How to Fill the Gap between Practice and Higher Education: Performing eduScrum with Real World Problems in Virtual Distance Teaching

Michael Neumann
Dpt. of Business Information Systems
Hochschule Hannover
Hannover, Germany
michael.neumann@hs-hannover.de

David Mötefindt
Software Development
AWIN AG
Hannover, Germany
david.moetefindt@awin.com

Lukas Linke
Customer Management Tech
Otto GmbH & Co KG.
Hamburg, Germany
lukas.linke@otto.de

Dirk Radtke
Agile Processes
Otto GmbH & Co KG.
Hamburg, Germany
dirk.radtke2@otto.de

Annika Mattstädt
Agile Processes
Otto GmbH & Co KG.
Hamburg, Germany
annika.mattstaedt@otto.de

Frederik Herzig
HR Management
Otto GmbH & Co KG.
Hamburg, Germany
frederik.herzig@otto.de

Patricia Regel
Advertising Services
Otto GmbH & Co KG.
Hamburg, Germany
patricia.regel@otto.de

***Abstract*—Social skills are essential for a successful understanding of agile methods in software development. Several studies highlight the opportunities and advantages of integrating real-world projects and problems while collaborating with companies into higher education using agile methods. This integration comes with several opportunities and advantages for both the students and the company. The students are able to interact with real-world software development teams, analyze and understand their challenges and identify possible measures to tackle them. However, the integration of real-world problems and companies is complex and may come with a high effort in terms of coordination and preparation of the course. The challenges related to the interaction and communication with students are increased by virtual distance teaching during the Covid-19 pandemic as direct contact with students is missing. Also, we do not know how problem-based learning in virtual distance teaching is valued by the students. This paper presents our adapted eduScrum approach and learning outcome of integrating experiments with real-world software development teams from two companies into a Master of Science course organized in virtual distance teaching. The evaluation shows that students value analyzing real-world problems using agile methods. They highlight the interaction with real-world software development teams. Also, the students appreciate the organization of the course using an iterative approach with eduScrum. Based on our findings, we present four recommendations for the integration of agile methods and real world problems into higher education in virtual distance teaching settings. The results of our paper contribute to the practitioner and researcher/lecturer community, as we provide valuable insights how to fill the gap between practice and higher education in virtual distance settings.**

***Index Terms*—Agile methods, agile education, eduscrum, distance learning, virtual distance teaching, problem based learning, Covid-19.**

I. Introduction

This paper describes the integration from real world problems provided by companies (clients) into the Master of Science course ”Innovative Methods of Project Management” during the Covid-19 pandemic and related distance teaching activities. A central purpose of the course is to integrate challenges and problems from the real world. We prepared, organized and conducted the course with an adapted eduScrum method and integrated real world clients since the summer term in 2019.

Agile and hybrid methods are well-known approaches in software development for more than two decades [1]. The use of agile methods like Scrum is widely accepted in practice [2] and education [3]. Agile methods focus on social aspects like collaboration and communication [4]. Thus, (social) values and principles are of high importance in the field of agile software development. The widely use of agile methods in practice led to an increased integration into higher education over the years [5], [6]. Also, the combination of software processes with the integration of real world problems or project based approaches is often described by other authors (e.g., [7]–[10]). Agile methods were adapted for their use in educational settings by several lecturers (e.g., [11]–[16]). Especially, the focus on social aspects and teaching such skills is of high importance in higher education [17].

The Covid-19 pandemic and the switch to virtual distance teaching provides several challenges for lecturers and students in higher education (e.g., [18]–[20]). Especially, project related courses in lab settings may be affected from the switch, but also most of the courses, which comprises physical activities such as game based learning approaches were influenced (e.g., Lego Serious Play [21]). In 2019, we adapted the eduScrum method for higher educational settings in an onsite environment and integrated real world clients to the course [22]. Thus, the new situation also provides several challenges to us as our course organization set-up was initially designed for onsite

 ISBN: 978-1-61208-997-3

teaching. This leads us to our two research questions:

- **RQ1:** How can we perform eduScrum integrating real world problems in higher education in a virtual distance teaching environment?
- **RQ2:** How do the students value the work with eduScrum in a virtual distance teaching environment?

This paper focuses on our adaptions during the Covid-19 pandemic and how we counteract the challenges of distance learning. However, we identified several upcoming challenges related to the new circumstances occurred due to the pandemic. We present four recommendations for other lecturers, which are interested to overcome specific challenges in nowadays higher education and integrate agile methods as well as real world problems to their courses.

The paper at hand is structured as follows: First, we describe the related work in Section II, followed by the course overview in Section III. We explain the data collection and give a brief overview of our results in Section IV. The results are discussed in Section V. Before the paper closes with a conclusion in Section VII, we present our recommendations for other lecturers in Section VI.

II. Related Work

To provide an overview of the literature related to the topic of our study, we searched for primary studies dealing with agile methods in higher educating using problem-based approaches in virtual distance classroom settings during the Covid-19 pandemic. The search was performed in two digital libraries (Google Scholar and Scopus) and focused on peer reviewed literature.

We identified five studies dealing with findings related to the Covid-19 indicated switch to distance teaching. Matthies et al. [18] discuss the impact of the switch to a remote teaching in their agile software engineering project course during the Covid-19 pandemic. The authors identified ten challenges concerning the distance teaching activities and present specific counter measurements. Most of these challenges are also described in practitioner contexts like decreased social exchange (e.g., [23], [24]) or less focus due to distractions [25]. Matthies et al. also identified 13 opportunities, which positively affected the teaching activities [18].

Stevanovic et al. analyzed the students perspective of virtual distance teaching during Covid-19 [26]. The survey results show that students lost focus in virtual distance settings. Also the motivation of the students is negatively affected, especially for students, which are used to onsite teaching. Iglesias-Pradas et al. point out that the ad hoc switch to virtual distance teaching during Covid-19 is not comparable to a prepared, permanent integration of virtual distance teaching in higher education [27]. The authors recommend drawing lessons from distance teaching during Covid-19 and transferring suitable concepts to the post-pandemic period.

Another paper, which deals with the Covid-19 related impact on teaching activities is presented by Siegel et al. in form of a workgroup report [20]. The authors describe how the teaching landscape may look like after the pandemic indicating the lessons learned from the past two years with Covid-19. However, the literature concerning the impact of distance learning, especially related to the field of software engineering and agile software development in particular is limited [28] and needs more attention.

Although we performed the literature search in two digital libraries, we could not identify peer-reviewed studies dealing with agile methods using problem-based approaches in higher education virtual classroom settings.

III. Course Overview

A. General Information of the Course

The course *Innovative Methods of Project Management* is organized annually during the summer term and integrated into the Master of Science program *Digital Transformation*. The master program is supervised by the Business Computing department of the University of Applied Sciences and Arts - Hochschule Hannover since winter term 2018/2019. A student group comprises 25 persons.

Each term is divided into different phases: lecture period (16 weeks), examination period (three weeks) and lecture-free period (seven weeks). The course is planned with total effort of 180 hours (68 hours in attendance, 112 hours self study). The 68 hours are planned as lecture units, as well as during the Covid-19 pandemic. Thus, the course is planned with four units á 45 minutes per week in an onsite setting.

In the course, students should gain an understanding and knowledge of new (innovative) methods and upcoming challenges of project management. The students should be able to select and perform specific systematic measures to counteract relevant challenges. An outline of the learning objectives is given in Table I.

TABLE I
Learning objectives

Learning objectives
Understand the characteristics, challenges and opportunities of agile, plan-based and hybrid approaches in a software development context
Understand the challenges of intercultural project teams
Understand the challenges of (virtual) distributed international teams
Leadership and team coordination for different project sizes
Conflict management in projects
Presentation of status reports for selected stakeholder

The examination is split into a written paper and a presentation of the study results by each students team. 50 percent of the grade results from both types of examination.

Our course was initially designed for classroom teaching in person, as we are an onsite university. The global shift to virtual and distance learning due to Covid-19 affected also our university. Covid-19 reached Germany in February 2020. The summer term in 2020 started in March at our university. After

 ISBN: 978-1-61208-997-3

two weeks of onsite teaching in March 2020, we switched to virtual distance teaching. Thus, the course was offered once in person (2019) and two times virtually in a distance learning (2020 and 2021).

B. Pre-pandemic Course Information

This subsection describes the course organization during the summer terms of 2019 and 2020 and aims to provide an understanding of our adapted eduScrum approach based on classroom teaching.

The eduScrum approach was developed by Willy Wijnands for organizing school lessons [29]. Wijnands et al. present their guidelines for the agile education method in the eduScrum guide [30]. The eduScrum guide describes specific practices, artifacts and roles, as well as a process model aiming to provide a common understanding how eduScrum may be performed in schools. However, the approach is not designed for higher education integrating real world problems and clients or stakeholders into the teaching activities. Thus, we decided to adapt the eduScrum method based on the theoretical knowledge of well-known agile methods such as Scrum with the aim to enable students to work with agile practices and gain practice-relevant experiences. We present the elements of our adapted eduScrum approach for higher eduction in Figure 1.

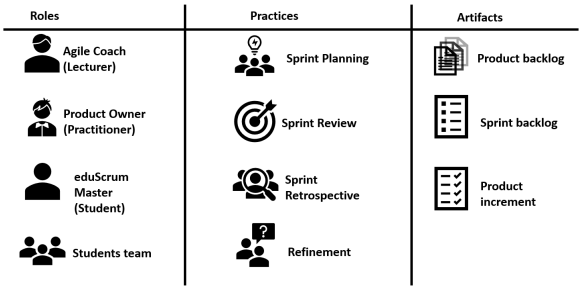

Fig. 1. Elements of the adapted eduScrum approach

Our adaptions affect the roles, practices (events) and artifacts of the eduScrum approach. In a first step, we added the role of an Agile Coach, which is taken by the lecturer. The Agile Coach is responsible for supporting the students related to upcoming questions related to the course organization or the underlying theoretical knowledge or challenges during the term. Furthermore, we changed the responsibilities of the Product Owner. The practitioner from a specific company takes this role and is responsible for preparing a product backlog, which comprises specific requirements for the students teams and keeping the backlog up to date. The role also supports the students teams related to content-related questions or challenges, e.g., providing project or company documentations such as guidelines. The students team is self-organized and thus, decides how to implement the specific requirements from the product backlog. The size of the team is restricted to three to seven students. Each students team choose one student, who takes the role of the eduScrum Master. This role is responsible for removing impediments during a sprint.

We organized the agile practices Sprint Planning, Review and Retrospective with respect to the eduScrum Guide. In terms of conducting respective practices such as the Retrospective the students team have the possibility to select specific micro practices (or techniques), such as the starfish model [31]. However, we added the refinement meeting to our adapted eduScrum approach, as we identified the need for integrating an agile practice which aims to provide the possibility for the students and product owners to collaborate directly concerning the quality of the product backlog. The refinement always takes place in the week between the sprint changes.

The artifacts are not described in the eduScrum guide. Thus, we decided to integrate necessary artifacts from Scrum [32], in order to integrate real world companies, which are used to work with artifacts, like product/sprint backlogs and increments. It provides the possibility for the students to discuss specific requirements documented in the backlogs and deal with challenges such as not done increments or negotiations with the product owner.

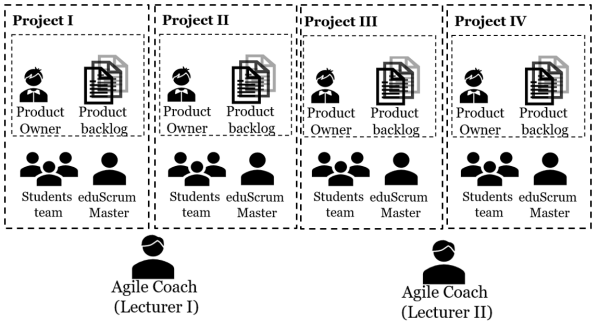

Fig. 2. Course organization in 2019 and 2020

Changes in the students team (e.g., new team assignments) are not planned in the term. The students should get a chance to learn the challenges and opportunities of a team development through the whole term and gain experience of such a process.

In 2019 and 2020, the course was prepared and performed by a teaching pair. Each agile coach was responsible for supporting two student teams (see Figure 2). We integrated four companies in the summer terms in both years. We selected the companies based on their project proposals related to the learning objectives of the course. All companies are part of our educational and research network and from certain industries like finance, retail or chemical. For instance, the companies proposed projects with the aim to identify success factors of an agile transition in the finance industry, or to analyze project management methods in use at an energy company in order to provide an approach for a tailored hybrid project management approach. All projects are based on real world problems and challenges.

We split the student group of 25 persons and assigned the students randomly to one of the four eduScrum student teams. Each student team had one associated product owner and project.

 ISBN: 978-1-61208-997-3

During the first lecture of the summer terms in 2019 and 2020, we held an introductory event in which we explained the module's organization, the examination requirements and repeated basic theory. Building on this, a kick-off meeting was held with the product owners in the second event. The kick-off meetings were already student team-specific events, so each product owner held the event with the respective student team. The aim of the kick-off meeting was to ensure a uniform understanding of the requirements and goals of the respective project and to be able to move on to the iterative organization in the form of sprints. In the third week of the term, the event was the first sprint planning. Starting this week, two-weekly sprints were planned and executed. In the week without a sprint planning, refinement meetings were held with the aim of discussing open questions or ambiguities. One week before the exam date (submission of the written exam and presentation of the results), the last sprint in the respective term ended.

C. Modified Course Organization due to Virtual Distance Teaching

This subsection describes the course organization during the summer term of 2021 and aims to provide an understanding of our corrections made due to the switch to virtual distance teaching during the Covid-19 pandemic.

Our experiences of 2019 and 2020 have shown that the preparation of the projects with several companies is extensive and complex. In addition, there is a risk when integrating several companies that the product owner cannot always guarantee high-quality support for the students, for example with regard to the quality of the requirements. Due to this challenge and an organizational change, which meant that only one lecturer was available for the summer term 2021, we decided to integrate fewer companies into the course with the same number of projects in order to decrease the organization and coordination workload.

Due to the effects of the Covid-19 pandemic on how agile software development teams work (e.g., [33], [34]), we have also decided to integrate companies whose teams having a high degree of maturity in terms of agile methods. We assumed that the challenges caused by virtual collaboration had increased and therefore wanted to integrate companies that have already successfully met these challenges in the first year of the pandemic aiming to provide the opportunity that our students benefit from these experiences. Thus, we sent inquiries to six companies from our network and provided them with comprehensive requirements such as the provision of several projects at the same time and dedicated support for each student team. We then held preliminary talks with four companies and ultimately selected two companies. The companies come from the e-commerce and online marketing sectors.

The preparation lay on both sides, the companies and university side. The preparation activities for the summer term 2021 started with initial discussions in November 2020 (see Figure 3. We discussed the specific project aims and fine-tuned the requirements in January and February 2021. The companies

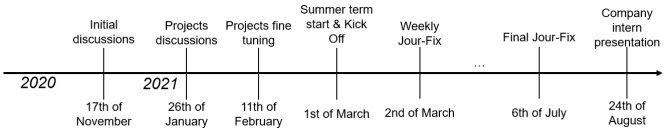

Fig. 3. Timeline summer term 2021

created internal accounts for the students in order to provide access on the company internal infrastructure. Furthermore, our colleagues at the companies discussed with agile software development teams their motivation to work with students on specific projects, challenges or conduct experiments together. Also, we discussed and clarified all research specific documentations such as non disclosure agreements and privacy policies. On university side we prepared the courses in our e-learning platform and the plan of the timeline throughout the summer term including the examination dates.

We divided the student group of 25 persons randomly into five eduScrum student teams and assigned a product owner and a project to each student team. A description of the projects is shown in Table II.

TABLE II
OVERVIEW OF THE PROJECTS IN SUMMER TERM 2021

Company identifier	Project goal
Company A	We want to understand how a 4-day workweek and a remote work setting influences the use of agile methods in software development
Company B	Analyze if a reduced workload leads to a higher quality of work. We assume that the teams outcome can be maintained with a reduced workload. What measures are there to reduce the workload? How is the quality of work rated?
Company B	What works conditions (e.g., room for maneuver; flexibility in terms of time and location; social resources) make "good work" possible. "Good work" means both the perspective of work quality and quantity, but also that people work in a mode that works in the long term and does not "wear out".
Company B	We want to analyze how personal autonomous gains and interaction losses in remote work settings are impacting the teams work.
Company B	We want to understand if and how self-direction and self-organization became more important and maybe a critical skill for work success during the remote work.

Concerning the eduScrum approach, we did several adaptions related to the switch to virtual distance teaching.

First, we decided in discussions with the companies that a high level of self-organization of the student teams may be a good idea but needs support from our sides. In order to be able to support the student teams, we defined the refinement meetings as obligatory. The student teams should prepare

the meetings in terms of discussing requirements, providing insights on problems and challenges related to the team work.

Second, we wanted to increase the opportunities to provide feedback in order to support the self-optimization of the teams. Thus, the support of experienced practitioners from the company is necessary and we (lecturer and companies) decided that the product owners from the company should have at least five years of experiences working in agile software development. The student teams got the opportunity to perform retrospectives aiming to optimize the self-optimization through the term and discuss upcoming problems directly with professional support from the company and university side. The decision who (agile coach from university and/or product owner from company side) support the student teams lay by the students.

Third, the phenomena of video call fatigue and increased (mental) effort of meetings in remote work in practice is described in the literature (e.g., [23], [24]). Thus, we decided to conduct the team events with a timebox of 60 minutes and camera always on policy. The timebox support focusing on specific aspects, which need to be discussed or presented in the performed agile practices. The timebox was also defined for further meetings like workshops, besides the regular weekly schedule. Although we did not ask for the specific work environment and equipment of the students, all of them respected the camera always on policy and activated their cameras during our video calls. We did not had any major infrastructure related problems in terms of internet connection or hardware issues.

Fourth, besides all scheduled events and meetings, we offered support and availability to the students by several communication types (chat, email, phone and video calls) in order to provide as much support as possible during the term.

Finally, we prepared and performed a kick-off and introduction event at the first lecture. We used the event to explain the course organization, regulations according to the examination and the theoretical basis. Also, the product owners gave a brief overview of the company and the project aims. From the second lecture and during the term, we ran a two-week sprint rhythm. Thus, as in the 2019 and 2020 summer terms, a sprint planning and review was carried out every two weeks. The student teams and the product owner and agile coach were obligated to be present at the sprint planning dates. In the weeks without Sprint Change, optional Refinement Meetings were held. To ensure coordination with the companies, we have planned and carried out weekly jour-fix appointments. A project coordination group was set up at both companies, consisting of the product owners, the agile coach and stakeholders from the respective agile software development teams. The jour-fix events aimed to remove impediments, to synchronize the product coordination group and to prepare further measurements and tasks. The jour-fix events were conducted over the entire term. In addition to the examination presentations, the results were also presented in the companies. These took place after the summer term and did not influence the evaluation.

IV. Evaluation

In this section, we explain the used evaluation methods and give a brief overview of the results.

A. Evaluation Method

Usually, we conduct the evaluation data via an anonymized and analog survey at the end of each term. Due to the switch to virtual distance teaching the evaluation survey was transferred to a digitized version. We decided to conduct the evaluation data via the online survey two times, once during the term and the other one after the examination. The survey consists of eight closed questions using a likert scale of 5 (1 totally agree - 5 totally disagree). Mainly the closed questions ask for the quality of didactic. Also, two open questions are part of the survey. The students have the opportunity to name specific aspects that they liked or didn't like.

In addition to the data collection with the online survey, we used qualitative data collection. By participating in agile practices, eduScrum offers the opportunity to observe the work results and organization of the students regularly. There is also space for informal discussions with the students. The same applies to the weekly exchange with the product owners, in which we discussed our impressions of the student groups and their results. We documented the data collected anonymously in a Microsoft Excel file and compared it with the data from the online survey at the end of the term to validate it.

B. Results Overview

The first online survey was sent to the students on the 17th of May 2021. The students had 14 days to fill it out. 14 students (out of 25) took part in the first survey. The second survey was sent to the students on the 9th of August 2021. In the second version, they had 21 days to participate to the survey. Only six students (out of 24; one student de-registered) completed the second survey. The low response rate may have several reasons, e.g. the time as the survey was sent during the free lecture period. However, we notice a decreased rate of respondents in online survey compared before the Covid-19 pandemic and a physical survey.

The students used different tools during the term. Certain tools were selected by the companies (e.g., Atlassian Confluence, Atlassian Jira, MS Teams) or the university (Moodle). Others were selected by the student teams (like Google Docs or Trello). We give an overview of the tools in Table III.

V. Discussion

In this section, we will discuss the results of our evaluation data and answer the two research questions of our study.

We begin with our first research question: How can we perform eduScrum integrating real world problems in higher education?

We present our adapted eduScrum approach for higher education and the optimization adaptions for virtual distance teaching in Section III. The virtual distance teaching comes with several challenges in higher education. In particular, we noticed an increased effort of preparing and organizing

 ISBN: 978-1-61208-997-3

TABLE III
OVERVIEW OF THE TOOLS IN USE

Tool	Objective of use
Atlassion Confluence	Visualization of the sprint backlog
Atlassion Jira	Sharing and management of documents
Dropbox	Sharing and management of documents
Google Docs	Sharing and management of documents
Moodle	Learning platform
MS Excel	Documentation
MS Powerpoint	Results presentation
MS Teams	Team communication and coordination
MS Word	Documentation
Trello	Visualization of the sprint backlog
WhatsApp	Team communication and coordination

courses. Also the coaching and support of students take more time in such an environment. Also, we want to point especially to the situation when we are integrating external partners in our lectures. The coordination and collaboration with companies is complex and takes an increased effort. However, the switch to virtual distance teaching also provides several opportunities. We were able to integrate companies from other cities and areas of Germany to our course. This provides the opportunity to focus on specific social skills also in a distributed remote work environment. In addition, we have already collaborated with the selected companies on other research projects. Another important aspect was the existing experience in remote work settings, as the summer term in 2021 was already the third term in a virtual distance teaching environment during the Covid-19 pandemic. So everybody involved had experiences with distance teaching and learning or remote work. We also had the advantage that most of the students already knew each other, so effective team development could be carried out.

Interestingly, the students rate the course organization overall positive (1.7 and 1 in average scores; see Table IV). We assumed that the direct virtual lecture environment will be missed by the students and that the responsiveness of the lecturer will be decreased. Interestingly, the students value the visibility and quick response time from the lecturer and their product owners. For instance, one student mentioned in the survey: "*The commitment of the lecturer is great! The lecturer is always available and takes a lot of time for the group work*". The aspect of lecturer support for the student teams is also validated by several informal talks between the students and the lecturer as well as the product owners.

Also some improvement proposals were made by the students. The interaction and communication among the student teams could be improved. This could lead to a better transfer of learn effects from other teams. Following this idea, we recommend to implement a community of practice in which the eduScrum masters can be discuss their learning's to improve the collaboration among the specific teams. Another facet which is described negatively is the extensive project scope and thus, the needed effort to provide good results.

The second research question is defined as: How do the students value the work with eduScrum in a virtual distance teaching environment?

TABLE IV
AVERAGE SCORES ON THE COURSE CONTENT AND LECTURERS QUALITY

Survey item	Avg. score (1st survey)	Avg. score (2nd survey)
Overall, I rate the content of the course positive.	1.7	1
The course content was conveyed clearly.	2	1
The lecturer explains in a way that is easy to understand.	1.8	1
The students actively contributed to the success of the course.	1.6	1
There is a pleasant atmosphere between students and lecturers.	1.6	1
I was encouraged for independent thinking.	1.6	1
I had the opportunity to actively participate.	1.7	1

In general, the students enjoyed the organization with eduScrum. The survey data as well as our formal (during agile practices) and informal talks and discussions with the students show mostly positive feedback. Especially, the integration of practice related problems from real world companies and the work with software development teams were valued by the students. Also the research characteristic of the projects, especially conducting experiments with the software development teams were rated positively. For instance, a student commented in the survey: "*In this course, the practice-oriented character that is attributed to a university was lived... Just as you know it from agile software development and it can also be expected of Master's students, there was a high degree of self-organization and also personal responsibility... We had free ones Decision-making power when considering possible experiments, as long as they are scientifically sound and added value can be hoped for.*" Another student described the used eduScrum method in a virtual distance teaching environment as: "Excellent example of how an online event works".

However, we identified several improvement measures, especially concerning the forming phase of the teams at the beginning of the term. Also the transfer of theoretical knowledge could be improved in the future. Thus, we recommend to perform workshops with the whole course at the first two or three lectures. Also it could be helpful to implement specific team development measures per eduScrum students team, especially with the support from the already integrated practitioners from the companies.

VI. LESSONS LEARNED AND RECOMMENDATIONS

In this section, we present six specific recommendations for integrating agile methods into higher education in virtual distance settings. The recommendations are based on our experiences from the summer terms in 2020 and 2021.

a) Recommendation 1: Overcome the social distancing in virtual classroom settings: One major challenge in virtual

classroom settings is social distancing between the lecturer and the class, as well between the students. This challenge may becoming a problem especially in didactic approaches with group based organizations through the term. Our experiences and the results of this paper show that the usage of an agile method and specific agile practices support us to overcome the social distancing. Due to the regular (weekly) coordination and the associated expectation on all sides (companies, lecturers, students) to produce results regularly and to put them up for discussion, the need arises in the student groups to work together on solutions in self-study. This circumstance leads to an increased focus among the students. In the last two summer terms we have not experienced a situation in which groups of students have not taken an examination. From our point of view, the students benefit from the organization of the course, since there is a likelihood of working in practice in the future and being confronted with social distances in remote work settings.

b) Recommendation 2: Increase the focus of students in virtual classroom settings: We also used strict timeboxes for agile practices in use aiming to support the students focus during the video calls. The timeboxes were 60 minutes for the weekly meetings per student team. This short timebox helping to minimize the risk of video call fatigue [18]. Thus, the defined weekly schedule increased the opportunity to perform the agile practices effective and leads to a better focus of the student teams. Similar effects are described by Matthies et al. [18]. If necessary, we have planned and carried out additional coordination and clarification appointments on other days of the week.

c) Recommendation 3: Impacting the motivation of students in virtual classroom settings through the term: A positive impact on motivation of students is of high relevance when organizing courses with problem based approaches. The relevance of the course topics, the course organization and the examination may motivate students performing good results and stay focused through a term. Several studies show that our didactic approach and the course organization support the motivation of students [7], [35]. However, the examination was planned within the examination period and we discussed internally several options to integrate part-examinations during the term. We decided to define four increments based on the content, which needs to be provided for the examination. The student teams had to present the increments during the term on specific dates, which we communicated in the first lecture. The increments support a goal-oriented learning for the students' exam and provides us the opportunity to investigate the students results. The student teams presented the increments in several ways using various tools and got directly feedback by the product owners and agile coach. Thus, we recommend a clear communication what is expected by university and company side through the term, which leads to a positive impact on students motivation.

d) Recommendation 4: Increase the opportunities to support the students in virtual distance teaching: Even if the use of agile methods is not an option for other lecturers, we would like to point out that a specific, targeted exchange with students brings advantages in virtual distance settings. Especially, when organizing a course in groups, we have found that questions were more often asked by the students and introverted students also participate more often. Interestingly, we cannot confirm these experiences for other modern didactic approaches such as flipped classroom with larger groups. We therefore recommend considering how the possibilities for specific support from lecturers can be optimized in virtual distance teaching. From our point of view, the offer to contact the IT professionals involved in the course is also supportive. Even if the social distance causes a loss of trust between teachers and students, the offer to contact other people (in our case from the companies) may be helpful in order to be able to increase the support. Based on our learning's, offering specific agile practices such as refinements and retrospective meetings help the students to counteract the decrease of feedback within the student teams and among the stakeholders. This may lead to an increased trust, especially between lecturers and students and thus, lead to the opportunity to support the students related to specific problems and challenges they have.

e) Recommendation 5: Increase the collaboration with companies and integrate real world problems into higher education: The integration of real world problems including the collaboration with companies may lead to a high effort of preparing and performing courses in higher education. However, several studies show that the problem based learning approach provide several positive effects on the students motivation and learning outcomes, especially when integrating real world problems and IT professionals (see Section II). From our point of view, it is helpful to strive for collaboration with several companies and to align it in the long term. The preparation and implementation of courses in higher education requires thorough preparation. This requires mutual trust and a corresponding commitment to agreements on both sides. We made a conscious decision to work with companies with whom we performed various research projects in the past. The regular and recurring collaboration inevitably leads to a trusting cooperation in which common goals can be pursued and so the companies can also benefit by having the opportunity, for example, to scientifically examine current challenges and problems. The strong practical relevance combined with scientific work is an advantage for the students. They have the opportunity to get insights from different contexts and have the opportunity to examine specific problems scientifically.

f) Recommendation 6: Engage the students for publishing their research: After completing the examination of the course, we gave all student groups the opportunity to strive for scientific publications based on the results gained from their work in the summer term. Four out of five groups took advantage of this opportunity. On the one hand, this shows us that the Master's students are interested in scientific work. The motivation of the participating students was always high. This is shown in particular by the fact that the publication processes of some papers continue to this day. One of the four papers has been already published [36]. Furthermore, two

 ISBN: 978-1-61208-997-3

papers are currently in the review process (one at a conference, one at a journal). Another paper is in revision for a German-language journal. To prepare for writing the paper, we first held a workshop on scientific work and writing. This workshop was structured in the same way for all four student groups. On the basis of the workshop, we jointly defined specific measures to optimize the written examination, which were largely carried out by the students. We recommend other teachers, especially in master courses, to motivate students about science and to show them specific possibilities to share their results in the research community. Even if the publication does not work on the first try, the learning effect is given, for example for the master's thesis and other scientific projects in future.

VII. Conclusion and Future Work

The Covid-19 pandemic came with several challenges and advantages for teaching in higher educational settings. Many universities were not used to organize and perform distance learning courses before the pandemic.

This paper presents our learning's performing an adapted eduScrum approach for higher education in virtual distance teaching with integrated real world problems. We adapted eduScrum for the use in virtual distance teaching in a Master of Science course in the summer term 2021. Our results show that the students value the work with eduScrum and collaborating with companies aiming to analyze their real world challenges and problems. Also, the research focused characteristic of the projects is perceived positively by the students. From the lecturer and companies points of view, we recommend to switch the focus to more scientific grounds while using problem-based learning approaches in higher education. We saw valuable research results, which we could submit at conferences and journals. The first paper is already published, further papers are currently under review.

Based on our results we present four recommendations for other lecturers to integrate agile methods using a problem-based approach in virtual classroom settings (recommendations 1 to 4). Furthermore, we call to increase the collaboration with companies and set the focus on scientific grounds and motivating students for scientific activities (recommendations 5 and 6):

- Recommendation 1: Overcome the social distancing in virtual classroom settings
- Recommendation 2: Increase the focus of students in virtual classroom settings
- Recommendation 3: Impacting the motivation of students in virtual classroom settings during the term
- Recommendation 4: Increase the opportunities to support the students in virtual distance teaching
- Recommendation 5: Increase the collaboration with companies and integrate real world problems into higher education
- Recommendation 6: Engage the students for publishing their research

In the future, we are planning to put more focus on the research characteristic and aim to support the students in scientific activities. Also, we want to consolidate the cooperation with the companies for the long term and work on strategies how to establish collaborations also in undergraduate courses.

Appendices

The survey data is available at the academic cloud: https://sync.academiccloud.de/index.php/s/JIsGAOS6is5OlVs

Acknowledgment

First of all, we would like to thank our partners from practice, who put a lot of suggestions, ideas and effort into the preparation of the projects. A lot of effort was also put into the summer term regarding coordination and establishing contacts with the respective software development teams. Particularly noteworthy here is the effort at the operationally working agile software development teams, who were involved in the various research methods (experiments, semi-structured interviews, etc.) and always actively supported the students and projects. We also would like to thank the students for their engagement during the summer term and their willingness to take part in further events such as panel discussions and presentations of results at the companies.

References

[1] VersionOne and Collabnet, "15th annual state of agile survey report," 2021, (Last accessed: October 2022). [Online]. Available: https://www.stateofagile.com/

[2] M. Kuhrmann et al., "Hybrid software development approaches in practice: A european perspective," *IEEE Software*, vol. 36, no. 4, pp. 20–31, 2019.

[3] V. Mahnič, "Scrum in software engineering courses: an outline of the literature," *Global Journal of Engineering Education*, vol. 17, pp. 77–83, 2015.

[4] E. Whitworth and R. Biddle, "The social nature of agile teams," in *Agile 2007*, J. Eckstein, Ed. Los Alamitos, Calif.: IEEE Computer Soc, 2007, pp. 26–36.

[5] A. López-Alcarria, A. Olivares-Vicente, and F. Poza-Vilches, "A systematic review of the use of agile methodologies in education to foster sustainability competencies," *Sustainability*, vol. 11, no. 10, 2017.

[6] T. F. Otero, R. Barwaldt, L. O. Topin, S. V. Menezes, M. J. R. Torres, and A. L. de Castro Freitas, "Agile methodologies at an educational context: a systematic review," in *Proceedings of the 2020 IEEE Frontiers in Education Conference (FIE)*. IEEE, 2020, pp. 1–5.

[7] W. Brown, L. Zhang, D. K. Sharma, I. Dabipi, W. Zhu, Y. Jin, and D. Bagwell, "Engaging undergraduate engineering and aviation students to explore project based learning with regard to community impact using data analytics in higher education," in *Proceedings of the 2019 IEEE Frontiers in Education Conference (FIE)*, 2019, pp. 1–5.

[8] M. Gorlatova, J. Sarik, P. Kinget, I. Kymissis, and G. Zussman, "Project-based learning within a large-scale interdisciplinary research effort," in *Proceedings of the 18th Conference on Innovation and Technology in Computer Science Education*, ser. ITiCSE '13, 2013, p. 207–212.

[9] R. Wlodarski and A. Poniszewska-Maranda, "Applying a traditional software development process to drive projects in higher education," in *Proceedings of the 45th Euromicro Conference on Software Engineering and Advanced Applications (SEAA)*, 2019, pp. 309–316.

[10] M. Zarb, T. Young, and W. Ballew, "Integrating real-world clients in a project management module," in *Proceedings of the 2019 ACM Conference on Innovation and Technology in Computer Science Education*, ser. ITiCSE '19. New York, NY, USA: Association for Computing Machinery, 2019, p. 329–330.

[11] J. Dinis-Carvalho, S. Fernandes, and J. C. R. Filho, "Combining lean teaching and learning with eduscrum," *International Journal of Six Sigma and Competitive Advantage*, vol. 10, pp. 221–235, 2017.

 ISBN: 978-1-61208-997-3

[12] S. Hof, M. Kropp, and M. Landolt, "Use of gamification to teach agile values and collaboration: A multi-week scrum simulation project in an undergraduate software engineering course," ser. ITiCSE '17. New York, NY, USA: Association for Computing Machinery, 2017, p. 323–328.

[13] P. K. Linos, R. Rybarczyk, and N. Partenheimer, "Involving it professionals in scrum student teams: An empirical study on the impact of students' learning," in *Proceedings of the 2020 IEEE Frontiers in Education Conference (FIE)*, 2020, pp. 1–9.

[14] C. Matthies, T. Kowark, and M. Uflacker, "Teaching agile the agile way — employing self-organizing teams in a university software engineering course," in *2016 ASEE International Forum*. New Orleans, Louisiana: ASEE Conferences, June 2016, https://peer.asee.org/27259.

[15] C. Matthies, "Scrum2kanban: Integrating kanban and scrum in a university software engineering capstone course," in *Proceedings of the 2nd International Workshop on Software Engineering Education for Millennials*, ser. SEEM '18, 2018, p. 48–55.

[16] J. C. Metrôlho, F. R. Ribeiro, and P. Passão, "Teaching agile software engineering practices using scrum and a low-code development platform – a case study," in *Proceedings of the 15th Conference on Software Engineering Advances*, 2020, pp. 160–165.

[17] G. Lang, "Agile learning: Sprinting through the semester," *Information Systems Education Journal*, vol. 15, no. 3, pp. 14–21, 2017.

[18] C. Matthies, R. Teusner, and M. Perscheid, "Challenges (and opportunities!) of a remote agile software engineering project course during covid-19," in *Proceedings of the 55th Hawaii International Conference on System Sciences*, 2022, pp. 911–920.

[19] Y. Y. Ng and A. Przybyłek, "Instructor presence in video lectures: Preliminary findings from an online experiment," *IEEE Access*, vol. 9, pp. 36 485–36 499, 2021.

[20] A. A. Siegel et al., "Teaching through a global pandemic: Educational landscapes before, during and after covid-19," in *Proceedings of the 2021 Working Group Reports on Innovation and Technology in Computer Science Education*, ser. ITiCSE-WGR '21. New York, NY, USA: Association for Computing Machinery, 2022, p. 1–25.

[21] M. Paasivaara, V. Heikkilä, C. Lassenius, and T. Toivola, "Teaching students scrum using lego blocks," in *Companion Proceedings of the 36th International Conference on Software Engineering*, ser. ICSE Companion 2014, 2014, p. 382–391.

[22] M. Neumann and L. Baumann, "Agile methods in higher education: Adapting and using eduscrum with real world projects," in *Proceedings of the 2021 IEEE Frontiers in Education Conference (FIE)*, 2021, pp. 1–8.

[23] K. Marek, E. Winska, and W. Dabrowski, "The state of agile software development teams during the covid-19 pandemic," in *Proceedings of the 5th International Conference on Lean and Agile Software Development*. [S.l.]: Springer, 2021, vol. 408, pp. 24–39.

[24] M. Neumann, Y. Bogdanov, M. Lier, and L. Baumann, "The sars-cov-2 pandemic and agile methodologies in software development: A multiple case study in germany," in *Proceedings of the 5th International Conference on Lean and Agile Software Development*. [S.l.]: Springer, 2021, vol. 408, pp. 40–58.

[25] S. A. Butt, S. Misra, M. W. Anjum, and S. A. Hassan, "Agile project development issues during covid-19," in *Proceedings of the 5th International Conference on Lean and Agile Software Development*. [S.l.]: Springer, 2021, vol. 408, pp. 59–70.

[26] A. Stevanovic, R. Bozic, and S. Radovic, "Higher education studentséxperiences and opinion about distance learning during the covid-19 pandemic," *Journal of Computer Assisted Learning*, vol. 37, no. 6, pp. 1682–1693, 2021.

[27] S. Iglesias-Pradas, Hernandez-Garcia, J. Chaparro-Pelaez, and J. L. Prieto, "Emergency remote teaching and students' academic performance in higher education during the covid-19 pandemic: A case study." *Computers in human behavior*, vol. 119, 2021.

[28] M. Bond, S. Bedenlier, V. Marin, and M. Haendel, "Emergency remote teaching in higher education: mapping the first global online semester," *International Journal of Educational Technology in Higher Education*, vol. 18, no. 50, 2021.

[29] W. Wijnands and A. Stolze, "Transforming education with eduscrum," in *Agile and Lean Concepts for Teaching and Learning*, 2019, pp. 95–114.

[30] W. Wijnands et al., "The eduscrum guide," 2020, (Last accessed October 2022). [Online]. Available: https://www.eduscrum.nl/img/The_eduScrum_guide_English_2.pdf

[31] A. Przybyłek, M. Albecka, O. Springer, and W. Kowalski, "Game-based sprint retrospectives: multiple action research," *Empirical Software Engineering*, vol. 27, no. 1, 2022.

[32] K. Schwaber and J. Sutherland, "The scrum guide," 2021, (Last accessed: October 2022). [Online]. Available: https://www.scrumguides.org/scrum-guide.html

[33] M. Neumann and Y. Bogdanov, "The impact of covid 19 on agile software development: A systematic literature review," in *Proceedings of the 55th Hawaii International Conference on System Sciences*, 2022.

[34] N. Ozkan, O. Erdil, and M. Ş. Gök, "Agile teams working from home during the covid-19 pandemic: A literature review on new advantages and challenges," in *Proceedings of the 6th International Conference on Lean and Agile Software Development*. Springer International Publishing, 2022, pp. 38–60.

[35] V. Mahnič, "Teaching scrum through team-project work: Students' perceptions and teacher's observations," *International Journal of Engineering Education*, vol. 26, p. 96, 2010.

[36] J. Topp, J. H. Hille, M. Neumann, and D. Mötefindt, "How a 4-day work week and remote work affect agile software development teams," in *Proceedings of the 6th International Conference on Lean and Agile Software Development (LASD)*, Cham, 2022, pp. 61–77.

 ISBN: 978-1-61208-997-3