Designing a Gamified Learning Tool for Enhancing Project Monitoring Skills in Technical Engineering Projects: An Interdisciplinary Approach Integrating Project Management and Systems Engineering.

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Abstract: Within project management and systems engineering there are five process groups. While the theory related to these groups is covered well in higher education, there is limited room to explore challenges that mimic the execution and monitoring of real-world engineering projects. The main reason this step is usually left behind, is the high variability during the execution. This gap in education limits the student's ability to grasp the dynamic nature of project execution, where progress must be tracked, risks mitigated, and baselines for scope, time, and cost frequently adjusted. Since various studies in recent years have described the benefits of gamification in education, a gamified learning tool to enhance project monitoring skills could help in the teaching of the execution process group of a project. The aim of this study is to create a boardgame that uses the best project management and systems engineering practices from the execution and monitoring process groups. In this way, students can use the safe environment provided by the game to gain experience. The boardgame will be based on the best practices and challenges of project management and systems engineering, as well as the best practices of gamification and the interdisciplinary approach. The review also covers a look into previously developed serious games and the best ways to track learning outcomes. The game aims to be customizable to simulate different real-world scenarios to allow for diverse projects in the technical engineering field.

Keywords: project management, systems engineering, gamification, game-based learning

1. Introduction

Project management and systems engineering are two important aspects of real-world engineering projects, which is why they are thought at various universities. Most of these studies focus heavily on the initiation and planning process groups. However, to fully grasp the extend of the theoretical instructions, experiential learning is required. It allows students to understand and appreciate the dynamic nature of project execution, and teaches them to track progress, mitigate risk, and adjust baselines for scope, time and costs. (Project Management Institute (PMI), 2022)

A lack of knowledge in this regard can lead to problems such as missed deadlines, compromised quality, and overrun costs. It is therefore important that these skills are thought to students through innovative teaching methods. One such solution lies with gamification principles. By simulating a realistic project scenario, using adaptive dashboards, students can have an engaging learning experience where they participate in a practical project management scenario.

The goal of this project is to incorporate challenges and best practices from project management and systems engineering into a game that allows students to develop the skills necessary to properly react in the monitoring process group of a real-world project. The game should be adaptive and thereby simulate multiple real-world scenarios.

2. Approach

To create a gamified learning tool that helps students to understand the monitoring process group of project management and systems engineering, one must first understand the challenges and best practices from that monitoring process group. To achieve this, an in-depth literature review has been conducted, covering topics such as: project monitoring in project management and systems engineering; dashboards in project management; project management education; systems engineering education; gamification in education; serious games and learning outcomes; and interdisciplinary approaches to education in technical fields. In these topics different search quarries were created to answer certain questions. The quarries were then sorted both on the number of citations and on the most recent publications. The papers that seemed relevant, based on the content in their abstracts and conclusion, were then analysed in greater detail to answer the questions at hand. After this analysis the game will be created incorporating the above-mentioned challenges and best practices.

3. Learning Goals

The aim of this project is to give students the opportunity to practice with the execution of a project, without having to spend a lot of real resources on set project. However, to actually learn useful project management and systems engineering skills, there should be more defined learning goals to strive for.

Olechowski, Oehmen, Seering, & Ben-Dava (2016) provided one such source of proper learning goals that can be derived from the ISO 31000:2009 on risk management. In those principles it is states that risk management should create value; be an integral part of organizational processes; be part of decision making; explicitly address uncertainty; be systematic, structured and timely; be based on the best available information; be tailored; take human and cultural factors into account; be transparent and inclusive; be dynamic, iterative and responsive to change; and facilitate continual improvement. While there is a reasonable chance that not all of the above listed principles will be reached, the players should be able to incorporate the ISO principles in future projects after playing the gamified learning tool.

4. Octalysis

A good way to create a gamified learning tool is by the principles of Octalysis. (Chou, 2015) The Octalysis framework has eight core drives, including epic meaning; accomplishment; empowerment; ownership; social influence; scarcity; unpredictability; and avoidance. The principle in Octalysis is that these core drives are the drives people experience to do anything. By filling out the Octalysis tool and creating different ways to motivate students, the game should help to keep students engaged in the Project Monitoring Game (PMG).

Figure 1: Octalysis chart of the Project Monitoring Game

The eight core drives each help in a different way to keep someone engaged. Epic meaning gives the player the feeling like they were chosen for a greater purpose. It accounts for things that are greater than the player themselves. In the PMG this core drive will be achieved with story telling aspects, as the players will be in charge of the monitoring of a project that would suggest a life-saving situation. This will cause the players to feel a 'bigger than themselves' responsibility.

Accomplishment is all about the internal drive to make progress and overcoming challenges. The PMG will pursue this core drive by creating challenging aspects in the game and rewarding the players with checkpoints.

Additionally, in learning environments with multiple groups, there will be a leaderboard which will motivate the players to achieve better results.

Empowerment drives players by giving them creative freedom and feedback on their choices. In the PMG the players will attain this core drive by gaining more options as the game progresses. Each of these options will have a certain risk and reward. By having a game with many solutions, the players get to feel that their choices matter. An example could be the use of a special card, after a certain threshold is reached.

Ownership is the drive someone has to accumulate wealth and is accomplished when the player owns something and has the ability to make what they own better or get more of it. In the PMG, the players will be the owners of their projects, and have visual resources, such as tokens for money, various valuable assets that are needed for the project and cards they are able to play or obtain. By playing certain cards, the players will be able to gather more resources, while other cards might prevent them from loosing resources.

Social influence as a core drive accounts for all social elements that drive people. For the PMG this will mostly incorporate the team effort that the players will have, as they will all work together to reach a positive end state of the PMG.

The core drive scarcity regards wanting things but not being able to have them. The PMG will incorporate this core drive by having limited amounts of certain resources, which can only be obtained once during the game. This could include special onetime cards, or an exclusive bonus where the players have to pick one of three options.

By not knowing what will happen next, the unpredictability core drive will be achieved. It is all about the curiosity of the unknown. The PMG will incorporate this with the many variabilities that can be encountered in the game. The cards the players have access to will be distributed and drawn at random, and events that can occur during the game will also be determined with a certain randomness.

The last core drive is avoidance. Which is the drive to do something in order to avoid negative consequences. This core drive has not been fully analysed and incorporated for the PMG. When creating an actual game, this core drive is often not what creators want to incorporate, as it generally has negative connotations. However, it could be incorporated with a story aspect, at which point it ties in closely to the epic meaning core drive.

5. Game prospect

The game should consist of a dashboard, that clearly indicates various aspects of real-world aspects of project management. Among the aspects included should be scope, time, and cost. There should also be a clear indication of what risks are taken, and which are avoided. This will be done by visual indicators, such as tokens on trackers, cards on certain areas, and pawns on certain fields.

The game will generally be set in three stages. The first stages will in learning environments be set by a teacher or supervisor. This will include the timeframe in which the project should be finished, what requirements should be met at the end, and what limitations the project has. Overall, phase one will try to mimic the planning process group of a real project. For a version of this project that is more of a game, the first stage could include more of a play-style similar to phase two, but this still has to be figured out.

In the second phase of the game, the players will be able to play cards to act as preventative measures. At certain intervals the players will encounter events, which will influence the dashboard. Certain events could be countered by certain preventative measures, while other events can only be handled after the fact. These steps of encountering events, and reacting to those events, as well as trying to prevent upcoming events will be the core of the second phase of the game. The details of playing cards and events still have to be determined.

In the third phase of the game, the players will be able to reap their rewards. Effort that was put in could be converted into points, while preventative measures that were needless could be seen as losses. The exact detail of this pointing system is still to be sorted out.

Ethics declaration

There were no participants involved in the creation of the initial PMG. This research and proposed testing will be reviewed by the Natural Sciences and Engineering Sciences (NES) ethics committee, before any testing with human participants will be conducted.

AI declaration

No artificial intelligence has been used in the creation of this paper.

References

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