The team's approach to management and structure has evolved throughout the project to support the changing needs and risks for each assessment. As the project has progressed each member's strengths have become more apparent and hence changes were made to the structure to best utilise each member's skills. Our knowledge of software engineering and team management evolved throughout the project also, from knowledge gained through lectures, reading literature and feedback on previous assessments, making us able to use this new understanding to make improvements. We decided to use the Capability Maturity Model Integration (CMMI) [1] to continually develop our approach.

At the beginning of the process, we knew little about each team member's strengths and weaknesses besides what we had learnt from group discussions and the Myers-Briggs personality tests [2]. The team was unstructured and was at the lowest maturity level of CMMI (level 1). However, following the personality test results and group discussions we devised a clear organisational structure with Theo taking on the role as 'Scrum Master' [3] and Team Leader; being the one best suited to a managerial role. The rest of the team were assigned roles in pairs that best suited them based on results from the personality tests. This helped us move towards maturity level 2 for the following assessments. Few structural changes were made as the project progressed; demonstrating that all team members were well assigned despite the initial lack of knowledge.

The decision to assign two lead developers for Assessment 2 was made to obtain a clear hierarchy in the team. This meant that development could proceed swiftly following the concrete plan of action [4]. As well as this, with the new briefs for each assessment, it was important that we had a clear approach to managing the differing risks and requirements. Hence for Assessment 3 Matthew Dunn was appointed Method Manager [3] to ensure that we had a clear and structured approach for management of any future changes. In line with the implementation of a Method Manager, team members were given new responsibilities to ensure all changes were made clear in the documentation we produced. A Risk Manager and Product Owner were assigned [3] to make sure that updates were made to the risk and requirements documentation, as well as providing detailed justifications as to why these changes were necessary. This change was made to accommodate the feedback received on Assessment 2, especially by relating our changes back to the Requirements in a clearer fashion and also by including better justification of choices made throughout the development cycle. This was all part of project monitoring and control [5]; which is a key process area in CMMI that helped the team reach maturity level 2.

For Assessments 3 and 4 there was a change in development behaviour from 'packs' to lead-dev pairs as the team decided that having individual team members work on their own sections was not the most productive. We found that some members of the team had a better understanding of the programming aspect of the project, and so we paired them up with a less able member. This allowed them to both contribute without feeling overwhelmed but also to give them a chance to improve and learn whilst not having a negative impact on the team and productivity as a whole. We found this to be highly successful, despite the fact that the development may have taken slightly longer than if it were one or two people doing it alone. We were able to get a broader range of ideas and contributions leading to a more rounded and well thought out code base. Organisational training is a key process area at maturity level 3 of CMMI [5], further demonstrating how this strategy helped the team to develop.

For Assessment 4, team members worked in pairs to complete the game and the supporting documentation. Team members were assigned roles that best suited their strengths and knowledge. For example, Matthew Dunn worked on improving the AI player as this is what he had worked on previously, while Mik and Julia play tested to find any potential bugs due to their in-depth knowledge of the requirements. This helped us to reduce the amount of time spent doing managerial and planning activities, leaving the teams to work mostly autonomously. This was even more important due to the fact that a large proportion of the time allocated for this section was during the holiday period meaning we weren't able to have whole team meetings. The lead-dev pairs worked well for this as they were able to confidently get on with their sections and manage their own risks without the direct input from the rest of the team.

As the project progressed we were given new requirements to meet and as such the team felt that it was important to improve the software engineering methods used in order to best support our productivity. To continually develop and refine our processes, we used Capability Maturity Model Integration (CMMI) [1].

At present the team is considered to be working in maturity level 3. A validation of this is included below. We also outline why we think in some areas we still have room to improve, and those in which we think we have struggled. To do this we will list how the team has gone from maturity levels 1 through 3. We will also evaluate various different Key Process Areas [5], each is assigned a capability level (0-5) and once all of the goals and generic practices within a process area are achieved the process area is also achieved. Each process area has an associated maturity level [5]. For a project to progress a maturity level each key process area at that level must be met. Only relevant sections are included for brevity.

Level 1 : During early development in Assessment 1 research was conducted into various management strategies, to develop a structured and efficient working environment. This research was greatly influenced by the content of our lectures and interactions with our stakeholders. This provided the groundwork for moving towards level 2. At this stage, we knew little about the team's strengths and weaknesses beyond a Myers-Briggs personality test.
Level 2: Subsequent Assessments required an increased level of coordination and planning, to this end we began identifying defects and implementing appropriate mitigation strategies (Causal Analysis & Resolution process area). From this we began to establish schedules and risk management in addition to a general plan for the project (as seen in the Project Planning process area) and chose to follow a SCRUM based methodology. During this time, our risk management strategies proved to be inadequate with our qualitative risk scale being ill-defined. However, due to this it proved easy to implement Project Management and Monitoring, despite a lack of detail during early stages of development - due to a lack of experience -it has matured throughout the project and was well defined by the 3rd assessment.

Integrated project management led us to manage the project using sub-plans, with group planning sessions to discuss the broad ideas, with specifics left to the team. To make all of this viable, especially when every team member was writing code, GitHub with ZenHub were used. This allowed us to assign requirements as issues to individual team members. We also used Source Tree to give a visual representation of our repository to each member of the team, allowing for easy management of branches. It also lead us to define practices around interacting with the relevant stakeholders and to actively manage and cultivate the relationship through the use of a single contact.

The Project monitoring and control process area aims to monitor the progress of the project and apply corrective action when performance deviates. This is done through risk management monitoring incremental progress, and commitments of the individuals within the team. Risk management was initially carried out by the entire team. This evolved to each individual team member reporting their concerns to Mik, who maintained a weekly ranking of top risks. Much of the method decision and design process was inspired by Laurie Williams' 'Risk Management' [6]. Our risk categories and evaluation strategy required refinement. We evolved from a qualitative evaluation of risks to a quantitative one which allowed the mitigation strategy to be more autonomous and methodical in both it's planning and execution.
Level 3: The use of GitHub and ZenHub also allowed us to track versions and changes, part of the Configuration Management process area. By adopting aspects of XP the development of code could be conducted in lead-developer pairs, while supporting more inexperienced members of the team by improving their skills and fulfilling the Organizational Training (OT) process area. Open Plan Programming (OPP) was adopted for the third assessment when all team members were involved in the code development for the game. This allowed for the more experienced members of the team to work on solving more complex problems while supporting more inexperienced members. This meant that all members of the team were aware of any development issues. To establish performance baselines and models, in line with Organizational Process Performance (OPP), the team used the marking criteria provided to continually assess our performance.

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