Fostering Agile IT Project Management and Interpersonal Skills Using AI-Enhanced Game-Based Learning

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***Abstract*—This research-to-practice full paper showcases the integration of AI-enhanced game-based learning in an IT project management course, aimed at improving students' Agile project management skills.**
We provide a qualitative analysis of students' reflections on teamwork in the IT project management course, alongside standardized course feedback. Students collaborate in teams of 5-7 on self-selected topics, creating coarse prototypes.
The analysis revealed key success factors in teamwork, including effective communication, apportionment of work, regular meetings, and high motivation. Barriers included poor time management, unproductive meetings, external obligations, and absenteeism. Course feedback was overwhelmingly positive, with students valuing the course structure, atmosphere, and lecturer. Suggestions for improvement focused on workload reduction.
Then, from these 48 teamwork reflections, we identify requirements for developing an AI-enhanced game-based project simulation platform. The main goal of the platform is to enhance the Agile skills of the students.
The course and prototype serve as valuable resources for educators and curriculum designers, with future work focusing on student evaluation and further AI integration.

***Index Terms*—AI-enhanced game-based learning, IT project management course, Agile skills.**

I. Introduction

The 21st century is shaped by digitization, which has had a lasting impact on the skills demanded by professionals - especially in the IT sector. Future skills, including digital, personal, and interpersonal skills, are more relevant than ever and should be considered and managed in every IT project which plays a fundamental role in the success of organizations and companies.

The significance of project management in computing education is highlighted by its inclusion in the ACM/IEEE Computing Curricula 2020, listed among the six knowledge areas within the "Users and Organizations" category [1]. Surveys conducted by the task group responsible for developing the ACM/IEEE Curriculum Guidelines in IT revealed that "project management" was rated as the most useful domain for IT professionals by mid-2020, with an appeal of 78%, followed by "cybersecurity skills" (73%) and "non-technical skills" (64%) [2]. The task group further mentioned that industry managers emphasize the importance of soft skills as a primary criterion for hiring IT graduates. They argue that while educational institutions are successful in teaching technical skills, they encounter challenges in providing students with non-technical or soft skills. This underlines the need for further research and the establishment of best practices in this domain.

To excel in this field, project managers are required to acquire technical expertise, strategic thinking, and communication skills. They must understand the IT systems, deal with challenges, and manage teams consisting of diverse technical professionals. To this aim, different project management methodologies such as Agile, Waterfall, or Scrum have been proposed in order to help project managers with their tasks.

Therefore, it is crucial for universities to prepare students for the challenges they will encounter in their future providing them with the needed skills.

Techniques that are becoming more and more relevant in this context are gamification and game-based learning. Gamification is a relatively modern term that refers to the practice of integrating game elements to tackle problems and engage audiences, and it has deep historical roots [3]. Broadly, gamification involves applying game design principles to non-game settings [4]. Market trends indicate significant growth in gamification, especially in education.

Game-based learning, differently from gamification, designs learning activities that are intrinsically game-like. Including these elements in education seems to be a natural choice to increase engagement and motivation. Thanks to the recent advancements of Artificial Intelligence (AI), and the availability of tools such as ChatGPT, game-based learning can be enhanced using an innovative approach that merges AI technology with the immersive engagement of games.

Motivated by these findings, in our paper we present the results of a qualitative content analysis of students' reflections on their teamwork experiences within the scope of a

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learner-centered IT project management course as well as an analysis of the standardized course feedback. This mandatory course is part of the undergraduate program of a large mid-European university and introduces students to the basics of IT project management with a focus on future skills, thus covering complementary topics such as giving and receiving feedback, active listening, and presentation techniques. Since the identified success factors aligned with the principles of Agile project management, we designed a prototype of a gamified AI-enhanced project simulation platform to immersively teach Agile project management. We conclude that personal, interpersonal, and digital skills play an essential role in modern teamwork and should therefore be explicitly addressed and reflected in project management education, while AI opens up new possibilities in the field of project management. The course as well as the prototype should serve as inspiration for researchers, instructors, and curriculum designers. Future work includes the evaluation of the developed prototype with students and exploring additional ways of utilizing AI in projects.

II. Background

A. Agile Project Management

The Agile framework [5] represents an iterative and adaptable approach to project management, particularly prevalent in IT and software development projects. It promotes collaboration, flexibility, and continuous feedback throughout the project lifecycle. In this framework, projects are broken down into small, manageable iterations, with each iteration delivering a product increment. Overall, Agile supports teams in delivering high-quality products more rapidly, adapting to changing requirements, and better satisfying customer and stakeholder needs. This framework has received increasing attention as testified by different works such as [6] where a framework is presented for teaching Scrum all semester in the IT project management course, without having students design software; or [7] which reports on a Master's level Agile project management class in which the entire course was converted to a Scrum-like structure. Other works only focus on examples of using Agile in project management with only one or two broad lessons and no examples of how to teach Agile or Scrum in the rest of the course [8]. These works, and references therein, differ from ours because they do not use game-based learning enhanced with the application of AI.

B. Game-based Learning

Many papers analyze the effects that game-based learning has on students. This approach has been used in combination with the concepts of flipped classrooms by introducing the game-based student response system Kahoot! into a flipped seminar course [9]. As a result, the authors report a significant increase in learning interest, learning attitude, and interaction. Moreover, the applicability of the game-based student response system Kahoot! has been analyzed on an object-oriented design course in a flipped classroom setting [10], and as a self-evaluation tool in a flipped, person-centered course on the introduction to C programming [11].

C. Artificial Intelligence

Nowadays, AI is becoming increasingly important in many fields (see, e.g., [12], [13]). In education, AI-enhanced game-based learning methods exploit application programming interfaces (API) provided by AI frameworks to tailor learning experiences to individual students [14]. Thanks to the possibility of adding the required functionalities to our own applications, products, or services, we can adapt content to students' learning pace, and offer challenges that match their skill levels. The recent introduction of the Generative Pre-trained Transformers (GPT) increased the integration of AI into educational games [15]. However, our work is novel because it presents the prototype of a game rather than a model for delivering Agile Scrum training through an assistive web-based conversational service [16].

D. Research Questions

The first research question aims to compare the results of the most recent course edition to those of our last study [17], considering and evaluating new adjustments made to the course:

RQ1: What factors of success and challenges of teamwork do students identify when planning an IT project?

Since some students expressed a wish for a focus on Agile project management in our last course edition [17], we decided to investigate this matter further:

RQ2: In how far do students see methods of Agile project management as a useful addition to an introductory course in project management?

RQ2: How can a web-based and AI-enhanced platform using a game-based learning approach be developed to playfully teach the basics of Agile project management?

III. Methods

A. Course Description

The course project management is part of the bachelor's degree program in computer science and encompasses 3 European Credit Transfer and Accumulation System (ECTS) credits. This mandatory course, which was addressed in prior studies [17]–[19], introduces students to the foundations of traditional project management. It is usually attended in the 3rd semester but is also offered in the summer term. Students are introduced to basic project management methods, such as the definition of requirements, work breakdown structures, and software development estimation. However, another important aim of the course is to foster students' personal and interpersonal skills by providing them the freedom to work in groups on self-selected projects that are developed from simple requirements specifications to functional specifications, including a project plan and designed mock-ups of the software. This is in accordance with the guidelines for computer science curricula by the ACM/IEEE, which suggest that the learners' communication skills should be fostered in project settings

[20]. Furthermore, it aligns with the recommended strategy to combine the acquisition of future skills with subject- and content-related knowledge and skills [21]–[24], which in this case is project management.

Since student-centered approaches [22], [25]–[27] and self-directed [28] as well as self-regulated learning [29] were found to facilitate the development of non-cognitive skills, this course employs a learner-centered approach with a high degree of freedom and autonomy for the project teams of 5-7 students. To support this self-driven approach, the course is organized to follow a biweekly lesson plan, resulting in a course plan as indicated in Table I. The course starts with an introduction to project management, which is complemented by theories of learning. During the first session, students are given enough time to form groups of 5-7 and do a brainstorming on possible ideas for their self-selected IT projects. After the kick-off session, students keep being introduced to new topics of project management and are given the opportunity to directly apply the learned methods in their own projects during the following self-study week(s). After each of the first six sessions, they are given the possibility to submit a written reflection on the unit, amounting up to 15% of their grade. The project work is divided into three milestones, which award 20% each. Each project team is asked to present once for another 10%. The remaining 15% can be achieved individually by specializing in a self-chosen topic of project management and writing a report. Notably, the course targets fostering students' non-cognitive skills by actively including complementary topics like active listening, giving constructive feedback, and giving students the possibility to present the current status of their project in front of the class. On that note, unit 5 involves a workshop with an external expert on teamwork, in which students reflect on their current teamwork and aim to improve it – this is an addition to the last course edition. Unit 6 provides students the opportunity to present their projects in the setting of a "review bazaar", in which the teacher and invited experts from the industry get to experience the projects and prototypes and provide feedback, followed by showcases of Agile project management presented by the guests. The final unit is reserved for submission interviews, in which the project teams explain their work individually in order to detect possible free riders.

Using a learner-centered approach, the students are actively included as much as possible in the course design itself using discussions, written reflections – which are read and considered by the teacher before the next unit –, and interactive sequences, such as quick surveys, exercises, and the aforementioned workshop with experts from the industry.

TABLE I: Project Management Course Plan of Winter Term 2022/23

Unit	Topics	Submission
1	Course organization, kick-off, introduction into project management, learning theory, group formation, topic brainstorming	Reflection (5%)
2	Active listening, giving & receiving constructive feedback, project initiation, project goals, requirements, stakeholder analysis	Reflection (5%), presentation of 1-2 teams (10%)
3	Project structuring, work breakdown structure, risk management, software development estimation	Milestone 1 (20%), Reflection (5%), presentation of 1-2 teams (10%)
4	Project planning, project schedules, milestone plan, resource & cost estimation, project planning tools	Reflection (5%), presentation of 1-2 teams (10%)
5	Project coordination & controlling, guest lecture / workshop about teamwork	Milestone 2 (20%), Reflection (5%), presentation of 1-2 teams (10%)
6	Review bazaar workshop, guest lecture about Agile project management	Milestone 3 (20%), Reflection (5%)
7	Submission interviews in time slots	Submission interview, individual reports (15%)

B. Research Design and Instruments

Using a mixed methods research design and a realist approach [30], we combined quantitative and qualitative instruments to gain deep insights into our course participants' perspectives. To answer our research questions, we therefore employed the following research instruments:

1) Pre-Course Survey: To find out more about our course participants, we collected background data about our students using an anonymous survey in the first unit of the course. The same questionnaire was used as in our last course edition [17]. Participation was voluntary. The results were discussed in class immediately after the survey, as another goal of the survey was to also address students' expectations and worries regarding the course.

2) Teamwork Reflection Form: We used the survey of our last study [17] to explore the new cohort's perspective on the success factors and challenges of teamwork. The questionnaire was answered by the students after the final submission interviews.

3) Analysis of Written Reflection: To investigate our students' opinions on Agile project management, we analyzed their written reflections on the workshop and guest lecture on Agile project management. Students were asked to submit 150-300 words reflecting on the workshop and the course itself.

4) Prototype Development: To address students' feedback on the last course edition, we iteratively developed a prototype of an AI-enhanced, game-based web platform to teach the basics of Agile project management. The third author developed the prototype in the course of his master's thesis [31], while the first and second authors provided feedback and support regarding the definition of the requirements. The development process itself followed an Agile approach, namely Scrum. The frontend was written in TypeScript using Next.js [32], which is a framework for React [33], while the backend was built on Convex [34], a backend-as-a-service. As for the large language model, it was decided upon the new GPT-4o model API by OpenAI [35], as our tests showed that it seemed to provide the best balance between accessibility, simplicity, response time, rate limits, and dialog ability as a dungeon master. In-game visualizations are generated using DALL·E 2 [36].

C. Data Analysis

The pre-course survey was carried out using the anonymous feedback activity on Moodle; no further data handling was therefore required.

The teamwork reflection forms were filled out by hand; the forms were therefore digitized and analyzed in Microsoft Excel. A qualitative content analysis [37] was carried out by the first author to reasonably group and aggregate students' reported success factors and challenges. For this, the provided text was divided into units of analysis, which were defined as a coherent sequence of words or sentences. The categories were defined deductively based on our previous study [17], while the codes were abstracted inductively to detect possible new factors and finally assigned to the given categories. The data indicated that no adjustments to the categories were necessary.

The written reflections were conducted using Moodle text submissions. They were aggregated and labeled in Microsoft Word by the first author, whereby three different labels were used: "positive attitude towards a workshop on Agile project management", "positive attitude towards Agile project management", and "suggestion for improvement". The suggestions for improvement were further analyzed to find out whether they addressed Agile project management in order to investigate our students' perspectives on this topic.

D. Course Participants

Table II shows the basic characteristics of the students who attended the project management course in the winter term 2022/23, collected using the anonymous pre-course survey in the first unit of the course. Similar to the previously analyzed edition of the course [17], a lot of students reported working alongside their studies, amounting to up to 40% of the responses. 47% of the respondents stated to have never worked on a project before. 30% of the students reported having medium to high previous knowledge of project management. While most students expressed a positive attitude towards working in teams, 16% of the respondents stated to (rather) not like working in teams. Overall, the students did not show notable differences compared to previous cohorts [17]; it was a rather balanced sample with a generally positive attitude towards projects and teamwork. Unfortunately, only 15% of the course attendees were female.

TABLE II: Description of Students Attending the Project Management Course in Winter Term 2022/23 Based on an Anonymous Pre-Course Survey (N=48)

Characteristic		n (%)
Gender		
	male	41 (85%)
	female	7 (15%)
Employment		
	working alongside studies	17 (35%)
	not working alongside studies	26 (54%)
	N/A	5 (10%)
Experience in project work		
	worked in projects before	23 (48%)
	not worked in projects before	20 (42%)
	N/A	5 (10%)
Previous knowledge of project management		
	high	2 (4%)
	rather high	1 (2%)
	medium	10 (21%)
	rather low	12 (25%)
	low	18 (38%)
	N/A	5 (10%)
Teamwork affinity		
	likes working in teams	9 (19%)
	rather likes working in teams	10 (21)
	moderately likes working in teams	17 (35%)
	does rather not like working in teams	5 (10%)
	does not like working in teams	2 (4%)
	N/A	5 (10%)

Note. Students who were absent in the first unit or did not provide an answer were coded as "N/A". The same questionnaire was used as in [17].

IV. Results and Interpretation

A. Teamwork Survey

Table III shows students' reported factors of success for their teamwork. All 48 students filled out the teamwork reflection form. Compared to our analysis of a previous course edition [17], project management-related skills made up the largest category, including a good apportionment of work, meetings, time management, a designated project manager, organization in general, utilizing team members' specific strengths and weaknesses, reviews, digital tools, proper preparation, and having the same goals. A deeper analysis of students' answers reveals that many answers may be a result of the workshop on teamwork – for instance, one student named restructuring the meetings based on the findings of the workshop a success factor. This could explain the difference compared to our previous analysis, in which interpersonal skills were the most mentioned success factor.

Interpersonal skills were the second most common category. Reported success factors of this category addressed communication, conflict resolution, reliability, cooperation, respect, support, trust, understanding, and friendship. The found codes were therefore very similar to our previous study [17], in which communication was also the most mentioned factor of success, highlighting the important contribution of interpersonal skills to a project's success.

The last category encompasses skills attributed to an individual, namely personal skills. Identified factors of success were motivation, fun, friendliness, openness, interest in the topic, personal responsibility, self-reliance, honesty, and initiative. While motivation was also the most common factor of success in our previous analysis [17], the other factors were slightly different.

Students reported challenges of teamwork can be seen in Table IV. Similar as in our previous analysis [17], most students reported having encountered no challenges at all, indicated by not providing an answer or explicitly stating so. This time, project management-related factors represented the most frequent category, which included unproductive meetings, bad time management, bad task allocation, and getting lost in details. While time management was a challenge that was also named in our previous study, the other challenges were novel.

External factors comprised issues that could not be directly

TABLE III: Qualitative Content Analysis of Teamwork Success Factors

Category / Code	Exemplary Answer	Count
Project management related methodological skills		80
Apportionment of work	Good / fair task allocation	30
Meetings	Regular meetings	11
Time management	Clear deadlines	9
Project manager	A good team leader	7
Organization	Structured organization & planning	6
Using team members' potential	Strengths and weaknesses were considered	4
Reviews	Everyone reviewed 2 team members	4
Digital tools	Especially online (e.g. using Discord)	4
Preparation	Clarifying everything before starting	3
Same goals	Common vision of the product and what has to be done in the project	2
Interpersonal skills		57
Communication	Communication: It is always possible that something comes up. It is important to communicate if something is wrong.	31
Conflict resolution	Making a compromise	5
Reliability	Keeping promises / fulfilling assignments	5
Cooperation	Cooperation	4
Respect	Mutual respect	4
Support	Mutual support	3
Trust	Trust	2
Understanding	Understanding	2
Friendship	Friendship	1
Personal skills		37
Motivation	Motivation of all team members	10
Fun	Fun in doing the project	6
Friendliness	Everybody was collegial, friendly	5
Openness	Open for ideas / suggestions	4
Topic	A topic that was interesting for all team members	4
Personal responsibility	Team members with a sense of responsibility	4
Self-reliance	Independent work of each individual team member	2
Honesty	Honesty	1
Initiative	Initiative	1

Note. Answers were translated from German. The same questionnaire was used as in [17].

TABLE IV: Qualitative Content Analysis of Challenges of Teamwork

Category / Code	Exemplary Answer	Count
No reported challenges		19
n/a	(no answer given)	13
No	No, there were none	6
Project management related methodological skills		16
Unproductive meetings	As our meetings tend to last long (7-8 hours), the concentration loss could be felt, especially when our conversation went in other direction	7
Bad time management	Sometimes parts of the project were done rather close to the deadline (teamwide)	7
Bad task allocation	Nobody knew their tasks	1
Lost in details	We often got lost in details	1
External factors		14
Other responsibilities	Lack of time (private)	5
Work	Due to work we had to move our appointment	3
Absence	That once someone could not attend a meeting	3
Other courses	Deadlines for other courses	2
Unclear assignment	Partly unclear assignment	1
Personal and interpersonal factors		8
Communication issues	Lacking communication	4
Conflict resolution	It was difficult to consider every opinion and find a good compromise	1
Distance	Distance to each other was large	1
Procrastination	Procrastination	1
Concentration	Concentration	1

Note. Answers were translated from German. The same questionnaire was used as in [17].

linked to project management or personal/interpersonal skills. They accounted for the second most reported challenges. This category includes other responsibilities, work-related issues, absence, other courses, and an unclear assignment description. Considering the rise of this category compared to our last year's analysis [17], it seems that students had to face more challenges outside the course or their responsibility – although COVID was not an issue anymore.

Compared to our previous study [17], personal and interpersonal factors were the least mentioned category of challenges, including communication issues, issues regarding conflict resolution, distance, procrastination, and concentration. This could be another effect of the workshop on teamwork, which could have contributed to a more positive atmosphere and better, more effective teamwork.

B. Analysis of Written Reflection

Since the most frequent category of challenges was related to project management and methodological skills, we were especially interested in students' feedback on the workshop on Agile project management, as methods of Agile project management could help facing students' mentioned challenges.

Our analysis of students' written reflections, which were 18 in total, revealed the following findings:

- 18 (100%) written reflections mentioned the Agile project management workshop positively
- 6 (33%) written reflections explicitly expressed their interest in Agile project management
- 11 (61%) written reflections provided suggestions for improvement for the course, two of which (11%) explicitly asked for tighter integration of Agile project management in the course

We took our students' feedback as inspiration and therefore aimed for a tighter integration of Agile project management in our course. To consider the tight schedule of the course, the approach should be efficient. After several iterations of brainstorming, we decided on a novel, game-based, and AI-supported approach to playfully introduce our students to the foundations of Agile project management.

C. Prototype of a Game-Based AI-Supported Platform

Based on our findings and students' feedback, we developed a prototype of an AI-enhanced, game-based web platform with the goal of teaching the basics of project management. A detailed description can be found in [31]. Our idea is to use AI-enhanced, game-based learning to foster students' collaboration and problem-solving skills by interacting with and in a virtual world and encountering and overcoming challenges together. This approach holds great potential by making learning more dynamic, adaptive, as well as enjoyable, thus helping students to achieve a deeper understanding and mastery of complex concepts, but fostering their personal

and interpersonal competencies at the same time. While the prototype itself was designed to be operated by one person, the idea is to play the game in a group in front of the same device, discussing and making decisions in teams.

The overall setting of the game uses a Science-Fiction scenario in which the player is responsible for the success of a mission (project). At the beginning of the game, the player may choose between the three Scrum roles, namely Scrum master, product owner, and developer. After a short introduction and tutorial, the AI generates a scenario and story of a mission in a Sci-Fi setting, e.g. a spaceship crew is sent to civilize a new planet. The AI therefore assumes the role of a game master comparable to common tabletop or pen-and-paper role-playing games. Fig. 1 shows the main interface of the game.

The middle column displays the sprint logbook, which presents users with the scenario and the latest turn of events. After each story sequence, the player has several possibilities to interact with the AI and influence the progress of the story, whereby the overall goal is to complete the mission in time by burning all story points within 14 in-game days – a typical duration of a sprint in Scrum. The first way of interaction is by making a decision after each story sequence. The AI offers the player five possible decisions that can be made to continue the story, the success of which will be determined by rolling a six-sided die. The initial version of the prototype did not involve those five AI-generated suggestions; the player was rather encouraged to enter their decision or interaction as full text which was interpreted by the AI. However, after careful consideration, we decided to keep the interaction as simple as possible, as some players might not know what decisions could be even made, causing them to stop playing. Fig. 2 displays the explanations of the tutorial presented to players at the beginning of the game.

The team panel on the left-hand side of the interface visualizes the current stage of the story using an AI-generated image. Furthermore, it shows the current level and experience points the player has accumulated throughout the game so far. Moreover, it allows the player to activate three skills, which can be used once during the game and have to be unlocked by leveling up, embodying the second type of interaction offered to players. Finally, the player can confer with the other team members, who are non-playable characters that are also controlled by the AI and aware of the current turn of events. This represents the third and last type of possible interaction. The explanations of the team panel presented to players in the tutorial can be seen in Fig. 3.

The current status of the project's progress is displayed in the project panel on the right-hand side, visualized in a burndown chart covering the 14 in-game days. The progress of the burndown chart is determined by the decisions made by the player and the respective dice rolls. The glossary grows as the story progresses and allows players access to explanations of all discovered Agile project management terms, such as sprint and scrum master. Finally, the timer shows the remaining time before the game ends automatically. It is initialized with 15 minutes, the typical duration of a Scrum standup meeting. The tutorial is presented in Fig. 4.

The game ends when the player manages to burn all story points, thus successfully completing the mission, the timer ends, or the 14 in-game days have passed. Finally, the player is placed in a leaderboard ranked by collected experience.

The used database scheme can be seen in Fig. 5. The game session is stored in the table scenarios, while each story stage is persisted in the entity entries. The AI-generated visualizations of the latest events are saved in the table visualizations, while the project's progress is represented by the table progress. The table glossary contains all available entries of the glossary, which are unlocked per session by the tutorials table. Finally, the table leaderboard stores the players' scores.

D. Preliminary Evaluation

A pilot workshop carried out with 30 undergraduate students attending the project management course in the summer term 2024 revealed several promising and interesting results [31]:

- 19 of 22 respondents reported a positive player experience
- 18 of 22 respondents stated that playing the game contributed to their learning
- 21 of 22 respondents perceived a growth in their understanding of the Agile framework Scrum
- Students' biggest point of criticism was the time pressure posed by the 15-minute timer

V. Discussion

A. Findings

We found the following answers to our research questions:

RQ1: What factors of success and challenges of teamwork do students identify when planning an IT project?

We found that students' reported success factors were similar to our last study's results [17], but differed in some details. The most common success factors were communication, a good apportionment of work, motivation, meetings, and time management, four of which correspond to our previous findings. The novel factor "meetings" seems to be a result of the newly introduced workshop on teamwork, in which meeting culture was discussed. 54% of the named factors correspond to personal and interpersonal skills, while the remaining 46% rather address the "hard skills".

Students' identified challenges of teamwork mostly revolved around project management methods and external factors; the most reported barriers were unproductive meetings, bad time management, other responsibilities, and communication issues. Personal and interpersonal skills were notably less present (14%) compared to the previous course edition (26%) [17], which could be another positive effect of the teamwork workshop.

RQ2: In how far do students see methods of Agile project management as a useful addition to an introductory course in project management?

In light of the positive feedback on the workshop on Agile project management, we strongly believe in our students'

Fig. 1: Main Interface of AI-Enhanced Game-Based Web Platform [31]

Fig. 2: Content Area of AI-Enhanced Web Platform [31]

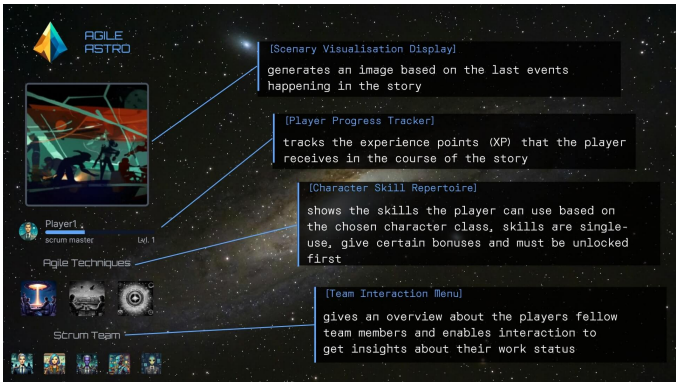

Fig. 3: Team Panel of AI-Enhanced Web Platform [31]

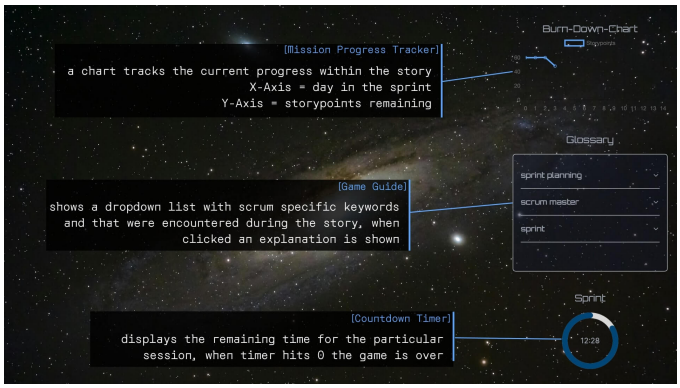

Fig. 4: Project Panel of AI-Enhanced Web Platform [31]

appreciation of the provided value of Agile methods. All 18 provided reflections mentioned the workshop positively, while 6 students explicitly expressed their interest in the topic of Agile project management. 2 students even suggested a tighter integration of Agile methods in the course.

RQ3: How can a web-based and AI-enhanced platform using a game-based learning approach be developed to playfully teach the basics of Agile project management?

We developed a prototype of an AI-enhanced, game-based platform with the aim of teaching Agile project management in a joyful manner. The prototype was developed in React, Convex, and the GPT-4o model using an Agile and iterative approach. The functional prototype uses AI to generate an

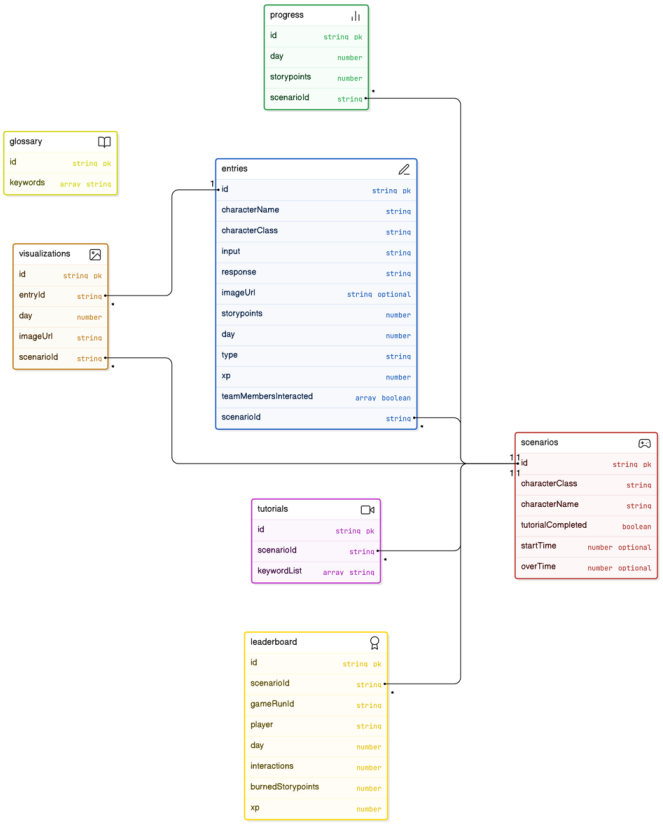

Fig. 5: Database Schema of AI-Enhanced Game-Based Web Platform [31]

immersive Sci-Fi story in which the player assumes one of the three Scrum roles and is tasked to fulfill a mission, the project. The player then interacts with the AI which assumes the role of the game master. Based on the player's decisions, the project and story progress, eventually burning enough story points to complete the mission or failing the project if time runs out.

B. Limitations

While we are convinced of the promising results of this study, certain limitations to this work exist. First, the sample size of 48 could be considered rather small, limiting the generalizability of the results. However, the response rates of 90% and 100% respectively are far above the recommended rate of 25% for small sample frames [38]. Second, this study is subject to natural bias, as random assignment is not possible and/or feasible. Finally, this study was carried out in a large mid-European city; further studies in different settings and at different universities would be highly interesting.

Regarding the prototype itself, the scope had to be well-defined to keep the development of a first minimum viable product (MVP) feasible. Hence, we are aware of several additional features and improvement measures that would provide great additional value to it. First, a multiplayer version of the platform would enable playing the game in an online setting, extending the prototype's area of application to distance learning scenarios. Second, the prototype still misses performance, load, and cost optimization – currently, a single average play session of 15 minutes consumes tokens and runtime worth about 0.50€. Finally, several extensions could provide an even better learning and gaming experience, such as opening the prototype to additional genres (e.g., fantasy), supporting additional subjects other than project management, and implementing more in-game learning opportunities, such as quizzes. However, we still strongly believe that this MVP is a great first step in the direction of game-based AI-supported learning and thus a great contribution to the field of technology-enhanced and student-centered education.

VI. Conclusion

We investigated students' reported success factors and challenges when working in teams to plan a self-selected IT-project. Project management plays an important part in the education of tomorrow's engineers as most software systems are not developed by a single individual but rather project teams. Therefore, it is not only important to possess relevant project management skills, but also essential personal and interpersonal skills, which is the overall goal of the investigated course. This is supported by the results of this study: We found that students' reported success factors were almost equally attributed to project management skills as well as (inter-)personal skills. Reported challenges mostly addressed project management and external factors. The observed differences compared to our previous research [17] could be a result of the introduced workshop on teamwork, the follow-up of which is the subject of another study [39].

The developed prototype using AI to create a game-based environment aimed at teaching Agile methods and interpersonal skills at the same time looks promising and will be further investigated and tested with students (e.g., the effect of chance on decisions and modifications to the timer). Possible future work also includes repeating the study at other universities or with future cohorts to observe trends or the introduction of additional AI-driven technologies, e.g. to further support students in managing and working on their projects.

To conclude, we believe that the developed prototype and AI in general can provide a valuable contribution to the progression of technology-enhanced and student-centered learning, not only teaching subject-related knowledge and skills but also essential personal and interpersonal skills.

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