

Investigating Computer Science Students' Perceptions of Team Coaching

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Abstract—This research-to-practice full paper explores the effectiveness of coaching interventions with the goal of enhancing teamwork and project management skills among students in higher education. The paper reviews related studies on coaching practices aimed at developing students' professional skills as part of their higher education. It proceeds by investigating computer science students' perspectives on selected team coaching interventions. These build upon agile practices are targeted at facilitating and accelerating students becoming professional and productive – a ubiquitous need in the industry. To assess the efficacy of introducing team coaching in a project management course of the faculty of computer science at a large mid-European university, the researchers employed a method triangulation consisting of a pre-survey, focus groups, and retrospectives. The pre-survey assessed students' prior experience with teamwork, perception of project success factors, and interest in coaching interventions. Besides conducting a one-hour coaching workshop for all course participants, two out of eight student-teams expressed particular interest in participating in regular coaching sessions conducted remotely and in-person throughout the semester. The coaching sessions introduced students to various frameworks and approaches, including the Tuckman stages of team development, and focused on improving communication, organization, and task distribution within teams. Regular retrospectives allowed teams to reflect on their progress, identify areas for improvement, and implement action items for the next milestone. At the end of the semester, in-person retrospectives and focus groups illuminated students' experiences and preferences regarding coaching and teamwork. Results of the study indicate that optional team coaching interventions have the potential to improve students' team projects, application of agile practices, teamwork, and organizational competencies, given that students are open and willing to invest their time. Thus, this paper seeks to build a basis from which to spark curriculum designers, educators, educational researchers, and administrators to consider ways to include targeted team coaching interventions into undergraduate computing curricula.

Index Terms—higher education, coaching, agile, teamwork, project management

I. INTRODUCTION

In higher education, especially in the field of computer science, effective teamwork and project management skills are very important. Recognizing this, our research investigates the efficacy of team coaching interventions with a combination of agile methodology practices to enhance these skills among

project management students of a large mid-European university. This research builds upon existing studies that explore coaching methods with a focus on developing professional skills like conflict resolution, teamwork competencies, and other needed teamwork skills, as well as how agile methodology practices can support and improve teamwork in team projects in a higher education context.

Our study employed a method triangulation approach, including pre-survey, coaching interventions including retrospective sessions and retrospectives integrated into focus groups. The pre-survey focused on gathering students' prior experiences with teamwork and the perception of project success factors. The coaching interventions and the focus groups session focused on providing deeper insights into the ongoing effects of the coaching interventions and sharing the lessons learned during the teamwork project period.

We aim to find out how to effectively equip future professionals with the needed tools and skills to be prepared for the work environment to align more closely with the needs of the industry. Hence, this paper will be of interest to curriculum designers, educators, educational researchers, and administrators who seek ways to include targeted team coaching interventions into computing curricula.

II. BACKGROUND AND RELATED WORK

A. Coaching

Coaching is a setting in which there is a relationship between a coach and the person who is being coached, the so-called coachee. The coach helps the coachee, in the process of setting goals and developing solutions [1]. The coach is trying to help the coachee with self-directed learning and personal growth of the coachee.

Coaching helps students to gain soft skills like communication, collaboration, and other needed competencies. Also, there is a significant change in the retention [2], [3], [4]. Studies also mentioned that mentoring and/or coaching helped to improve professional skills like collaboration, communication, goal orientation, and critical thinking [5], [6], [7], [8]. Not only improvement of professional skills has been observed but also academic performance has been positively affected [7], [9].

The personal engagement with the mentor was mentioned to be one of the most critical elements [2] and the favorite part of the mentees [10]. Chat-based mentoring helps shy people to feel more comfortable, but an in-person meeting creates a “sense of room” [11]. Furthermore, face-to-face mentoring and coaching are essential in building a strong community [12]. Regarding females in STEM education, mentoring improved female retention rates and advancement of females [3]. Those women would also encourage other women to join these studies [10]. If the mentor is working closely with the team, they can observe teamwork and can react immediately like a Scrum Master does [6].

B. Agile Approaches

Agile methodologies offer many techniques that are deemed to be very useful in the educational environment, especially in the student-centered approach [13], [14], [15]. Agile methodologies were initially developed for software development but also started to go beyond the technology sector. Agile methodology uses the iterative and incremental development and continuous improvement process. In the student-centered approach, the usage of agile methodologies could be very helpful. In agile the needs and the requirements of the customer have the main focus. This could also be matched in an educational area. That means, that the student is in the main focus. This is implemented for example by letting students co-design the course structure.

The Agile Manifesto and the Agile Principles [16] were modified to be used for the education area. The following principles are central to the Agile Manifesto [17].

- Students over traditional processes and tools
- Working projects over comprehensive documentation
- Student and instructor collaboration over rigid course syllabi
- Responding to feedback rather than following a plan

As in the Agile Manifesto, the focus is on the individuals rather than the tools, processes, documentation, and so on. More emphasis should be placed on the values on the left side than on the right side. However, this does not mean that topics such as documentation, processes, and tools are not important. They are indeed important, but the students, the functioning project, and the professor hold greater value.

Examples of agile practices in the classroom would be in Software Engineering classes, political science, civic studies, information systems, and supply chain management [18]. In these classes, agile tools would be the usage of Kanban boards and retrospectives, as well as writing user stories and introducing daily standups.

One of the biggest challenges in the agile setting is team collaboration and communication [19]. A Scrum Master who has experience in agile methodologies should serve as a guide for the teams [19]. The Scrum Master also needs to have strong communication and visualization skills [20]. In some settings, the teacher could have the role of the Scrum Master [21]. The role of a Product Owner could be held by the professor or by

an industry partner or external person [17], [19], [20], [22]. In the case that the Product Owner is an industry partner, this person must have enough time to support the students [19]. It is also said that it is not that important that the work is distributed equally in the team, but it is more important that everyone from the team is active in the process. Every team member needs to have a feeling of ownership. The original Scrum Framework that was invented by Ken Schwaber [23] was also modified to be used in higher education [20].

The collaborative adoption of Scrum for Higher Education improved the self-learning process, self-motivation as well as the self-emotion of the learner [20]. Also, solution-focused coaching is beneficial for overcoming the students’ learning team working and learning obstacles [20]. A Sprint could be the period between one lesson to the next lesson [20] i.e., one week or longer.

Also in the educational area, the retrospective is one of the most important events [20]. It focuses on inspecting, understanding, and adapting the interactions [20].

C. Course Description

The course project management introduces students to the foundations of project management and was subject of prior research [24], [25], [26]. It is part of the bachelor’s degree program computer science at a large mid-European university. This compulsory course awards students with 3 European Credit Transfer and Accumulation System (ECTS) credits and is typically attended in the 3rd semester. Besides teaching basic project management methods, such as defining functional and non-functional requirements, work breakdown structures, and software development effort estimation, the course seeks to convey valuable personal and interpersonal skills essential for teamwork in the 21st century. Therefore, topics like active listening, receiving and giving constructive feedback, and giving professional presentations are actively addressed and discussed in this course. This is in line with the ACM/IEEE Computer Science Curriculum Guidelines [27], which state that students should be given the opportunity to cultivate their interpersonal skills in projects.

The course concept relies on biweekly lectures and self-selected topics on which students work in self-chosen teams of 4-6 persons. The projects are developed from the basic functional and non-functional requirements up to a simple prototype; the actual implementation of the product is not part of the course due to its limited ECTS credits but may be part of a follow-up course on software engineering. Students are given new input regarding project management methods in each unit and may apply them directly in their projects in the following self-study week autonomously, while the course instructor acts as a coach guiding students and supporting them in their project work. By using this self-directed and self-regulated approach, students additionally develop their personal and interpersonal skills that are essential to a project’s success. The project work is divided into three milestones, which make up 20% of students’ grades each. Each team is required to present the current state of the project once, which

awards an additional 10%. The course uses a student-centered approach: Students are included in the course and its design as actively as possible using interactive discussions, workshops, guest lectures, and reflections, which can be written after each unit and award up to 15%. The remaining 15% can be acquired by writing a short paper on a self-selected project management topic. In a final submission interview, students are asked basic questions about their projects to confirm their authorship and pick out “freeloaders”. As the university’s strategy for a beginners’ course is to expose students to the basic concepts of project management, the course covers agile project management only to a limited extent, such as within the scope of a workshop. A reasonable integration of agile methodologies into the course considering the limited time is therefore subject of ongoing research.

III. METHODOLOGY

A. Research Question

Our aim of this paper is to answer the following questions:

- RQ 1: Which issues do students of the studied project management course indicate to contribute to project failure?
- RQ 2: What did students of the project management course report to have learned from participating in the agile coaching techniques?

B. Research Design and Instruments

This study employed a method triangulation approach. To increase the validity of the study and capture versatile perspectives, three research instruments have been used:

- Pre-survey at the beginning of the semester with all participants of the Project Management course
- Coaching interventions with two teams during the semester
- Focus groups at the end of the semester with all course participants

Additionally, agile practices were used in all activities with the students, for example retrospective sessions [28] and usage of Kanban boards.

C. Sample Description

In the summer term of 2023, 39 students attended the project management course. Table I gives an overview of the students. The majority (54%) of the students worked on projects before. Half of the students who answered the pre-survey were employed alongside their studies. 33% of the students reported having moderate prior knowledge in project management, and 3 students even estimated their prior knowledge rather high. 31% of the students expressed a rather high affinity for teamwork; only 3 students revealed a dislike towards teamwork. This shows that the majority of the students have prior experience in projects and also a positive affinity for teamwork. A significant portion is employed alongside their studies.

TABLE I
PARTICIPANTS DESCRIPTION OF THE PROJECT MANAGEMENT COURSE IN THE SUMMER TERM 2023 (N=39)

Characteristic	n (%)
gender	
female	10 (26%)
male	29 (74%)
employed	
yes	15 (38%)
no	15 (38%)
n/a	9 (23%)
has worked in projects before	
yes	21(54%)
no	9 (23%)
n/a	9 (23%)
prior knowledge in project management	
high	0 (0%)
rather high	3 (8%)
moderate	13 (33%)
rather low	6 (15%)
low	8 (21%)
n/a	9 (23%)
affinity for teamwork	
high	6 (15%)
rather high	12 (31%)
moderate	9 (23%)
rather low	1 (3%)
low	2 (5%)
n/a	9 (23%)

Note. “n/a” includes participants who did not provide an answer to the pre-survey.

D. Pre-Survey

At the beginning of the semester, a pre-survey was conducted with the students of the project management course.

In the first session of the project management course, the coach presented herself and talked about the coaching opportunity. During the session, the coach asked the students to take part in the survey. A QR code to the online survey was presented and the students had time to answer the questions.

The questions were the following:

- How often have you already worked in a group? (e.g. school, study, work,...)
- Rate your experience with teamwork in general. (0-catastrophic; 10-super)
- How would you know if you went up one point on the scale? What would have been different then? (e.g. your vote was an 8, what should have happened for you to vote a 9?)
- What are in your point of view issues, why projects and teamwork often fail?
- Would you like your team to be coached during your teamwork?
- If you answered the question above with YES, please provide your team number!
- If you answered the question above with NO, please let me know why?
- How would you imagine a team coaching to take place?

These questions were selected to get a better understanding of the experience of teamwork and project work as well as to see if there is an interest in being coached and to understand how the students would imagine that the coaching would take place.

E. Coaching sessions with students-teams

Two student-teams of the project management course were coached during the project work. The coaching sessions were held remotely as well as in person. The first session was about getting to know each other, explaining how the coaching interventions would take place and students had the opportunity to express their expectations of how they would imagine the coaching to be. To provide a foundational understanding, the coach also offered insights into the development phases teams typically undergo using the Tuckman stages as a framework [29]. In total, three to four coaching interventions took place. After every milestone, there was a retrospective that focused on what went well and what did not go well while working on the submission for the milestone. Together with the teams, action items were generated on how the work for the next milestone could be improved.

During the coaching sessions, an online whiteboard tool was used to show how this online whiteboard tool can help in organizational and project-related work. Every team had its own space in this whiteboard tool. In order for the students to use this tool for their project work, all the online sessions were documented in this whiteboard tool except the last in-person session which was held in person at the university. This session focused on the lessons learned from the coaching interventions. For this purpose, the retrospective method 4L's was used [30]. The 4L's stand for Liked, Learned, Lacked, and Longed for. The coach met the two teams at the university, one team after the other one. One and a half hours were allocated per team.

During the session, the participants shared what they liked about the coaching experience and highlighted aspects that were particularly effective or enjoyable. The learned component encouraged teams to reflect on the valuable lessons and insights gained throughout the semester. The teams also explored what they lacked during the semester, addressing the challenges they encountered. Finally, the longed-for area allowed teams to express their aspirations and desires for future coaching interventions.

The coach prepared post-its and cards with the 4L's written on them and they were put on the table. Unfortunately, there was no appropriate room available, so the session was held in an open space room at the Faculty of Computer Science. The students got an introduction from the coach on how the session would look like, and the students had 15 minutes to write down their input per category of the 4L's. After the time passed, the students presented their post-its to the rest of the team members and they put their sticky notes in the corresponding category. Topics that were mentioned several times were grouped.

F. Focus groups at the end of the semester

Towards the end of the semester, a group discourse was organized for all students enrolled in the project management class. The students were divided into focus groups and they worked out in a KALM retrospective method [31], what to keep, what to add, what to remove, and what to do more often in a group work.

The focus groups procedure was organized to foster productive discussion among the participants of the project management course. To ensure diverse perspectives, the students were divided into smaller groups, avoiding placing them with their project team colleagues. This aimed to encourage fresh insights and to prevent group thinking and as well to share the outcome from each group. For this purpose, the students were instructed to count off, to ensure random group assignments. The group size was from 3 to 5 students. Each group had the task to discuss what to keep, what to add, what to do more of, and what to do less of in a teamwork project. Once the new groups were formed, students were given 15 minutes to discuss. The students were equipped with post-it notes, and students wrote their thoughts on each topic. After that, the groups presented their findings to the rest of the groups. The post-it notes were put on a whiteboard, and categorized into specific columns for Keep, Add, Less, and More. Finally, similar topics on the whiteboard were clustered together. The visual representation facilitated comprehension and comparison across groups.

KALM stands for Keep, Add, Less, and More, providing a structure and engaging framework for students to reflect on their teamwork experiences and collaboratively identify areas for enhancement.

G. Data Analysis

The pre-survey data was quantitatively analyzed using descriptive statistics to summarize the students' prior experiences with teamwork, their perceptions of why projects fail, and also if they were interested in being coached over the semester. Open-ended questions were divided into categories and analyzed quantitatively to identify common themes. The data from the focus groups were written down by the students on post-its and were presented to the rest of the groups. The recurring themes and patterns were grouped into larger themes, and the retrospective at the end of the coaching sessions were thematic analyzed. The action items and improvements were tracked in an online whiteboard tool to be made visible to the coaching group.

IV. RESULTS

A. Pre-Survey

The pre-survey was answered by 20 (51%) out of 39 course participants. Table II, Table III, Table IV, Table V, Table VI, Table VII and Table VIII give an overview of the outcome.

The first question about how often the students worked in a group was answered by nine students with 'More than 10 times'. Seven students said that they worked in a group 5-10 times. The rest (4) said that they worked 4-5 times in

a group. The question about the experience of the students with teamwork was that the students had a rather positive experience with teamwork. Six students answered with 8 on a scale of 0 to 10, also six students rated their teamwork experience 6 on a scale of 0 to 10. Only four students rated their experience with less than 6 on a scale of 0 to 10. Two rated 5 and one student rated 3 and one 2 on a scale of 0 to 10. One student rated their experience with a 9 on a scale of 0 to 10. The responses indicate that the majority of the students had a rather good teamwork experience. The next question focused on what needs to be done to get one point higher on the scale. This question was an open-ended question. The communication topics were mentioned several times. Also, better organization within the teams for example better work distribution between team members, as well as to stick to the plan and achieve the deadlines. Also, the meetings need to be better and productive. Four students did not provide any answer. In an open-ended question, the students were asked why teamwork and projects often fail. This question was answered by all the survey attendees. The most common reason was bad communication, as well as a lack of motivation. Very often it was said that organization and planning of the to-dos were issues, as to why teamwork and projects fail.

The question about whether the team would like to have coaching during their semester was again answered by all attendees. 11 students said yes they would like to be coached. The rest said no. In total, 2 teams opted for being coached during their semester. For those who answered no, there was a second question to find out why they did not want to have coaching. The answers were that coaching is a very time-consuming topic and they were afraid of not being able to manage it. For the students that answered, they would like to be coached, there was a second part of the question focusing on how they imagine, the coaching would take place. Most of the students said that they imagined the coaching being held in-person as well as remotely, the topics would focus on how to communicate better in the team, as well as support in planning and organization.

Table V shows the numbers if students who would be interested in being coached during their teamwork project. 11 students said that they would like to be coached and provided their team number. It seems that there is an interest in being coached. If students had more time, we assume that more students would take the opportunity of being coached.

TABLE II
RESPONSES TO: HOW OFTEN HAVE YOU ALREADY WORKED IN A GROUP?
(E.G. SCHOOL, STUDY WORK,...)

Group Work Experience	Number of Students (%)
0–3 times	0 (0%)
4–5 times	4 (20%)
5–10 times	7 (35%)
More than 10 times	9 (45%)

TABLE III
RESPONSES TO: RATE YOUR EXPERIENCE WITH TEAMWORK IN GENERAL
(0 - CATASTROPHIC, 10 - SUPER)

Rating	Number of Students (%)
0	0 (0%)
1	1 (5%)
2	1 (5%)
3	0 (0%)
4	0 (0%)
5	2 (10%)
6	3 (15%)
7	6 (30%)
8	6 (30%)
9	1 (5%)
10	0 (0%)

TABLE IV
RESPONSES TO: WOULD YOU LIKE YOUR TEAM TO BE COACHED DURING
YOUR TEAMWORK?

Response	Percentage
Yes	55%
No	45%

TABLE V
RESPONSES TO: WHICH TEAM WOULD LIKE TO BE COACHED

Team Number	Number of Responses	Percentage
Team 1	2 (18.2%)	18.2%
Team 5	2 (18.2%)	18.2%
Team 7	4 (36.4%)	36.4%
Team 8	3 (27.3%)	27.3%

B. Results from the Coaching sessions with students-teams

Two teams were coached during the semester. Both teams consisted of five students each. Some of the students knew each other before and worked together, and some were together for the first time in a team and thus met during the project management course. The students studied Computer Science. The teams were gender diverse. One team had three female

TABLE VI
RESPONSES TO: HOW WOULD YOU KNOW IF YOU WENT UP ONE POINT ON
THE SCALE? WHAT WOULD HAVE BEEN DIFFERENT THEN?

Category	Exemplary Answer	Count
Interpersonal skills	Communication	2
	Active Listening	1
	Team dynamics	1
Project Management related skills	Planning/Organization	4
	Experience/Knowledge	2
	Meeting deadlines	2
	Work distribution	2
	Balanced outcome	1
Personal skills	Creativity and Flexibility	2
	Motivation	1

Note: The answers were translated from German to English

TABLE VII
RESPONSES TO: WHAT ARE IN YOUR POINT OF VIEW ISSUES, WHY
PROJECTS AND TEAMWORK OFTEN FAIL?

Category	Issues
Motivation	<ul style="list-style-type: none"> • Lack of motivation, especially with given topics, particularly in schools/universities, where interest is simply not present. • Job-related motivation, as individuals actively choose project management roles. • No motivation. • Mostly when people involved in the project are not motivated, they do not adhere to rules, deadlines, etc. At the same time, there is at least one person who wishes the project to be successful and ends up doing 80% of the work.
Communication and Engagement	<ul style="list-style-type: none"> • Communication and people not caring. • Communication, different opinions. • Communication, lack of interfaces to avoid dependency on others, absence of retrospectives. • Poor communication, possibly insufficient contribution from one or more team members due to disinterest or personal issues. • Lack of communication, conflicting schedules. • Communication, poor planning, little commitment. • No collaboration, no team leaders, no clear tasks assigned to each team member, no original idea for the project. • Lack of communication. • Misunderstanding, not enough questions.
Organization and Planning	<ul style="list-style-type: none"> • Organization and allocation of tasks, defining/finding goals. • Insufficient interest, little communication, disagreement, inadequate planning. • Different desires, demands, and time resources. • Task distribution, interpersonal dramas, excessive focus on management and tools rather than actual project development and work.

Note: The answers were translated from German to English

students, and the second team had two female students. The teams were also culturally diverse.

To conclude the coaching interventions at the end of the semester, a retrospective was held to find out what the students learned, liked, longed for, and lacked during the coaching interventions. Table IX shows the students' feedback on the coaching interventions. This session was an in-person session at the University. The outcome was that the students liked the coaching in general as well as the tools and the new concepts that they used. Furthermore, it was mentioned that the "therapy session" (i.e., the session in which the conflict in the team was resolved) was really helpful for their teamwork in the rest of the course. Also, the communication within the team got better and they learned how to distribute the work better within the team. They learned that it was facilitative to have smaller internal deadlines to achieve the milestone and not to finalize the work that they had to do right before the milestone, helping to reduce time pressure. They also learned new tools and concepts that they could use for future university projects

TABLE VIII
RESPONSES TO: HOW WOULD YOU IMAGINE A TEAM COACHING TO TAKE
PLACE?

Category	Answers
Project Management and Planning	Discussing the current state of the project and next steps
Problem identification and prevention	<ul style="list-style-type: none"> • Recognizing and preventing common problems in team communication and task distribution • Identifying obstacles and providing tools • Establishing processes and feedback mechanisms for continuous improvement
Skills development	<ul style="list-style-type: none"> • Teaching theoretical concepts for task allocation • Practicing conflict resolution. Fostering positive team dynamics and leveraging individual strengths • Tips and advice on improving team communication
Emotional support	Understanding the emotional states of each
Structure	Conducting sessions at the university or online

Note: The answers were translated from German to English

and teamwork as well as for future workforce areas. What they found lacking was that it was not easy to find a perfect time slot where everyone had time to meet. The students would have liked to have more in-person coaching sessions rather than online sessions. What the students longed for was that they expected to have more input and support on project-related topics. This was mentioned in the first coaching intervention session that this would not be provided by the coach. The coach should be there to provide support regarding soft skills and interpersonal topics rather than project-related matters.

C. Results from the Focus groups

At the end of the semester, focus groups were conducted with all students enrolled in the project management course. Table X shows the responses of the focus groups. The outcome was that it is good to keep the team spirit, the good organization but also to keep the work equally distributed within the teams. The students mentioned that they should add clear rules at the beginning of the project work and have smaller internal deadlines. Also, it was mentioned that they should add more in-person meetings. What should be done less was that team members should not take things too personally, not procrastinate, and focus more on the parts that each person had to do. In teamwork, there should be more communication, more fun, more support from other team members and more praise within the team.

The Keep phase encouraged participants to highlight aspects of their teamwork that were successful and effective.

In the Add part, students explored opportunities for improvement by suggesting new elements to introduce into their teamwork dynamics.

The Less component shows the aspect they considered less beneficial or obstacles that hindered teamwork.

TABLE IX
LESSONS LEARNED OUTCOME OF COACHED STUDENTS' TEAMS

Category	Feedback
Liked	<ul style="list-style-type: none"> • Coaching in general • Used tools & new concepts learned • Coaching in person • Conflict solutions tools • Project management examples • Better communication • "Therapy session" when faced with issues/problems
Learned	<ul style="list-style-type: none"> • How to distribute the work better in teams • Smaller internal deadlines • Tools and concepts
Lacked	<ul style="list-style-type: none"> • It was hard to schedule appointments with bigger teams • Team-related issue: Organization of documents at the end of the semesters (how to deal with the outcome; how to organize the document, etc.) • More coaching in person rather than online
Longed for	<ul style="list-style-type: none"> • More support for the project (more detailed project/topic-related support)

Note: The answers were translated from German to English

TABLE X
OUTCOME STUDENT FOCUS GROUPS

Category	Feedback
Keep	<ul style="list-style-type: none"> • Equally distributed work • Team spirit • Good organization
Add	<ul style="list-style-type: none"> • Set clear rules • More in-person meetings • Smaller internal deadlines
Less	<ul style="list-style-type: none"> • Do not take things personally • Do not procrastinate • Focus on your part
More	<ul style="list-style-type: none"> • Communication • Fun • Supporting other team members • More praise

Note: The answers were translated from German to English

Concluding the retrospective, the More phase encouraged participants to brainstorm additional elements that could further enhance their teamwork experience.

V. DISCUSSION AND CONCLUSION

A. Discussion

The following answers according to our research questions were found:

RQ 1: Which issues do students of the studied project management course indicate to contribute to project failure?

This question was answered through the pre-survey. The participants mentioned that the common issues why team projects fail are lack of motivation, communication, and engagement in organization and planning. These were the main categories summarized. It was also mentioned that if the people in a team are not motivated enough, they are not adhering to the rules and deadlines. Very often there is only one person in the team who wants the project to be successful. This person is very often doing most of the work. Communication was also emphasized as crucial. If there is no or bad communication, this could lead to insufficient contribution from one or more team members as well as conflict situations in teams. Also, bad communication can lead to misunderstanding. Additionally, uneven task distribution was identified as a significant barrier to successful team projects. Following the CHAOS reports [32] analyzing project failures in industry, students' team projects much like projects in industry tend to fail due to insufficient interpersonal skills like communication, organization, and planning. This finding corroborates an earlier study on the same project management course in higher education [26].

RQ 2: What did students of the project management course report to have learned from participating in the agile coaching techniques?

This question was answered by the outcome of the lessons learned sessions of the two teams that were coached, held at the end of the coaching sessions, as well as in the focus groups and from observing how the students interacted. In these sessions, two different retrospective techniques were used. The use of the 4L's and KALM methods proved highly effective outcomes and improvement points.

In the focus groups, it was mentioned that teams should keep the work equally distributed, the team spirit up as well as the good organization. The students would like to add to their teamwork more clear rules, more in-person meetings and to set smaller internal deadlines in order to achieve the main milestone. On the other side, students would also like to do less of taking things too personally. Communication, having fun, and supporting other team members were mentioned to be done more in teamwork. The KALM retrospective method not only provided a structured approach for teams to reflect on their teamwork but also created an interactive and collaborative environment during the workshop. By engaging the students in discussions about what to keep, to add, to do less, and to do more of, the KALM method empowered them to actively contribute to the continuous improvement of their teamwork

dynamics as well as their communication and collaboration within the team.

In the lessons learned sessions of the teams that were coached, students reported an improvement in planning and organizing tasks. The coaching interventions encouraged the teams to identify effective strategies for managing their work, which led to a more structured and feasible achievement of the project. Students learned to inspect and adapt their work through the retrospective session held after every milestone. The introduction of tools such as the online whiteboard and Kanban Boards during the coaching sessions helped students visualize tasks and workflows, leading to better transparency and efficiency in task management. Regular retrospective sessions fostered open communication, where team members could discuss issues and find better solutions. Also, teams were able to point out interpersonal conflicts and misunderstandings. Furthermore, team collaboration within the retrospective sessions contributed to a more supportive team environment.

The coaching helped the teams to better communicate, to better distribute the work and they learned new tools and concepts for organization, for planning and conflict management. Students mentioned that participating in these retrospective and coaching sessions not only enhanced their technical skills in project management but also their interpersonal skills such as communication, organization, and planning were positively influenced.

Finally, it was observed that these interventions highlighted the beneficial usage of agile coaching in enhancing not only project management skills but also communication and collaboration within teams.

B. Limitations

We are aware of certain factors that may limit the generalizability of our work. First, the sample size of 20 students is rather small, which is a common issue in educational settings. However, considering the given sample frame of 39 students, this study achieved a response rate far above the recommended 25% for small sample frames [33]. Second, this study may be subject to natural bias, as random assignment was not possible. Future work therefore includes performing the study with a larger sample size and in the context of other courses. Third, the timeframe of one semester may be considered rather short; researching coaching interventions for longer project work would be highly interesting and may be part of future research in a setting allowing for longer observation periods. Finally, the results of this research would greatly benefit from complementary qualitative research, such as in-depth interviews with students and teachers to gain a more-detailed understanding of their perspectives on coaching interventions.

C. Impact

Despite the small sample size, some significant hypotheses with presumably high impact can be derived.

Students who are supposed to work in teams tend not to come with sufficiently evolved professional skills to manage team assignments. In many cases, this may compromise their

expected team outcome. This can leave both students and instructors frustrated about teamwork and trying to avoid it whenever possible, with negative effects on graduates' teamwork competencies. As teamwork skills require experience and reflection to evolve [34], [35], a reduction of teamwork during bachelor studies would have unfortunate effects on graduates' employability.

Supportive means such as knowledge about the Tuckman process, the availability of collaborative project management tools, training in active listening and team communication as well as agile coaching techniques are examples of what to offer to students to facilitate teamwork and make team success more feasible. Knowing which skills and tools students feel they miss and what they perceive to block effective teamwork is considered to be key to implementing any supportive means that would be appreciated by students and assimilated into their teamwork endeavors across courses, projects, and jobs.

Agile team coaching turned out to be particularly useful for student-teams and a promising approach to follow up in practice as well as in accompanying research. Since the basic principles that apply to agile IT project management and agile team coaching are the same, the experiential learning in either of the application areas can reinforce the other leading to coherence and synergies.

Hence, the results emanating from investigating students' views on teamwork and its support by agile team coaching are considered as a significant contribution on the path to improve teamwork and increase project success in academia, as well as in industry.

D. Conclusion

In conclusion, this paper shows the key factors why team projects often fail and explores the efficacy of agile practices especially, retrospective techniques in a higher education area. The pre-survey findings indicated that team projects often fail because of a lack of motivation, bad or poor communication, and bad organization and planning. These issues often lead to conflicts between team members and to not well-distributed workload. The usage of agile retrospective techniques, especially the 4L's and KALM methods, improved the team dynamics. Coaching interventions played a role in addressing specific challenges and resulting in better teamwork and conflict resolution.

In the future, similar studies will be done to explore the effects of agile coaching interventions on teamwork as well as on inclusive education across computer science courses. Furthermore, the researchers investigate approaches to motivate staff and student-tutors to acquire and integrate agile coaching interventions as integral elements of their courses.

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REFERENCES

- [1] S. Losch, E. Traut-Mattausch, M. D. Muehlberger, and E. Jonas, "Comparing the effectiveness of individual coaching, self-coaching, and group training: How leadership makes the difference," *Front. Psychol.*, vol. 7, art. 629, 2016.
- [2] P. Plotkowski and J. Joseph, "Enhancing graduation rates through high impact activities: Experiential learning, engagement, mentoring, and scholarships," in *Proc. ASEE Annu. Conf. Expo.*, Vancouver, BC, Canada, 2011, pp. 22.618.1-22.618.9. doi: 10.18260/1-2-17899.
- [3] N. Thomas, J. Bystydziński, and A. Desai, "Changing institutional culture through peer mentoring of women STEM faculty," *Innov. High. Educ.*, vol. 40, pp. 143-157, 2014, doi: 10.1007/s10755-014-9300-9.
- [4] N. A. Brake and T. Selvaratnam, "Peer mentorship and a 3D printed design-build-test project: Enhancing the first year civil engineering experience," presented at the *2020 ASEE Virtual Annu. Conf. Content Access*, Virtual Online, Jun. 2020, doi: 10.18260/1-2-35045.
- [5] R. Kinzel, J. Veltsos, R. Bates, R. Cohen, W. Sealy, and D. Nykanen, "Evaluation and continuous improvement in a multidisciplinary S-STEM program focusing on professional skills, goals & mentoring," in *Proc. IEEE Front. Educ. Conf.*, 2015, pp. 1-7, doi: 10.1109/FIE.2015.7344343.
- [6] P. Gestwicki and B. McNely, "Interdisciplinary projects in the academic studio," *ACM Trans. Comput. Educ.*, vol. 16, pp. 1-24, 2016, doi: 10.1145/2732157.
- [7] A. Morales et al., "The role of customized mentoring in a successful STEM scholarship program for underrepresented groups," in *Proc. ASEE Annu. Conf. Expo.*, Columbus, OH, USA, Jun. 2017.
- [8] J. Aliu, C. Aigbavboa, and W. Thwala, "Role of industry employers in fostering employability skills," in *Proc. Int. Struct. Eng. Constr.*, vol. 6, 2019, doi: 10.14455/ISEC.res.2019.145.
- [9] P. Jacobs, "Computing MATTERS: Building pathways to cyberinfrastructure," in *Proc. 1st Conf. Extreme Sci. Eng. Discovery Environ. (XSEDE '12)*, New York, NY, USA: ACM, 2012, Art. no. 56, pp. 1-4. [Online]. Available: <https://doi.org/10.1145/2335755.2335854>.
- [10] E. Kloos and S. Furterer, "Designing an undergraduate engineering mentoring program to enhance gender diversity through application of Lean Six Sigma methods and tools," presented at the *ASEE Annu. Conf. Expo.*, 2019, doi: 10.18260/1-2-32615.
- [11] K. Lei et al., "Compass: Supporting large group mentorship in a chat-based UI," *Proc. ACM Hum.-Comput. Interact.*, vol. 7, no. CSCW1, Art. no. 37, pp. 1-25, Apr. 2023. [Online]. Available: <https://doi.org/10.1145/3579470>.
- [12] B. F. Martensen, D. K. Nykanen, M. C. Hart, and R. A. Bates, "Interdisciplinary STEM peer-mentoring and distance-based teams," presented at the *ASEE Annu. Conf. Expo.*, San Antonio, TX, USA, Jun. 2012, doi: 10.18260/1-2-21588.
- [13] C. R. Rogers, *Freedom to Learn for the 80's*, Merrill Publishing, Columbus, OH, USA, 1983.
- [14] S. Hoidn and M. Klemenčič, Eds., *Handbook of Student-Centered Learning and Instruction in Higher Education*, Routledge International Handbooks, London, UK, 2020.
- [15] J. H. D. Cornelius-White and R. Motschnig, "Person-Centered Learning," in N. M. Seel, Ed., *Encyclopedia of the Sciences of Learning*, Springer, 2012, ISBN 978-1-4419-1427-9.
- [16] J. Grenning et al., "Manifesto for Agile Software Development," Agile Alliance, 2001. [Online]. Available: www.agilemanifesto.org/, Accessed: Feb. 23, 2024.
- [17] P. Salza, P. Musmarra, and F. Ferrucci, "Agile Methodologies in Education: A Review, Agile and Lean Concepts for Teaching and Learning - Bringing Methodologies from Industry to the Classroom," *Springer*, 2019, pp. 25-46.
- [18] T. C. Krehbiel et al., "Agile Manifesto for Teaching and Learning," *The Journal of Effective Teaching*, vol. 17, no. 2, pp. 90-111, 2017.
- [19] K. Lundqvist, A. Ahmed, D. Fridman, and J.-G. Bernard, "Interdisciplinary Agile Teaching," in *Proc. 2019 IEEE Frontiers in Education Conference (FIE)*, Covington, KY, USA, 2019, pp. 1-8, doi: 10.1109/FIE43999.2019.9028544.
- [20] M. Müller-Amthor, G. Hagel, M. Gensheimer, and F. Huber, "Scrum Higher Education - The Scrum Master Supports as Solution-focused Coach," in *Proc. 2020 IEEE Global Engineering Education Conference (EDUCON)*, pp. 948-952, doi: 10.1109/EDUCON45650.2020.9125304.
- [21] A. M. Turcios-Esquivel, E. G. Avilés-Rabanales, and G. Sayeg-Sánchez, "Use of technology and Scrum as an agile methodology to favor the development of balanced teamwork enrichment skills in higher education subjects," in *Proc. 2023 IEEE Global Engineering Education Conference (EDUCON)*, Kuwait, Kuwait, 2023, pp. 1-3, doi: 10.1109/EDUCON54358.2023.10125262.
- [22] M. Neumann and L. Baumann, "Agile Methods in Higher Education: Adapting and Using eduScrum with Real World Projects," in *Proc. 2021 IEEE Frontiers in Education Conference (FIE)*, 2021, pp. 1-8, doi: 10.1109/FIE49875.2021.9637334.
- [23] K. Schwaber, "SCRUM Development Process," in J. Sutherland, C. Casanave, J. Miller, P. Patel, and G. Hollowell, Eds., *Business Object Design and Implementation*, Springer, London, 1997.
- [24] C. Böhm, R. Motschnig, and L. Obiagwu, "Constructive Communication in Teams that Succeed," in *Proc. 5th International Conference on Social Communication in the Real and Virtual World (CMEP 2014)*, Wroclaw, Poland, pp. 25-27, 2014.
- [25] R. Motschnig and J. H. D. Cornelius-White, "Person-Centered Theory and Practice: Small versus large student-centered courses," in *The Routledge International Handbook of Student-Centered Learning and Teaching in Higher Education*, S. Hoidn and M. Klemenčič, Eds., London, Routledge, pp. 269-289, 2021.
- [26] D. Dolezal and R. Motschnig, "What Makes Project Teams Succeed? Students' Post-COVID Perceptions on IT Project Management education Fostering Professional Skills," in *Proc. 2023 IEEE Frontiers in Education Conference (FIE)*, College Station, TX, USA, pp. 1-9, Oct. 2023, doi: 10.1109/FIE58773.2023.10343002.
- [27] CC2020 Task Force, "Computing Curricula 2020: Paradigms for Global Computing Education," Association for Computing Machinery, New York, NY, USA, 2020.
- [28] M. Jovanovic, A. Mesquida, N. Radaković, and A. Mas, "Agile retrospective games for different team development phases," *Journal of Universal Computer Science*, vol. 22, pp. 1489-1508, 2016, doi: 10.3217/jucs-022-12-1489.
- [29] A. Jones, "The Tuckman's Model Implementation, Effect, and Analysis & the New Development of Jones LSI Model on a Small Group," *Journal of Management*, vol. 6, no. 4, pp. 23-28, 2019. [Online]. Available: <https://ssrn.com/abstract=3525281>
- [30] AgileBox, "Liked, Learned, Lacked and Longed For - The 4Ls Retrospective," Available online: <https://agilebox.app/blog/4ls-retrospective/>, Accessed: Feb. 23, 2024.
- [31] Fun Retrospectives, "KALM: Keep, Add, More, Less," Available online: <https://www.funretrospectives.com/kalm-keep-add-more-less/>, Accessed: Feb. 23, 2024.
- [32] H. Portman, "Review Standish Group Chaos 2020: Beyond Infinity," *Henny Portman's Blog*, Jan. 6, 2021. [Online]. Available: <https://hennyportman.wordpress.com/2021/01/06/review-standish-group-chaos-2020-beyond-infinity/>, Accessed: May 10, 2024.
- [33] K. Fosnacht, S. Sarraf, E. Howe, and L. K. Peck, "How Important are High Response Rates for College Surveys?" *The Review of Higher Education*, vol. 40, no. 4, pp. 457-481, 2017. [Online]. Available: <https://doi.org/10.1353/rhe.2017.0003>
- [34] D. Baker, L. Horvath, M. Campion, L. Offermann, and E. Salas, "The ALL Teamwork Framework," in *Measuring Adult Literacy and Life Skills: New Frameworks for Assessment*, International Adult Literacy Survey, vol. 13, pp. 229-272, 2005.
- [35] D. W. Johnson and F. P. Johnson, *Joining Together: Group Theory and Group Skills*, Pearson Allyn and Bacon, 2006.