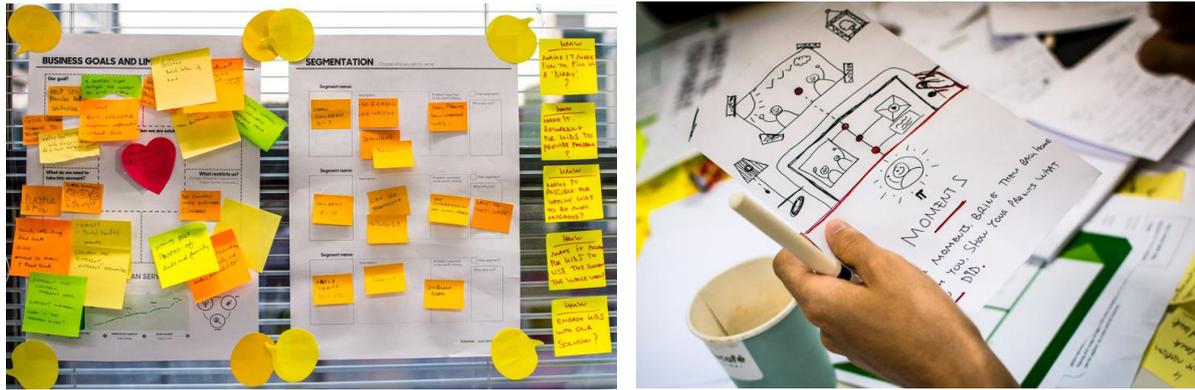


Fig. 1. Left: an example of one group's canvases about *business goals and limitations* and *segmentation*. Right: an example of an early-phase service concept.

On the 2nd day, the workshop started by planning for Solution interview. During the solution interview, groups presented their fake advertisements to one of the two customer representatives and had a chance to ask further questions about the target user group and their needs. Based on the interview results, the groups listed the main use cases of their application concept, drew navigation map and sketched wireframes for the main use cases. Some of the groups also proceeded into creating visuals for the screens and even into creating an interactive prototype.

At the end of the second day, each group gave a final presentation about one of their solutions for a specific type of target users. Based on the final presentations, a jury—consisting of the two customer representatives, three experts from the collaborating company and one from the organizing university—gave feedback on each concept and selected the winning concept. After the presentations, a quick retrospect of the two days was organized, resulting in feedback about the overall methodology, the given case and various practicalities.

3 RESULTS

We report the didactics-related experiences from the seminar from several viewpoints: the students' subjective learning experiences, the teachers' subjective perceptions of educativeness, and the participating companies' experiences of the quality of the process and outcomes. To gain insight of the students' experiences, we analysed 18 students' learning diaries, 10 answers to a voluntary course feedback survey, and the notes from a retrospect session in the end of the seminar. The following sections combine the different sources of data and viewpoints into one report with various themes.

3.1 Positive experiences of the seminar

All in all, the Design Weekend was considered to have been very useful and educational. In the voluntary survey (N=10) there were two summarizing questions. "Overall grade for the course?" was rated with a Mean of 4.0 and Median of 4.5 (scale 1-5, standard deviation 1.12). "How well did the course address the learning goals?" received a Mean of 4.0 and Median of 4.0 (SD 1.05).

More importantly, the learning diaries contained very insightful reflections on the methodology itself, which is a strong indicator of in-depth learning. Many of the intended pedagogic aspects received positive feedback from most students: doing hands-on project work, involvement of a real customer with a real need, authenticity in terms of methodology and project context and timeline, working in groups with diverse

backgrounds, and mentoring by practitioners in the field. In the following we provide further viewpoints into these and other learning experiences. The presented quotes are verbatim from the students' learning diaries or the feedback survey.

"[Design weekend] showed me a concrete way to use Lean UX"

"I was so thrilled that the whole event was more than what I expected"

Following a company-developed methodology was highlighted in the students' expectations about the seminar. However, what was experienced even more important in the end was having a real customer actively involved. All the students had prior experience of doing project work for a company case. However, the fact that the customer organization was actively involved and presented a real and urgent problem seemed to add to the motivation of the students. In fact, as teachers we had never seen students as focused and willing to make notes by hand as they were during the problem introduction by the customer organization. Active involvement of the stakeholders seemed to allow for better consensus early on and help avoid going back and forth later in the process.

"Chance to interview social workers was very useful"

"I think organizing these kinds of design exercises is a nice way to connect students, researchers and company people to work on the shared problems."

"Working on a real life case instead of the usual imaginary scenario was very interesting."

Following a contemporary methodology under time pressure was found very interesting and motivating, although it was also a source of bewilderment. Designing a service in less than two days was seen to provide a fresh perspective compared to the earlier courses in their study programmes.

"The Design Weekend taught me about working on a fast pace mode and to get from A to Z in a very short span of time"

"I was really pleasantly surprised how much a concept or a design can change just in a few hours, from zero to hero almost. Amazing!"

"The method really pushes towards making rapid designs and evaluating [them] early"

As a positive sign of impact, the seminar also resulted in a follow-up thesis project for one of the students and a charity project by the agency for the customer company.

3.2 Perceived Learnings

Looking in more detail into the *lessons learned* that the students highlighted in their learning diaries, we can see three broad themes.

First, the general principles of Lean and Design thinking that were emphasized in the methodology were also highlighted in the diaries. They contained insightful reflections of phrases like "love the problem, not the solution", "get in the field" (importance of gathering truthful user insight in authentic settings), and "kill your darlings" (be ready to drastically change direction and not stick to the first solutions that come to mind). The students also highlighted the importance of simplicity in design, questioning presumptions, and doing sketching work to advance thinking. While these were not surprising to see in the diaries, it was interesting to hear insightful interpretations of the phrases and verbalized in different ways.

"I decided instead of trying to show a 'brilliant' poster, show simple and understandable poster. In the end, customer liked it, moreover understood our concept. I made sure again that 'make it simple' was one of the best advice given to me."

“However, uplifting it to show off a nice UI, it isn’t worth anything if it doesn’t solve the client’s problem”

“It is so refreshing for our brains to take a step back, get a broader view and see different aspects of the given case, identify the root cause of a problem. Instead of sewing patches onto an existing system to solve an issue, maybe there is an unexpected way of removing the problem altogether.”

In addition to such principle-level aspects, many highlighted the goodness of specific methods and cleverly reflected on the phases of the process (e.g., considering the business goals and gaining new viewpoints to idea creation). However, a detailed account of such is left out from this paper as the focus is not assessing the given methodology per se.

Overall, we can argue that the ideology behind the methodology, as well as Lean thinking in general, was very well understood. Given the strong focus on doing hands-on design work, the abstract thinking behind the practical tools seemed to have been well internalized.

Second, considering collaboration and team work skills, the learning diaries highlighted (1) the general importance and pleasure of team work, (2) need for constant discussion and empathy skills in trying to achieve consensus and manage disagreements, and (3) particularly the significance of having a suitable combination of skills and personalities. Compared to many traditional PBL cases, here the active involvement of the stakeholders as well as the very tight timeframe forced the groups to make rapid decisions and avoid conflicts that could freeze the collaboration in traditional processes. Furthermore, involving the whole design group in all activities—rather than working in parallel—was found very useful to reach a solution that everybody agrees with and is willing to work for (i.e., internal buy-in).

“Oh boy, you are really getting to know the people you are working with”

“[Design weekend] also created an atmosphere where everyone gets to share their opinions and share their knowledge”

“I have learned that lean development makes the team members collaborate more often and share more ideas with each other”

Finally, the third cluster in the findings relates to self-knowledge. The diaries not only demonstrated good command of the substance but also showed students’ perceptions of their own strengths and weaknesses, emotional challenges in design work as well as in receiving feedback, and one’s professional profile and role in team work. It seemed that some could better envision their professional profile in the future and that some could learn something about themselves in ways that could not have been possible in project work at the university. In addition, some made insightful reflections of the methodology w.r.t. earlier learned methodologies and processes.

“I wanted to make every element of our presentation to be handled with the greatest care. By doing so I was too busy focusing on the little details [...] this minor setback taught me something about teamwork and myself.”

“The design weekend showed once again that my role in team is quite often to be the person who slightly guides the ideation to keep it on track and to make sure that we stick to the schedule.”

“As any process that happens fast, emotions are expected to rush (and this was a myriad of them), rapidly switching between one and other. I think that was one of the biggest challenges to overcome.”

3.3 Reflections on the seminar and applicability of the taught methodology

While the previous sections have focused on the positive elements of Design Weekend, the students also presented relevant and constructive critique, which further consolidates the didactic value of the seminar.

Some of the perceived weaknesses of the seminar included having too little time for thinking and discussing, missing important aspects (like getting to know the real users), receiving too little feedback during the hectic process, and lack of seeing the big picture because the design process was introduced in a step-by-step fashion. Many felt that the methodology belittles user research and too stiffly schedules the process, easily leading to less iteration. These caused some frustration and sense of insecurity in making design decisions. Unfortunate from the teachers' viewpoint, there wasn't much interaction between the groups, again due to the schedule, and the teams seemed to be competing with each other rather than collaborating.

"It was slightly confusing to keep on working without knowing what's going to happen next and what [maturity level] of a concept we are supposed to create. Everything just happened one at a time"

As for the applicability of the methodology, the diaries brought out clever viewpoints. For example, several doubted that the methodology would not be the practically feasible in large projects or organizations as it expects such intensive and continuous collaboration. One student was particularly interested in the prerequisites for using this methodology, considering, e.g., if the process could be started with an old concept to improve its UX, and if and how this could be used together with Scrum or other Agile process for the development phase. A common question was how to actually involve the developers and other roles in this kind of design process. Some also questioned how to apply such lean methods in groups that are spatially divided.

"Lean can work well only when UX experts start to work early in the process"

"It does not give tools for designing for special groups of users, fundamentally it seems to aim for 'mass market' products"

"I think it would be interesting to think about planning scientific UX research from a similar methodological viewpoint"

4 DISCUSSION AND CONCLUSIONS

We presented an extensive analysis of students' learning experiences of a novel collaborative hands-on Lean software design seminar. We explored how a traditional problem-based learning in project work could be further developed into more collaborative, authentic and industry-driven work so that it would effectively teach the meta-skills necessary for a user experience professional.

Based on the data and the teachers' and company representatives' observations, we conclude that the seminar was generally successful and reached the set pedagogical goals. In the learning diaries, the students brought out positive as well as negative aspects of the used methodology and shared clever insights about their learnings and, e.g., the applicability of the applied methodology. The data highlighted particularly lessons related to meta-skills like group working, customer involvement and personal growth. For students a valuable experience is to identify and reflect on own strengths and weaknesses; it helps build the professional identity as well as gain an understanding of personal development needs.

Also considering the balancing issue between educating currently relevant skills and the more abstract thinking skills, we argue that the Design Weekend was successful. Compared to traditional PBL and project work at universities, the added benefits of the Design Weekend were the active and self-motivated involvement of the customer and authenticity in terms of schedule, context and methodology. Furthermore, from a teacher's viewpoint a crucial element was the learning diary: while it is not a new invention in pedagogics, it clearly encouraged thinking and thus enriched learning. Post-hoc reflection of what happened, why, and what was learned seems to be crucial for learning especially in such fast-paced events.

Although the seminar was generally a successful exploration, we must remember that this was only one case study. The data does not allow generalizable conclusions, which neither was the intention. In contrast, our objective was to provide a qualitative analysis of the kinds of learning experiences that took place here in order to help planning more relevant and effective university teaching.

Furthermore, it is important to remember the fundamental premises for running this kind of events. First, considering the timing of such studies in the curricula, the students need quite solid skills about different methods and processes in human-centered design before they can be made "Lean". Our decision of targeting the seminar for 2nd-3rd year Master students and doctoral students seemed like a good choice. Second, a central requirement of utilizing this approach is that there are companies that are willing and have the time to collaborate. If one is applying a methodology created by a company, they need to have a structured enough design process to apply. Organizing the workshop was smooth in this case as the company had arranged similar types of events before, focusing on SW development. However, if the company was less experienced the lecturers would most likely need to take more responsibility in the planning and goal setting.

We want to highlight two aspects as something to reconsider in the future implementations of similar workshops. First, time was highly constraining factor in this implementation. On the one hand, fast working pace is part of the lean approach but, on the other hand, it may be challenging for the students to manage learning a completely new approach and at the same time focus on solving the customer's problem in an effective way. Adding an extra day and perhaps also more mentoring of the students could give more confidence in the learning process. The balancing between authenticity of the case (fast pace, independence) and the possibilities for learning (time for reflection, mentoring) needs to be carefully considered case by case. Second, unfortunately, it was impossible for the students to meet the end-users due to the time constraint of the implementation and nature of the case. This would be highly beneficial to be included in the future implementations. This may mean that the implementation needs to be divided in two separate sessions, e.g., two weekends a few weeks apart.

All in all, based on this case study and subjective evaluations of the seminar, our teaching approach with authentic cases, methodology, and scheduling and active involvement of stakeholders can be concluded to show much promise. We are planning to continue exploring this collaborative approach in the teaching to gather more insight about its benefits and drawbacks as well as long-term appropriateness.

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